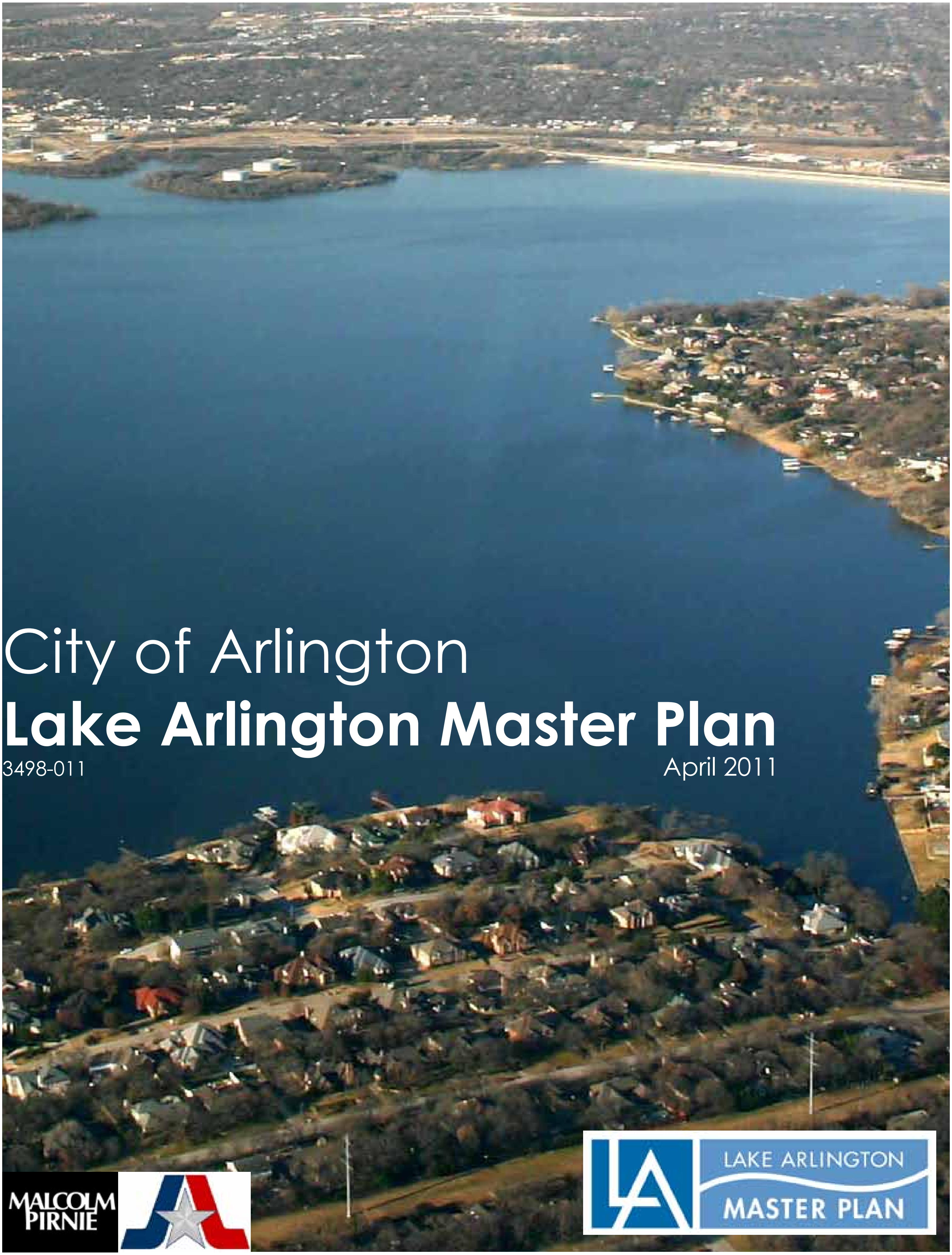

City of Arlington

Lake Arlington Master Plan

3498-011

April 2011

MALCOLM PIRNIE

LAKE ARLINGTON MASTER PLAN

Lake Arlington Master Plan
City of Arlington

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City of Arlington
As the sponsors of this Master Plan, the City of Arlington, Councilmembers and staff actively participated in the development of the Master Plan by participating in Roundtable Discussion Meetings, attending Public Meetings and speaking with stakeholders, and providing input and assistance for the study team throughout the planning process. The City of Arlington served as a vital informational tool throughout this process, and their support and participation are greatly appreciated.

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Lake Arlington Library
Arlington Urban Design Center

City of Fort Worth
The City of Fort Worth has been an active partner in the creation of the Lake Arlington Master Plan. City Councilmember Frank Moss, whose district includes the lake front property on the west (Fort Worth) side of the lake, served as a strong advocate for the Lake Arlington Vision and the collaboration with Fort Worth staff. We would like to specifically recognize the following:

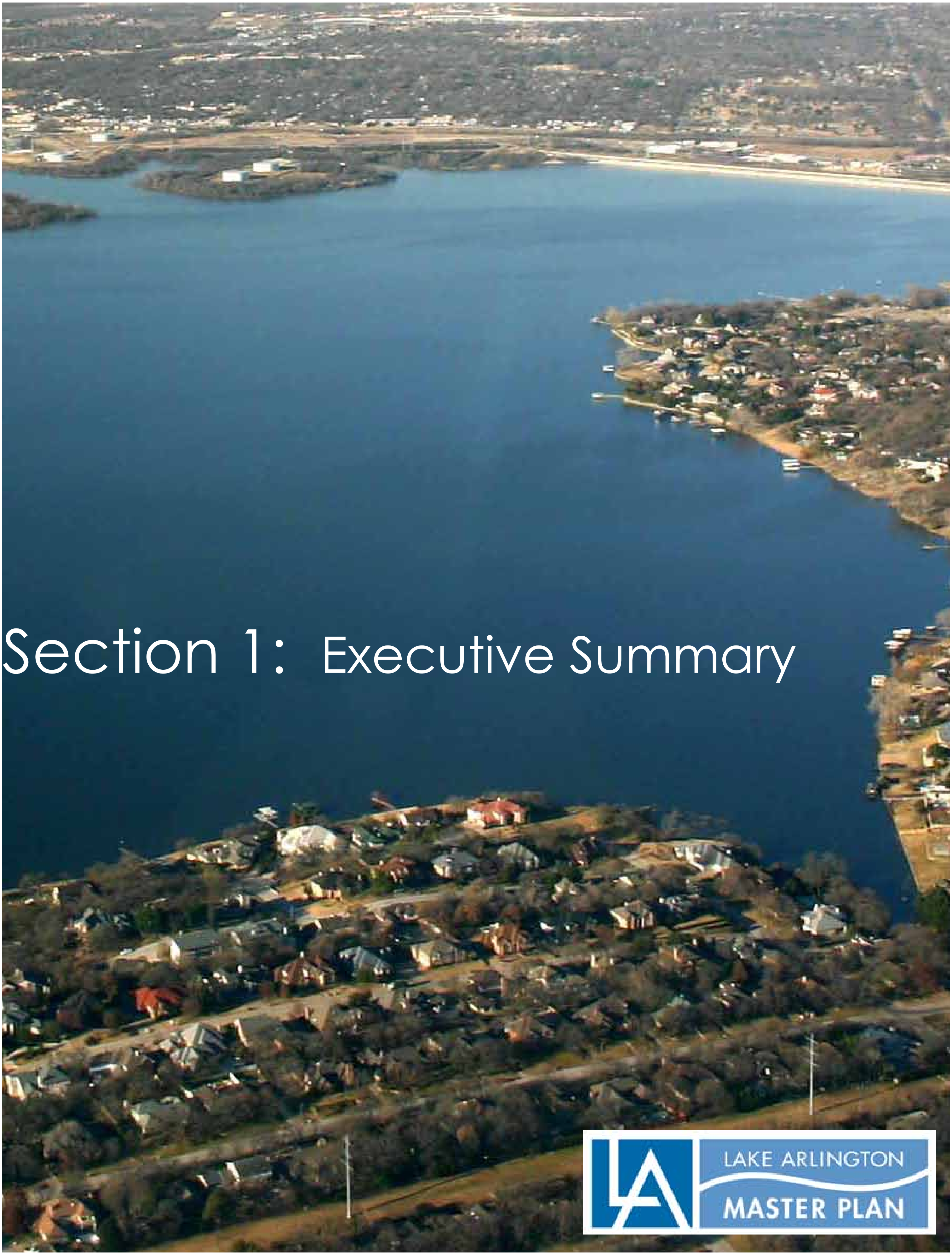
City of Fort Worth Staff and Consultants
Councilmember Frank Moss
Dana Burghdoff
Eric Fladager
Patrina Newton
Paul Bounds
Don McChesney, PE
Cornell Gordon
Al Godwin
Halff & Associates

North Central Texas Council of Governments (NCTCOG)
The Malcolm Pirnie team worked with the NCTCOG staff and shared information as it was gathered through the Master Plan process, including data for watershed modeling. The NCTCOG also co-hosted two regional meetings with the thirteen cities and two counties within the Village Creek watershed. Their coordination involved two regional meetings with the cities and counties within the watershed.

John Promise, PE
Jack Tidwell
Erin Blackman

Table of Contents

Section 1: Executive Summary



1. Executive Summary

In December 2009, the City of Arlington engaged the environmental engineering and science consulting firm of Malcolm Pirnie to assist the City in developing a master plan for Lake Arlington (the "Project"). Over a period of fifteen months, the study team used a holistic and collaborative process with a very significant amount of agency and public involvement to develop the Lake Arlington Master Plan.

Lake Arlington serves as the source of drinking water for over 500,000 people in Arlington and surrounding communities. Although the Tarrent Regional Water District supplies the majority of the Lake's supply, a significant portion of the drinking water initially comes from springs, stormwater runoff and tributaries within the Village Creek watershed, and drains into Lake Arlington. Figure 1.0-1 is a map of the Village Creek watershed and Lake Arlington. The watershed is approximately 143-square miles in size, however the impacts of activity immediately around the reservoir were also considered in the planning process. While the east side of the reservoir is located within the city limits of Arlington, the west side is predominantly within the City of Fort Worth. In the process of evaluating opportunities for recreational enhancements and land development, and in the development of standards for shoreline activities, the overriding consideration was the effect of those activities on the quality of Lake Arlington's water.

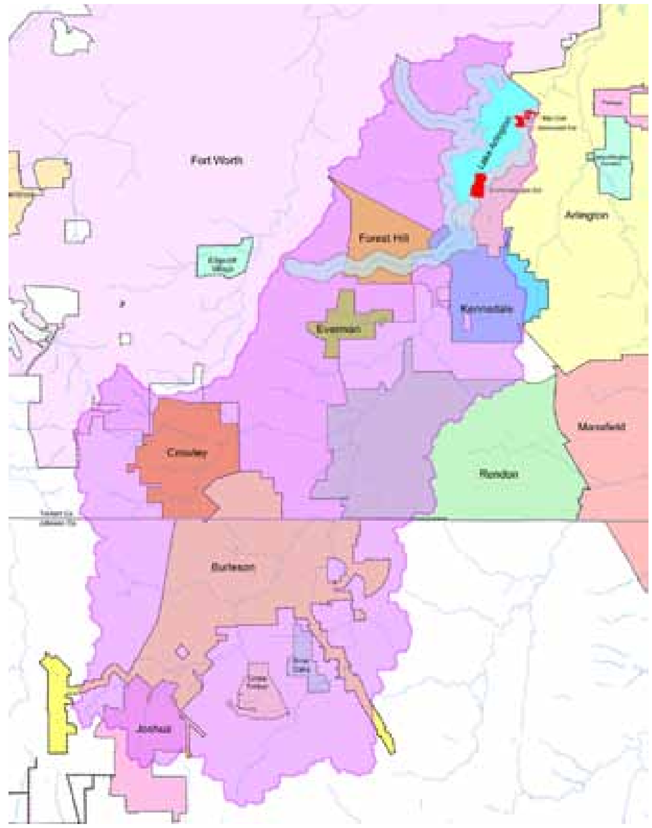


Figure 1.0-1: Village Creek Watershed

Although private property owners own the land surrounding Lake Arlington, the City of Arlington retains a peripheral easement for the temporary storage of flood waters (the "Flowage Easement"). The Flowage Easement of Lake Arlington is the area surrounding the lake between the elevation 560.0 feet above msl contour line and the lake (normally elevation 550.0 feet msl). A theoretical cross section of the Flowage Easement is shown below in Figure 1.0-2. Because of the importance of the Flowage Easement to the operation of Lake Arlington, the City of Arlington exercises considerable control over the activities within that area, both within Arlington and on the west side of the lake in the City of Fort Worth.

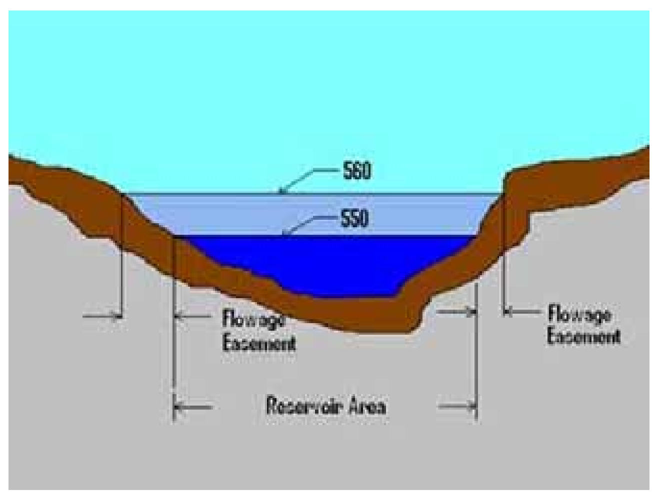


Figure 1.0-2: The Flowage Easement is generally defined as land adjacent to Lake Arl;ington that lies between elevations 550' and 560'.

There are eleven incorporated communities and two counties represented within the Lake Arlington watershed. In order to protect the quality of the water in the lake, it is important to manage the stormwater runoff originating from these various jurisdictions.

1.1 Purposes of the Project

The City's major overall goals of this Project were to:

- Protect the water quality of Lake Arlington
- Serve as both a short-term and a long-term planning tool
- Optimize the recreational use of the Lake and manage the related ecosystems
- Identify the impacts of future development

1.2 Vision Statement

The vision for Lake Arlington is to provide a safe drinking water supply and to protect the Lake and its surroundings by identifying and promoting sustainable uses and watershed management practices that enhance the beauty and the value of Lake Arlington to the community.

Key elements of a sustainable Vision include:

- Protecting lake water quality
- Promoting compatible quality development that strengthens neighborhoods
- Promoting walking, biking, hiking and paddling trails adjacent to the lake
- Enhancing compatible wildlife preservation and fisheries
- Developing watershed best management practices
- Maintaining safety and quality of lake activities
- Promoting natural open space, buffers and parks

1.3 Outcomes of the Planning Process

1.3.1 ***Fort Worth Coordination – included monthly meetings, support for permitting and code enforcement, sharing data, public meetings, Lakeshore Drive Project and use of aesthetics/Best Management Practices (BMPs) on that project. During the public meetings, most of the input received from both sides of the lake was consistent, and there were no major conflicting comments or recommendations.***

Lake Arlington is owned by the City of Arlington, but it is situated between the City of Arlington and the City of Fort Worth, making collaboration a necessity during the development of the Master Plan. Staff from both municipalities worked together during the planning process by sharing data, ideas and participating in monthly coordination meetings.

Arlington staff worked with Fort Worth staff to incorporate previous Fort Worth planning efforts into the development of the Vision Plan for the west side of the lake. An important part of Fort Worth's vision has been to spur economic development in the area by improving the street grid to create greater access to vacant parcels of land.

Lakeshore Drive is envisioned as a new roadway alignment that will provide improved north-south access on the Fort Worth side of Lake Arlington. Because a portion of the roadway would be within the Lake Arlington flowage easement, the City of Arlington provided a set of water quality protection and construction Best Management Practices to Fort Worth.

While future construction of Lakeshore Drive depends on the availability of funds, the Master Plan includes and details Fort Worth's approach to a two-lane road way that has bike lanes and pedestrian access.

In addition to Arlington's collaboration with staff from Fort Worth, citizens in Fort Worth were given an opportunity to provide input into the Lake Arlington Master plan through a series of public meetings. "It was very gratifying to see that residents on both sides of the lake shared similar views about how future development should occur," says Erich Dohrer, lead planner on the Master Plan project.

"Overall, we are very pleased," says Julia Hunt, P.E., Director of Arlington Water Utilities, "because we have worked really hard and well together to develop a Master Plan that addresses the needs of both communities while protecting the water quality of Lake Arlington."

1.3.2 ***Linear Parks and Open Spaces Systems/Arlington, Kennedale, and Fort Worth–to protect water quality, natural land uses are envisioned around Lake Arlington, including new trails proposed to connect to the surrounding city systems, including upstream and downstream of Lake Arlington along Village Creek.***

Part of the vision for Lake Arlington spells out a parks, trails and open spaces system around the lake that can be used by walkers, joggers and bicyclers. Although the neighboring community of Kennedale began work on the concept of a comprehensive trail system before the Lake Arlington Master Plan process started, the two ideas quickly merged.

Because Village Creek and some of its tributaries within Kennedale flow into Lake Arlington, it is in Arlington's interest to see them protected and kept in a natural state in order to protect water quality. Kennedale is proactively planning for future growth, with emphasis on its town center, and the "old town" area that includes an historic rail stop along Hwy 287 Business.

The trails would follow along streams and waterways to connect the Kennedale community. The Kennedale trails would merge with a potential Lake Arlington trails system at the upstream end of the lake. This entire proposed connected trail system would allow a trail user to access many miles of trails, parks and open spaces around Lake Arlington, adjacent to Village Creek and along the Kennedale creeks.

Kennedale was invited by the City of Arlington to participate in coordination meetings to share its progress of the trails initiatives. Another opportunity that arose from these discussions is the potential to have Kennedale and Arlington jointly work with the US Army Corps of Engineers on a Village Creek eco-restoration project, which would be a long term effort to restore the creek and

Figure 1.3-1: Regional Trail Alignment Strategy

evaluate flood management options.

1.3.3 ***Collaboration with NCTCOG – included sharing data, hosting regional meetings, and "Greenprinting". These activities are an integral part of the implementation because of the NCTCOG's emphasis on planning and implementation on a watershed basis.***

The City of Arlington worked closely with the North Central Texas Council of Governments (NCTCOG) to develop several key aspects of the Master Plan related to watershed management. The NCTCOG has an emphasis on planning and implementation of watershed protection and management strategies for watersheds and lakes within North Central Texas.

The NCTCOG is a voluntary association of, by and for local governments, established to assist local governments in planning for common needs, cooperating for mutual benefit, and coordinating for sound regional development.

Lake Arlington is a partner of one of the 21 "Regional Watersheds" within the 12-county Metropolitan Planning Area served by the NCTCOG.

To support the City of Arlington's efforts to protect the watershed, the NCTCOG shared data that Malcolm Pirnie used for water quality modeling and helped to facilitate a series of meetings with representatives from the 13 cities and two counties within the Village Creek watershed. The NCTCOG also provided information on the "Greenprinting" process that is being conducted by the Trust for Public Land, a national nonprofit organization working to protect land as parks and open space. That program can be used as an implementation step for the Master Plan by providing recommendations on the most cost-effective locations for the purchase of conservation easements and other land management practices.

John Promise, P.E., Director of Environment and Development for the NCTCOG, provided data necessary to develop the watershed modeling and Best Management Practices (BMPs) described in the Master Plan. "We immediately recognized the value of this unique approach to watershed planning and are excited about the benefits all of the cities in the watershed will receive as a result.

We wanted to help the team developing the Lake Arlington Master Plan find out what other cities were doing to protect the watershed and discuss different approaches with them."

"This type of collaboration can become a model for watershed protection planning for other areas of the state and country," adds Promise.

1.3.4 ***Water Quality Modeling/Approach to Best Management Practices (BMPs) – describes how management measures raise the bar for watershed protection within the region; this is accomplished throug forward-thinking concepts that support watershed cities by providing BMPs and low impact development recommendations that can be incorporated into future stormwater permitting***.

It is no accident that the City of Arlington enjoys a “superior” water quality rating by the Texas Commission on Environmental Quality (TCEQ). In order to maintain that quality and safety of drinking water for more than half a million citizens in North Central Texas, there must be planning and guideline development. That is where Best Management Practices (BMPs) come into play. BMPs describe technical standards and procedures that governments, businesses and individuals may take to keep pollution out of receiving waters.

In the planning process, Malcolm Pirnie evaluated the present standards, policies and guidelines, and used computer models to determine the potential impacts of current and planned development on the lake. The team then developed a watershed management strategy that includes BMPs to share with all of the cities within the Lake Arlington watershed.

“The BMPs and management measures included in the Lake Arlington Master Plan are forward thinking and give us the best strategic approach to watershed protection,” says Ms. Hunt. “If we are able to successfully employ these practices, our modeling effort has shown that we will eliminate a significant percentage of the potential pollutants projected to reach Lake Arlington over the next 15 to 20 years, allowing us to protect our drinking water quality and avoid additional treatment costs. This helps us keep our costs as low as possible for the delivery of quality drinking water to our customers.”

Each of the eleven cities within the watershed will benefit from the use of BMPs outlined in the Master Plan because adoption and use of the source water protection practices should keep them in compliance with future state and federal watershed protection regulations.

These BMPs include ideas and guidelines such as:

- Ordinances for stormwater management in areas of development and significant redevelopment
- Illicit discharge detection and elimination ordinances and programs
- Trash mitigation programs
- Recommended practices for oil and gas well drilling and exploration near Lake Arlington and Village Creek
- Management practices for construction in and near Lake Arlington and Village Creek
- Public involvement, education and outreach
- Pollution prevention and good housekeeping for municipal operations

1.3.5 *Boating Capacity Study – provided an understanding of how the lake is being used for recreation, the characteristics of users and their opinions about how the lake should be managed.*

Although Lake Arlington was developed to serve as a source of drinking water for Arlington and other Texas communities, the lake is also a place for recreational activities including boating, fishing and skiing. In order to more clearly understand how recreational users viewed the lake and to get their opinion on future needs and how Lake Arlington is managed, a comprehensive boating capacity study was conducted as part of the Lake Arlington Master Plan.

“We really needed to get the user’s perspective on boating-related recreational use of the lake so that they can be planned for and managed,” says Hunt. “The boating capacity study helped us to characterize the existing uses and identify areas that may require management to address safety and water quality needs.”

Of 1,200 surveys sent out, over 450 lake users and adjacent property owners indicated that they were primarily interested in the amount of litter along the shoreline, shallow water issues, variability in the lake level, and fish habitat. The respondents indicated that crowding and conflicts were not major concerns. This information is useful because it helped the Planning Team to make better decisions and understand the impact of those decisions to property owners along the lakefront and other users.

1.3.6 ***Property Database – the Arlington Water Utilities Department initiated a data-collection project to provide updated information on the lake and to make it more efficient to implement the recommendations in the Master Plan.***

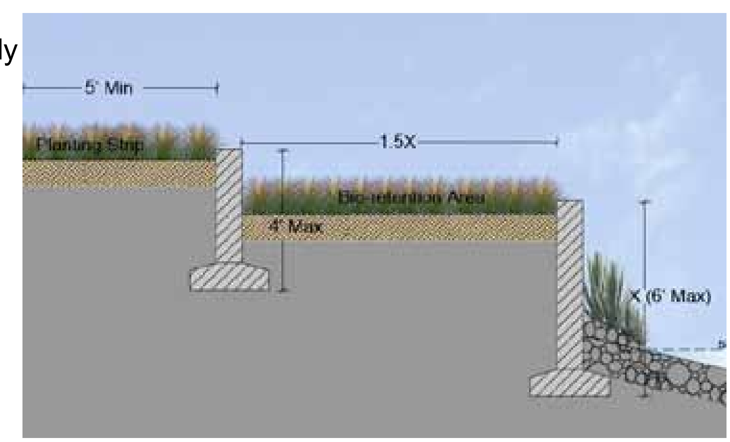
During the course of the Master Planning process, the Arlington Water Utilities Department gathered a significant amount of data about structures and development along the shoreline of the lake. Photographs of each structure and property were organized into a Geographic Information System (GIS) database. This database will serve as a valuable tool for future management of the lake.

1.3.7 ***Standards and Guidelines – provide a uniform set of policies for development around the shoreline of Lake Arlington and within the Flowage Easement.***

A new set of guidelines and standards for docks, piers, retaining walls and marinas are included in the Lake Arlington Master Plan. The purpose of the guidelines and standards are to protect the water quality of Lake Arlington, to protect private and public property values, and to maintain the storage capacity of Lake Arlington.

Once adopted by Arlington and Fort Worth City Councils, the new standards and guidelines are also envisioned as a way to protect the integrity of the lake's shoreline by only permitting sustainable structures and improvements that are well-designed and capable of being properly maintained. The standards also help to support habitat for fish and other wildlife. In addition, the proposed new standards provide incentives to property owners to protect water quality by maintaining or enhancing natural areas immediately around the lake, such as the shoreline.

Included in the standards are simple measures such as adding an address plate and reflectors to all boat docks, to more detailed guidelines for the construction methods and materials to be used in building retaining walls, docks and piers.



1.3.8 ***Public Involvement--public meetings and roundtables produced valuable information beyond just the input needed for the Master Planning process—for both the cities of Arlington and Fort Worth—value added.***

Creating a document that articulates the vision for Lake Arlington included technical and scientific “number crunching” as well as input from stakeholders who had an interest in decision making for the protection and management of Lake Arlington.

The City of Arlington proactively engaged citizens on both sides of Lake Arlington in the Master Plan on issues such as:

- BMPs for water quality protection
- Standards for docks, piers, retaining walls, and marinas
- Ideas for new trails and open spaces
- Recreational uses on the lake
- Future development opportunities
- Enhancements to existing parks

There were five public meetings, in addition to regular agency coordination meetings, and a series of small roundtable discussions all geared at sharing data and listening to stakeholders.

“Our public input process was designed to accommodate as much one-on-one conversation and direct interaction with citizens as possible. We believe it is a better way to learn from each other,” says Valery Jean-Bart, P.E., Civil Engineer in the Water Utilities Department and Lake Arlington Master Plan project manager. Public meetings were held in both Arlington and Fort Worth.

Jean-Bart added that “we were pleased to learn that citizens on both sides of the lake shared similar concerns and wanted to see development occur in a similar fashion. Our team certainly learned a lot and really appreciated the comments we received from stakeholders who participated in the public input process either at one of our meetings or on-line.”

In addition, information about the Master Plan was posted on the project website (www.arlingtontx.gov/water/lakearlingtonmasterplan.html) and a display was mounted at the Lake Arlington Public Library.

1.4 Summary of Recommendations

Section 9 of the Final Report describes in detail all of the Master Plan recommendations. In summary, the Master Plan has recommended the following prioritized principles with regard to implementation:

1.4.1 Organizational Structures and On-going Processes

An organizational structure (shown below in Figure 1.5-1) and on-going processes/programs are needed to assure the protection and enhancement of Lake Arlington's water quality. Ongoing public involvement and communication are integral to the successful implementation of the Master Plan.

1.4.2 Area of Primary Influence

The Area of Primary Influence (API) is located immediately around and within 1,000 feet of Lake Arlington. Within the API, the Master Plan recommends the implementation of specific projects, processes and programs that protect and enhance the quality of the lake.

1.4.3 Watershed

Within the remainder of the Lake Arlington watershed, work collaboratively with other cities, the counties, and other entities, including the NCTCOG, to implement projects, processes and programs that protect and enhance the quality of stormwater runoff into the lake.

1.4.4 Funding

Continue to pursue funding from a variety of sources in order to expeditiously implement projects, processes, and programs that protect and enhance the quality of Lake Arlington. To be successful, it is recommended that the City tailor its funding efforts to specific agencies and sources, while continually looking for new program.

1.5 Implementation—What is next?

Both Arlington and Fort Worth City Councils will be provided with the opportunity to adopt the Master Plan as part of each city's Comprehensive Plan. In addition, many players will have a role in continuing to carry out the vision. Malcolm Pirnie developed a recommended organizational structure to guide the implementation processes.

The Arlington Water Utilities Department is interested in implementing parts of the Master Plan that focus on protecting water quality. Many other municipal departments will also be involved in carrying out the Vision and associated plans, policies, procedures and ordinances. The City of Fort Worth will be directly involved in implementing parts of the Master Plan related to development on the west side of the lake. In addition, the eleven cities and two counties within the Lake Arlington watershed will have an opportunity to address how they can reduce potential sources of pollution and manage storm water.

Private developers can now put together a more specific plan and funding programs to develop vacant land or new projects as part of the overall vision. These projects would follow the normal review and permitting processes of both Arlington and Fort Worth.

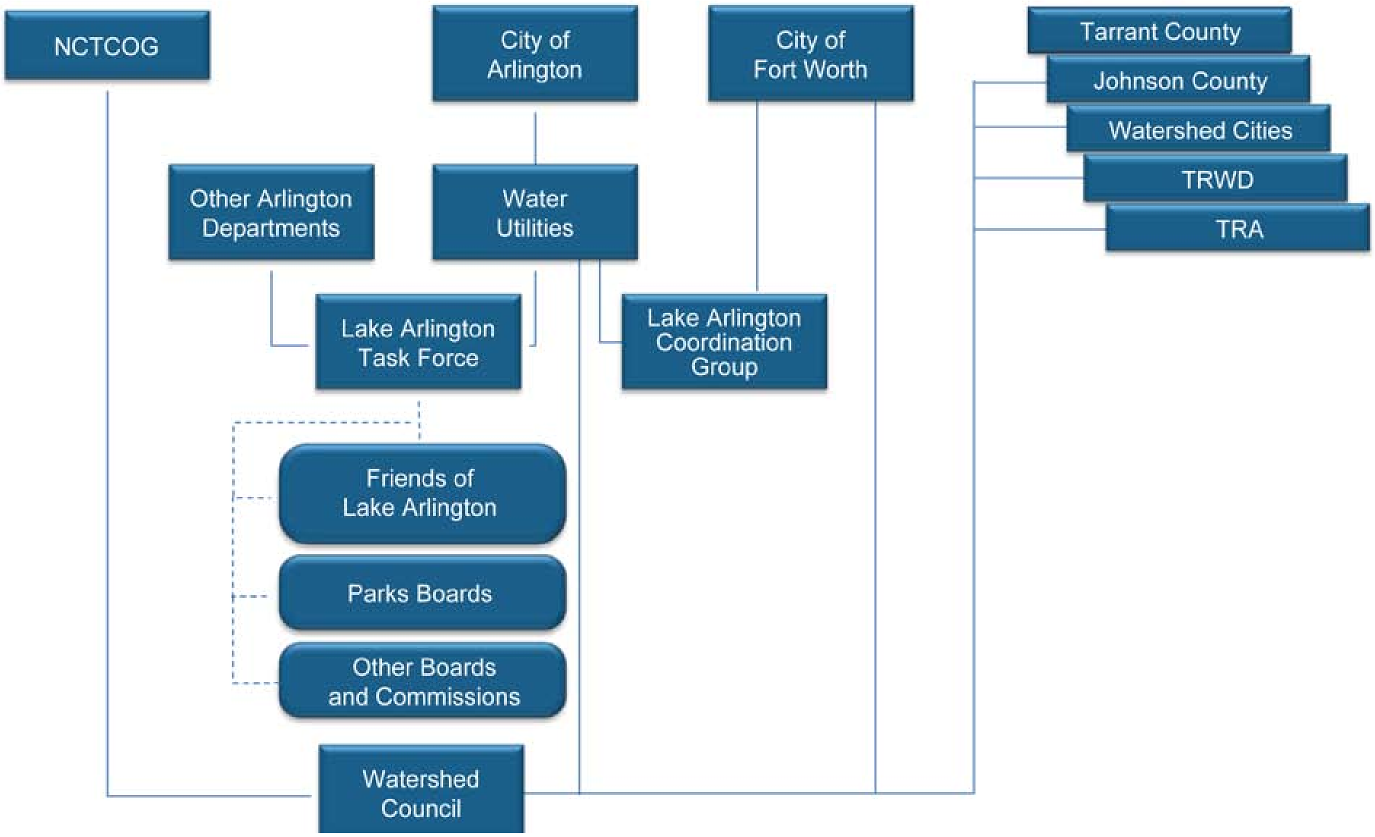
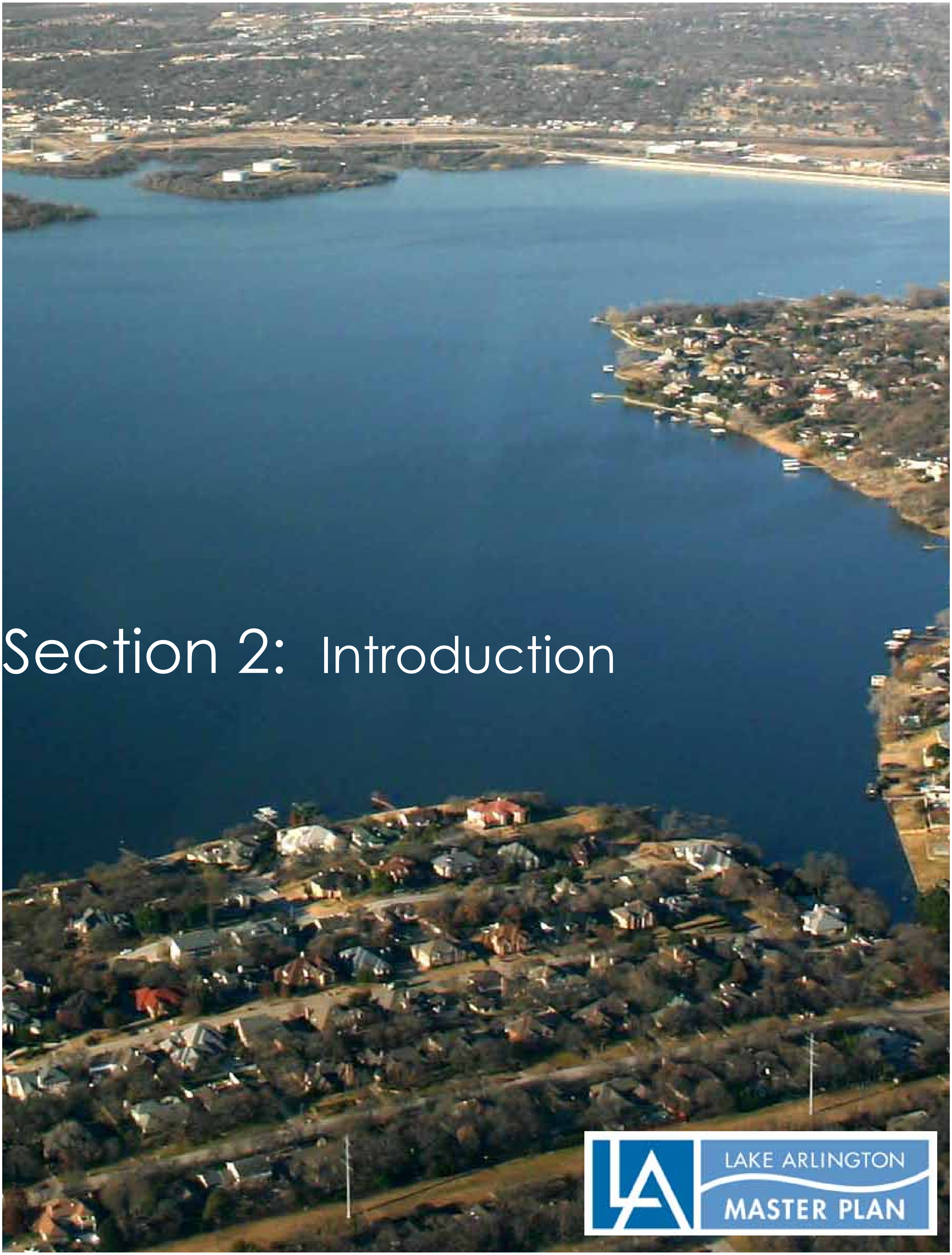


Figure 1.5-1: Organizational Structure

Section 2: Introduction



2. Introduction

2.1 Introduction

The City of Arlington (the "City" or "Arlington") has actively managed Lake Arlington since the reservoir was constructed in the late 1950's. Arlington has a significant interest in protecting the water quality in the reservoir because the Lake serves as a water supply source for the City and other communities. The Lake also serves as a cooling pond for an electric generating station. Because the Lake also provides significant recreation opportunities for the area, the City is very concerned about maximizing the aesthetic aspects of the reservoir. The City's Water Utilities Department recognized the need for a planning tool to guide the future management of the Lake, and on December 16, 2009 the City engaged Malcolm Pirnie, Inc. to prepare a Master Plan for Lake Arlington (the "Project"). The Project schedule called for the Master Plan to be finished by the Spring of 2011.

A master plan is a comprehensive long range (10-20 years) plan intended to guide growth and development. It includes analysis, recommendations, and proposals. It is normally based on public input, surveys, and an analysis of planning initiatives, existing conditions and development, physical characteristics, and social and economic conditions. Although conceptual site plans, schematics and renderings are usually shown, master plans are not intended to address issues related to detailed implementation, engineering, detailed design or operations. Cost estimates are normally given in ranges and are conceptual in nature.

Conceptually, the benefits for having a master plan usually include:

1. Consistency in decision making - the plan gives decision makers a steady point of reference for future actions.

2. Ability to make informed decisions - the plan provides facts on existing conditions and trends, and recommendations for future activities, enabling decision makers to better understand the impact of their decisions versus relying on a "gut instinct."

3. Achieving predictability - the plan describes where and what type of development the community desires. This information allows individuals to plan for the purchase, development and use of property consistent with community goals.

4. Wise use of resources - the plan includes information from numerous sources. This information can be used in deciding and prioritizing which projects to undertake. It also can be used to direct the location of future projects and improvements.

5. Preserving community character - the plan describes a community's vision for the future and establishes its existing and intended growth. It permits the community to identify what is important and how it should be protected.

6. Producing positive economic development - planning helps residents and businesses owners better predict the future development of the study area. This prediction creates a comfort zone of knowing what to expect on neighboring properties.

The following diagram illustrates a typical master planning process, and it closely represents the process used for the Lake Arlington Master Plan.

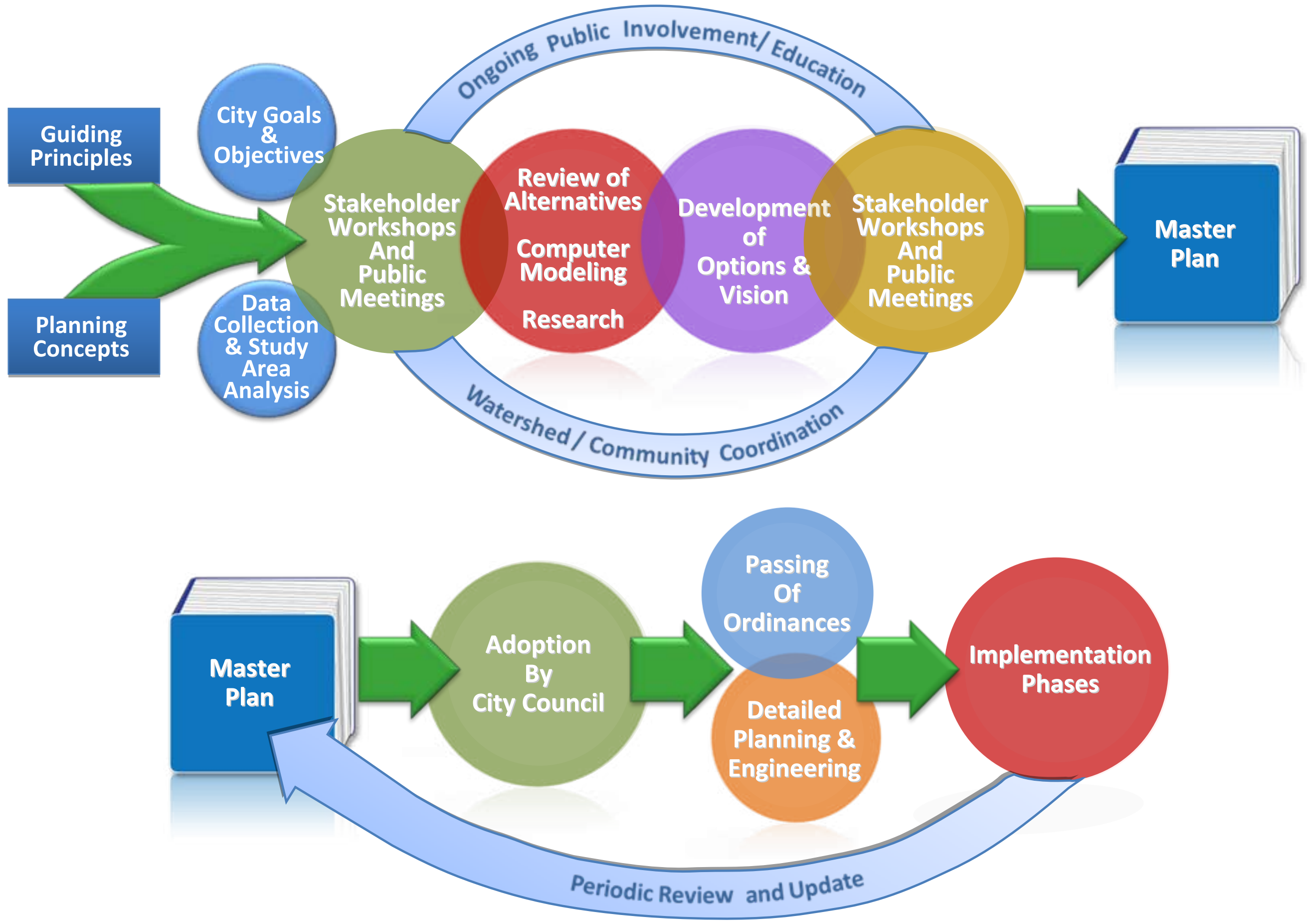


Figure 2.1-1: Master Planning Process for Lake Arlington

In preparing for Lake Arlington planning process, the City identified a number of major issues that needed to be addressed in the Master Plan. Those issues included:

- Drinking water quality
- Drilling of natural gas wells in proximity to the lake
- Trash and debris entering the lake
- Boating and recreational capacity
- Fishing and wildlife
- Standards for the construction and maintenance of shoreline features such as docks, piers and retaining walls
- Dredging

This master planning process included some very technical aspects such as: water quality computer modeling; the development of Best Management Practices (BMPs) for water quality protection; the preparation of standards and guidelines for activities around the Lake; planning for recreational activities and open space; and the determination of the Lake's capacity for boating. The process also included a very significant public education and outreach component. The significant public involvement aspect included: the development of a website for the Project; monthly coordination meetings with the City of Fort Worth ("Fort Worth") and other communities; a series of focus group workshops and public meetings; and two meetings with the NCTCOG and the cities in the Village Creek watershed.

This Master Plan Final Report is the result of that planning process. It serves as the planning tool and guidance manual for the future management of Lake Arlington.

2.2 Arlington's Goals and Objectives

As owner and manager of Lake Arlington, the City's overall objective is to protect its drinking water supply by protecting the quality of the source water. Although all surface water requires treatment before use, protecting the source water is an important part of providing safe drinking water to the public. The City has two surface water treatment plants, but only the Pierce-Burch Water Treatment Plant uses raw water from Lake Arlington. In addition, the Trinity River Authority (TRA) diverts raw water from Lake Arlington for its water treatment plant.

The underlying principle of source water protection is that it costs much less to protect a potable water supply than to restore water quality if it becomes compromised. According to the American Water Works Association, cleanup costs range from 30 to 200 times the cost of preventing contamination.

From the City's perspective, the major overall goals of this Project were to:

- Protect the water quality of Lake Arlington
- Serve as both a short-term and a long-term planning tool
- Optimize the recreational use of the Lake and manage the related ecosystems
- Identify opportunities for development and enhancement
- Identify the impacts of future development

Because all of the goals revolved around the primary goal of water quality protection, the remainder of this introductory section focuses on the goal of water quality protection and watershed management, and how this goal impacted the development of the Master Plan.

2.3 The Need for Watershed Management

The need for stormwater and watershed management within the area that drains into Lake Arlington is driven by several common themes:

- Stormwater runoff and potential impacts are directly linked to land use change within the watershed.
- Control of stormwater runoff quantity and quality is necessary to minimize property damage, stream degradation, and water quality impacts.
- A long-term goal of mimicking natural hydrologic conditions will help address potential impacts from stormwater runoff.
- Multiple regulatory requirements and regional programs have evolved to address the increasing importance of stormwater management and water quality protection and improvement.
- Integration of the existing programs and requirements and working collaboratively with other communities in the watershed will reduce duplication of effort and associated costs. Such integration and collaboration will also improve implementation of a comprehensive program for watershed management.

Existing regulatory requirements serve as the framework for watershed management and protection. Federal and State regulations serve to protect and improve water quality by establishing and enforcing standards and by regulating discharge of pollutants into waters of the United States. In addition, the North Central Texas Council of Governments (NCTCOG) has begun a stormwater management program that provides valuable data and recommended processes.

The recommendations found in the Lake Arlington Master Plan serve to fill in areas of watershed protection that are not covered by Federal or State regulations, current programs developed by the NCTCOG, and the activities of cities in the watershed. The recommended policies and programs will serve to define the concepts of a watershed protection plan that can be implemented to protect the quality of Lake Arlington. The Master Plan will also serve to establish watershed protection standards, BMPs and approved activities within the Lake Arlington watershed and immediately around the reservoir.

2.4 Influence of Land Use Change

In general, as land use changes from rural to urban purposes, the effect on water quality within a watershed also changes. While population growth can be beneficial for economic reasons, the pace and type of growth present challenges for reservoir owners. An increasing population requires more water from available surface waters while increasing the amount of wastewater and stormwater pollutants (point and non-point source) that flow into streams, rivers and lakes. Additionally, when land is developed, the hydrology, or the natural cycle of water, is altered. Clearing removes the vegetation that intercepts, slows and returns rainfall to the air through evaporation and transpiration. Grading flattens hilly terrain and fills in natural depressions that would otherwise slow and provide temporary storage for rainfall. The topsoil and sponge-like layers of humus are scraped and removed and the remaining subsoil is compacted. Rainfall that once seeped into the ground now runs off the surface. The addition of buildings, roadways, parking lots, and other surfaces that are impervious to rainfall further reduces infiltration and increases runoff.

Much of the water that is stored in Lake Arlington originates from the land area that drains downstream into the Lake. A significant portion of the drinking water that the citizens of Arlington receive from the Water Utilities Department ultimately comes from springs, stormwater runoff and tributaries within the Village Creek watershed that drains into Lake Arlington. Figure 2.4-1 is a map of the Village Creek watershed and Lake Arlington. The watershed is approximately 143-square miles in size, however the impacts of activity immediately around the reservoir must also be considered. While the east side of the reservoir is located within the city limits of Arlington, the west side is predominantly within the City of Fort Worth. In the process of evaluating opportunities for recreational enhancements and land development, and in the development of standards for shoreline activities, the overriding consideration was the effect of those activities on the quality of Lake Arlington's water.

The sections below describe why protecting drinking water sources requires the combined efforts of many partners. For Lake Arlington, these partners include Tarrant and Johnson Counties, Fort Worth and the other municipalities within the watershed, land developers, construction contractors, agricultural operators, and private landowners. There are thirteen municipalities within the Village Creek watershed. Because two of the municipalities (Pantego and Dalworthington Gardens) are located downstream of the Lake, there are eleven municipalities in the segment of the watershed that drains into Lake Arlington.

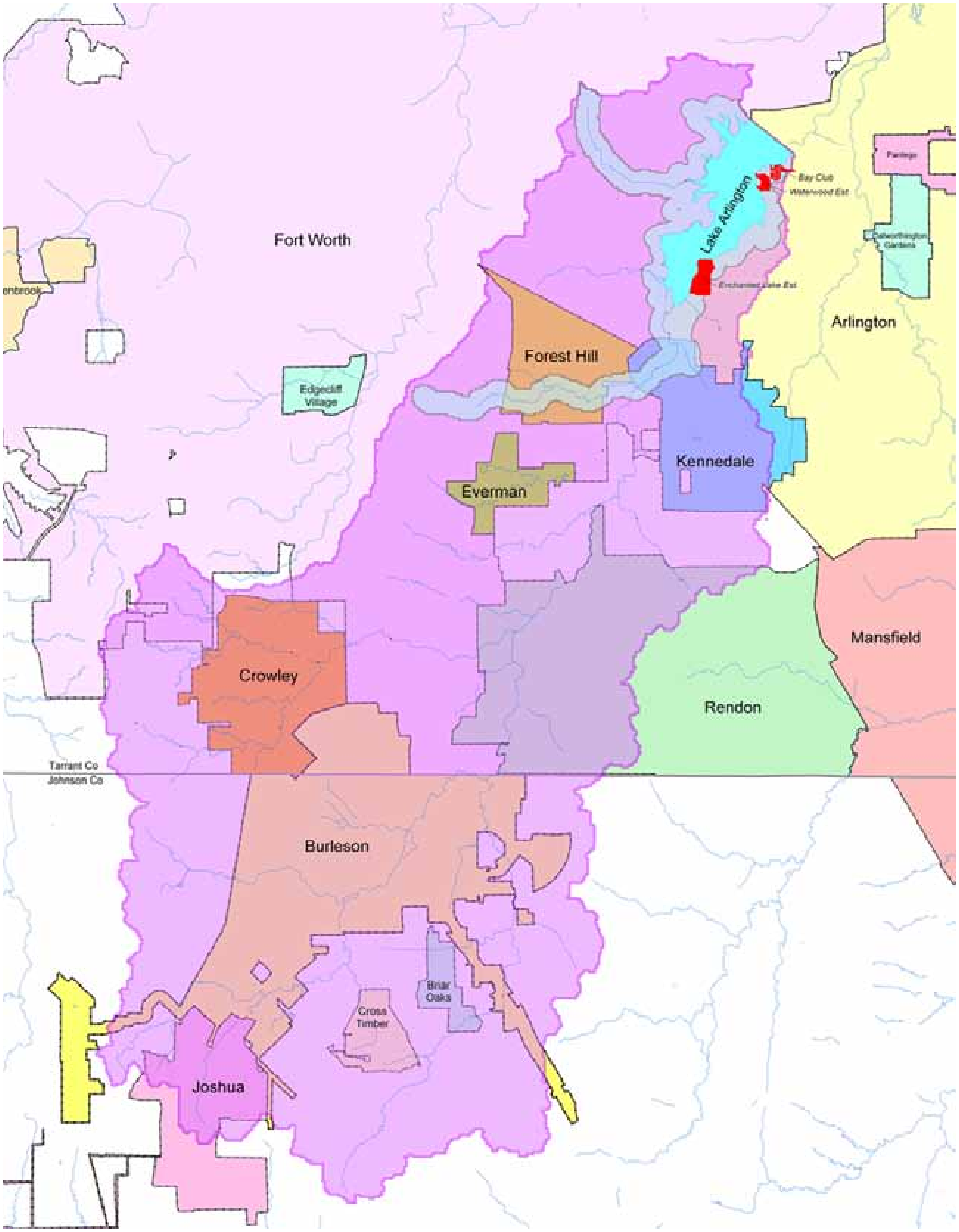


Figure 2.4-1: Village Creek Watershed

2.4.1 Where Rainfall Goes Before and After Development

Figure 2.4.1 illustrates how the water balance changes when natural cover is replaced by residential and urban development. The example percentages in the drawing highlight the magnitude of the additional volume of water that must be handled by a drainage system after land is cleared. The actual percentages vary from region to region, but the relationships are universal.

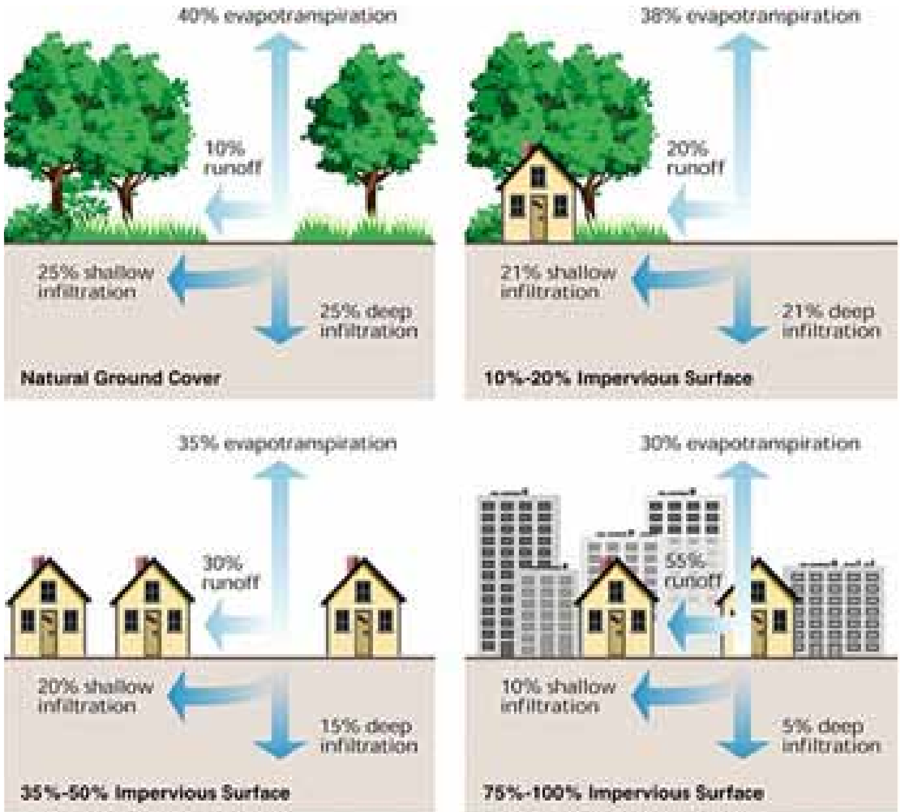


Figure 2.4-2: Where Rainfall Goes Before and After Development

On an annual basis, surface runoff from a naturally vegetated watershed is normally expected to be minimal as a proportion of total water volume. Before development, the flow observed in streams (base flow) results from interflow, or water passing through the unsaturated soil zone. After development, flow in streams typically originates as surface runoff. As interflow is replaced by runoff as the most significant component of flow, base flow is reduced (SMRC, 2002).

As a watershed is developed, surface runoff volume increases in proportion to the percentage of impervious surface area, defined as non-infiltrating surfaces (e.g., concrete, asphalt, rooftops, compacted soils, and exposed rock). Once a stormwater collection pipe system is installed to drain these impervious areas, the rainfall results in runoff.

The cumulative effects of these changes in land use include significant shifts in storm water quantity and quality. These changes in stormwater runoff characteristics and the resulting effects are observed across the nation. The primary impacts include:

- Changes in stream flow – increased runoff volumes, increased peak discharges, greater runoff velocities, increased flooding, and lower dry weather stream flows.

- Changes in stream geometry – stream widening and down-cutting, loss of riparian tree cover, sedimentation in the channel, and increased flood elevations.
- Degradation of aquatic habitat – degradation of habitat structure, loss of pool-riffle structure, reduced stream base flows, increased temperatures, and reduced abundance and diversity of aquatic life.
- Water quality impacts – reduced dissolved oxygen (DO) and increases in nutrient enrichment, microbial contamination, hydrocarbons (oils and grease), toxic materials (pesticides, metal, organic contaminants), sedimentation, temperature, and trash/debris.

2.4.2 Relationship between Hydrology and Watershed Health

There is a logical link between changes in watershed land use and the cumulative impacts of stormwater runoff on watershed health, whether those impacts are in the form of flooding, streambank erosion, aquatic habitat degradation, or declining water quality. The link is the change in the volume and timing of surface runoff that is created as the result of alteration of the natural landscape. Figure 2.4.2 illustrates a developed watershed that is more prone to flooding due to a greater rate and volume of runoff compared to an undeveloped watershed (Schueler, 1995)

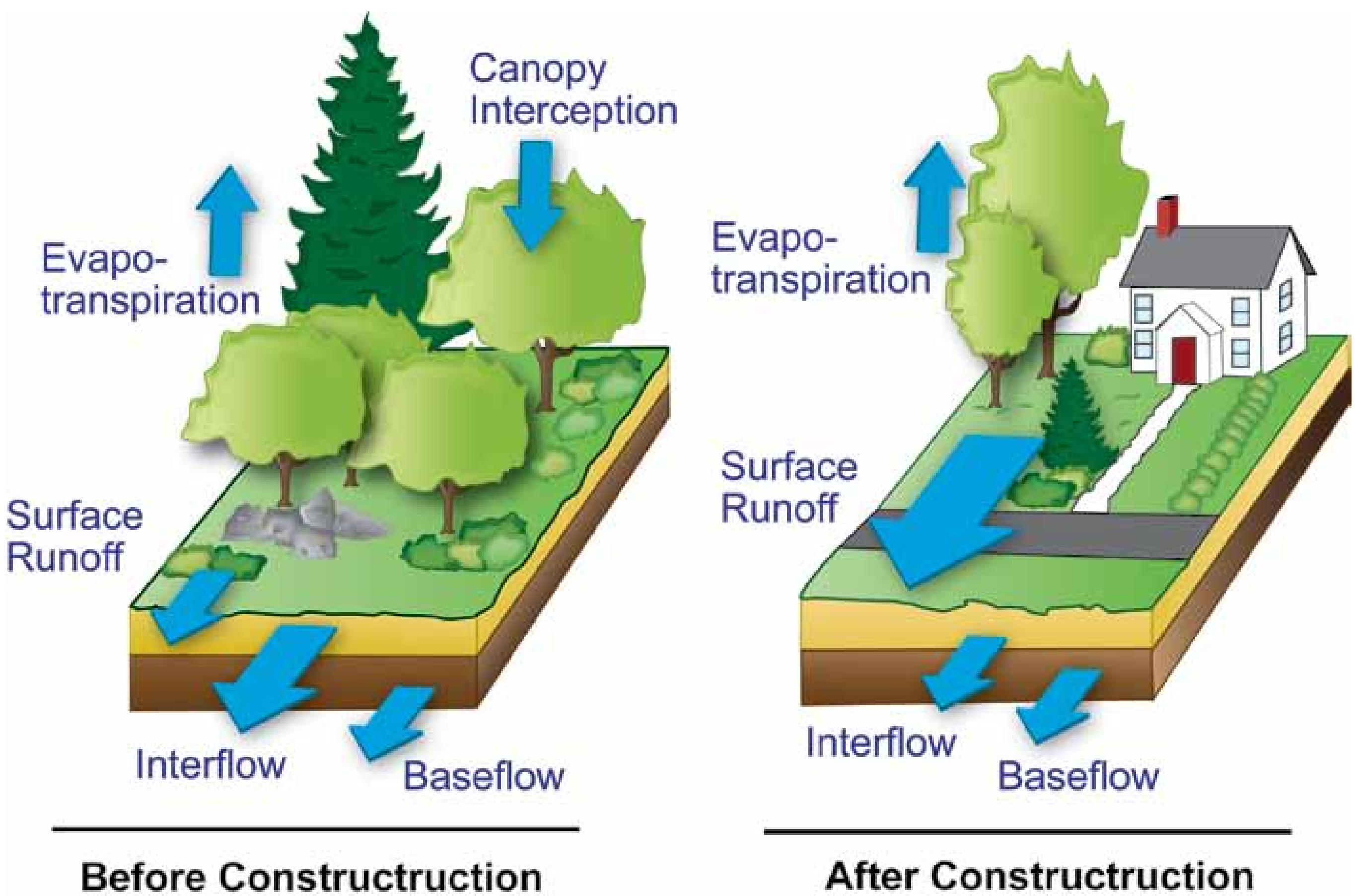


Figure 2.4-3: Effects of Development on the Floodplain

Impacts of uncontrolled stormwater runoff can also have socio-economic impacts on communities, including:

- Impairment of Drinking Water Supplies
- Increased Cost of Water Supply Treatment
- Loss of Recreational Opportunities
- Loss of Fisheries
- Increased Litigation
- Reduction in Quality of Life
- Flooding

2.4.3 What is Impervious Surface?

As noted previously, "impervious surface" refers to land cover, both natural and man-made, that does not allow rainfall to soak or infiltrate into the soil. Consequently, precipitation that falls on impervious surfaces either runs off to a pervious area where all or a portion of the runoff infiltrates into the soil, or it continues to flow until conveyed to a ditch, a storm drain network, or a receiving waterbody such as Lake Arlingon. Impervious cover in a watershed can be organized into two main categories:

- Rooftops – Impervious cover created by buildings, homes, garages, stores, warehouses, and other structures with roofs.
- Roadways and Parking – Impervious cover created by structures such as roads, highways, driveways, and parking lots.

Generally, the roadways and parking component occupies a larger percentage of land than the rooftops component.

2.5 Watershed Protection Planning

2.5.1 Addressing Stormwater Runoff and Maintaining Watershed Health

Stormwater management involves both the prevention and mitigation of stormwater runoff impacts through a variety of methods and mechanisms. A key to protecting watershed health is to maintain as close to the natural hydrologic and water quality conditions and water balance as is achievable and practicable. This can be achieved through one or more of the following:

- Developing land in a way that minimizes its impact on a watershed and reduces both the amount of runoff and pollutants generated.
- Using the most current and effective erosion and sedimentation best management practices (BMPs) during the construction phase of development.
- Using BMPs to control stormwater runoff peaks, volumes, and velocities to prevent both downstream flooding and streambank/channel erosion.
- Treating post-development stormwater runoff before it is discharged to a waterway.
- Implementing pollution prevention practices to prevent stormwater from becoming contaminated in the first place.
- Using various techniques to encourage groundwater recharge.

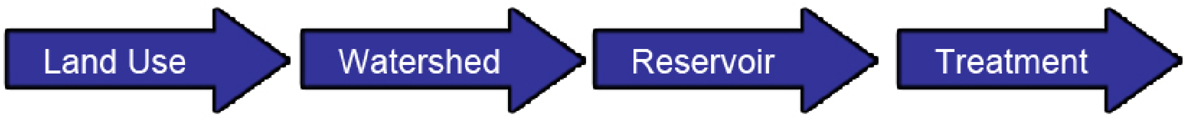
There are a variety of structural, nonstructural, and site design measures which can be used on an individual site for achieving the goal of water quality improvement. In addition, it is important to assess the larger scale of the entire watershed through considerations of land use and planning.

2.5.2 Watershed Protection Planning

One of the major objectives of this master planning process was the development of BMPs and recommended policies to protect the quality of Lake Arlington's water supply. A step-wise approach with significant stakeholder involvement was used to develop the recommended protection measures and BMPs for Lake Arlington. This approach was designed to facilitate an open process that focused on the City's specific goals for water resource protection and maximized the use of existing information.
The primary steps in this process included:

Development of goals – Goals for the development of the watershed protection task in the Lake Arlington Master Plan were developed in coordination with the City. Those goals are as follows:

- Develop an integrated modeling approach that links changes in land use with potential operational and economic impacts to the treatment facilities.



- Analyze various future development and land use condition scenarios.
- Develop quantitative and qualitative methodologies for assessing the impacts of each future land use scenario on the source water and ultimately the treatment facilities.
- Develop recommended policies that support long-term protection of the Lake Arlington source water.

Characterization of existing watershed conditions – Available data and studies were used to evaluate existing conditions in the Lake Arlington watershed with the use of the PLOAD Model. Similar data were used to evaluate the conditions of the Lake itself using the BATHTUB Model.

Development of pollutant loading and water quality models to estimate existing and future pollutant loads – The pollutant loading model of the entire watershed and the reservoir model were developed to assist in estimating the existing and future pollutant loads and water quality with and without source water protection policies.

Evaluation of the impact of development on the existing water treatment facilities - An assessment of the impacts on the source of water for the Pierce-Burch Water Treatment Plant was made.

Development of the recommended Lake Arlington BMPs and policies - The watershed protection sections of the Lake Arlington Master Plan were the culmination of the previous planning steps. These recommendations take into consideration activities in the watershed and immediately around the Lake. The recommendations also take into consideration the development and recreation concepts described in other parts of this Master Plan.

2.6 Planning Process Highlights

Because the City had multiple goals for this Master Plan, this planning process was much more involved than a traditional watershed study or water resources master plan. The Malcolm Pirnie Team and the City staff were in almost daily contact throughout the planning process, and the cities of Arlington and Fort Worth worked very closely together on a wide variety of issues - some of which were not even anticipated when the planning process began. The two cities and the Pirnie Team held monthly coordination meetings to discuss the Master Plan, as well as ancillary issues related to Lake Arlington. These issues included the City of Fort Worth Lake Shore Drive Project, gas well drilling on properties adjacent to the lake, and opportunities to develop a trail system that fits into regional plans. In all of these areas, the communities worked collaboratively to make enhancements that truly improved the quality of proposed activities, and resulted in a Master Plan that can really serve as a guidance document for development around the Lake and within the watershed. For example, the proposed alignment and amenities for Lake Shore Drive were reviewed by Arlington and the Pirnie Team, and Fort Worth readily accepted suggestions. Both cities worked with gas well drillers to improve the aesthetics of the drilling areas and lay the groundwork for future use of the properties for potential trails and recreation facilities. There was very significant involvement by communities in the watershed, and they readily provided data, land use plans and other documents that greatly increased the accuracy of the water quality modeling. The NCTCOG provided invaluable assistance by organizing community meetings and providing data.

References
Stream Corridor Restoration: Principles, Processes, and Practices (10/98) by the Federal Interagency Stream Restoration Working Group.

Stormwater Manager's Resource Center (SMRC), 2002. Center for Watershed Protection, Inc. www.stormwatercenter.net.

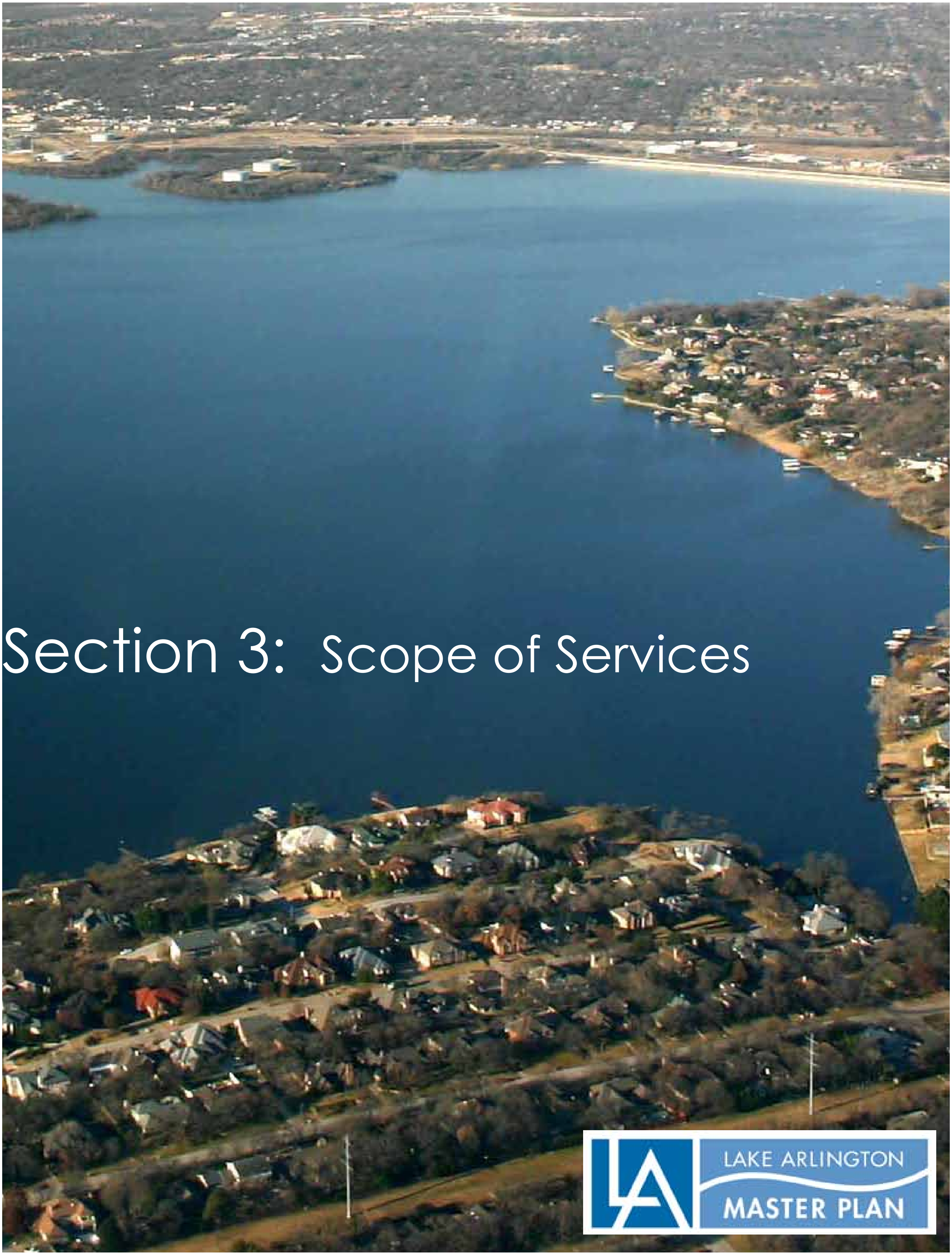
Schueler, Thomas R. 1995. *Site Planning for Urban Stream Protection*. Center for Watershed Protection, Ellicott City, MD.

EPA, 2002. Source Water Protection: Best Management Practices and Other Measures for Protecting Drinking Water Supplies. US Environmental Protection Agency Drinking Water Academy.

Caraco, D., R. Claytor, P. Hinkle, H.Y. Kwon, T. Schueler, C. Swann, S Vysotsky, and J. Zielinski. 1998. Rapid Watershed Planning Handbook. Center for Watershed Protection, Ellicot City, MD.

Schueler, T. 1994 "The Importance of Imperviousness" *Watershed Protection Techniques* 2(4): 100-111.

Section 3: Scope of Services



LAKE ARLINGTON
MASTER PLAN

3. Summary of Scope of Services

In an Engineering Services Contract dated December 16, 2009, the City of Arlington engaged Malcolm Pirnie to prepare a Master Plan for Lake Arlington. The primary objective of the Master Plan and the planning process was to prepare a guidance document for the protection of the water quality in Lake Arlington. However, this planning effort went far beyond the traditional aspects of a source water protection and watershed management document. As described in more detail below, the Lake Arlington Master Plan process included components related to land use and urban planning, recreation and open space development and management, and public education and outreach. The planning process included five specific tasks.

3.1 Data Collection

Data collection was the first major task in the Project because all of the other work was founded on data and information. Because of the many facets of the planning process, data collection went on throughout the Project. Data was obtained from a wide variety of sources. Data was obtained from all of the entities participating or involved in the planning process, especially the cities of Arlington and Fort Worth, the NCTCOG, communities within the watershed, Tarrant Regional Water District (TRWD), Trinity River Authority (TRA), Texas Parks & Wildlife Department (TPWD), U.S. Geologic Survey (USGS), Texas Commission on Environmental Quality (TCEQ), and other public and private sources. Much of these data were obtained in GIS format.

Some of the more important documents and sources of information included:

- Relevant policies and ordinances of the cities and towns in the watershed
- Stormwater program documentation
- Water quality and watershed data
- USGS monitoring data
- TCEQ water quality data
- TCEQ NPDES discharge data
- TMDL implementation plans
- Master plans, economic development plans and comprehensive plans from the cities in the watershed
- Existing land uses (including natural gas drilling)
- Zoning maps
- Population data
- Conservation plans
- Inventories of natural resources and soils
- Meteorological data
- Current MS 4 NPDES permits and annual reports
- Stormwater management plans

3.2 Source Water Protection and Watershed Management

The objective of the source water protection and watershed management task was to develop a plan aimed at minimizing the negative impacts to water quality that may occur from future development within the watershed. This was accomplished by developing standards, policies and BMPs that can be implemented by cities, counties, construction contractors and developers. Public education was also a major component of the recommended guidelines. In order to accomplish this task, the Malcolm Pirnie Team was required to assess the current standards, policies and management practices, and then determine the

potential impacts of current and planned development activities on lake water quality.
More specifically, this portion of the work consisted of the following major subtasks:

- Review of lake water quality and likely pollutant sources
- Review of current standards, policies and guidelines within the watershed
- Review of BMPs currently being implemented
- Computer modeling of the watershed and Lake Arlington
- Development of recommended standards and guidelines
- Development of recommended BMPs

3.3 Recreation, Open Space and Development

This portion of the work focused on identifying open space and recreational improvements, land development opportunities, and guidelines that will regulate new construction and development on and adjacent to, Lake Arlington. Public involvement activities associated with these steps was directed toward developing consensus with area stakeholders and land owners. Included in this task is a boating capacity study for the Lake. The following sections describe the four sections of this task.

3.3.1 Project Initiation and Study Area Analysis

During this task the Project Team reviewed past efforts and key features related to Lake Arlington, and with input from the City defined the study area. The study area for this task is shown on Figure 3.3.1. The Project Team reviewed the Lake Arlington Ordinance, and previous planning efforts by both Arlington and Fort Worth. Information was also obtained from other cities near the study area to understand past goals and to place our future efforts in the context of previous studies. Next, the Team analyzed existing city codes and zoning to understand potential barriers to redevelopment. In tandem with the previous efforts, the Project Team conducted a field analysis of the study area and tours of the Lake.

3.3.2 Public Workshops & Vision Planning

The Project Team acted as a facilitator at focus group and public workshops to share the background data assembled and to solicit public input regarding goals and desires for the study area. During the first phase of the workshops, the Project Team used a visual preference exercise. Through this process, we were able to gather the group's preferences for desirable planning approaches towards forging stronger linkages and development strategies.

Based on the planning process and public input, the Project Team prepared a vision plan that illustrates the ideas generated in the public workshop, with an emphasis on market-based realities, goals and objectives, visions and preferences. The Master Plan incorporates the vision for development around Lake Arlington, and forms the foundation for recommendations for design guidelines. The Master Plan includes a prioritized list of action items to be completed around the Lake, and proposed modifications to the Lake Ordinance.

3.3.3 Design Guidelines

Based upon the vision plan created in the previous two subtasks, the Project Team prepared design guidelines that focused upon establishing quality standards for four major areas:

- Parks and open spaces
- Lake Arlington Flowage Easement
- New development around the lake
- Shoreline-related development (docks, marinas, piers and retaining walls)

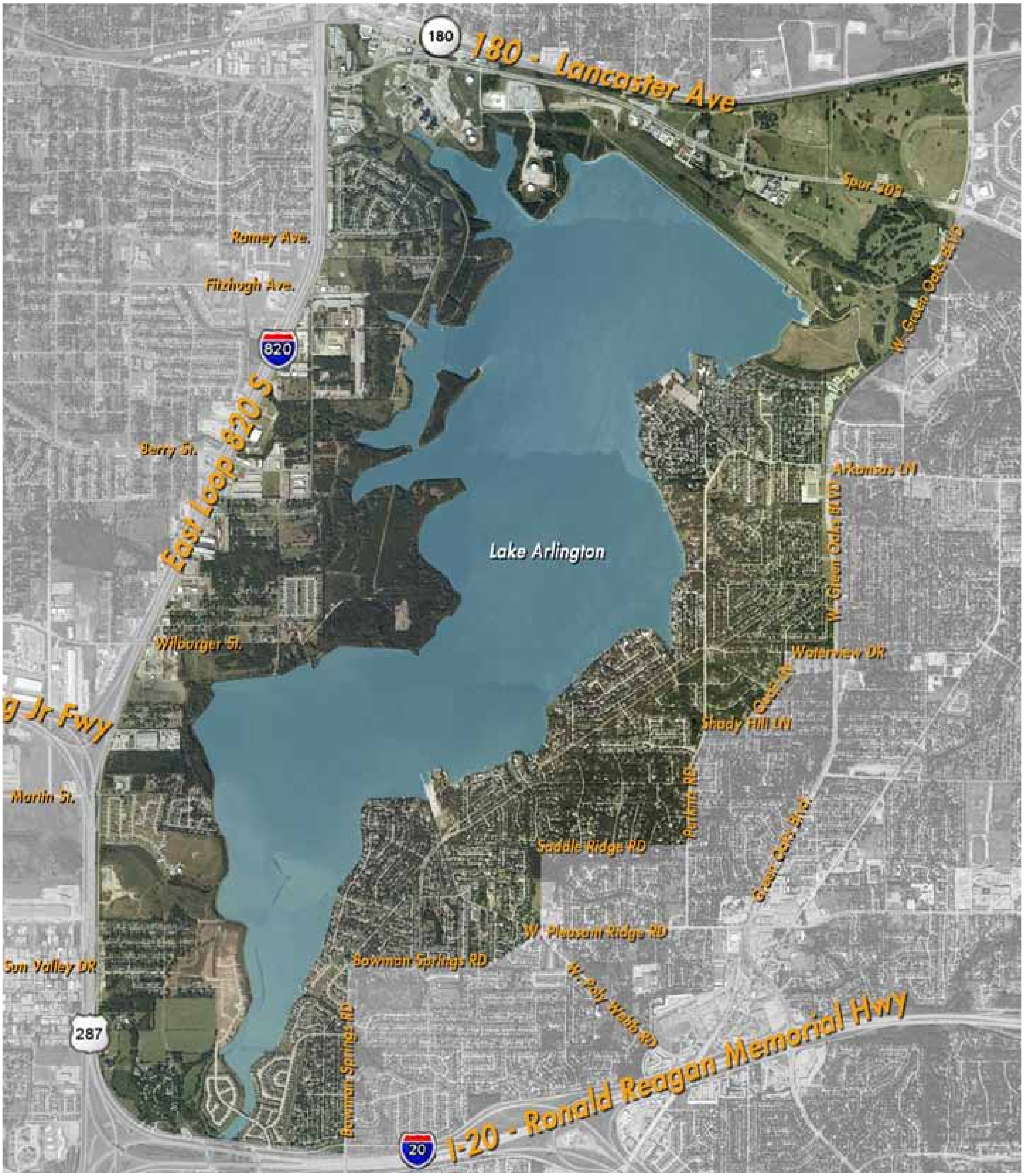


Figure 3.3-1: Lake Arlington Study Area

3.3.4 Boating Capacity Study

The objectives of this subtask were to: characterize existing uses of Lake Arlington; identify areas of use, conflict and displacement across the Lake and among boating groups; identify areas of the Lake that might require additional management; and identify areas around the Lake suitable for potential shoreline development.

The boating capacity study was conducted by Texas AgriLife Research (a branch of the Texas A&M University System) using a team of professors and graduate students from the Department of Recreation, Park and Tourism Sciences at Texas A&M in College Station. The capacity study recommendations were based on a site visit and a survey administered to calendar year 2009 annual and daily Lake Arlington permit holders, and landowners around the Lake. Additional respondents were also drawn from residents living within five miles of the Lake.

3.4 Public Involvement

Public education and outreach was a major component of the project, and it was an integral part of everything we did. The Project Team, especially Adisa Communications, worked closely with City staff to develop and implement an effective Public Involvement Plan that informed and engaged affected stakeholders in the Lake Arlington Master Plan. The plan focused on the identified internal and external audiences with the goal of informing and engaging them about the Project. The Malcolm Pirnie Team worked with City staff to frame messages, create engagement opportunities, and anticipate and respond to communications issues. The team developed a project identity, including a Lake Arlington Master Plan logo that was used consistently throughout the project.

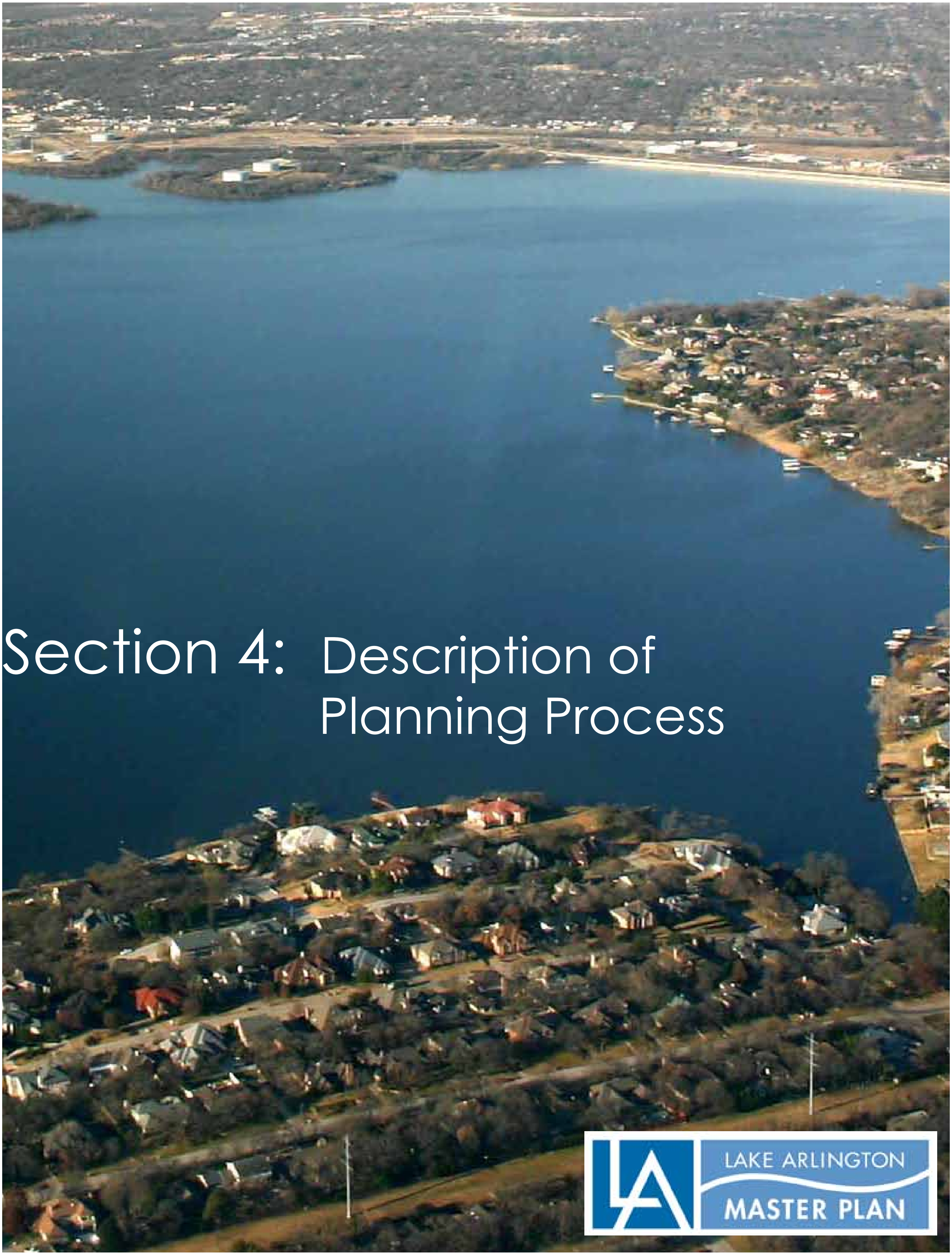
The Malcolm Pirnie Team worked with the City to plan and implement effective stakeholder meetings that engaged citizens on the Master Plan project. Citizens of Arlington and Fort Worth were specifically targeted. The meetings included both Focus Group Workshops with small groups of individuals with specific interests in the project, and public meetings for anyone with a general interest in the project.

The Team also developed project related materials such as press releases and fact sheets. These materials, maps and Frequently Asked Questions (FAQs) were used to populate a webpage for the project that provided information on public meetings, the Master Plan process and the schedule.

3.5 Funding Sources

The Malcolm Pirnie Team identified potential funding sources for both planning and implementation. These sources included federal, state and local public/private opportunities. The Team also assisted the City by reviewing applications and commenting on materials developed by others.

Section 4: Description of Planning Process



4. Description of the Planning Process

4.1 Planning Process

The planning component to the Lake Arlington Master Plan is meant to develop a template for long-term future growth within the lake area. The master plan provides a series of recommendations relating to future land use, parks and open spaces, and streets. The study outlines opportunities as they relate to existing and new development within the study area, as well as provides the basis for the design guidelines (Section 8.13).

4.1.1 Research, Resource Inventory, & Assessment

The first step of the planning process was a multi-faceted research effort that included:

- Review all previous planning efforts
- Analysis existing city codes and zoning
- Field analysis
- Compilation of existing base data
- Study of the history of the lake
- Determination of the study area
- Analysis of potential opportunities and constraints

This step was crutcial in determining the parameters of the planning study and understanding the most important issues related to further analysis of the issues relating the the study area.

4.1.2 Focus Group Roundtables and Public Meetings

After studying the preliminary findings, a series of roundtables and public meetings were conducted to gauge stakeholder's interest in a variety of planning issues. A visual preference survey was conducted where stakeholder's were presented initial findings of the physical analysis. Next, a visual preference exercise was conducted in which a carefully selected series of photographs were presented addressing such issues such as: land use, building type, streetscape, parks and outdoor space, recreational amenities, water quality improvement, and infill options. Each category displayed a range of strategies, densities, and approaches.

Public meeting attendees were asked to place their individual markers by category for those images/approaches they like the most, and those they least prefer. Through this method, the group's preferences for desirable planning approaches were expressed. Section 4.2 details the categories of issues presented to the public and outlines general public comments and concerns. The results of the visual preference exercise provided a basis for the design team to better understand the opportunities, issues, and public's vision for future development around Lake Arlington.

Figure 4.1-1: Example of Visual Preference Voting Board

The next set of focus group and public meetings focused on a discussion of specific opportunites and constraints. The variety of issues and questions presented to the public were a direct result of the previous visual preference exercise and designed to garner a more detailed understanding of the preferences of the public.

4.1.3 Vision Plan

The vision plan is the physical design of the master plan, meant to illustrate the ideas generated in the public workshop. An emphasis was placed on creating design strategies based on market realities, goals and objectives of the City of Arlington, and the visions and preferences of the public. Section 8 highlights the vision plan and presents recommendations in the following categories:

- Land Use Strategy
- Parks and Open Space Strategy
- Street Framework Strategy

4.1.4 Design Guidelines

Based upon the framework established in the vision plan design guidelines were created that focus upon establishing quality standards and outline specifications for elements within the Flowage Easement. These guidelines describe detailed standards and establish a base against which future development and site improvements can be judged.

4.2 Public Involvement Program

4.2.1 Public Involvement Program

An essential component of the Lake Arlington Master Plan was public information, education and outreach. In order to create an open and transparent planning and decision-making process, stakeholders were proactively engaged and asked to provide ideas, feedback and to ask critical questions throughout the year-long planning process.

The main goal of the Public Involvement Program was to engage Arlington and Fort Worth citizens and those stakeholders directly affected by the Master Plan in order to obtain public input and participation in the development of the Lake Arlington Master Plan. The second goal was to provide timely, factual information to the general public about the Master Plan.

The following objectives were identified in support of the Public Involvement goals:

- Foster a relationship with the community to engage them in the planning process
- Host a series of Roundtable Discussions with stakeholders in the Development/Business Community, Parks and Recreation Advocates, and Neighborhood and Adjacent Property Owners
- Host a series of Public Meetings in Arlington and Fort Worth
- Create informative handouts and visual presentations for meetings
- Create a web page to provide public information and receive public feedback
- Establish a local phone number to receive community feedback

Public involvement activities provided several formal feedback mechanisms including:

- Public Meetings
- Focus Group Roundtables
- One on One Meetings

- Website feedback form
- Project phone line

The Water Utilities Department took the lead in ensuring that the goals and objectives of the public involvement program were met. Regular coordination meetings with the Malcolm Pirnie team were part of the internal implementation of the public involvement program, and included the discussion of issues, progress and next steps for the Master Plan.

Prior to the initiation of a Public Involvement program, the Malcolm Pirnie team worked with City staff to define an effective public involvement strategy for Lake Arlington's Master Plan. During this kickoff meeting the City of Arlington and Malcolm Pirnie agreed upon:

- Overview of overall project schedule
- Specific public involvement deliverables
- Identification of key stakeholders and groups impacted by the Master Plan
- Strategy for Focus Groups and Public Meetings

The initial meeting and the ongoing coordination laid an important foundation for the implementation of an effective public involvement program.

Communications protocols were also established and observed that supported the public involvement process. These protocols included a process for collaboration on all materials and information being presented to the public. There was an internal review of all materials by the Water Utilities staff and other City Departments impacted by the Master Plan. As necessary, the City of Fort Worth staff was also asked to provide comments and feedback on the ideas and materials before they were presented in public forums.

Over the course of the interaction with the public and stakeholders throughout the Master Planning process, key issues were identified and addressed as part of the public involvement program. During each public forum, the City of Arlington staff provided information about these issues in an attempt to both gather ideas and opinions to include in the Master Plan, and to educate stakeholders. The key issues included:

- Drinking water quality
- Natural gas drilling
- Trash
- Lake's capacity to support boating and recreation
- Fishing and wildlife
- Development along the lakefront
- Standards for docks and piers
- Dredging
- Potential for increased water treatment costs

4.2.2 Focus Group Roundtables and Public Meetings

A. Focus Group Roundtables

The City of Arlington provided two types of forums designed to provide face to face interaction with stakeholders for the Master Plan. A series of small focus group meetings, called Roundtable Discussions, were held with the Arlington business and developer community, parks and recreation advocates/users, and neighborhood groups and property owners. The focus groups provided an opportunity for more in-depth discussion and idea sharing about the Master Plan.

The small representative groups of 15-25 people met several times during the project to provide comments on key elements of the Master Plan including potential development ideas, opportunities and constraints, water quality protection and the Vision for the Master Plan.

The Project Team arranged the meetings and facilitated the discussion so that each person in attendance could provide his or her ideas and opinions, as well as ask questions about the planning process. The meetings were generally 1.5 hours and included a formal presentation of 15-20 minutes.

The business/developer focus group met twice and they were interested in:
- Desire to make Lake Arlington a point of interest by redesigning existing or new facilities
- Costs associated with the development of lakeshore properties and who would pay for compliance with new standards
- Protecting water quality
- Development opportunities on the Fort Worth side of the lake, and if Fort Worth was interested in development
- Site constraints on the Fort Worth side: some of the vacant land is low lying and marshy, therefore, not conducive to new development
- More information on standards for docks, piers, and retaining walls
- Creating public/private partnerships as a potential funding source
- Beautification along the lake, and who would be responsible for maintaining this
- Negative impacts to water quality from dredging
- Creating incentives to rehabilitate housing developments as they age, and looking for opportunities to upgrade development
- Implementing a good mix of residential, commercial, and open space along Lake Arlington

The parks and recreation focus group met three times (after the first meeting of this group participants were included in the Neighborhood group) and they were interested in:
- More control on visitation to the lake during evening hours
- Replacing the Simpson Park Lake House with a similar multi-purpose building
- Improving Richard Simpson Park
- Existing traffic on the Arlington side of the lake – participants did not want additional traffic to result from any development around the lake
- Limitations to new development in Arlington due to existing neighborhoods
- Concern about herbicide/pesticide use around the lake
- Vision of additional access to the waterfront, more events organized by the city, and a way to utlize the vacant land on the Fort Worth side for public and passive open spaces
- Concern that lake level fluctuation can limit use of the lake
- Potential for a linear park upstream of the lake along Village Creek
- Protecting water quality with green spaces and wetlands
- Enhancing wildlife management, especially waterfowl

The neighborhood/property owner focus group met three times and they were interested in:
- Concern about an increase in traffic with the development of a new marina

- The need for dredging
- Development along the Fort Worth side of the lake, and who would be responsible for implementing this
- Desire for retail and restaurants, and a marina as a destination – combine this destination with an emphasis on wildlife/nature tours
- Non-motorized watercraft being able to use/access the shallow end of the lake
- Standards and guidelines for docks, piers, and retaining walls
- Safety at Richard Simpson Park, and the need for this park to be patrolled 24 hours a day
- Better dock fishing access, and the need for more fish structures

One set of recommendations included in the Master Plan are Standards and Guidelines for Docks, Piers and Retaining walls. Prior finalizing these specific guidelines the Planning Team brought together a group of contractors, architects and property owners to review the proposed standards. Attendees were asked to comment on the ideas presented and to share what they thought about the proposed standards and guidelines in terms of constructability, costs and marketability. From this discussion the Planning Team made revisions to several of the guidelines for docks, piers and retaining walls

B. Public Meetings

In addition to the focus group meetings, the project team organized and hosted five public meetings. The purpose of these meetings was to involve the Arlington and Fort Worth communities in the Master Plan in an engaging and constructive environment. The project team was responsible for the meeting strategy and logistics, as well the creation of all the necessary meeting materials.

1. Public Meetings 1 and 2 – Visual Preferences

The City of Arlington wanted to get a sense of what the public wanted to see in terms of future development along the lakefront and within the study area. The first two public meetings, one held in Arlington (3/30/10) and the other in Fort Worth (4/5/10), were designed to present the findings of the team's preliminary data gathering and physical analysis and to discuss the impacts of this analysis on potential development around the lake. Meeting participants were able to participate in a visual preference exercise based on a series of photographs depicting options and opportunities related to:

- Docks and piers
- Marinas
- Water's Edge Character
- Retaining Walls
- Open Space
- Streets
- Residential Development
- Commercial Development

Stakeholders were asked to indicate their preferences by category for those images/approaches they liked the most, and those they preferred the least. Through this method, the Project Team was able to gather preferences for desirable planning approaches towards forging stronger linkages and development strategies.

From the visual preference exercise, the Project Team was able to ascertain the types of development and open spaces that attendees preferred. There was significant consensus between the Arlington and Fort Worth meetings. Lower density and passive open space areas were preferred in both meetings. Specifically, when asked about how Open Spaces should be developed or maintained, stakeholders indicated a preference for community parks that are passive rather than active, and the creation of a natural buffer/water oriented park system between the water's edge and new streets or development.

In terms of potential development there was general opposition to commercial streets and boulevards and a preference for Single-family/ Residential clusters and lifestyle retail such as a village-scale development.

For elements within the flowage easement stakeholders expressed a preference for terraced, masonry walls over concrete or gabion walls. Covered docks and piers were also favored.

2. Public Meeting 3 – Opportunities and Constraints
   The third meeting (9/13/10) gave the public an opportunity to review and comment on the draft Vision for Lake Arlington that was developed on the basis of the physical analysis and the input from the first round of public meetings. The City of Arlington and project team shared the potential opportunities and constraints for development within the study area, answered questions about the ideas presented and collected citizen feedback.

   The format of the meeting was designed to encourage interaction between the project staff/planners and citizens. Both Arlington and Fort Worth citizens were invited to the third meeting. After a brief presentation, participants spent the remainder of time in one-on-one discussions at the information stations that were set up around the room. These stations focused on:
   - Lake Arlington Master Plan Vision
   - Water Quality
   - Opportunities and Constraints
   - Feedback from previous public meetings

   Participants were concerned about an increase in noise and traffic with any new development along Lake Arlington, and the need for patrolled parks in the Lake Arlington area. Some commented on the importance of maintaining water quality and wildlife in the lake, and the importance of maintaining the integrity of residential areas on Lake Arlington. Participants also requested a better method of cleaning up the lake area and having a trash pickup plan to do so. Others agreed that there are opportunities for development on the Fort Worth side of the lake; however, some participants expressed concern that the City of Arlington would be responsible for the costs of this development. Attendees were happy to have the opportunity to be informed at these public meetings, and provide input and comments to the study team to be considered throughout the LAMP process.

3. Public Meetings 4 and 5 – Vision Plan
   The final round of public meetings included separate meetings, one in Arlington (2/15/11) and one in Fort Worth (2/17/11). The Project Team presented the vision plan illustrations, shoreline design standards and guidelines recommendations, and watershed BMPs during these workshops. The presentations revisited the process performed to date, focusing on the refinements made leading to

the preferred planning approach.

4.2.3 Lakeshore Drive Alignment
As part of its master thoroughfare planning, the City of Fort Worth has proposed to build a four-lane divided arterial (Shoreline Drive) within the Lake Arlington study area. The proposed roadway is designed to address mobility needs and to spur development in Southeast Fort Worth. Because portions of the roadway alignment would be within the Lake Arlington Flowage Easement, the City of Arlington began coordination with City of Fort Worth staff and roadway consultants in early 2010 as part of the Master Planning process.

Development and improvements within the Arlington Flowage Easement were reviewed and approved by the Arlington Water Utilities Department. The City of Arlington was primarily concerned with the runoff and potential pollutants caused by a roadway within the flowage easement, and on potential reductions in the flood storage capacity of the reservoir.

On June 23, 2010, the City of Arlington provided testimony to the City of Fort Worth Planning Board in support of the Lakeshore Drive project and later provided recommendations on best management practices for roadway construction within the Lake Arlington Flowage Easement. The first phase of Lakeshore Drive has been approved for design and construction from Berry Street south to Wilbarger Street.

4.2.4 Gas Well Development
Over the years there has been public concern about the safety, potential pollution and visual impacts of natural gas drilling operations that are located near Lake Arlington. During the Lake Arlington Master Plan process, representatives from the gas well development companies participated in discussions regarding runoff/pollution control measures and aesthetic practices. As part of the process the planning team provided recommendations for aesthetic practices to be incorporated in permits given to drillers. These areas include screening, vegetation and plantings and restoration once a site has been abandoned. In addition, the planning team developed recommendations for lakeside trail routings through properties owned by the drilling companies. These recommendations were provided by the City to the drilling companies. The Master Plan also includes BMPs for water quality protection to specifically address gas well drilling operations.

4.2.5 Involvement of NCTCOG
The NCTCOG hosted two multi-jurisdictional watershed briefings to encourage collaboration on source water protection issues and potential stormwater BMPs. Representatives from the 15 political subdivisions within the Village Creek watershed were invited to participate in this regional dialogue so that planners could better understand how to prepare for and manage growth in a manner that promotes economic development while protecting our land and water resources.

One of the key benefits of the Lake Arlington Master Plan was that it provided valuable modeling data about the impacts of this growth and how to mitigate the degradation of the water that flows into Lake Arlington. The watershed modeling study includes a screening level pollutant loading and reservoir eutrophication model (oxygen depletion due to algae, etc.) for the entire watershed. The intent is to use information observed in the model to develop recommended BMPs for source water protection. However, it will be up to each individual government to implement those protections.

A set of Management Measures and Best Management Practices have been developed based on meeting state and federal regulations/new requirements for watershed management.

4.2.6 Website

The Malcolm Pirnie Team developed a webpage for the Master Plan, which was located on the City of Arlington website, on the Water Utilities Department page. The website describes the purpose of the Master Plan, displayed a map of the study area, provided information on Lake Arlington, and contained a link to the Frequently Asked Questions document developed by the team. Each time the Frequently Asked Questions document was updated throughout the Master Planning process, an updated document was then posted online. The website also provided updates on upcoming public meetings, and provided contact information so that those interested in speaking with a team member had the option of emailing or calling the team, and the opportunity to get involved in the Master Plan process.

The website also contained a link to an online survey that visitors could complete, which was automatically submitted to the study team for consideration throughout the Master Plan process. The survey asked questions about one's current use for the lake, what one would like to see/would not like to see happen on the lake, their thoughts on development around the lake and opportunities for development, and the opportunity to provide overall, general comments. Once the Vision for Lake Arlington was created and presented to the public, visitors to the website also then had the opportunity to go online and comment on this Vision, and on the identified opportunities and constraints. The study team considered all comments submitted by stakeholders from the online survey, and kept record of every comment in a survey log. The images below display the online survey from the website.

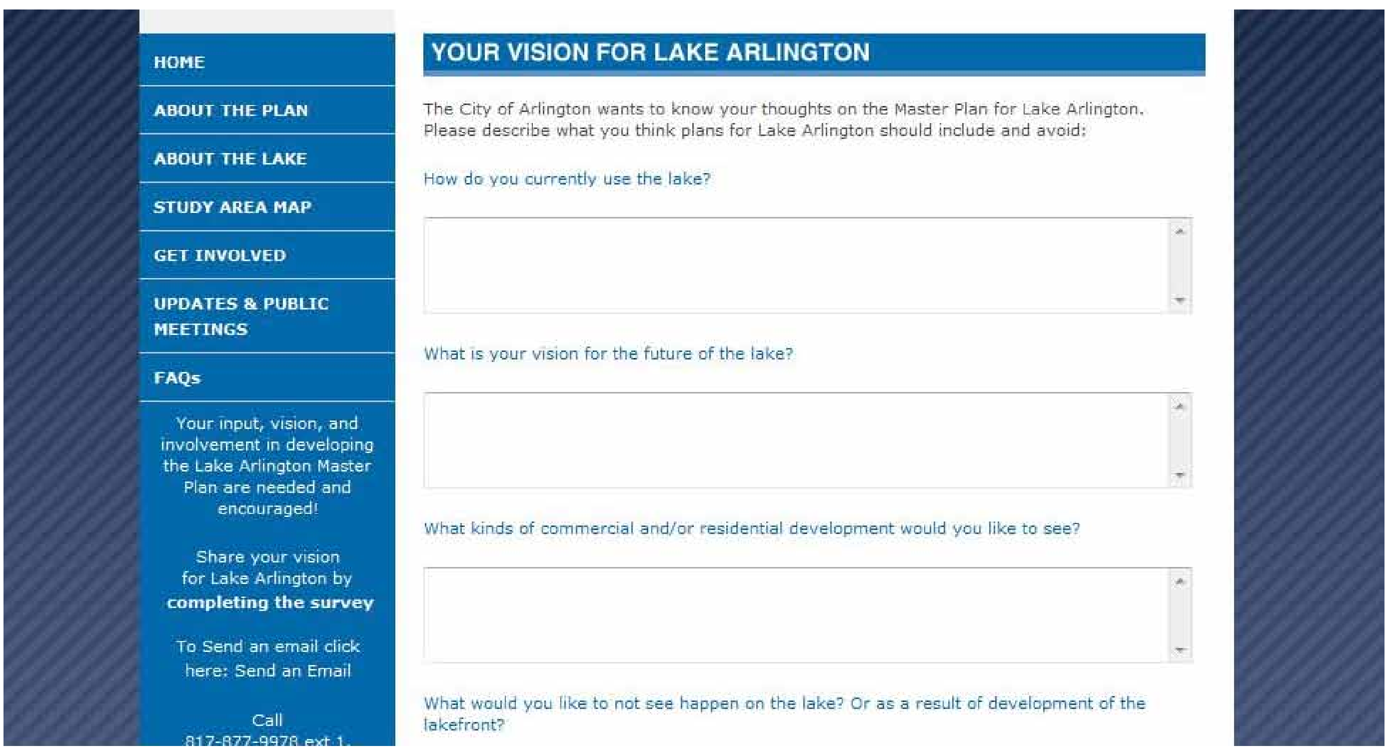
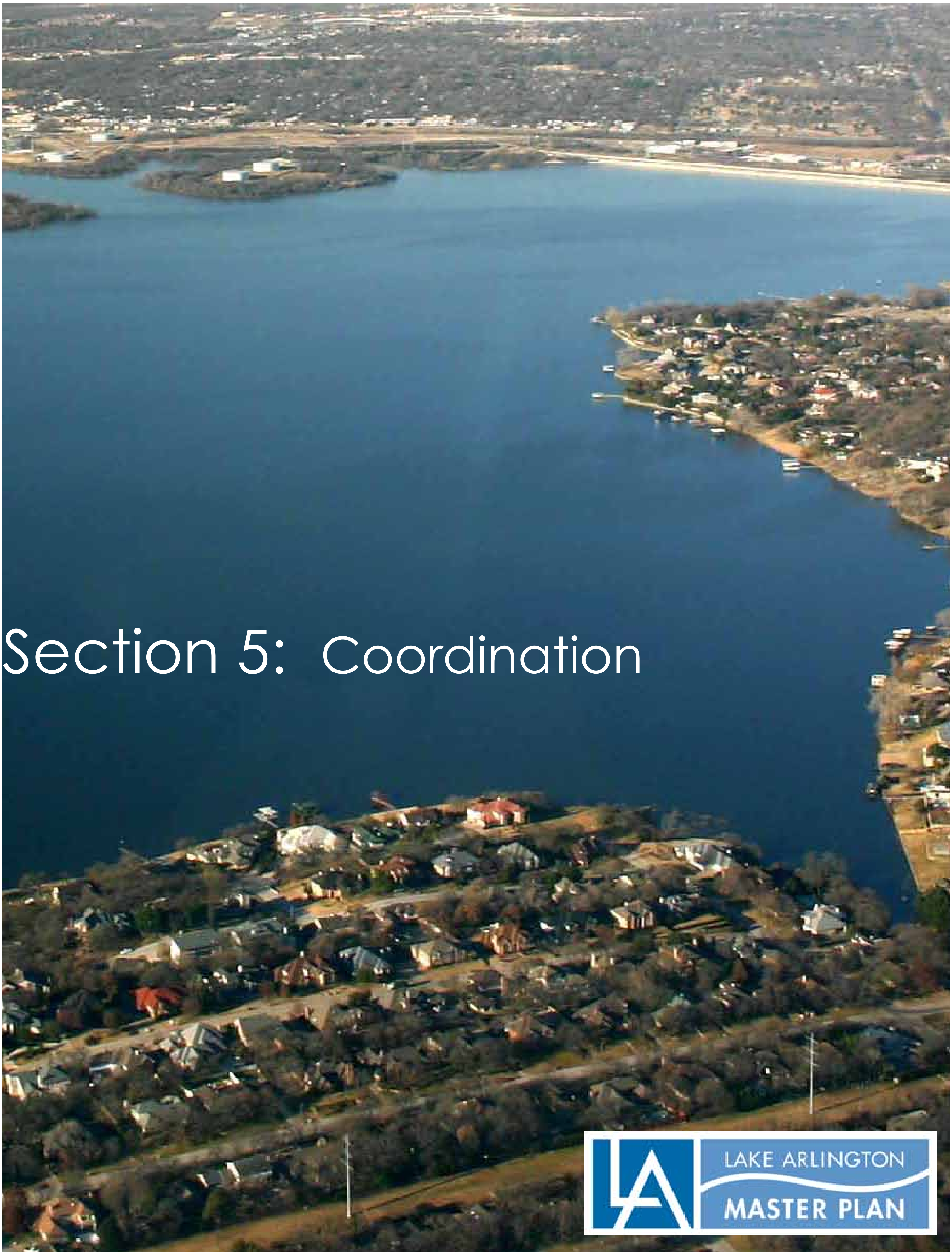


Figure 4.2-1: Lake Arlington Master Plan Website

Section 5: Coordination



5. Coordination and Acknowledgements

5.1 Introduction

The uniqueness of the Lake Arlington Master Plan approach required coordination across City of Arlington departments, with water resource entities, and planning agencies at regional and state levels, and collaboration between all 13 cities and the two counties within the Lake Arlington watershed.

Because the Master Plan addresses both water quality and land use development, multiple departments within the City of Arlington participated in the planning process. Each department contributed expertise and insight in order to address the numerous issues related to the protection of water quality, while at the same time laying out a vision for sustainable development within the planning area. Representatives from Water Utilities, Parks and Recreation, Community Development and Planning, Public Works, Communications, Community Services and Police each played a significant role in the development of the Master Plan.

Arlington's neighboring city, Fort Worth, is located on the west side of Lake Arlington. The City of Arlington proactively sought the participation and input from City of Fort Worth staff in the master planning process because of the immediate impact of any decisions to Fort Worth city government and residents along the lakefront. Monthly coordination meetings were held to address how to create a vision that took into account the needs of the City of Fort Worth, and the citizens and property owners on the lake front side of Fort Worth. Fort Worth councilmembers and staff were given tours of Lake Arlington. Two public meetings on the Master Plan were held in Fort Worth to engage its residents, property owners and citizens.

On a regional and statewide level, organizations such as the North Central Texas Council of Governments (NCTCOG), Tarrant Regional Water District (TRWD), Trinity River Authority (TRA) and the Fort Worth District of the U.S. Army Corps of Engineers (USACE) provided important data for use in watershed modeling as well staff support towards the development of the Master Plan. The NCTCOG played a major role in bringing together the political jurisdictions within the watershed to brief them on the Master Plan and to discuss ways to protect water quality.

5.2 Fort Worth Coordination

Staff from both the City of Arlington and the City of Fort Worth worked together during the planning process by sharing data, ideas and participating in monthly coordination meetings.

The monthly coordination meetings, which began in March 2010, became the cornerstone of the collaborative efforts between Fort Worth and Arlington. During these meetings staff were able to provide data and guidance on how to best develop the vision and to work through specific issues. Information and data that were provided included planning information, trails and parks information, similar studies on Lake Worth, stormwater management plans and trash collection, databases and contacts.

One specific issue addressed during the coordination process was the best way to align and design the proposed Lakeshore Drive without negatively impacting Lake Arlington water quality. The City of Arlington provided Fort Worth with best management practices for roadway construction and aesthetics for use within the Lake Arlington flowage easement. Gas well drilling sites was another issue on which the two cities worked collaboratively to set specific guidelines for how these drilling sites within the Lake Arlington planning area could be developed without negatively impacting future development and redevelopment activities. The cities worked with the drilling companies to address how the sites could be used in the future to benefit the lake and surrounding properties.

Another key issue that benefitted from the two-way dialogue between cities was related to the creation of new standards for docks, piers and retaining walls. Each city had to ascertain how to handle permitting requests and construction inspections for development within the Lake Arlington flowage easement on the Fort Worth side of the lake.

There was also communication between the cities at the Council level. The City of Arlington presented briefings to the Fort Worth City Council. These briefings helped to ensure that all levels of City of Fort Worth decision makers were included in the process.

Fort Worth residents and property owners were also invited to engage in the master planning process in order to give their input and opinions. Two public meetings were held in Fort Worth on the Master Plan, and Fort Worth residents were invited to a joint meeting in Arlington in the middle of the planning process. The input received from Fort Worth citizens was found to be very similar to ideas and opinions expressed by Arlington residents.

Overall the enhanced communication and collaboration facilitated the creation of a Master Plan that addresses the needs of both communities. It is anticipated that the collaboration between Arlington and Fort Worth will continue during the implementation of the Lake Arlington Master Plan.

5.3 Involvement with Other Water Organizations

5.3.1 General
During the planning process, the Malcolm Pirnie Team and the City of Arlington continually coordinated with regional, state and national organizations that currently impact or could impact the watershed and Lake Arlington. We greatly appreciate the cooperation and assistance provided by each of these agencies.

5.3.2 Tarrant Regional Water District
Lake Arlington is owned and operated by the City of Arlington; however because the reservoir is part of the Tarrant Regional Water District (TRWD) regional water system, TRWD plays a significant role in the water quality aspects of the reservoir, and in the lake level. A more detailed description of the lake operations is provided in Section 6.4.

TRWD owns and operates two East Texas surface water reservoirs that are used to supply make-up water to Lake Arlington. Pump stations and pipelines from Richland-Chambers Lake and Cedar Creek Lake supply raw water to Lake Arlington, as shown in Figure 5.3-1. These facilities allow TRWD to operate the reservoirs and Lake Arlington as a system in order to maximize the availability of water while minimizing the cost of power.

TRWD provided water quantity and quality data that greatly benefited the project. TRWD staff members also provided information on the operation of their reservoirs and the land management and shoreline permitting programs in place on the two reservoirs.

5.3.3 Trinity River Authority

Lake Arlington is used as a raw water supply source for the Trinity River Authority (TRA) for treatment at its Tarrant County Water Supply Project water treatment plant. This project serves as a primary water supply for the communities of Bedford, Colleyville, Euless, Grapevine, and North Richland Hills. The treatment plant went into operation in 1974. It has been expanded six times to its present capacity of 87 mgd. During calendar year 2009, the average daily flow was approximately 28 mgd, with a peak day flow of 64 mgd.

5.3.4 U.S. Army Corps of Engineers

The Fort Worth District of the U.S. Army Corps of Engineers (USACE) was established in 1950 after disastrous floods in the area. It is responsible for water resources development in two-thirds of Texas, and military design and construction in Texas and parts of Louisiana and New Mexico.

Representatives of the Environmental Resources Branch of the Fort Worth District attended meetings related to the Lake Arlington Master Plan, and provided information on proposed planning activities within the Village Creek watershed. At the present time, the District is working with the cities of Kennedale and Arlington, as well as the NCTCOG on a proposed eco-restoration project for Village Creek. The agencies are working on a preliminary Project Management Plan (PMP) that will include a scope of work that has yet to be defined.

5.3.5 Coordination with North Central Texas Council of Governments

Throughout the planning process, the Pirnie Team coordinated with the North Central Texas Council of Governments (NCTCOG), and their cooperation and assistance is much appreciated. The NCTCOG provided valuable data for use during the planning process.

In developing this Master Plan, planners referenced regional documents such as Vision North Texas and the North Texas Alternative Futures Plan. The planners attempted to link the recommendations and action items in those types of documents to the proposed plan for Lake Arlington. For example, major components of the Master Plan conform to regional planning elements such as pedestrian design elements; conservation development; preservation of undeveloped areas; use of programs such as iSWM; transfer of development rights through techniques such as conservation easements; and taking a holistic approach to developing the Master Plan.

5.3.6 Coordination with Texas Parks and Wildlife

Texas Parks and Wildlife Department (TPWD) representatives attended roundtable and public meetings, and actively participated in discussions. TPWD also provided information on fishing and waterfowl activities on Lake Arlington, and boating safety issues on the lake.

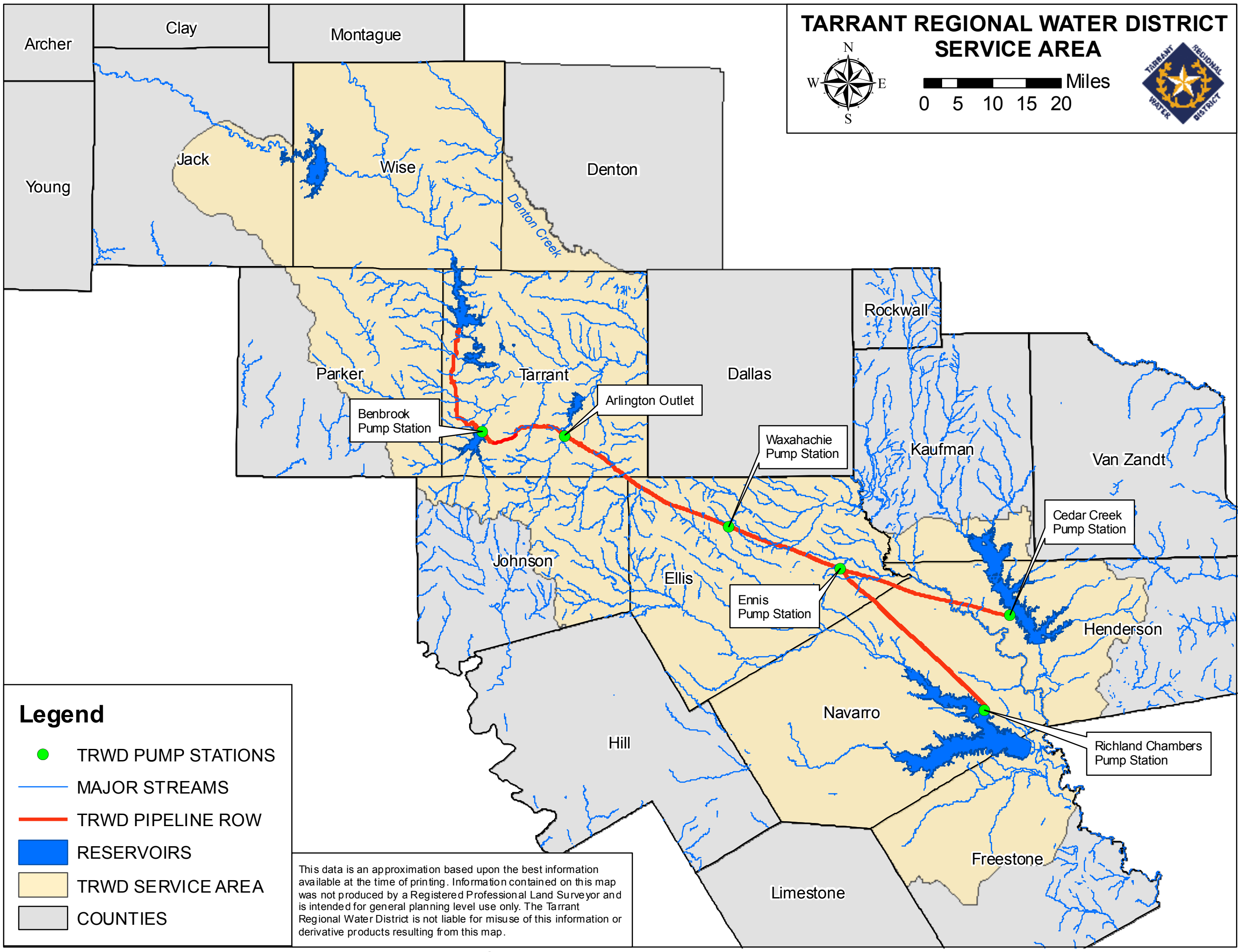
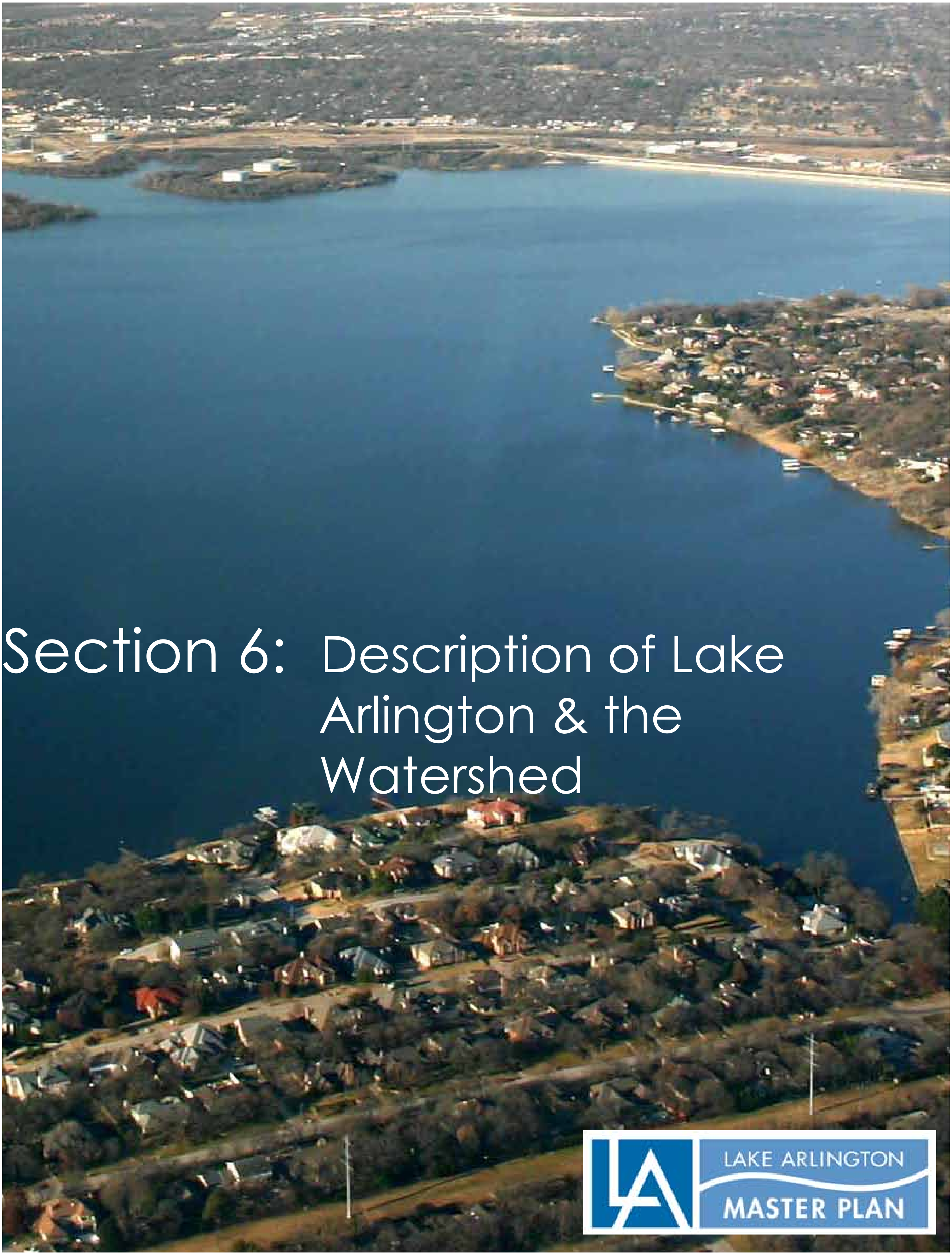


Figure 5.3-1: TRWD Trinity River Diversion Water Supply Project

Section 6: Description of Lake Arlington & the Watershed



6. Description of Lake Arlington and the Watershed

6.1 History of Lake Arlington

In the early 1950s Arlington's mayor, Mr. Tom Vandergriff, proposed building a reservoir to ensure an adequate water supply for a growing city and an increasing industrial base. The lake was built in the Village Creek watershed and incorporated a smaller reservoir called Lake Erie that had provided cooling for an electric generating plant. The generating plant was located in the community of Handley and had originally powered the Interurban trolley system.

Construction of Lake Arlington was completed in 1957, near the end of the 1950's drought. In many parts of Texas, including the Dallas-Fort Worth Metroplex, the 1950's drought has been considered the "drought of record." This term means that the ten-year drought from 1946 through 1957 is considered the worst drought in recorded history. Following this drought, many communities constructed reservoirs or developed alternatives sources to provide a more reliable supply of water.

A 100-year rainfall event in the spring of 1957 filled Lake Arlington in 30 days, ending the debates that usually accompany reservoir projects. Today the lake receives supplemental water piped in from East Texas water supply reservoirs managed by the Tarrant Regional Water District (TRWD). Lake Arlington is now operated as a terminal storage reservoir within the TRWD regional raw water system.

6.2 Uses of Water

Water from Lake Arlington is used for municipal and industrial (cooling) purposes. In addition, the reservoir is used for public recreation and as wildlife habitat. Lake Arlington is foremost a water supply reservoir, providing a source of drinking water to approximately 500,000 people in the City of Arlington, and other communities. Water from Lake Arlington supplies the Pierce-Burch Water Treatment Plant (WTP), owned and operated by the City of Arlington, and the Tarrant County Water Supply Project (TCWSP) WTP, owned and operated by the Trinity River Authority (TRA). The Pierce-Burch and TCWSP WTPs intakes are at the northeast end of the Lake near the east end of the dam. There are two treatment facilities at Pierce-Burch. The north plant has a current rated capacity of 75 million gallons of water per day (mgd)and the south plant has a current rated capacity of 34 mgd for a total of 109 mgd. The TCWSP WTP treats up to 72 mgd of raw water from Lake Arlington and has planned expansions to 100 mgd.

Table 6.4.1 provides a summary of the sources of supply and uses of water within the reservoir system. The average annual evaporation based on TRWD daily evaporation data from 2005 to 2009 is 4.32 feet.

6.3 Description of Lake and Immediate Surrounding Area

Lake Arlington covers approximately 2,000 surface acres and is located at the northeast end of the Village Creek watershed. As described above, Lake Arlington receives water from runoff within the Village Creek watershed and from TRWD's Richland-Chambers and Cedar Creek Reservoirs through 72-inch and 90-inch pipelines. TRWD also has a pipeline connection to Lake Benbrook as well. The area immediately around the reservoir is a mix of urbanized and natural land uses. On the east (Arlington) side of the reservoir, the area is predominantly residential, with two public parks located on the lake. On the west (Fort Worth) side of the reservoir, the area is predominantly natural opens space, with some residential development on the south (upstream) end of the reservoir. The Exelon Handley Power Plant dominates the land use in the northwest corner of the reservoir near the dam. Current land use activities in the Village Creek watershed include a mix of urban and rural, with some pastureland.

Lake Arlington Supplies and Uses	Average Annual Inflows	Average Annual Withdrawals
Natural supply from watershed	50,995 acre-ft(1)	N/A
City of Arlington Pierce-Burch WTP	N/A	32,800 acre-ft(2)
Trinity River Authority TCWSP WTP	N/A	34,000 acre-ft(2)
Exelon Handley Power Plant	N/A	4,000(3)
Tarrant Regional Water District Discharge from Cedar Creek and Richland Chambers Reservoirs to Village Creek	43,500 acre-ft(4)	N/A

Table 6.4-1: Sources of Supply and Uses of Water

N/A – not applicable
(1) Based on rainfall data from 1992 – 2009 and PLOAD model projections. Estimated annual inflow includes baseflow from Village Creek (2,735 acre-ft) and estimated surface runoff. See Water Quality Modeling Report – Existing Conditions.
(2) Average annual withdrawal between 2009 and 2010.
(3) Projected 2010 net demand, taking into consideration diversions and return flows. (Source: TRWD, 1998)
(4) Average of monitored discharges between 2005 and 2009.

6.4 Dam and Lake Operations

6.4.1 Background

Lake Arlington is located on Village Creek, a tributary of the Trinity River. It is located between the cities of Arlington and Fort Worth, approximately seven miles from downtown Arlington. The normal conservation level of the lake and the normal shoreline is elevation 550.0 feet above mean sea level (msl) (NGDV 29). A flood storage easement (the "Flowage Easement") held by the City of Arlington extends from the lake up to elevation 560.0 feet. The 2007 volumetric survey performed by the TWDB indicated that Lake Arlington has a total reservoir capacity of 40,188 acre-feet and a surface area of 1,926 acres at its normal conservation pool elevation.

The Lake Arlington dam is an earthfill structure with a total length of 6,482 feet (1.2 miles) and a height of 83 feet. The top of the embankment is 572.0 feet above msl, but according to the TWDB volumetric survey, a parapet wall was added to the dam making the top elevation 577.5 feet above msl.

The service spillway or outlet structure is used to release water when the elevation of the lake is above the normal conservation level. The outlet is an uncontrolled "morning glory" type circular drop inlet set at elevation 550.0 feet msl. The discharge conduit is 10-feet in diameter. Figure 6.4-1 shows the drop inlet structure.

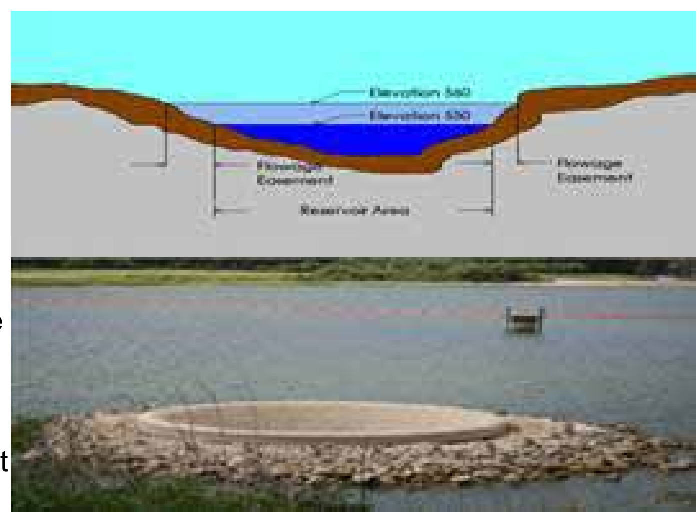


Figure 6.4-1: Flowage Easement Diagram

An emergency spillway is used to release water during flood events when the elevation of the lake rises above the outlet structure and the inflow exceeds the capacity of the discharge conduit. The uncontrolled emergency spillway is a cut in the right (or east) end of the embankment. It has a length of 882 feet and a crest elevation of 559.7 feet above msl, which is 9.7 feet above the lip of the drop inlet structure.

The drainage area of Lake Arlington is 143 square miles in size. According to an April 1999 Memorandum Report Investigation of Lake Arlington Operation Policies prepared for the Tarrant Regional Water District (TRWD), the average inflow into the reservoir from the watershed is approximately 30,000 acre-feet per year, however, the 1978 inflow was only 2,720 acre-feet. The average annual evaporation from the reservoir is 3.09 feet. The 1999 Memorandum Report states that the calculated firm yield of Lake Arlington is approximately 6,000 acre-feet per year (ac-ft/yr).

6.4.2 Operating Criteria
Lake Arlington is a source of water to three primary users: (i) the City of Arlington's Pierce-Burch Water Treatment Plant; (ii) the Trinity River Authority's water treatment plant (a component of its Tarrant County Water Project); and (iii) the Handley Generating Station. The Handley power plant is operated by Exelon Power, which is a business unit of Exelon Generation Corporation ("Exelon"). It is a 5-unit, 1,441 mega-Watt (MW) fossil power plant that provides electricity on an as needed basis to customers in the Electric Reliability Council of Texas (ERCOT) grid system.

The water rights used for the operation of Lake Arlington are held by the City and Exelon (the power plant was formerly owned by Texas Utilities Electric Company). Certificate of Adjudication (COA) 08-3391 authorizes the City and Exelon to impound up to 45,710 acre-feet of water in the reservoir. The City is authorized to divert and use up to 13,000 ac-ft/yr (an average of 11.6 mgd) for municipal purposes, and Exelon is authorized to divert and use up to 10,120 ac-ft/yr for industrial (cooling) purposes. Therefore, the City owns 56% of the conservation capacity and firm yield of the reservoir.

The Trinity River Authority (TRA) diverts water from the lake under contractual arrangements with TRWD, and that water is actually supplied from TRWD's East Texas reservoirs, not from the yield of Lake Arlington.

The operation of Lake Arlington is predicated on four major factors: (i) inflows into the reservoir; (ii) evaporation from the surface of the reservoir; (iii) diversion/use of water from the reservoir by the City, Exelon and TRA; and (iv) makeup water supplied by TRWD from Richland-Chambers and Cedar Creek reservoirs through TRWD's East Texas pipeline system, and potentially from Lake Benbrook. See Figure 6.4-2. The difference between the Lake Arlington yield, and total water demand and evaporation is provided by TRWD from the two East Texas reservoirs. The water from East Texas is discharged into Village Creek just upstream of Lake Arlington. Therefore, Lake Arlington serves as a terminal storage reservoir in the TRWD water supply system. TRWD uses an operational computer model to determine monthly targets for delivery of water to Lake Arlington from East Texas. The model is designed to optimize the operation of the TRWD system to meet water supply demands and contractual obligations while minimizing the cost of electric power and the other operations and maintenance expenses related to the TRWD system.

The operation of the lake and the water level (especially during the summer months) is also a function of contractual relationships between TRWD and the various entities using water. Because Exelon does not have a significant amount of consumptive water use and one of its major concerns is the water temperature of the lake, its contractual relationship with TRWD is based on minimum lake levels. Under a 1971

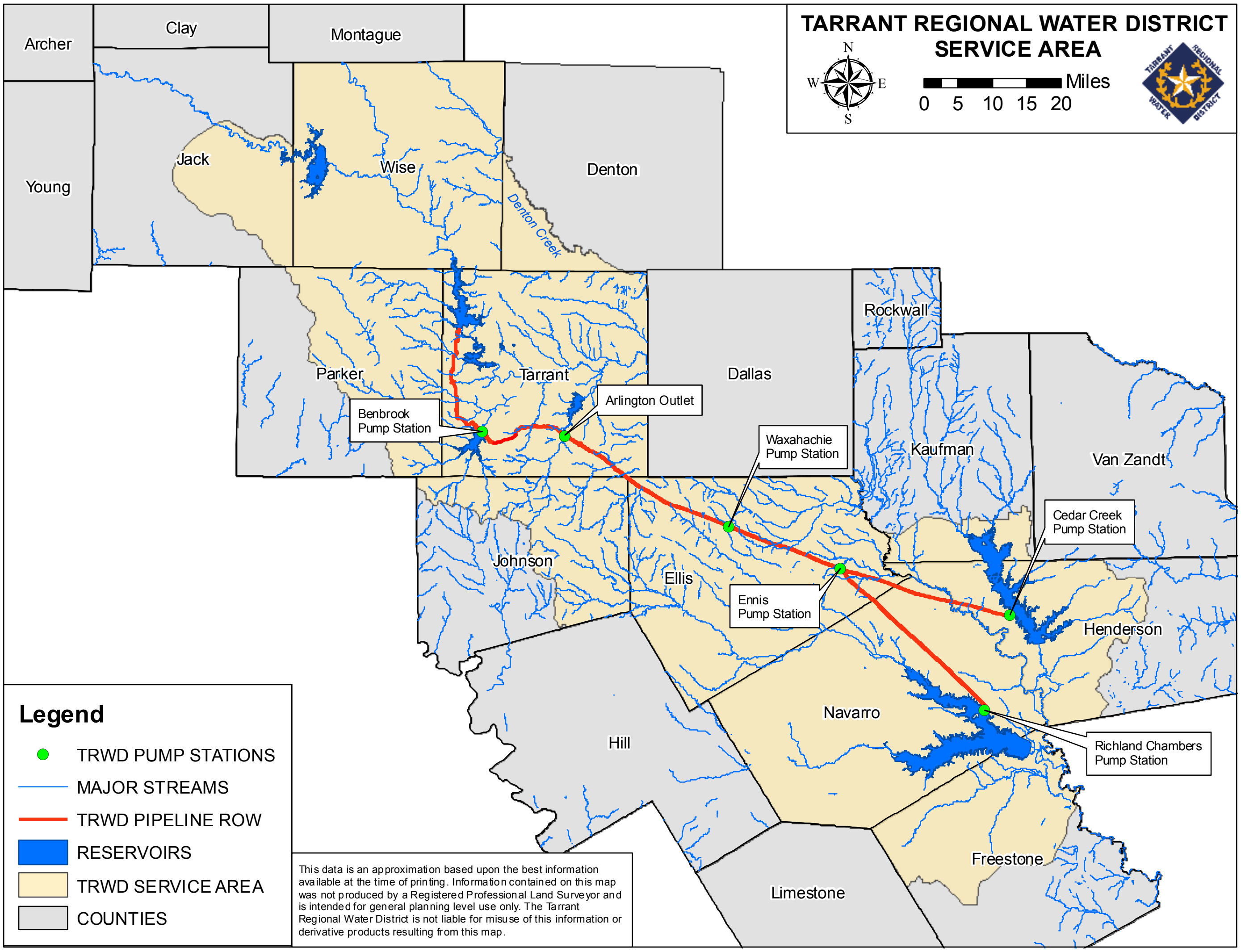


Figure 6.4-2: TRWD Service Area

agreement, TRWD has agreed to “use its best efforts” to maintain specified water levels. The required minimum water elevations are 540 feet (10 feet below normal pool) from June 1 through September 1; 535 feet (15 feet below normal) from September 1 to September 30; and 535 feet at all other times (September 30 to June 1).

There is also a water supply agreement between the City of Arlington and TRWD. Under that 1982 agreement, TRWD agrees to supply all of the City’s raw water requirements for the life of the TRWD system, and Arlington agrees to take all of its raw water from TRWD. All of the water diverted by Arlington from the lake is considered to be TRWD system water, and TRWD has the right to use the lake for the storage of its water. That agreement also requires TRWD to maintain the lake level at or above elevation 531 feet at all times. Therefore, the Exelon contract (referenced above) currently controls the minimum water level of the lake.

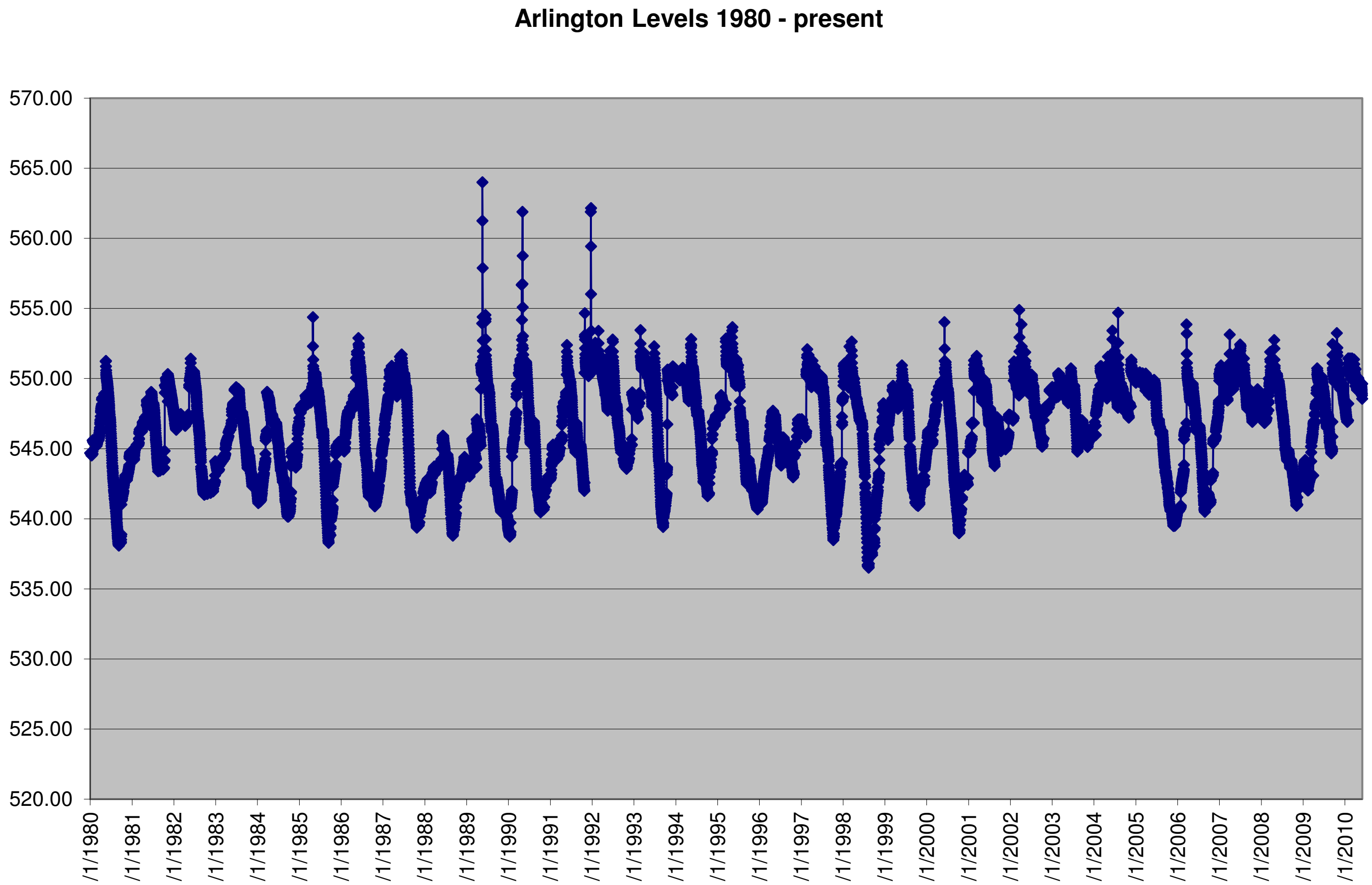


Figure 6.4-3: Lake Arlington Historic Level Since 1980

6.4.3 Lake Level Impacts

Figure 6.4-3 shows the historic level of Lake Arlington since 1980. The graph shows the regular fluctuation in lake levels, predominantly during the summer months.

Lake Arlington is an integral part of the City's water supply and utility system, and it serves a valuable purpose as a regional storage reservoir. From a water supply standpoint, lake level fluctuations do not affect availability because the City is not dependent upon the reservoir for its firm supply of raw water. TRWD is contractually obligated to supply the needs of the City and TRA. Because of the agreements between the City and TRWD, Lake Arlington is now a storage reservoir within the TRWD raw water supply system, and the level of the lake is determined by TRWD's system operations.

The water level of Lake Arlington remains an issue for some recreational users and shoreline property owners who would like to see higher lake elevations closer to 550.0 feet msl. Some boat ramps become difficult to use at elevation 542.0 feet. The upstream (south) end of the lake becomes very shallow at lower lake levels, and this reduces access to portions of the lake. At lower elevations, obstacles such as tree stumps are exposed, posing safety hazards and reducing the area that can be used for skiing and boating.

At the same time, during this planning process there were some reported benefits from lower lake levels. The exposed islands and mud flats in the upstream end of the reservoir create recurring habitat for waterfowl, and some lake users said that they appreciate the fact that lower levels force boaters to slow down in some sections of the lake.

6.5 Flowage Easement

Although private property owners own the land surrounding Lake Arlington, the City retains a peripheral"flowage and soakage" easement for the storage of flood waters (the "Flowage Easement"). The Flowage Easement of Lake Arlington is the area surrounding the lake between the elevation 560.0 feet above msl contour line and the lake (normally elevation 550.0 feet msl). This is the area that is used to temporarily store flood waters during a high flow event within the watershed. A theoretical cross section of the Flowage Easement is shown in Figure 6.4-1.

Because of the importance of the Flowage Easement to the operation of Lake Arlington, the City exercises considerable control on the activities within that area, both within the City of Arlington and the City of Fort Worth. For example, Arlington requires that property owners obtain a permit from the City prior to constructing, repairing or modifying structures within the Flowage Easement. Recommended standards for those activities are discussed in detail in other Section 8.11 of this Master Plan.

6.6 Lake Arlington Ordinances

The City of Arlington has enacted a series of ordinances to regulate activities in, on and around the lake, and establish procedures for management of this resource. The current ordinances are shown in Appendix 6.6.

The ordinances deal with a variety of issues and activities, including: the use of watercraft; fishing; construction, repair and modification of buildings and other structures; docks, piers and boathouses; and sanitation. Swimming is currently prohibited in Lake Arlington, and certain fishing activities are regulated. Permits are required for many activities within the lake and the Flowage Easement.

In February 2010, the Arlington City Council passed a resolution temporarily suspending the issuance of permits for structures (docks, piers, retaining walls, etc) and earthwork in Lake Arlington and the Flowage Easement. This suspension was enacted in order to give the City Council an opportunity to review the recommendations contained within this Master Plan and to make informed decisions concerning permitting of future improvements in the Lake Arlington area.

6.7 Description of Watershed

The following figures describe general conditions within the watershed.

6.8 Discussion of Potential Sources of Indirect Reuse

At the current time, the only two sources of supply for Lake Arlington are natural runoff from the Village Creek watershed and make-up water from the TRWD regional water system. In the future, as the population continues to grow in the watershed, it might be possible to add highly treated wastewater ("reclaimed water") as a source of supply. The dedication of reclaimed water discharges could be a source of indirect reuse water that would augment the other sources.

6.7.1 General Description

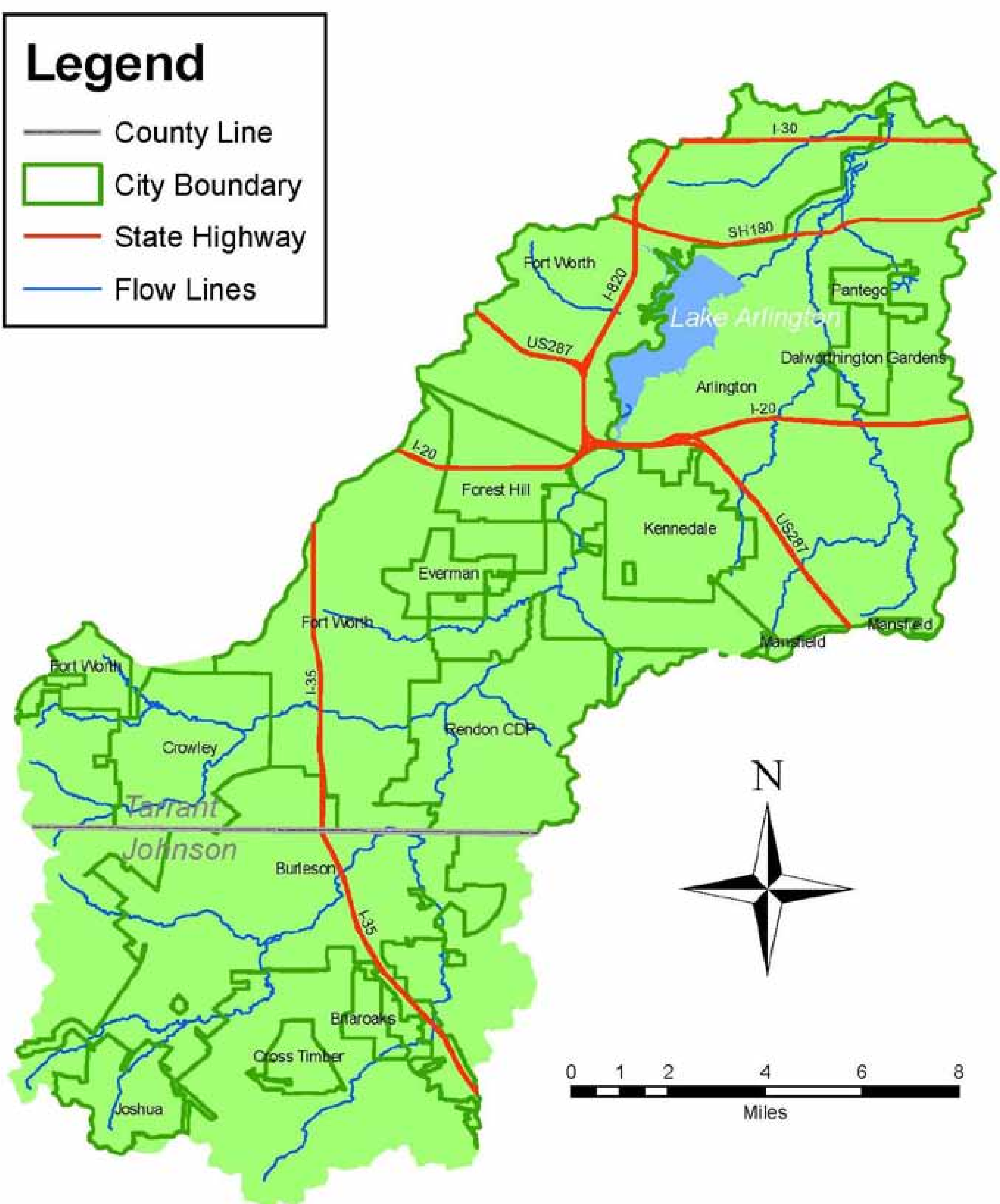


Figure 6.6-1: General Description

6.7.2 Geology

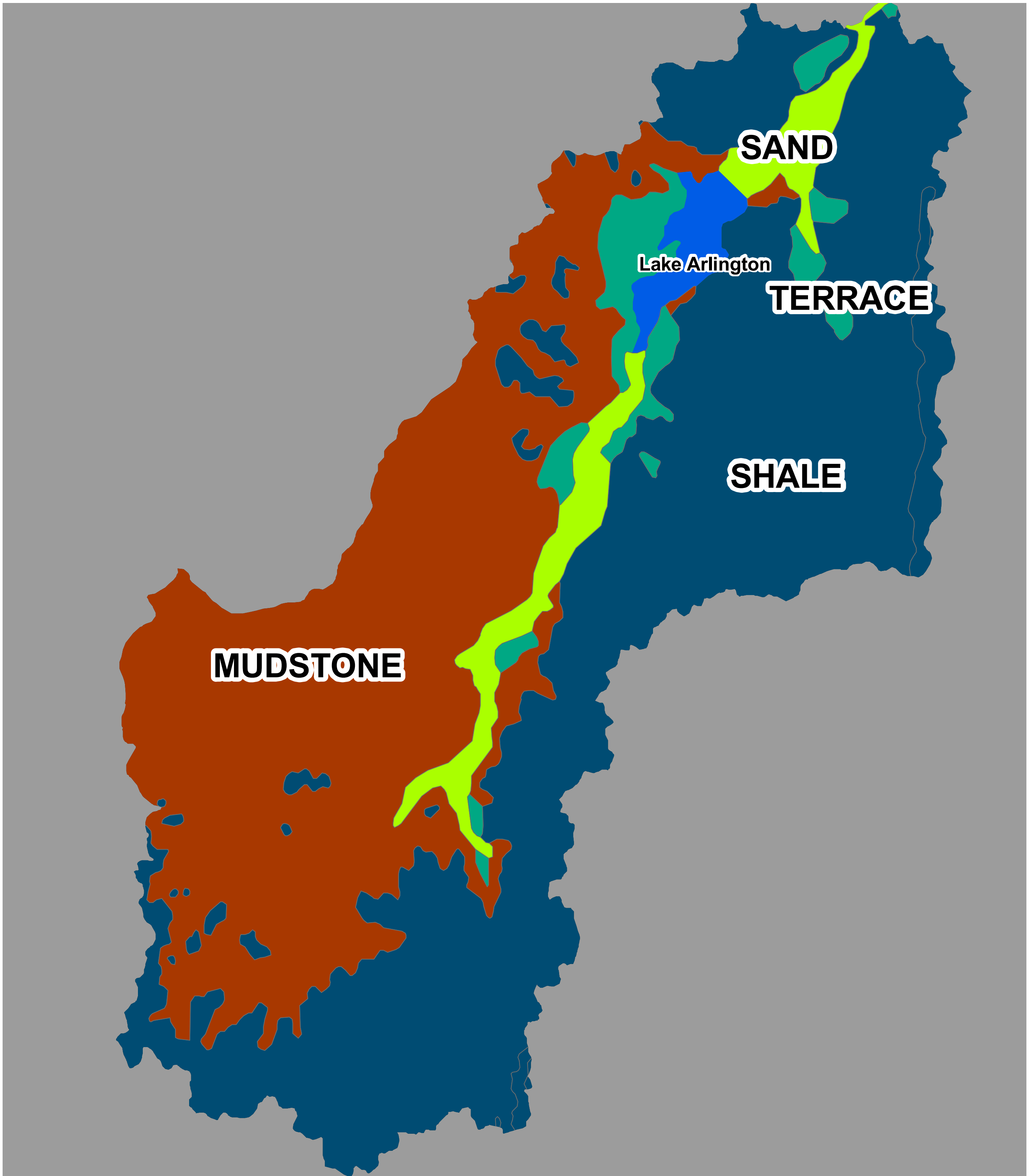


Figure 6.6-2: Geology

6.7.3 Topography

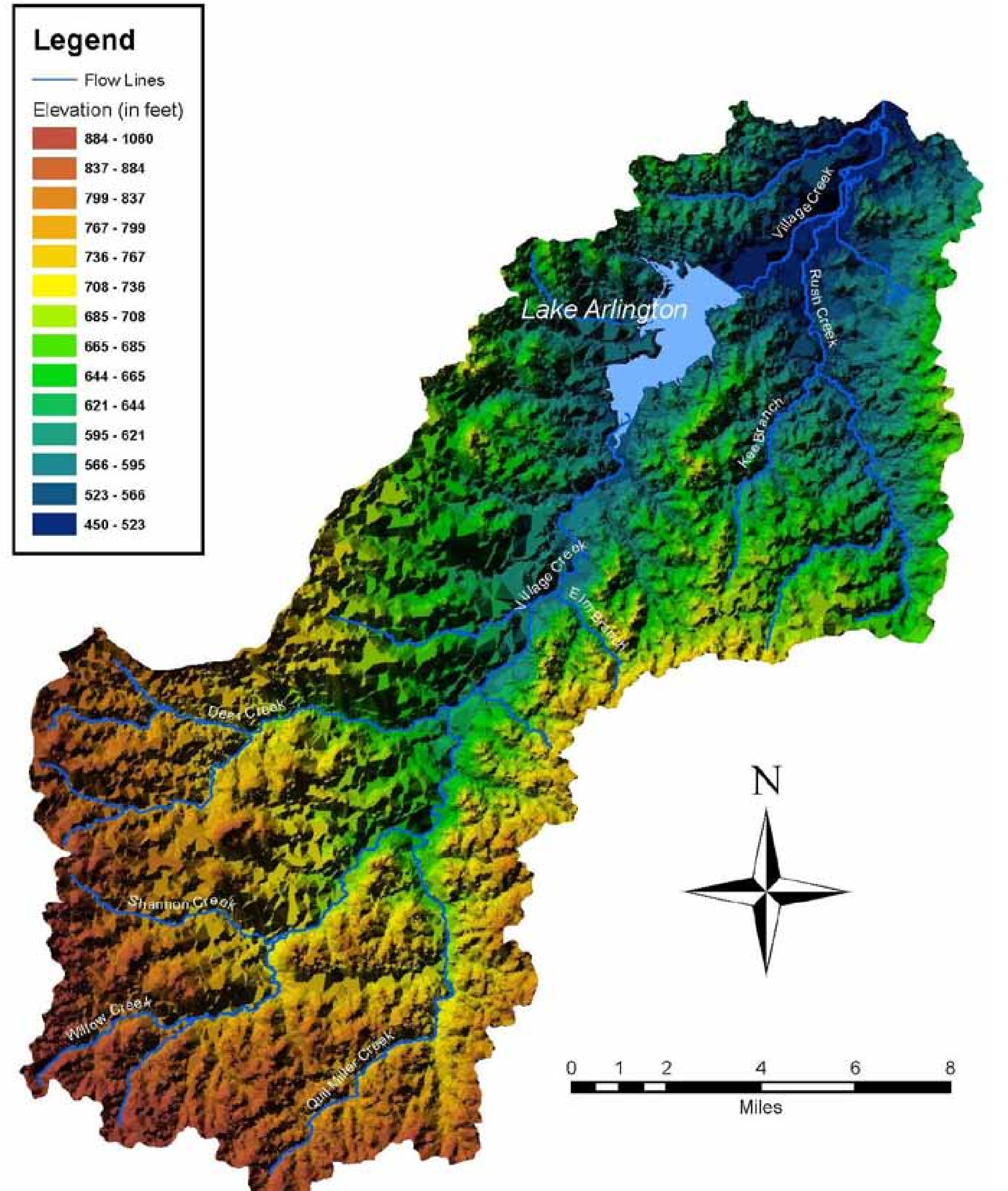


Figure 6.6-3: Topography

6.7.4 Precipitation

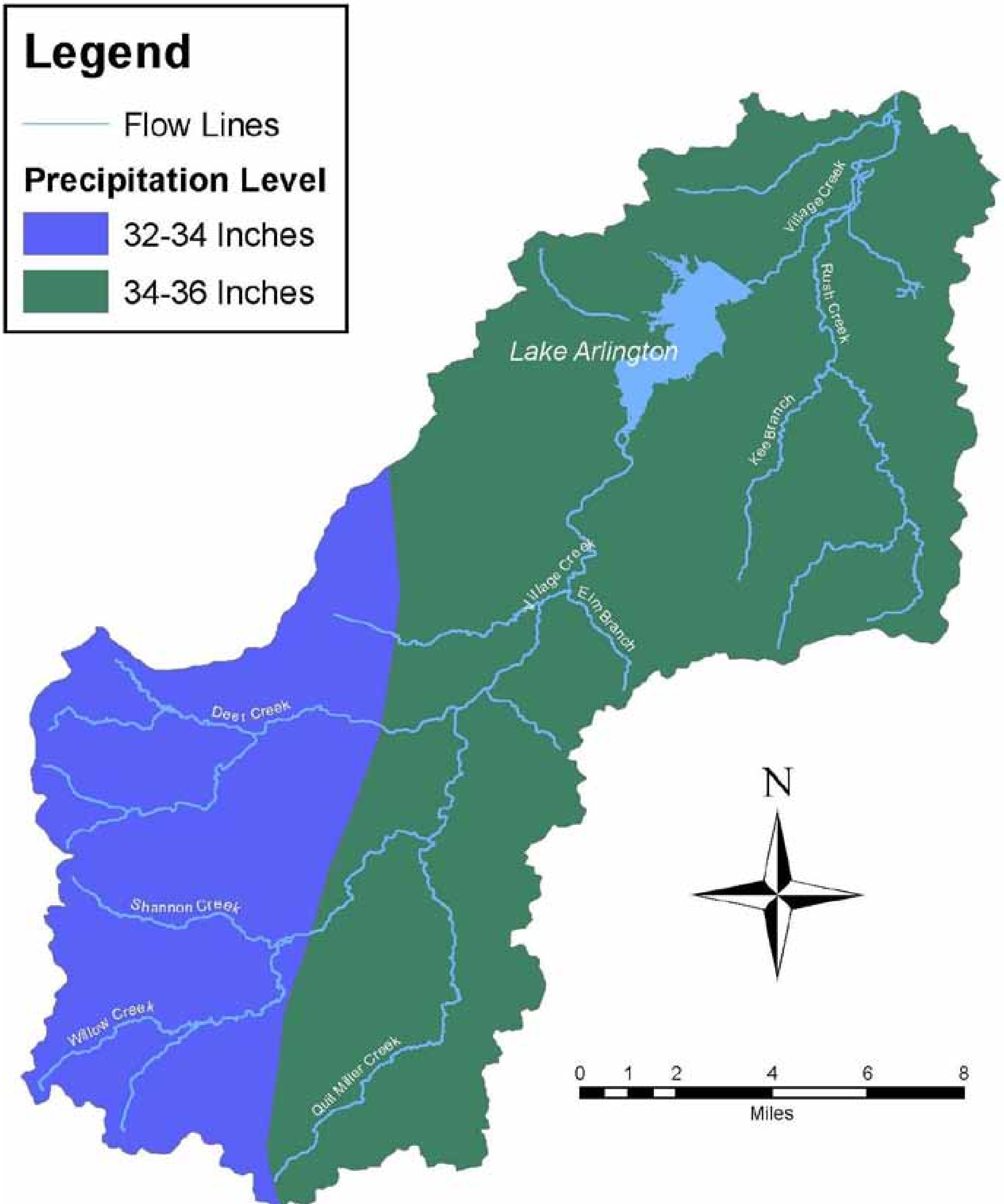


Figure 6.6-4: Precipitation

6.7.5 Land Use

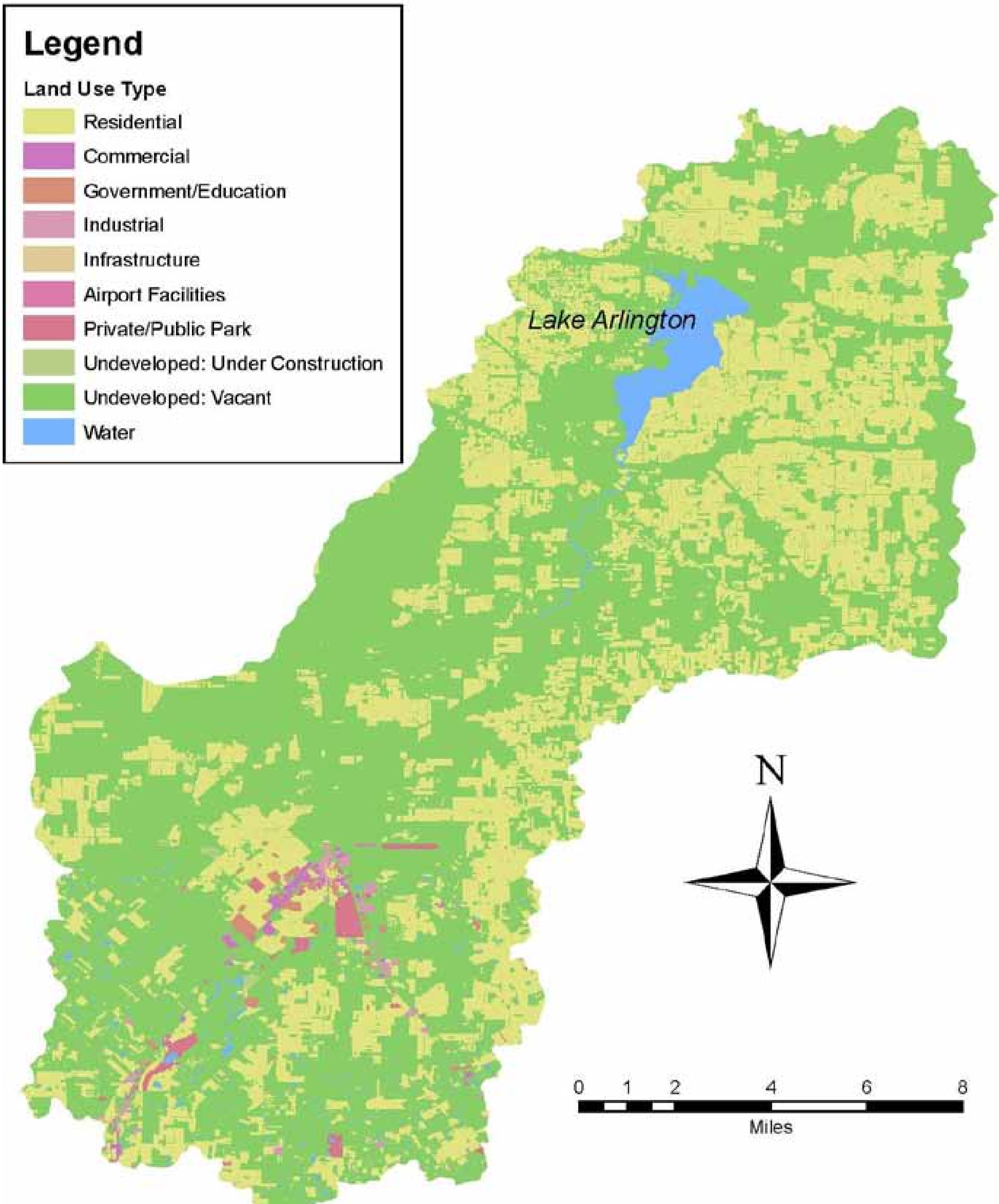
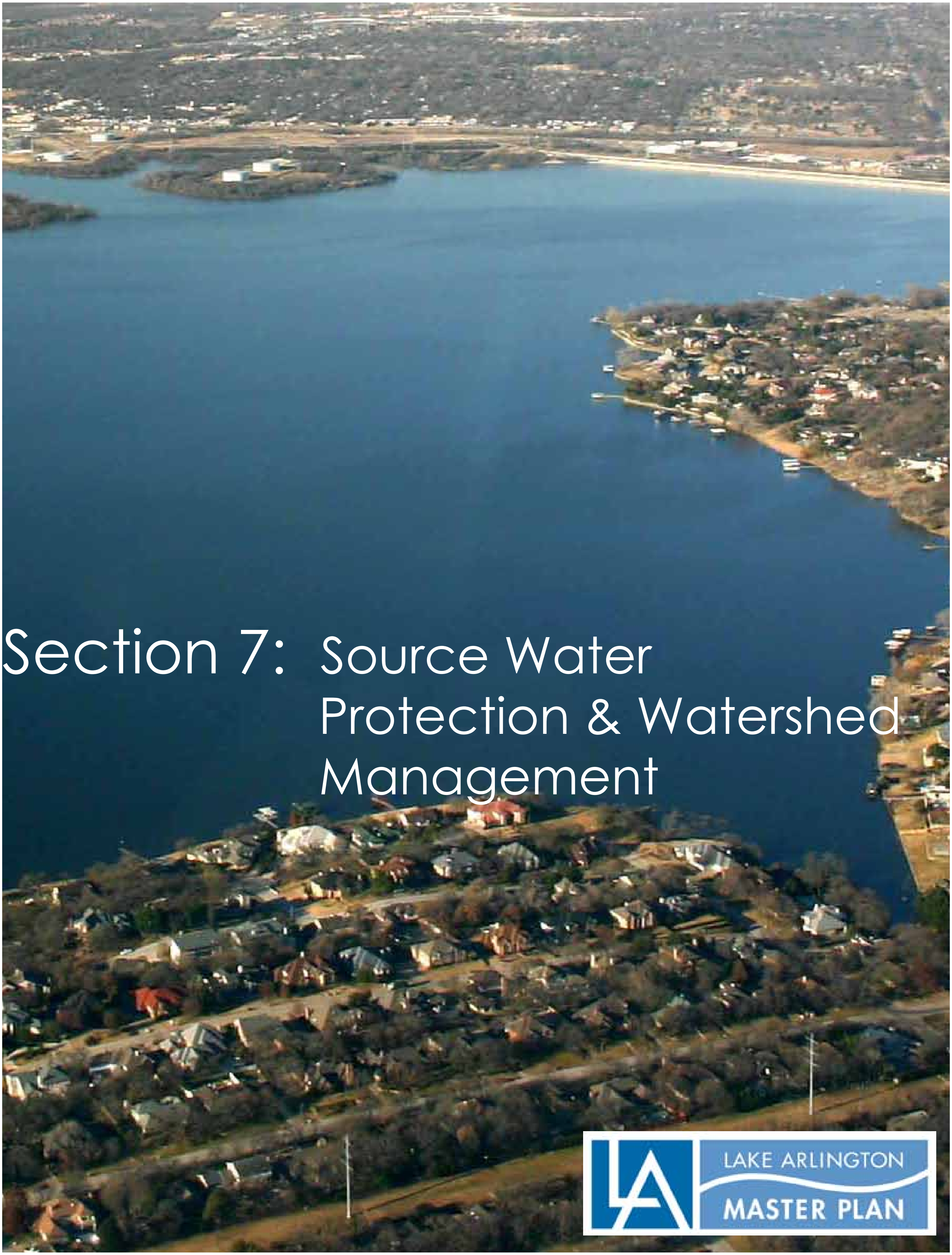


Figure 6.6-5: Land Use



Section 7: Source Water Protection & Watershed Management

LAKE ARLINGTON MASTER PLAN

7. Source Water Protection and Watershed Management

7.1 Rationale for Watershed Protection

7.1.1 Need for Protecting Lake Arlington

Lake Arlington supplies a substantial amount of raw water for public use as treated drinking water, and for industry. The quality of this water supply is critical to the public health, safety and general welfare of the community. Land uses and activities in the Lake Arlington watershed can affect the quality of water supply due to potential pollutants from various land use practices. High impact land uses and unmanaged development can contribute to the degradation of water quality of Village Creek and Lake Arlington both directly and indirectly through the degradation of contributing waters.

7.1.2 Common Themes for Watershed Management

The need for stormwater and watershed management is driven by several common themes:

- Stormwater runoff and potential impacts are directly linked to land use change.
- Control of stormwater runoff quantity and quality is necessary to minimize property damage, stream degradation, and water quality impacts.
- A long-term goal of mimicking natural hydrologic conditions will help address potential impacts from stormwater runoff.
- Multiple regulatory requirements are evolving to address the increasing importance of stormwater management and water quality protection and improvement.

Regulatory requirements serve as the framework for watershed management and protection. Federal and State regulations serve to protect and improve water quality by establishing and enforcing water quality standards and by regulating discharge of pollutants into waters of the United States. Federal regulations include the Clean Water Act and the Safe Drinking Water Act. These regulations are typically becoming more stringent.

The recommendations for watershed management strategies for the Lake Arlington watershed discussed in this document serve to assist watershed municipalities in watershed protection. The recommendations are goals that will serve to define a long-term watershed protection strategy in order to control runoff associated with land development, control construction site erosion and sedimentation, control trash and debris and other sources of pollution, and protect the public water supply. The recommended strategies also provide guidance on development policies, illicit discharge detection and elimination ordinances, establishment of environmentally sensitive areas, riparian corridor and conservation subdivision policies, public education programs, and permit reviews for proposed or upgraded wastewater treatment plants (WWTP). The recommended policies and programs will require additional review before they are adopted. The City of Arlington plans to work with other jurisdictions in the watershed to encourage the implementation of these requirements.

7.1.3 Regulatory Compliance

This section outlines the Federal and State regulatory requirements that provide much of the impetus for implementing the recommended watershed strategies in this document for the Village Creek/Lake Arlington watershed. These Federal and State regulations protect and improve water quality by establishing and enforcing water quality standards and by regulating discharge of pollutants into bodies of water.

A. Federal Water Protection Programs

Clean Water Act

The Federal Water Pollution Control Act of 1972, as amended by the Clean Water Act of 1977 (CWA), and the Federal Safe Drinking Water Act (SDWA) of 1986 are the primary federal regulatory drivers behind protecting and improving water quality. Administration and enforcement of these programs are delegated to the Texas Commission on Environmental Quality (TCEQ) by U.S. Environmental Protection Agency (EPA).

NPDES Program

The National Pollutant Discharge Elimination System (NPDES) permit program was established under the CWA to control water pollution by regulating the discharge of pollutants into waters of the United States. The NPDES program covers several pollutant sources that are regulated by permits issued by the TCEQ. These include:

- Municipal Wastewater Treatment Facilities
- Sanitary Sewer Overflows (SSOs)
- Combined Sewer Overflows (CSOs)
- Industrial and Commercial Wastewater Discharges
- Pretreatment Facilities
- Concentrated Animal Feeding Operations (CAFOs)
- Municipal Storm Sewer Discharges
- Industrial Stormwater
- Stormwater Permits for Construction Areas

Each of these programs has a role in protecting water quality and must be considered in a watershed management program. The following is a discussion of the major regulatory requirements for local governments under the NPDES program and implications for watershed and stormwater management. Several of the NPDES permit program areas affect how municipalities within the watershed handle sanitary wastewater flows. Regulations address publicly-owned treatment works (POTWs), separate and combined wastewater sewer systems, sludge and biosolids handling, and pretreatment requirements for industrial users discharging into a municipal wastewater system. Typical permits establish discharge levels (e.g., pollutant-specific limits and waste loads), monitoring requirements, and reporting requirements.

Under TCEQ's Municipal Separate Storm Sewer System (MS4) permit program, local governments in regulated areas are required to establish a comprehensive stormwater management program (SWMP) and to develop a plan and program to control stormwater pollution discharges to waters of the State to the maximum extent practical and to prevent non-stormwater discharges from entering the stormwater system.

This is accomplished through a local program which includes such measures as structural and non-structural stormwater controls, Best Management Practices (BMPs), regular inspections, enforcement activities, stormwater monitoring, and public education efforts. Stormwater management ordinances, erosion and sedimentation control ordinances, development regulations, and other local regulations provide the legal authority necessary to implement the stormwater management programs.

Federal and state regulations regarding discharges of stormwater require operators and owners to apply for and obtain NPDES permit coverage prior to conducting regulated construction disturbance and/or initial operation of small non-coal, nonmetallic mining sites, and associated land disturbance activities. These rules require that a Construction Best Management Practices Plan (CBMPP), prepared by a qualified credentialed professional (QCP), that is designed to minimize pollutant discharges in stormwater runoff to the maximum extent practicable during land disturbance activities, be fully implemented and effectively maintained.

In addition to technical and administrative requirements, the rules require that regular inspections be performed by a QCP, a trained person under the direct supervision of a QCP, or a qualified credentialed inspector (QCI) trained through the Qualified Credentialed Inspection Program (QCIP).

The registrant, owner, operator, contractor, or other responsible entity, separately or collectively, must retain NPDES registration coverage for regulated projects until existing disturbance activity and future proposed disturbance activity is complete and all disturbed areas have been reclaimed and/or effective stormwater quality has been remediation achieved.

Figure 7.1-1 illustrates the municipalities in the Village Creek watershed that are permitted by TCEQ under the Phase I or Phase II Stormwater Program. The cities with Phase I permits inlcude Arlington and Fort Worth. The entities with Phase II permits include: Burleson, Crowley, Everman, Forest Hill, Kennedale, Mansfield, Pantego, Dalworthington Gardens, Tarrant County, and Johnson County.

<u>Total Maximum Daily Loads (TDML)</u>
The Total Maximum Daily Load (TMDL) program specifies the maximum amount of a specific pollutant of concern that a designated segment of a waterbody can receive and still meet water quality standards. The TMDL also allocates pollutant loadings among point and nonpoint pollutant sources, including stormwater runoff based on waste load allocation, load allocation, and a margin of safety. Under Section 303 (d) of the CWA, TCEQ is required to develop a list of impaired waters that do not meet water quality standards.

<u>Screening Levels for Nutrient Levels</u>
In compliance with Sections 305(b) and 303(d) of the CWA, TCEQ evaluates water bodies in the state and identifies those that do not meet uses and criteria defined in the Texas Surface Water Quality Standards (TSWQS). Guidance developed by the EPA directs each state to document and submit the results of its evaluation to the EPA biennially, in even-numbered years. The TCEQ also publishes the results on its website as the Texas Water Quality Inventory and 303(d) List (the “Integrated Report”) prepared by the TCEQ and submitted biennially to the EPA. The Integrated Report is also published on the TCEQ Web site.

The Integrated Report describes the status of water quality in all surface water bodies of the state that were evaluated for a given assessment period. The TCEQ uses data collected during the most recent seven-year period in making its assessment. The data are gathered by many different organizations that all operate according to approved quality control guidelines and sample collection procedures. The quality of waters described in the Integrated Report represents a snapshot of conditions during the specific time period considered in the assessment. In most circumstances, the period of record for water quality data and information used in preparing the Integrated Report is the most recent seven years.

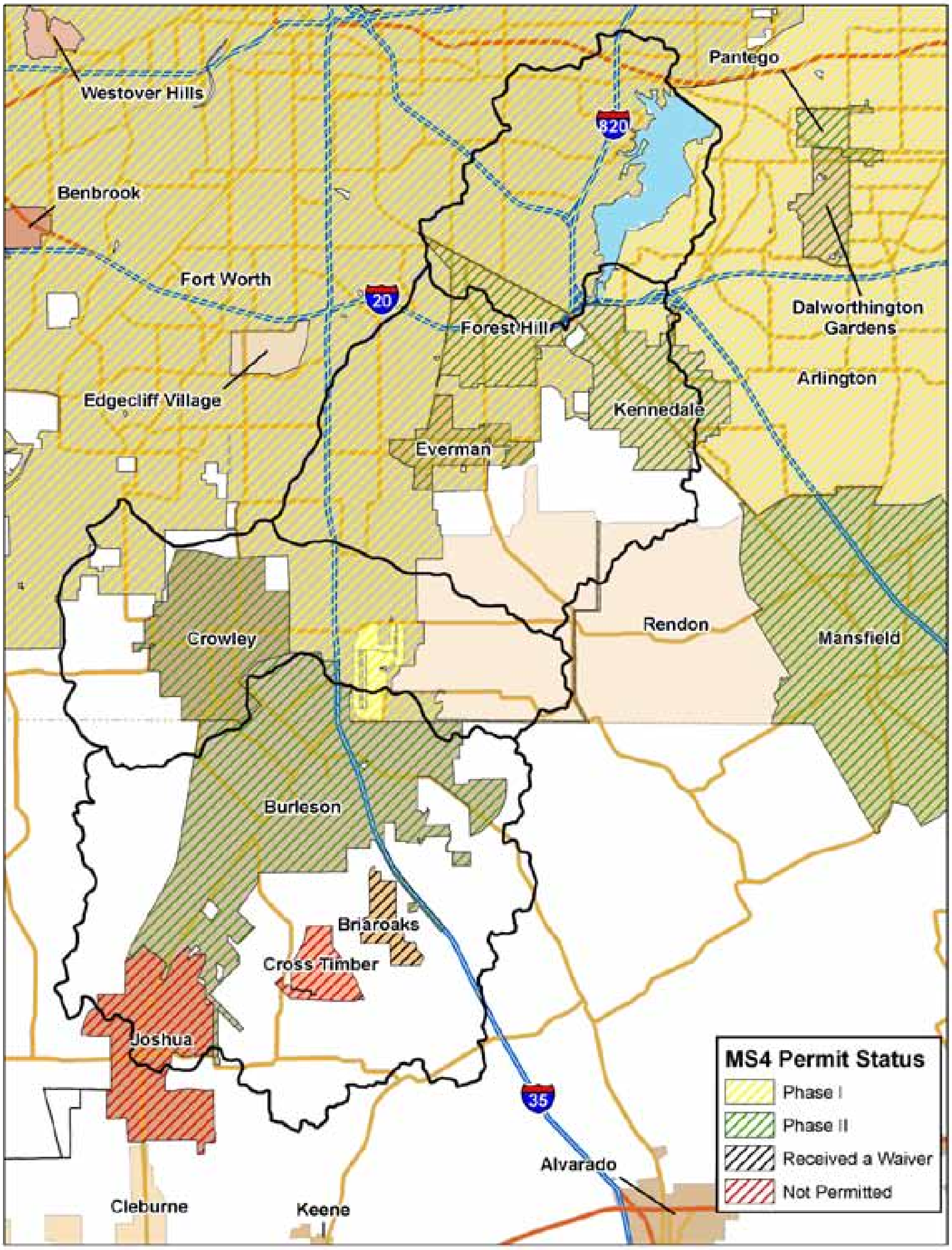


Figure 7.1-1: MS4 Designations in the Watershed *It is important to note that the Cities of Dalworthington Gardens and Pantego are in the Village Creek Watershed downstream of Lake Arlington

TCEQ has drafted the Integrated Report for 2010. *The Draft 2010 Texas Water Quality Inventory: Water Bodies with Concerns for Use Attainment and Screening Levels* lists Lake Arlington as a water-body of concern. More specifically, portions of the lake are listed as having a concern for water quality based on screening levels of chlorophyll-a, which is 26.7 ug/L.

B. Safe Drinking Water Act (SWDA)

The 1996 amendments to the Federal SDWA of 1986 (USC 42 Public Health and Welfare 300f – 300j) brought about significant changes in pollution prevention and protection for public water suppliers, as well as the State and Federal governments. One element of these amendments led EPA to require States to submit a program for development of Source Water Assessment Plans (SWAPs), with a national goal that SWAPs would be completed for watersheds serving the majority of the population by mid-2003. EPA anticipated that the assessment information would lead to the development of source water protection plans.

The benefits of a source water protection plan include:

- A more secure and safe drinking water supply.
- Possible reduction in treatment and monitoring costs.
- General cost reduction through pollution prevention.

In Texas, source water protection is a voluntary program that helps public water systems protect their drinking water sources and to ensure its continued reliability. Locally controlled and implemented, a source water protection program is designed to protect drinking water sources from potential sources of contamination.

The program involves the public water system conducting a site-specific survey to identify the potential sources of contamination near water supply wells or intakes. This inventory is conducted, at a minimum, within the area of primary influence (API) for surface water intakes. Nearby Public Water Supplies may share the same API and/or watershed. The API is based upon a 1000-foot buffer from a waterbody shoreline. It may extend upstream for PWS intakes drawing from rivers or streams. How far upstream the API extends depends upon a two-hour time of travel. These areas are referred to as source water protection areas (SWPAs).

7.2 Data sources and quality

7.2.1- GIS Data

Geographic Information Systems (GIS) was used to identify data needs and to locate good quality data sources. Most of the GIS data obtained for this project effort were provided to the Project Team by the North Central Texas Council of Governments (NCTCOG) Research Information Services department. Other sources include both public and private domain data providers. Due to large file sizes, significant data deliveries were provided via external hard drive, ftp sites, and DVDs. All of the available geographic information was then stored in a centralized location and disseminated to a secure ftp site for permitted users.

Current water and wastewater service area polygons	Texas Commission on Environmental Quality (TCEQ)
Land use layer with accompanying land use codes	North Central Texas Council of Governments (NCTCOG)
Wetlands layer	US Fish and Wildlife Service (USFWS)
Current aerial imagery	NCTCOG
Natural feature layers such as open spaces, parks, etc.	NCTCOG
10-digit and 12-digit HUC layers for the Village Creek Watershed	NCTCOG
Topographic layers (least interval contours)	NCTCOG
County soil data	United States Department of Agriculture (USDA) Natural Resources Conservation Sources (NRCS)
Natural gas well locations	Railroad Commission of Texas (RRC)
City coverage layer within watershed	Texas Natural Resources Information System (TNRIS)
Cultural features within the watershed (recreational facilities, schools, churches, etc.)	NCTCOG
Hydrography layer	NCTCOG
Surface water quality monitoring points	TCEQ
Surface water flow monitoring points	NCTCOG
Shapefile of Texas Pollutant Discharge Elimination System (TPDES) permitted dischargers and outfalls	TCEQ
Shapefile of industrial and hazardous waste sites	TCEQ
Shapefile of TPDES permitted water supply diversion points	TCEQ
Toxic Release Inventory (TRI) locations within watershed	TCEQ
Shapefile of Superfund sites within watershed	TCEQ
100-yr and 500-yr floodplain layers	NCTCOG
Floodway layer	NCTCOG
Tarrant and Johnson Counties Tax Assessor parcel data (shapefiles and associated owner information)	Tarrant Appraisal District (TAD)
Street centerline files	NCTCOG
Lake Arlington bathymetric layer	Texas Water Development Board (TWDB)

7.2.2- Policies, Regulations, and Procedures

Masterplans, land use policies, zoning ordinances, and development ordinances were obtained from the cities, townships, and counties that occupy the watershed, when available. NCTCOG provided a master contact list to the Project Team and every avenue was pursued to obtain supporting documentation for this effort.

Current masterplans and Comprehensive plans from the cities in the watershed	NCTCOG
Land use policies	City of Mansfield
Flood plain zoning ordinances	The City of Joshua
Subdivision and commercial development ordinances	NCTCOG Franklin Legal Publishing City of Mansfield

7.2.3- Other Electronic Data

Lake water quality data, water quality reports from the Handley Steam Generating Power Station, historic rainfall data, and population demographic data were obtained through public and private sources.

Regional stormwater removal efficiency data	TCEQ
Lake Arlington water quality data	TCEQ
Water quality data/reports from Handley Steam Generating Power Station	Post, Buckley, Schuh & Jernigan, Inc. (PBS&J) Hungerford, Thomas and Raphael Brock
Historical rainfall and reservoir evaporation data	National Oceanic and Atmospheric Administration (NOAA)
Population/ demographic information	NCTCOG Understanding Our Options for Growth

7.2.4- Carrying Capacity Information

Permitted dock owners and shoreline landowners were determined through the assistance of the City of Arlington and through the use of Tarrant County Appraisal District information.

List of dock permit holders	City of Arlington
List of shoreline property owners	City of Arlington
List of shoreline property owners	TAD

7.2.5- Other Reports and Information

Extensive research was performed at the Texas Commission on Environmental Quality to obtain multiple reports from overlying municipalities and industries that may impact the watershed.

WWTP annual reports for the City of Arlington for the past 3 years	TCEQ
Discharge monitoring reports for industrial facilities for the past 3 years	TCEQ
Lake level data	City of Arlington
WWTP annual reports for the cities of Ft. Worth, Kennedale, and Johnson County FWSD No. 1 for the past 3 years	TCEQ
Stormwater management plans	TCEQ
2008 and 2009 MS4 annual reports and permits	TCEQ

7.2.6- Public Involvement Information

All public involvement information was gathered with the help of both the NCTCOG and the City of Arlington.

7.3 Existing Resource Conditions

7.3.1 Lake Arlington

The primary use of Lake Arlington is for fresh water for potable purposes. Thus, the following review of lake water quality data focuses primarily on parameters of importance for water treatment plant operations and for compliance with U.S. Environmental Protection Agency (USEPA) and TCEQ primary drinking water standards. Water quality parameters of interest from a recreational and lakeshore aesthetics perspective are included in the discussion. The Review of Lake Arlington Water Quality technical memorandum (Appendix 7.3-A) provides information on the data sources reviewed for the Lake Arlington Master Plan.

Water quality in Lake Arlington is generally of good quality. Table 7.6-1 lists measured concentrations for various general physical, chemical, and microbial parameters in the lake[5]. Drinking water maximum contaminant levels (MCLs) and secondary MCLs are provided for reference. Note, however that the listed average, minimum, and maximum concentrations are for raw water samples; treatment is applied at the City of Arlington Pierce-Burch WTP and the TRA TCWSP WTP to meet the MCL requirements in finished water.

Raw water from Lake Arlington is characterized by moderate alkalinity, hardness, and pH. Average concentrations of salts in Lake Arlington water are low, with total dissolved solids (TDS) and chloride concentrations significantly below the SMCLs. At an average of 5.7 milligrams per liter (mg/L), total organic carbon (TOC) concentrations in Lake Arlington are fairly typical for surface water. Microbial characteristics of the raw water and concentrations of other parameters are discussed in the following paragraphs.

5 Data presented in the table were downloaded from the TCEQ Surface Water Quality Monitoring Information System (SWQMIS), which includes data for more than 270 different parameters. Data are compiled from USGS and other monitoring stations.

Microbiological Characteristics

E. coli and fecal coliform concentrations are also listed in Table CG-1, (Appendix 7.3-B). While E. coli and fecal coliform do not present a direct public health risk, their occurrence in water samples is an indication of animal or human fecal contamination and the potential presence of pathogenic microorganisms that do exert a health concern (e.g., *Giardia*). The average *E. coli* and fecal coliform concentrations in Lake Arlington samples are within range of expected values for surface water with upstream discharges from wastewater treatment plants and nonpoint sources of pollution (e.g., stormwater runoff, etc.). *Cryptosporidium* samples collected at the Pierce-Burch WTP raw water intake between January 2009 and November 2011 were non-detect and the Pierce-Burch WTP has been classified as Bin 1 under the LT2ESWTR based on data previously reported to TCEQ. The Pierce-Burch and TCWSP WTPs are designed to meet 4-log virus removal (i.e., 99.99% removal) and 3-log *Giardia* removal (i.e., 99.9% removal) to prevent exposure to pathogens that may be present in the source water.

In addition to pathogens, the presence of other microorganisms, such as algae, can also be a concern. Acceptable algal concentrations in drinking water are not explicitly specified in water quality standards. Algae are considered indirectly through non-specific parameters such as turbidity, color, or TOC. However, it is possible that finished water that meets regulatory standards may still contain a relatively high algal load.

Chlorophyll a is a pigment found in algae; chlorophyll a concentrations above 10 micrograms per liter (ug/L) can be used as a guideline for algal activity in water. The average chlorophyll a concentration in samples collected from USGS Site AC (see Figure CG-1, Appendix 7.3-B) between April 2005 and November 2008 (37.5 ug/L, see Table CG-1, Appendix 7.3-B), indicates significant algal activity in the lake. Complications associated with algae include:

- Presence of algal by-products, such as geosmin and methylisoborneol (MIB), impacting the taste and odor of WTP finished water.
- Lake eutrophication, leading to anoxic conditions and the potential release of dissolved iron and manganese from lake sediments.
- Increased chlorine demand with potential implications on drinking water treatment efficiency and operations, including clogging of intake screens, flow disruption and shortened filter run times.
- Presence of certain algal toxins (e.g., cyanobacterial secretions) that have been linked to fish kills, poisoning of shellfish, and illness in humans.
- Biological growth in the distribution system if algae pass through the filters.
- Increased DBP precursors concentrations leading to the formation of trihalomethanes, haloacetonitriles, and other halogenated by-products that may have adverse health effects.

Taste and odor concerns associated with the release of geosmin, and iron and manganese during anoxic conditions are likely the most pressing concerns related to algal growth for Lake Arlington. Geosmin is a metabolite of blue-green algae that imparts a characteristic earthy/beet odor to water. The odor threshold concentration (OTC) for geosmin is 10 nanograms per liter (ng/L); at concentrations above the OTC, sensitive portions of the population can usually detect the characteristic odor in water.

Figure CG-2, (Appendix 7.3-B) shows geosmin concentrations in samples collected from the Lake Arlington intake. As expected based on the relatively high chlorophyll a concentrations in Lake Arlington, geosmin concentrations above the OTC were routinely detected in samples collected between November 2007 and March 2008. The Pierce-Burch and TCWSP WTPs use ozone and biological filtrationto remove geosminand control taste and odor in the finished water. However, additional barriers my be needed if geosim concentrations increase and reach peak concentrations of several hundred ng/L.

Nutrients
Table CG-1, (Appendix 7.3-B) lists total ammonia, nitrate, and phosphorus concentrations in samples collected at the Pierce-Burch WTP intake. Ammonia and nitrate concentrations in Lake Arlington are low. However, average phosphorus concentrations are above the 0.039 mg/L draft criteria for total phosphorus established by the TCEQ Water Quality Standards Workgroup for Lake Arlington (see Attachment 3). TCEQ is establishing phosphorus (and chlorophyll a) standards for different water bodies in Texas to minimize algal growth and the potential for eutrophication and associated deterioration in water quality.

Inorganic Contaminants
Average iron and manganese concentrations in the lake exceed the SMCLs (Table [CG-1]), leading to potential aesthetic concerns if the metals are not removed through the WTPs. Elevated manganese concentrations are a well-studied water quality issue for both the City of Arlington and TRA. While iron and manganese do not present a health risk at concentrations found in drinking water, elevated concentrations of both metals can lead to colored water complaints due to a reddish appearance associated with iron precipitation and black particles associated with manganese precipitation. Dissolved manganese can also impart a yellow tint in water.

Iron and manganese are naturally-occurring metals. Village Creek flows through the iron-rich sandy soils of the Eastern Cross Timbers Region and is likely picking up both metals which then may accumulate in the sediments in Lake Arlington. As the water column becomes anoxic in summer months, iron and manganese are released from the sediments, leading to elevated concentrations at the TRA and City of Arlington raw water intakes (Figure CG-3, Appendix 7.3-B).

Table [CG-1] also lists average and maximum arsenic concentrations in lake samples collected from USGS Site AC between April 2005 and November 2008. Concentrations were below the 10 ug/L MCL. Arsenic is a naturally-occurring metal and elevated concentrations in Lake Arlington water are likely attributed to the mineralogy of the watershed.

Organic Contaminants
In addition to naturally-occurring organic matter (NOM), organic chemicals derived from human activities may enter the watershed either via direct point sources or from street runoff (e.g., polyaromatic hydrocarbons from vehicular traffic), agricultural runoff (e.g., herbicides/pesticides), or other contaminant routes. Organic chemicals can generally be defined within one or more of the following categories:

- Volatile organic compounds (VOCs),
- Other synthetic organic compounds (SOCs), or
- Pharmaceuticals and personal care products (PPCPs)

The TCEQ SWQMIS website only provided data on herbicides/pesticides that would likely enter the watershed via agricultural runoff. Data from a Handley Power Plant were also reviewed for potential point source contribution of organic compounds. Appendix 7.3-D lists concentrations for parameters analyzed in four samples collected from Outfall 001 on June 17, 2008. Compliance data for all of the organic compounds showed concentrations below the maximum acceptable level (MAL) established by TCEQ for the discharge location. However, the data are from only one day of sampling; additional data would be needed to further review organics concentrations in the power plant effluent.

Table [CG-2] lists minimum, average, and maximum concentrations of regulated organic compounds measured in finished water samples collected at the Pierce-Burch WTP in 2009. For all of the listed organic compounds, measured concentrations were below the MCL. The use of ozone could reduce concentrations of some organic compounds if present in the raw water; however, if the lake became contaminated with synthetic or volatile organic compounds, additional treatment would likely be required for regulatory compliance.

In 1986, USGS monitored for several organic compounds at the sites shown on Figure [CG-1]. Specifically, USGS monitoring data for the following compounds were available through the TCEQ SWQMIS website: 2,4-D, endrin, lindane, methoxychlor, silvex, and toxaphene. All six compounds are used either as a pesticide, insecticide, or herbicide. Several are currently regulated (or banned) herbicides that likely entered the watershed before the regulations were enacted. Concentrations of silvex and 2,4-D were detected at all three USGS sample sites. Concentrations of the other four organic compounds were below the detection limit.

Spatial Variations in Water Quality
Water quality data for samples collected in the northern, middle, and southern portions of the lake were reviewed for any spatial trends in water quality. Table [CG-3] lists the average concentrations of select parameters for samples collected from each location between April 2005 and November 2008. Several potential trends are worth noting:

- Turbidity is higher and transparency is lower in the southern portion of the lake, indicating particle settling across the length of the reservoir. While particle sedimentation improves influent water quality to the water treatment plant, the settled particles lead to gradual accumulation of sediments in the lake and reduced lake storage capacity.
- The average pH is lower at the dam (northern portion) where both of the WTP intakes are located. The pH is affected by various chemical and biological processes in the lake.
- The conductivity is slightly higher at the dam (northern portion). However, conductivity, which is an indirect measure of total dissolved solids concentrations, is relatively low throughout the lake.
- Fecal coliform concentrations are lower at the dam (northern portion), potentially due to particle settling, microbial inactivation from UV exposure, and/or dilution.
- Chlorophyll-A concentrations are lower at the dam (northern portion) than in other portions of the lake (Table [CG-3]). In contrast, the 2004 Village Creek Assessment report similarly showed chlorophyll a concentrations increasing through the reservoir.[6] Further assessment is required to confirm spatial trends in algal growth through the lake. Generally, chlorophyll a concentrations are high and the TCEQ draft chlorophyll a criteria (Attachment 3) for Lake Arlington are exceeded.
- Iron concentrations appear to be slightly higher in the southern portions of the lake.
- Average concentrations of 2,4-D, a regulated herbicide were highest in the southern portion of the lake, whereas concentrations of silvex (a banned herbicide) were highest at the dam. Agricultural activities are limited to the southern (upstream) portion of the watershed. The presence of the two herbicides in the lake is likely attributable to contamination from agricultural activities conducted prior to the regulation of or ban on those two chemicals. Accumulation of the herbicides in the lake sediments could also be contributing to release into the raw water.

6 2004 Water Quality Assessment Results for Individual Water Bodies (Segment 828 Lake Arlington).

Summary of Lake Water Quality

Water quality in Lake Arlington is generally good, with only a few specific issues of concern:

- Temperature. TCEQ's 303(d) report issued in 2002 lists high temperatures for Lake Arlington at several locations.[7] TCEQ's 2004 Assessment Report states that "additional data are needed to determine whether natural conditions alone can cause elevated temperatures in the lake or whether the Handley Power Plant is a significant contributing factor."
- Manganese. Manganese (Mn) concentrations increase during the late summer months due to anoxic conditions in the lake hypolimnium. The City of Arlington has the ability to vary intake levels to withdraw source water with lower manganese concentrations for the Pierce-Burch WTP. Oxidation followed by sedimentation and filtration reduces manganese concentrations in the finished water. However, if manganese concentrations increase and/or anoxic conditions occur at shallower depths, management of Mn in the WTP source water and at the WTP may become more challenging.
- Algae. The Village Creek screening level for chlorophyll a is exceeded[8] and concentrations in the reservoir indicate significant algal activity. Geosmin concentrations close to two orders of magnitude above the 10 ng/L odor threshold concentration were measured in samples collected at the Lake Arlington intake in 2008. Ozone addition at the Pierce-Burch WTP helps control taste and odor in the finished water.
- Synthetic Organic Compounds (SOC). A round of monitoring for all SOCs, including 2,4-D and silvex should be conducted to establish the current benchmark water quality. Monitoring should also include contaminants targeted for near term regulatory determination (e.g. nitrosamincs, carcinogenic VOCs) and of public concern (e.g. pharmaceuticals). Updated data on 2,4-Dand silvex should be reviewed to assess current concentrations since the 1986 USGS data showed detectable levels of both herbicides.

Current water quality conditions provide a baseline by which to consider future impacts to lake water quality under proposed developed scenarios. In particular, development activities that exacerbate the issues above should be mitigated through the implantation of best management practices. Future impacts to lake water quality and proposed best management practices are discussed in Section 7.7 through 7.10.

7.3.2 Watershed

Lake Arlington covers approximately three square miles and is located at the end (northeast portion) of the Village Creek Watershed. The tributary watershed area upstream of Lake Arlington, illustrated in Figure 7.3-1, is about 140 square miles. Since Lake Arlington is located at the downstream end of the Village Creek watershed, its water quality will be affected by human-induced activities in the overland area upstream on Village Creek and its tributaries. Measures need to be planned prior to future development of the watershed to prevent increased pollution in Village Creek and ultimately Lake Arlington. Current land use activities in the Village Creek Watershed include a mix of urban and rural with some pastureland. A brief review of potential pollutant sources in Village Creek Watershed and the area surrounding Lake Arlington is presented in the Section 7.4 of this report.

Watershed characteristics (e.g., soil type, terrain) and land use patterns impact water quality and provide an indication of potential contaminants that could be a concern for a given area. For example, animal and human activities in the watershed can impact microbial water quality, contribute chemical contaminants to

7 2002 Water Quality Assessments for Individual Water Bodies, http://www.tceq.state.tx.us/compliance/monitoring/water/quality/data/02twqi/02_305b.html

8 2004 Water Quality Assessment Results for Individual Water Bodies (Segment 828 Lake Arlington).

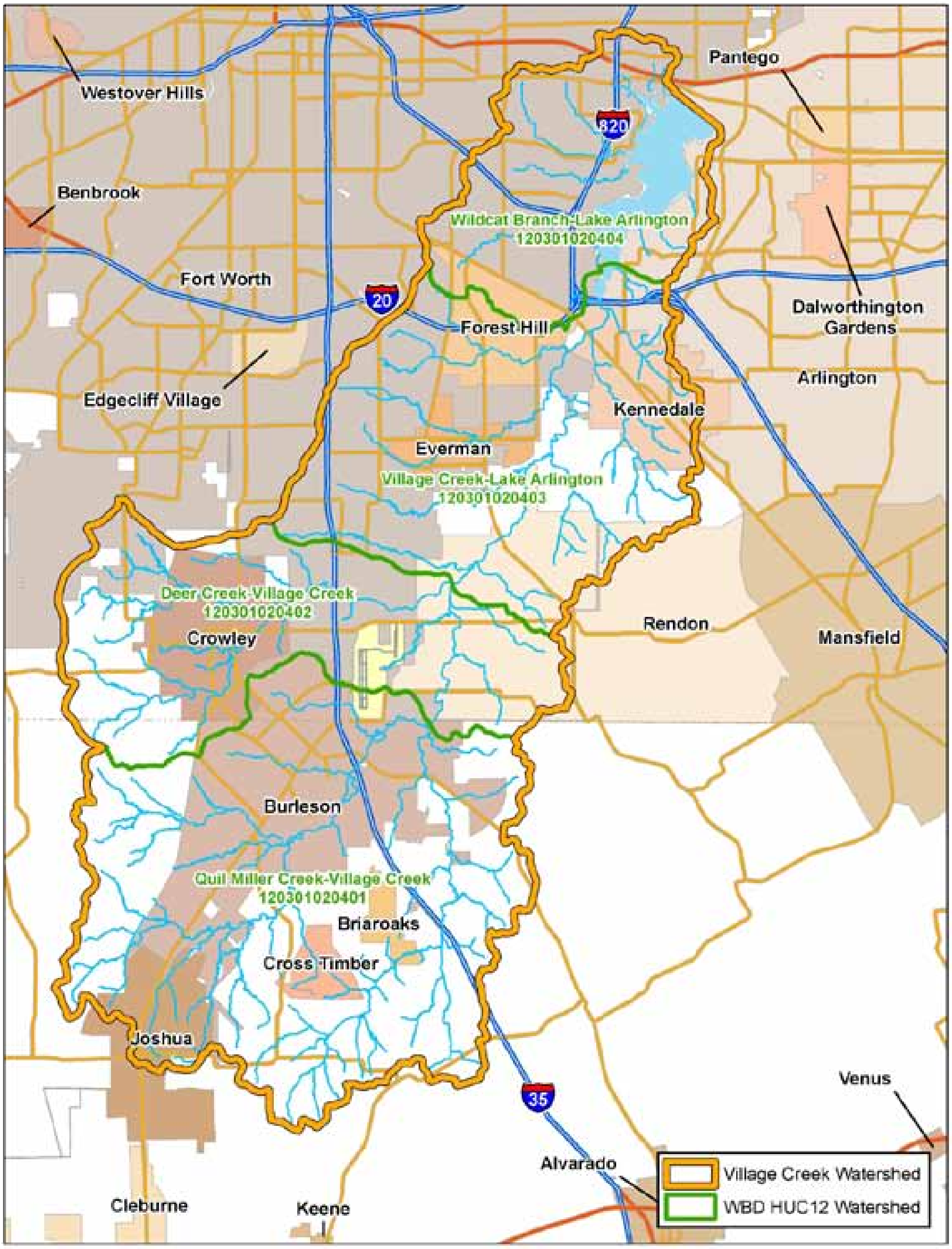


Figure 7.3-1: Lake Arlington HUC12 (Hydrological Unit Code 12) Watershed

the water, and can impact disinfection by-product precursor concentrations, affecting water quality issues resulting from treatment and distribution. Currently the watershed has about 1.9 million people and is projected to grow to approximately 2.5 million by 2030. Urban runoff during storm events can be a source of polyaromatic hydrocarbons (PAHs, from roads), pathogens (e.g., from pet excrements), metals (e.g., zinc from roofs), and other synthetic organic compounds (SOCs) used for basic human activities (i.e., cleaning products,herbicides used on lawns, etc.). Non-point source pollution from agricultural activities can contribute nutrients from fertilizers, pesticides (e.g., atrazine), animal pathogens, and growth hormones (e.g., endocrine disrupting compounds) to the watershed. Agricultural activities in the Village Creek Watershed are limited, occurring primarily near the watershed headwaters, and are not expected to have a significant impact on lake water quality. In fact, over time, agricultural activities can be expected to decrease with urbanization.

The industrial footprint in the Village Creek Watershed, in terms of land use, is relatively limited. Nevertheless, a variety of industrial activities are conducted within the watershed, with the potential to impact water quality. The Handley Generating Station, located on the northwest shore of Lake Arlington, has a TPDES permit allowing discharge of treated wastes into the reservoir. The permit specifies discharge limitations associated with temperature, total and free chlorine concentrations, total suspended solids, and oil and grease at two outfall locations (Outfall 001 and 201). One superfund site (Tricon America, Inc.) and one hazardous waste site (Everett Kates, Incorporated) are also located in the watershed. Five municipal wastewater treatment plants (WWTPs) currently discharge treated effluent into directly into Lake Arlington or its tributaries. Gas well development in the watershed is increasing as a point source load of TSS to the Lake Arlington and its tributaries.

The daily rainfall data monitored at the Dallas-Fort Worth International Airport rain gauge station by the National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) has shown an average annual rainfall of 35.2 inches. Since this station is in close proximity to the Lake Arlington watershed, the monitored data at the station should represent the rainfall patterns in the watershed. The period of rainfall data record used in the analysis included the years 1976 through 2009, a total of thirty-four years. These rainfall data were assessed for temporal trends and average annual rainfall depth. The year 1980 had the lowest number of days with rain (56), whereas 2007 had the highest number of rainy days (142). The maximum recorded daily rainfall depth of 4.4 inches occurred in 2002 for the period of record. On average, there were 93 average days with recorded rainfall per year. The maximum annual rainfall of 52 inches occurred in 1991 and the lowest annual total rainfall of 19.0 inches occurred in 2005. Figure 2 displays the annual total rainfall depths for the period of record. The rainfall data analysis details can be found in Attachment 1, Lake Arlington Rainfall Analysis (Malcolm Pirnie, August 2010) technical memorandum. Analysis daily flows record of USGS stream flow gauge station 08048970 at Everman has shown annual mean flow of about 26.300 ac-ft and mean annual baseflow of about 2,700 ac-ft. The data period for the analysis included the years from 1992 through 2009. The stream flow data analysis details can be found in Attachment 2, Water Quality Modeling Report – Existing Conditions (Malcolm Pirnie, December 2010).

7.4 Likely Pollution Sources

The City of Arlington is a participant in TCEQ's Source Water Protection Program (SWPP), which provides public water systems an opportunity to take an active role in maintaining source water quality. As a participant in the SWPP, the City conducted a survey in August 31, 2002 to identify potential sources of contamination to the water supply. The following paragraphs discuss potential point and non-point sources of pollution to the watershed.

7.4.1 Wastewater treatment plants

Figure [CG-X] shows known point source (TPDES-permitted) discharges in the Village Creek Watershed. Five municipal wastewater treatment plants (WWTPs) currently discharge treated effluent into Village Creek or its tributaries in the headwaters of the watershed. Treated wastewater from a motel/restaurant and from a Texas Department of Transportation (TXDOT) rest area is also discharged within the watershed. While treated to meet strict discharge standards, wastewater effluent can contain pathogens, nutrients, pharmaceuticals and personal care products (PPCPs), and organic precursors that are either unregulated or present at concentrations below the permit limits. Attachment 1 lists the name, status, permit number, and discharge limits (e.g., flow, nutrient concentrations, etc.) for the permitted sites.

All the pollutant discharge loads from WWTPs may not transport to Lake Arlington because they are a considerable distance from the Lake. For an example, a considerable BOD5 load will have decayed prior to reaching the Lake. Similarly, loads of nitrogen and phosphorus will be partially attenuated by settling and biological uptake in Village Creek and its tributaries, and then partially remobilized during higher flows or algal sloughing events. The delivery ratios for nutrients is not precisely quantified for the watershed but the majority of WWTPs nutrient load would be expected to eventually reach Lake Arlington.

7.4.2 Septic systems

The number and flow of septic systems in the Lake Arlington watershed cannot be precisely determined. However, most wastewater in the watershed was estimated to be treated by septic system. For an example, 2008 population of Tarrant and Johnson Counties, which cover the Lake Arlington watershed area, is estimated to be approximately 1.9 million, based on the U.S. Census Bureau's Population Estimates Program (PEP). Using a typical per capita wastewater generation rate of 70 gallons per day, the present population in the two counties would generate approximately 133 MGD. The WWTPs in the counties have capacity to treat about 0.5 MGD. It is assumed that at any given time, 2 percent of the BOD5, TSS, TP and fecal coliform from septic systems were delivered to Lake Arlington. Therefore, it was assumed that the wastewater in the watershed is primarily treated by septic systems. All of Arlington and Kennedale are presumed to have accessible organized wastewater service, but not all the septic waste in the service area is currently is believed to be treated by the wastewater treatment plants. Where the City might have an official certificated area that gives them the "authority" to provide wastewater treatment service, but it doesn't necessarily mean that service within that area is not via individual septic systems. The integrity of that assumption would break down if one were trying to determine areas treated by septic systems and areas served by the Arlington wastewater collection system.

Properly designed and functioning septic systems would be negligible sources of BOD5, TSS, and TP to surface waters. However, poorly designed or maintained subsurface disposal systems can fail, resulting in exfiltration (i.e., surface breakout) of septic tank effluent. Most nitrogen from subsurface disposal systems is nitrified in the soil and continues to be mobile in the environment, even if the system is working properly. When septic effluent is drained to drainfield (trench), the water slowly infiltrates into the underlying soil and evaporates in some instances. The amount of the septic effluent reaching surface water depends on different factors including soil type, proximity to surface waters, groundwater direction. Though no such information for the watershed is available, some time the effluents from drainfield are directed nearest stream through pipe.

7.4.3 Underground storage tanks

Leaking underground storage tanks (USTs) containing hazardous liquids, primarily petroleum products such as gasoline, diesel, kerosene, or oil have high potential for contaminating groundwater and eventually seeping to surface waters. Gasoline at gas stations is usually stored underground in tanks made of bare steel, which were not protected from corrosion—the oxidation, or rusting, of other metals as well as iron metal in steel that can cause metals to crack or disintegrate and leak. TCEQ publishes current and historic information about known leaking petroleum storage tanks in Texas and it updates the information on weekly basis. For the Tarrant County and Johnson County together there were 1,771 known leaked petroleum storage tanks as of January 06, 2010 updated TCEQ database. The most hazardous components of petroleum products when they are leaked can post high treat to the water pollution are the BTEX compounds—benzene, toluene, ethylbenzene, and xylenes. Another potentially hazardous compound in gasoline is methyl tertiary butyl ether (MTBE). Even at very low concentrations, MTBE makes drinking water unfit for human consumption with potential to cause cancer.

7.4.4 Water wells—active and abandoned

Poor construction and maintenance of wells can be primary reason for groundwater contamination. Toxic material spilled or dumped near a well can leach into the well's aquifer. Polluted water can leak through the walls of poorly maintained or shoddily constructed wells. Wells can get contaminated from septic tanks placed too close or abandoned wells in the area. Flood events can also impact the quality of groundwater. Contaminants that enter a well are introduced directly into the aquifer with no opportunity for natural filtration by soils or geologic materials. In cases, water in the polluted groundwater can eventually seep into nearby surface water. Abandoned wells are also a threat to water and public safety. Abandoned wells provide a direct channel for contaminants to pollute the aquifer below. Texas law makes the landowner responsible for plugging abandoned wells and liable for any water contamination or injury. TCEQ maintains the permitting authority for the water wells construction in the region. As obtained from the web based TCEQ Water Well Report Viewer (accessed on January 06, 2011), there are 315 water wells in the Tarrant County and 161 in the Johnson County.

7.4.5 Gas well drilling, operations and pipelines

Over 95 natural gas wells have recently been constructed in the watershed (Figure [CG-X]). As the development of the Barnett Shale natural gas field continues, plans for additional gas drilling sites and pipelines are anticipated. EPA published a report in 2004 evaluating the impacts of hydraulic fracturing on underground sources of drinking water. The study concluded that the process was safe; however, it did identify data gaps regarding the potential for migration of fracturing fluid through the subsurface. EPA has initiated a new study on hydraulic fracturing to further assess any relationships between the process and contamination of drinking water. The report is due to be released in 2012. The Railroad Commission of Texas (TRRC) oversees installation and operation of gas wells in Texas.

Natural gas wells are considered potential point sources of surface runoff pollution. Construction of the drilling pad, which is similar to constructing a residential or commercial building, is the major activity at the natural gas well site which contributes TSS to runoff during rain events. Once the construction phase of developing a natural gas well is finished, most of the disturbed area will be reclaimed to near natural condition. After construction of the drilling pad, other major pollutant contributors at the site may include oils and greases which may leak from the machinery operating at the site, illegal dumping of the material, wastes from the gas well, transportation pipelines, etc. Data containing the locations and categories of active natural gas and oil well sites were obtained from the NCTCOG. Dry holes, horizontal drain holes, permitted locations, plugged oil wells, service wells, shut-in wells (oil) and sidetrack wells present in the watershed were considered in estimating gas well point sources for PLOAD modeling. According to the data, approximately 1,150 wells were constructed over an assumed 5 year period.

The City of Denton, Texas and EPA (2007) monitored the stormwater runoff from three natural gas sites in North Central Texas. The monitoring results indicated high concentrations of TSS and are in the typical order expected for construction sites. The observed TSS concentrations ranged from 394 mg/L to 9,898 mg/L with average median concentrations from three sites of 2,745 mg/L. The monitored concentration for manganese ranged from below detection limit to 1.31 mg/L, with an average median concentration of 0.29 mg/L. Additionally most of the metals monitored at the site had higher concentrations than expected from natural undisturbed sites. Construction vehicles, oil and grease leaks at the site and waste from the gas well are expected to contribute to the stormwater runoff from the natural gas well sites. However, the monitored runoff quality in the North Central Texas study found that total petroleum hydrocarbons (TPH) concentrations were below detection limits for all collected samples, indicating that TPH contribution from site activities were negligible.

7.4.6 Fertilizer and pesticide application

Non-point source pollution from agricultural activities can contribute nutrients from fertilizers, pesticides (e.g., atrazine), animal pathogens, and growth hormones (e.g., endocrine disrupting compounds) to the watershed. Agricultural activities in the Village Creek Watershed are limited, occurring primarily near the watershed headwaters, and are not expected to have a significant impact on lake water quality. In fact, over time, agricultural activities can be expected to decrease with urbanization.

7.4.7 Industrial and Commercial Operations

The industrial footprint in the Village Creek Watershed, in terms of land use, is relatively limited. Nevertheless, a variety of industrial activities are conducted within the watershed, with the potential to impact water quality. The Handley Generating Station, located on the northwest shore of Lake Arlington, has a TPDES permit (WQ0000552000) allowing discharge of treated wastes into the reservoir. The permit specifies discharge limitations associated with temperature, total and free chlorine concentrations, total suspended solids, and oil and grease at two outfall locations (Outfall 001 and 201). Table [CG-X] summarizes the discharge limitations for each outfall. The 2002 Texas Water Quality Inventory lists a July 25, 1997 historical fish kill near the Handley Plant hot pond, with approximately 50 fish killed. The suspected cause of the kill was temperature. Based on the report, exceedances were reported for temperature, ammonia nitrogen, nitrite+nitrate nitrogen, and orthophosphorus in samples collected from the lake between 1996 and 2001.

7.4.8 Urban Runoff

Urban runoff during storm events can be a source of polyaromatic hydrocarbons (PAHs, from roads), pathogens (e.g., from pet excrements), and other synthetic organic compounds (SOCs) used for basic human activities (i.e., cleaning products, etc.). Figure [CG-X] shows turbidity levels before and after a September 10, 2010 rain event. The data illustrate the influence of stormwater runoff on particle loading in the source water to the Pierce-Burch WTP. Land use changes associated with development around Lake Arlington and their impacts on surface runoff and lake water quality are being assessed as part of the Master Planning process. For example, Fort Worth's proposed Lakeshore Drive project was reviewed, and BMPs were proposed to minimize impacts to the Lake. As the project goes into final design and construction it will be necessary for Arlington to stay closely involved.

7.4.9 Recreational Activities In and Around Lake Arlington (including fueling operations)—marinas, boat ramps, watercraft use

Recreational lake activities also have the potential to impact water quality. For example, the marina fueling station could be a source of polyaromatic hydrocarbons (PAHs) if spills occur during refueling. A 2003 EPA Handbook for Marina Operators and Recreational Boaters lists boat maintenance, discharge of sewage from boats, and fuel release during refueling or recreational boating as the primary sources of pollution from boating.

7.5 Description of Models

7.5.1 Watershed pollutant load modeling

Watershed loading models can range from simple, representing only a few measured or estimated input parameters, to complex, dynamic models that require significant data for set-up and calibration. An example of simple models includes PLOAD which is based on the Simple Method, and examples of complex models include the Storm Water Management Model (SWMM), the Hydrological Simulation Program-FORTRAN (HSPF), etc. The Source Loading and Management Model (SLAMM) is an example of simple to moderately complex watershed model which requires a detailed analysis of source areas and a fair amount of input data, and is more applicable for small storm hydrology. There are many computer models available for watershed modeling some which are public domain and others which are proprietary software. Often times it is confusing to choose a model for a specific purpose, but the right model is the one that: 1) the user thoroughly understands; 2) gives adequately accurate and clearly displayed answers to the key questions; 3) minimizes time and cost; and, 4) uses readily available or collected information.
The goal of Lake Arlington watershed modeling effort is to develop an approach that stays within the constraints dictated while providing supporting information to meet the identified objectives of the project. As stated above, the modeling effort for this project is to develop a screening level tool to assess proposed development versus existing conditions of the watershed and predicted lake water quality. Detailed short time increment predictions of pollutographs are not necessary for the assessment of receiving water quality in this project. Such details may be required if the objective of a study is to understand the variation in pollutant loads in the runoff along the length of a rain event, for example comparing the pollutant load in first flush versus pollutant load in the runoff from a fully developed event. But the overall objective of modeling for this paroject is to predict the Lake water quality from expected stormwater pollutant loads from its watershed. Hence, the total storm event loads are adequate for that purpose.

The SWMM, HSPF and SLAMM models may provide detailed analyses of the watershed but such detail analyses is seldom required for planning level work such as this project. Also as these models have high demand for input parameters, the input data collection task will require more time and cost. Simple spreadsheet-based loading models involving an estimate of the runoff volume which, when multiplied by an event mean concentration, provides an estimate of pollution loading. But such simple models lack the ability of calibration for the physical parameters of the watershed. However, the accuracy of simple model predictions can be improved when the predictions are averaged over longer periods, such as annual averages instead of event averages or daily averages.

For the reasons mentioned above, the PLOAD model was employed as the non-point source pollutant load model (USEPA, 2001) for modeling the Lake Arlington watershed. PLOAD is an extension of Better Assessment Science Integrating point and Non-point Sources (BASINS) model. It was developed by U.S. Environmental Protection Agency (U.S. EPA). BASINS is a decision support system for multipurpose environmental analysis by regional, state, and local agencies for watershed and water quality based studies.

PLOAD is one of three extension models in BASINS that can be used for constituent estimation in runoff from a specified watershed, and the other two BASINS extension models that are used for runoff pollutant load estimation are Soil and Water Assessment Tool (SWAT) and HSPF. SWAT is mostly applicable for agricultural and rural watersheds and may not serve the purpose of this project, and as already mentioned above HSPF is considered to be a complex model with a high demand for input parameters. PLOAD is a GIS-based model that can be used to calculate non-point source pollutant loads generated within a watershed. PLOAD estimates non-point constituent loads on an annual average basis, for any user-specified pollutant, relying on land-cover-specific runoff coefficients and pollutant concentrations. The PLOAD model is considered as an exploratory screening and planning level analysis rather than a calibrated model of non-point source loads. Within PLOAD, the Simple Method approach was chosen for calculation of pollutant loads. This technique requires a modest amount of information, including the watershed drainage area and impervious cover, stormwater runoff pollutant concentrations, and annual precipitation.

The PLOAD tool is capable of analyzing the watershed for pollutant loads using one of two methods, the Exponent Coefficient Method and the Simple Method. For modeling the Lake Arlington watershed, the Simple Method was used. Under this method, pollutant loads are calculated using the following equation:

$$LP = \sum u \, (P * PJ * RVU * CU * AU * 2.72 / 12)$$

Where: LP = Pollutant load, lbs
P = Precipitation, inches/year
PJ = Ratio of storms producing runoff (default = 0.9)
RVU= Runoff Coefficient for land use type u, inchesrun/inchesrain
CU = Event Mean Concentration for land use type u, milligrams/liter
AU = Area of land use type u, acres

Consistent with the purpose of LAMP modeling, the purpose of PLOAD model is to provide a general planning estimate of the likely increase in pollutant loads from the watershed for various future land use scenarios when compared to the existing conditions of the watershed. The PLOAD model is appropriate for comparing the changes in relative storm flow pollutant loads from various land use scenarios with proposed regulations. PLOAD estimates are considered more accurate when modeled for long periods rather than short periods. As a screening level tool, PLOAD may not be calibrated against observed data, but attempts are made to adjust the model input parameters to better represent the monitored data. The pollutant contributions caused by base-flows are estimated by the separation technique.

7.5.2 Reservoir model

The BATHTUB model was selected to analyze the water quality issues related to Lake Arlington itself. The BATHTUB model provides the capability for calibration to observed lake data, but it does not have extensive data requirements (and can therefore be applied with existing data). BATHTUB is recognized as an effective tool for lake and reservoir water quality assessment and management, particularly where data are limited (Ernst et al., 1994).

BATHTUB is a software program used primarily for estimating nutrient loading to lakes and reservoirs, summarizing information on in-lake water quality data, and predicting the lake/reservoir response to nutrient loading (Walker 1986). It was developed and is distributed by the U.S. Army Corps of Engineers. BATHTUB contains a number of regression equations that have been calibrated using a wide range of lake and reservoir data sets. It can treat the lake or reservoir as a continuously stirred, mixed reactor, or it can predict longitudinal gradients in trophic state variables in a reservoir or narrow lake. These trophic state variables include in-lake total and ortho-phosphorus, organic nitrogen, hypolimnetic dissolved oxygen, metalimnetic dissolved oxygen, chlorophyll concentrations, and Secchi depth (transparency).

BATHTUB's nutrient balance procedure assumes that the net accumulation of nutrients in a lake is the difference between: (i) nutrient loadings into the lake (from various sources) less (ii) the nutrients carried out through outflow and the losses of nutrients through whatever decay process occurs inside the lake. The net accumulation (of phosphorus) in the lake is calculated using the following equation:

Net accumulation = Inflow – Outflow – Decay

Input data requirements for BATHTUB include: physical characteristics of the lake morphology (e.g., surface area, mean depth, length, mixed layer depth), flow and nutrient loading from various pollutant sources, precipitation and phosphorus concentrations in precipitation (measured or estimated), and measured lake water quality data (e.g., total phosphorus concentrations).

7.6 Description and Delineation of Lake Arlington Watershed and Sub-watersheds.

7.6.1 Watershed and subwatersheds

The Lake Arlington watershed is approximately 143 square miles in size. Since the Simple Method was developed to predict the pollutant loads for smaller watersheds, the Lake Arlington watershed area was sub-divided to create 55 smaller sub-basins. The sub-basins in the project watershed were numbered from 1 to 55. A shape file provided by North Central Texas Council of Governments (NCTCOG) of the watershed boundary was used as a reference to delineate the watershed into sub-watersheds. The delineation was performed using manual delineation techniques in ESRI's ArcMap software, version 9.1. Figure 7.6-1 illustrates the watershed boundary with delineated sub-watersheds.

Average annual precipitation based on rain gauge data from Dallas-Fort Worth International Airport for a 34 year period of record was used in the model. Point sources consisting of wastewater treatment plants (WWTPs) and gas well sites were included in the model. Information about inventory, location and type of point source was obtained from the cities in the watershed. WWTPs discharge pollutant loads used in the model were estimated from the Discharge Monitoring Reports (DMRs), and other literature was used for modeling the gas well site pollutant loads. Because they are the major sources of make-up water, discharges from Cedar Creek and Richland Chambers Reservoirs to Village Creek were also considered point sources and annual pollutant loads were estimated from their discharge reports and literature values. Assuming the same level of discharge will be maintained from these two reservoirs to Lake Arlington in the future, the estimated annual pollutant loads used in the existing conditions model are used in the future conditions model. Water supplied from Lake Benbrook and from the future connection to Lake Palestine were not modeled. Additional parameters and input data used for modeling include land use, impervious factors and event mean concentrations (EMC) of pollutants. Regulatory requirements and best management practice (BMP) effectiveness was considered in the modeling, and the same level of treatment from these considerations is used when modeling the future watershed conditions. The EMCs of the modeled pollutants for major land use categories are summarized in the Table 7.6-1 and the changes in major land uses is illustrated in Figure 7.6-2.

Land Use	Pollutant EMC					
	TSS (mg/L)	TN (mg/L)	TP (mg/L)	COD (mg/L)	BOD (mg/L)	Fecal Coliform (cfu/100ml)
Residential	54	1.8	0.35	49	8.3	7580
Commercial	40	1.7	0.17	53	12.3	5480
Industrial	67	1.5	0.21	53	7.2	5425
Open Space	60	2.2	0.16	32	4.0	2500
Roads	74	1.9	0.22	59	6.4	1470

Table 7.6-1: Pollutants EMCs by Land Use Category used in PLOAD Model

Sub-Basin	TSS	TN	TP	COD	BOD	FC (counts/ac/yr)
1	249.0	3.6	0.5	94.8	16.3	5.28E+10
2	65.9	2.4	0.3	48.5	7.4	2.77E+10
3	98.2	3.2	0.4	90.8	15.3	4.14E+10
4	971.7	5.7	0.6	155.5	28.1	7.03E+10
5	109.3	3.4	0.5	89.0	13.5	4.77E+10
6	103.2	3.2	0.4	82.2	13.0	4.03E+10
7	69.2	2.4	0.3	47.4	7.0	2.52E+10
8	130.0	1.5	0.5	59.2	11.3	3.08E+10
9	75.3	2.9	0.4	61.0	9.7	3.35E+10
10	70.2	2.4	0.4	62.2	10.3	4.22E+10
11	29.5	1.1	0.1	15.7	1.9	5.49E+09
12	71.5	2.4	0.4	64.1	10.7	4.34E+10
13	563.2	1.2	0.1	19.7	2.5	7.68E+09
14	75.4	2.5	0.5	68.6	12.0	4.63E+10
15	235.5	3.7	0.4	89.7	13.5	3.62E+10
16	72.6	2.5	0.4	62.9	10.5	4.17E+10
17	155.1	3.1	0.5	84.2	12.7	4.11E+10
18	70.4	2.6	0.4	57.9	9.4	3.70E+10
19	118.4	3.0	0.4	73.2	11.6	4.03E+10
20	58.6	2.0	0.2	36.3	5.1	1.77E+10
21	72.1	2.6	0.3	46.8	6.6	2.21E+10
22	145.4	3.5	0.4	114.9	13.7	2.82E+10
23	98.5	3.0	0.4	64.8	10.0	3.56E+10
24	80.1	2.5	0.4	63.7	9.5	3.18E+10
25	148.3	3.7	0.4	81.4	12.8	4.25E+10
26	128.2	3.1	0.4	70.2	11.0	3.25E+10
27	132.2	2.1	0.2	44.6	7.5	2.06E+10
28	197.5	3.8	0.4	76.8	10.7	3.32E+10
29	181.3	4.6	0.5	99.3	13.7	4.42E+10
30	101.2	1.7	0.1	27.3	3.7	1.09E+10
31	112.6	2.4	0.3	43.0	7.5	2.34E+10
32	110.5	1.9	0.2	31.3	4.2	1.24E+10
33	100.5	2.4	0.3	44.9	6.6	2.33E+10
34	102.8	2.1	0.2	40.2	5.8	1.96E+10
35	256.1	2.7	0.3	57.3	9.1	3.08E+10
36	151.2	2.7	0.3	52.5	7.6	2.46E+10

Table 7.6-2: Lake Arlington Existing Conditions Load Estimations

Sub-Basin	TSS	TN	TP	COD	BOD	FC (counts/ac/yr)
37	104.2	2.3	0.2	45.5	6.7	1.90E+10
38	111.0	2.3	0.2	40.1	5.6	1.70E+10
39	124.8	4.3	0.5	95.1	14.9	4.98E+10
40	70.3	2.4	0.2	45.1	6.2	2.09E+10
41	126.1	3.8	0.5	90.9	12.9	4.51E+10
42	148.4	2.8	0.3	50.9	7.4	2.36E+10
43	82.0	1.6	0.2	28.1	3.9	1.27E+10
44	125.1	2.2	0.2	40.5	3.8	1.93E+10
45	109.4	2.2	0.3	44.6	6.7	2.47E+10
46	139.3	3.0	0.3	61.5	9.3	2.99E+10
47	122.3	2.0	0.2	39.2	5.7	1.98E+10
48	130.1	2.8	0.3	59.0	9.3	3.07E+10
49	102.2	1.7	0.1	27.9	3.8	1.19E+10
50	108.9	1.9	0.2	35.7	5.8	1.77E+10
51	108.3	1.8	0.2	30.3	4.2	1.38E+10
52	138.3	2.8	0.3	58.6	9.0	3.08E+10
53	118.6	2.2	0.3	45.4	8.0	2.51E+10
54	90.3	1.7	0.2	30.2	4.6	1.37E+10
55	104.7	1.7	0.2	30.4	4.2	1.38E+10

(Point source loads from East Texas Reservoirs, WWTPs and septic systems were excluded in the estimation of pollutant load rates)

Table 7.6-2: Lake Arlington Existing Conditions Load Estimations

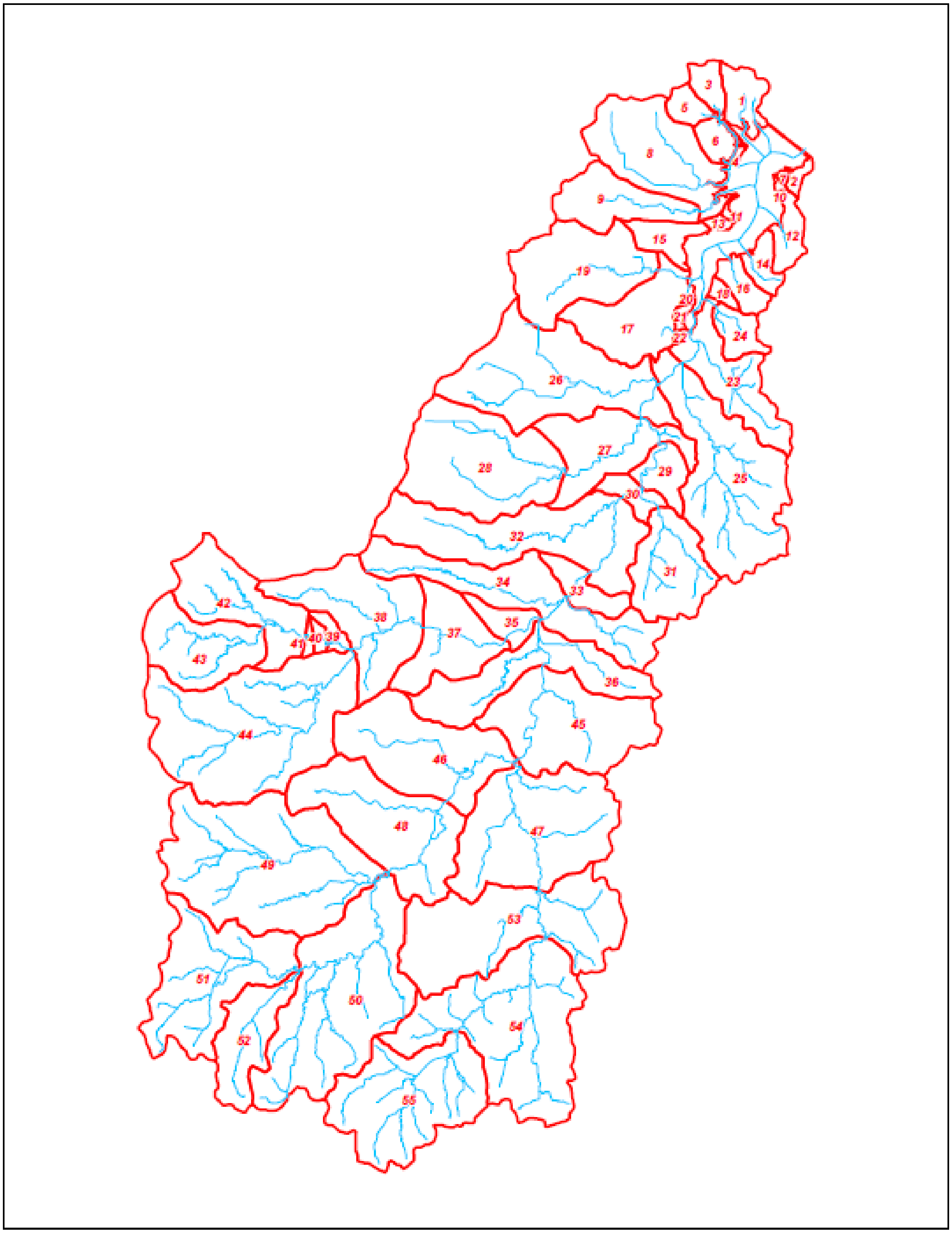


Figure 7.6-1: Modeled Sub-Basins of Lake Arlington Watershed

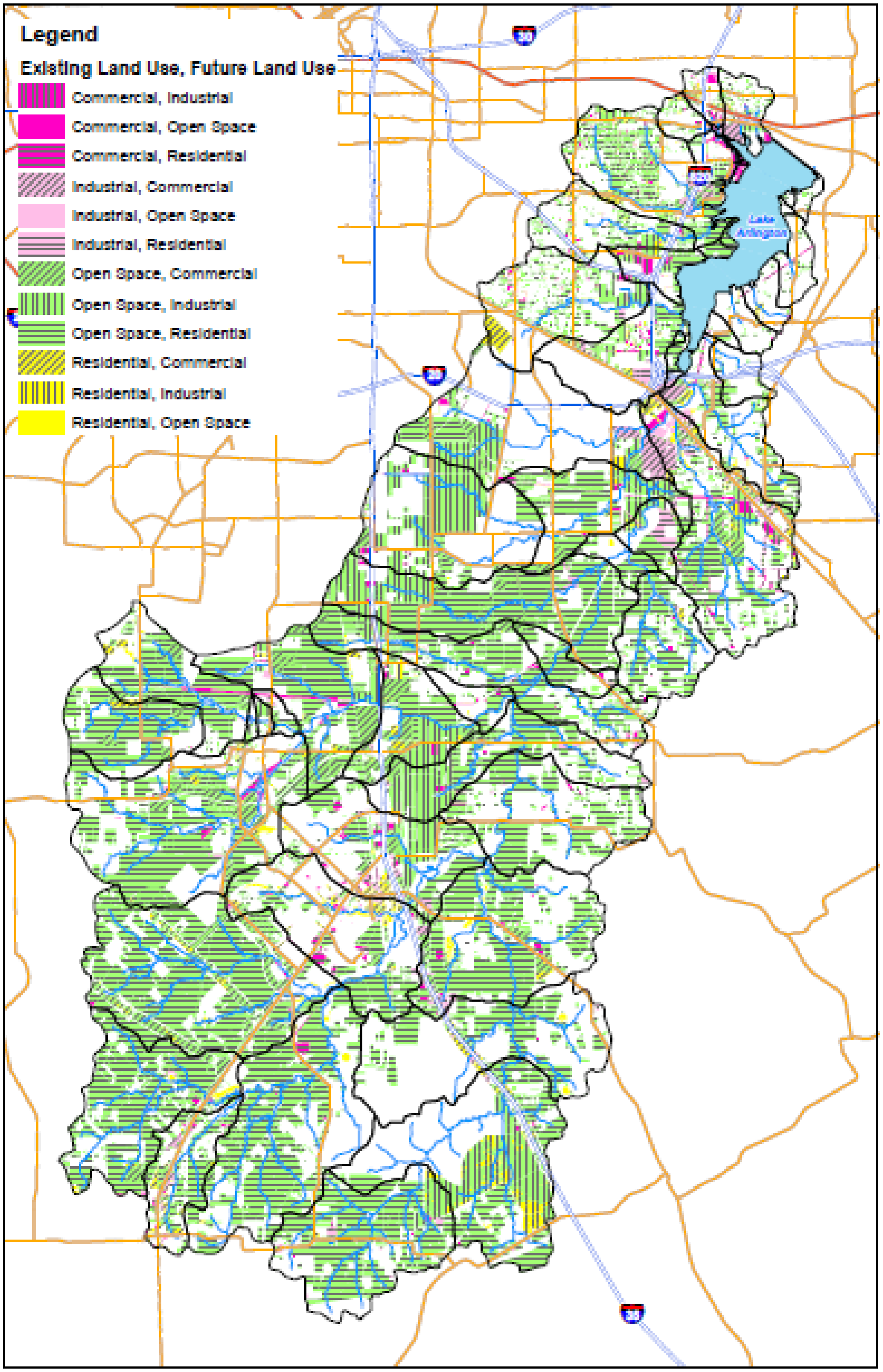


Figure 7.6-2: GIS Map of Projected Land Use Changes of Watershed

7.6.2 Model scenarios

Scenario 1: Lake Future Water Quality with Exiting Management Strategies
Scenario 1 evaluates the future water quality with projected land uses under existing stormwater management ordinances and other watershed management strategies currently in place for new development and re-development sites. The municipalities within the watershed have ordinances for stormwater management. In most cases, however, these ordinances are designed to reduce downstream flooding through the use of stormwater detention facilities. Such facilities are not designed to protect water quality or prevent excessive stream channel erosion, and are generally not effective in performing these functions. Rather, they are typically designed to limit post-development peak runoff rates to less than or equal to the predevelopment rates for specific return-interval storms. Even if peak flow rates of flow are properly controlled, the total volume of runoff from the site will still be much larger than under pre-development conditions. Following the intent of EPA's MS4 NPDES stormwater program and other related regulations to reduce non-point source pollution in the form of stormwater to receiving waters, it was assumed that the best management practices (BMPs) commonly promoted and implemented by municipalities in the watershed could, on average, reduce pollutant levels in runoff by approximately 20%. Under this scenario, the 20% reduction in the non-point source pollution was applied to all future developed areas, except open lands and water bodies in the watershed.

Under this scenario, all point source discharges including discharges from WWTPs, septic systems and gas well sites were modeled as having the same concentrations and loads of pollutants modeled in the existing watershed conditions simulation. The WWTP discharge loads from existing plants and future additional WWTP discharges based on projected population growth to the Lake are summarized in Table 7.6-3.

Location or Permittee	EPA ID	Annual Loads (lb) to Lake			
		BOD5	Nitrogen, ammonia total (as N)	Phosphorus, Total	TSS
Johnson County Special Utility District WWTP	TX0124923	2.18E+03	1.62E+04	9.70E+02	2.72E+04
Mayfair WWTP	TX0105872	3.01E+02	6.34E+02	9.95E+01	7.61E+02
Oak Ridge Square MHP WWTP	TX0102806	2.12E+02	7.54E+01	1.89E+01	4.89E+02
RV Ranch WWTP	TX0128490	1.77E+02	7.84E+01	1.96E+01	5.44E+02
Briarhaven Wastewater Treatment Facility	TX0128503	6.22E+02	2.23E+02	5.60E+01	9.95E+02

Table 7.6-3: WWTPs Pollutant Discharge Loads to Lake Arlington

The calculated annual total suspended solids (TSS) load from the natural gas well sites is presented in Table 7.6-4. It was assumed in this model, that gas well sites are projected to develop at same rate as in the existing watershed conditions model. Discharges from eastern reservoirs and Handley Power Plant are modeled the same as the existing conditions reservoir model.

Parameter	Concentration (mg/L)	Load (lb)
TSS (mg/L)	2,745	19,684

Table 7.6-4: Natural Gas Wells Point Source TSS Loads

Scenario 2: Lake Future Water Quality with Proposed Management Strategies
In Scenario 2 the proposed measures include a requirement to capture excess runoff corresponding to the 90th percentile of rain events depth and treat the remaining runoff corresponding to 1.5 inches of rainfall, and point source (WWTPs, septic systems, industrial dischrages and gas well sites) discharge control.
In addition, a 20% pollutant load reduction was applied, giving consideration to existing stormwater management BMPs applied for all other developed areas. This will cover the pollutant load reduction from continuous implementation of existing BMPs, both structural (eg. detention ponds or wet lands) and non-structural (eg. street sweeping, public education, etc).

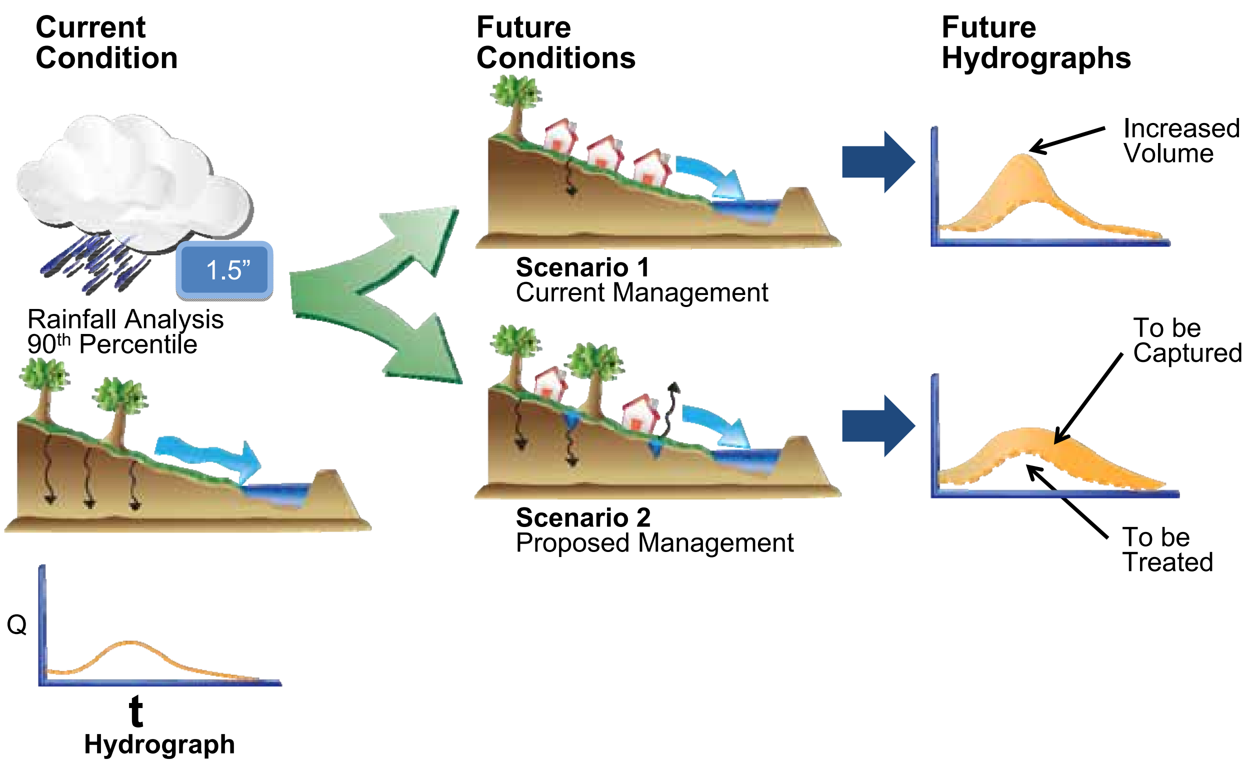


Figure 7.6-3: Lake Arlington Master Plan Watershed Modeling and Management

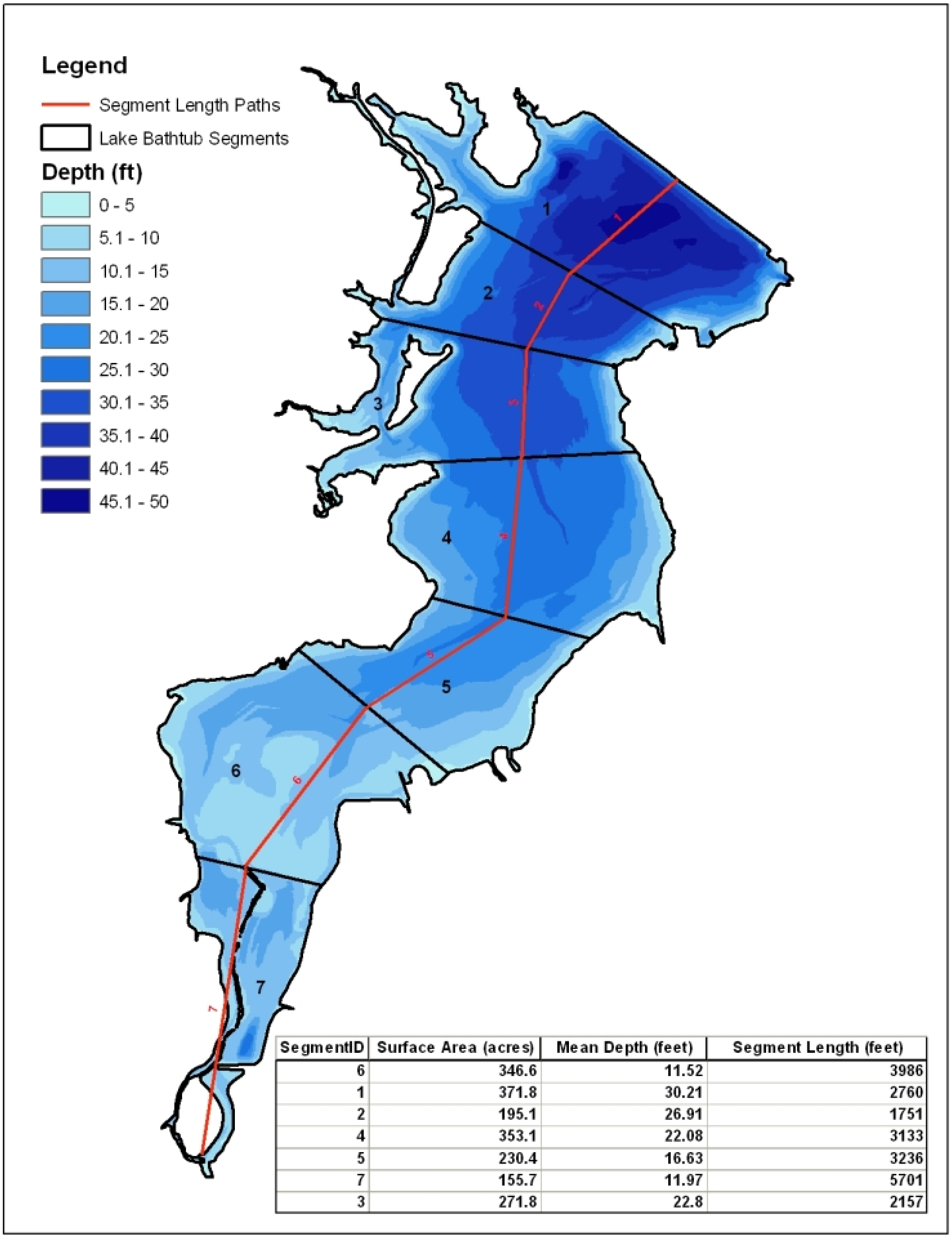
Details of the modeling approach, inputs and results of the models can be found in Appendix 7.3-D Water Quality Modeling.

7.7 Model Results
Table 4 summarizes the existing and post-development PLOAD-predicted pollutant loads to Lake Arlington by BATHTUB-modeled segment. The segments of Lake Arlington are illustrated in Figure 7.6-3.
The predicted pollutant loads to the lake showed significant increase over existing conditions for all pol-

lutants, except biochemical oxygen demand (BOD), modeled under Scenario 1 (Table 7.6-6). Scenario 2 has resulted in decreases in TSS and BOD annual load to the lake with a moderately low increase in total nitrogen (TN) and carbonaceous oxygen demand (COD). Whereas total phosphorus (TP) and fecal coliform showed moderate increases over existing conditions, the magnitude of increase was much lower in Scenario 2 than Scenario 1 (Table 7.6-6). A considerable portion (32%) of increased TP load under Scenario 2 was predicted to be the result of increased future WWTP discharges.

Compared to Scenario 1, Scenario 2 was predicted to decrease a considerable pollutant load to the lake, being approximately 31% of TN and 70% of TP (Table 7.6-7). It is important to note that control of nutrient loads to the lake is essential for controlling the algal bloom and eutrophic conditions. From the predictions, it is very obvious that for future watershed conditions with no additional management policies in place, nutrient loads to the lake will increase very significantly and therefore the lake may turn highly eutrophic. Point source nutrient loads were predicted to contribute a major portion of the total nutrient load to the lake, even under Scenario 2 which assumed lower discharge concentrations from the WWTPs. Since WWTPs are expected to provide better treatment of wastewater, in the future, if some of the septic system loads within the watershed are treated by WWTPs, the nutrient loads (especially for TN) can be expected to be reduced below the values predicted by the model. Additionally, by using tertiary treatment, the nitrogen levels in the WWTP discharges may be further reduced to 3 mg/L or less, which can yield further reduction of nutrient loads from WWTPs to Lake Arlington.

Segment 7 of Lake Arlington receives discharges from the major stem of Village Creek, which has most of drainage area in the Lake Arlington watershed. Therefore, the quality of discharges to segment 7 is expected to be impacted more from future development than the discharges into any other lake segment. Additionally, the projected wastewater discharges from future population growth, for both Scenarios 1 and 2, was assumed to be discharging into segment 7, so the predicted pollutant load increase was more for segment 7 than others. But not all the additional wastewater may be discharged into segment 7. In that case, the model predictions for future conditions are conservative for pollutant loads to segment 7.



SegmentID	Surface Area (acres)	Mean Depth (feet)	Segment Length (feet)
6	346.6	11.52	3986
1	371.8	30.21	2760
2	195.1	26.91	1751
4	353.1	22.08	3133
5	230.4	16.63	3236
7	155.7	11.97	5701
3	271.8	22.8	2157

Figure 7.6-3: Modeled BATHTUB Segments

Scenario	Lake Segment	TSS (lb/yr)	TN (lb/yr)	TP (lb/yr)	COD (lb/yr)	BOD (lb/yr)	FC (counts/yr)
Existing	1	1.55E+05	5.64E+04	1.19E+03	5.92E+04	2.84E+04	3.30E+13
	2	1.55E+05	7.81E+04	1.65E+03	8.93E+04	3.99E+04	4.38E+13
	3	8.90E+06	2.88E+05	6.19E+03	2.18E+05	1.35E+05	1.16E+14
	4	3.89E+04	4.88E+04	9.60E+02	2.84E+04	2.10E+04	1.90E+13
	5	7.36E+04	4.30E+04	8.41E+02	2.52E+04	1.86E+04	1.66E+13
	6	1.54E+05	6.93E+04	1.43E+03	6.86E+04	3.34E+04	3.40E+13
	7	1.41E+07	3.73E+06	8.88E+04	3.95E+06	3.73E+06	2.19E+15
Scenario 1	1	1.46E+05	5.61E+04	1.18E+03	5.80E+04	2.92E+04	3.39E+13
	2	1.06E+05	7.65E+04	1.46E+03	4.92E+04	3.34E+04	2.56E+13
	3	8.17E+06	3.21E+05	1.20E+04	5.33E+06	1.67E+05	7.29E+14
	4	3.09E+04	4.86E+04	9.22E+02	2.21E+04	2.00E+04	1.55E+13
	5	6.18E+04	4.25E+04	7.77E+02	1.55E+04	1.70E+04	1.05E+13
	6	1.50E+05	6.93E+04	1.51E+03	8.52E+04	3.53E+04	4.36E+13
	7	5.37E+07	6.40E+06	4.36E+05	4.10E+07	1.12E+07	2.56E+16
Scenario 2	1	8.66E+04	5.59E+04	1.25E+03	5.02E+04	2.75E+04	3.14E+13
	2	1.24E+05	7.80E+04	1.67E+03	8.88E+04	3.94E+04	5.25E+13
	3	8.78E+06	2.90E+05	6.24E+03	2.53E+05	1.40E+05	1.72E+14
	4	3.59E+04	4.88E+04	9.62E+02	2.76E+04	2.09E+04	1.58E+13
	5	4.47E+04	4.29E+04	8.38E+02	2.40E+04	1.84E+04	1.44E+13
	6	1.13E+05	6.91E+04	1.77E+03	7.81E+04	3.42E+04	5.27E+13
	7	1.07E+07	4.29E+06	1.25E+05	4.33E+06	2.23E+06	3.95E+15

Table 7.6-5: Pollutant Loads by Lake Segments for Modeled Scenarios

Scenario	TSS	TN	TP	COD	BOD	FC
1	165%	63%	349%	950%	188%	980%
2	-16%	13%	36%	9%	-37%	75%

Table 7.6-6: Predicted Increase in Constituent Loads to Lake from Existing Conditions

TSS	TN	TP	COD	BOD	FC
68%	31%	70%	90%	78%	84%

Table 7.6-7: Predicted Decrease in Scenario 2 Constituent Loads to Lake from Scenario 1

Table 7.6-8 presents the post-development PLOAD-predicted pollutant concentrations to Lake Arlington by BATHTUB segment.

Segment	Scenario 1				Scenario 2			
	Flow (MG)	Flow (hm^3)	TN (µg/L)	TP (µg/L)	Flow (MG)	Flow (hm^3)	TN (µg/L)	TP (µg/L)
1	1786	6.76	4264	143	1781	6.74	4262	139
2	740	2.80	12366	238	721	2.73	12956	235
3	85552	323.85	449	17	85288	322.85	407	14
4	388	1.47	14961	286	383	1.45	15274	287
5	343	1.30	14791	272	338	1.28	15243	275
6	695	2.63	11978	263	631	2.39	13150	266
7	74198	280.87	8081	513	66484	251.67	6556	206

Table 7.6-8: Predicted Decrease in Scenario 2 Constituent Loads to Lake from Scenario 1

Table 7.6-9 summarizes the predicted BATHTUB-modeled reservoir water quality for the existing and future scenarios. The BATHTUB model was calibrated for total phosphorus, chlorophyll a and secchi depth. The model calibration was discussed in the existing water quality conditions modeling report. The following paragraphs discuss the results summarized in Table 7.6-9.

Under existing conditions, Lake Arlington can be considered eutrophic with a predicted area weighted mean phosphorus concentration of about 68 ug/L and a chlorophyll-a concentration of about 36 ug/L. In Scenario 1, with no additional management strategies, apart from the controls required by existing policies, the mean phosphorus concentration was predicted to increase by up to 119 % of the existing concentration, with a maximum predicted phosphorus concentration of about 277 ug/L in segment 7 and an area weighted concentration of about 140 ug/L. Similarly, the total nitrogen concentration under Scenario 1 was predicted to increase by 15% with a maximum concentration of 4,212 ug/L predicted in segment 7 of the reservoir where most of the watershed drainage discharges into the lake. The area weighted average for TN under Scenario 1 was predicted to be 2,493 ug/L, which is about 10 % higher than existing conditions.

The mean chlorophyll-a concentration under Scenario 1 was predicted to increase up to 52% over the existing concentration with 34 ug/L and 93 ug/L in segments 1 and 7, respectively. The area weighted average of about 51 ug/L is 41 % higher than the existing conditions. Similarly, the secchi depth is predicted to decrease under Scenario 1 with a maximum reduction of 0.3 meters (m) for segment 6.

For segment 1, the predicted hypolimnetic oxygen depletion rate (HOD), which is measure of rate of oxygen depletion below the thermocline, was predicted during the approximate growing season. The lake hypolimnetic depth of 2.5 m was expected to increase by 19 % with 625 mg/m3-day under Scenario 1 compared to existing conditions.

The BATHTUB model is generally recommended for predicting HOD in the segment near a reservoir's dam, and the HOD predictions in the segments away from the dam are reliable only if the model is calibrated with observed data for the sections. Due to lack of monitored HOD data for Lake Arlington, no HOD predictions were made for segments of the lake other than segment 1. For this Master Plan, that is not a major concern because the drinking water intakes are located in segment 1.

Similarly, the frequency of exceedance, presented in the Table 7.6-11, of a given concentration of chlorophyll a was predicted to increase considerably under Scenario1 compared to the frequency predicted for existing conditions. For example, for a given threshold concentration for chlorophyll a of 30 ug/L, the area weighted frequency of exceedance was predicted to increase from 47 % for existing conditions to 66 % for Scenario 1.

Under Scenario 2—with additional controls for runoff capture and treatment—the mean phosphorus concentration was predicted to have a moderately low increase of about 2-14 %, with area weighted mean increase of 11 %. The predicted TP concentration increase in Scenario 2 was significantly lower than predicted for Scenario 1. Similarly, a very minimal increase of up to about 7% was predicted for chlorophyll a, except for segment 7 which was predicted to decrease in chlorophyll a concentration, as expected under Scenario 2. The predicted HOD under Scenario 2 for segment 1 was within 2% of the existing conditions, with predicted HOD of about 537 mg/m3-day. The predicted secchi depth for segments 1 – 6 was within 0.1 m of the existing conditions of the lake. For segment 7, the predicted secchi depth is the same as the existing conditions, which is expected. Under Scenario 2, the TN concentration showed a considerable decrease over the existing conditions for all segments, with a maximum decrease of about 18 % for segment 7.

Since, segment 7 receives discharges from the largest portion of the watershed, it is obvious that the future land use scenario may have a greater influence on the lake water quality in that segment or other portions of the lake near segment 7. However, for modeling purposes, all the additional wastewater discharges from future population growth, about 44 million gallons per day (mgd), were modeled to discharge to segment 7. Even under Scenario 2, with proposed enhanced nutrient treatment levels at the WWTP discharges, major portions of the nutrient loads to the lake were predicted to originate from the WWTPs. Therefore the high predicted nutrient loads from future additional wastewater discharges are expected to influence the water quality in segment 7 of the lake. Realistically, in the future, the additional discharges may or may not enter segment 7 of the Lake, so the water quality of this segment of the lake may be better than the model predicted.

Considering all the modeling results, it can be concluded that the trophic state of Lake Arlington can be controlled with additional controls of potential pollutants. However, the degree of lake's potential water quality degradation would vary greatly depending on the level of controls implemented. Segment 1, where the drinking water intakes are located, is more buffered from increased nutrient loadings from the upstream end of the lake. Segment 1 should not experience significant increases in algal biomass with pollution control implementation in the watershed.

Overall, Scenario 2 has predicted that current water quality conditions in Lake Arlington will be maintained, and the existing pollutant reduction BMPs and implementation of additional BMPs in the watershed are expected to further improve water quality. The model predictions for watershed pollutant loads and lake pollutant concentrations under Scenario 2 are considered conservative as these models did not include the possible pollutant load reduction from other BMPs proposed in other sections of the Lake Arlington Master Plan. For example, the Master Plan proposes: the implementation of riparian corridors and conservation development for the floodways and floodplains; a recommended model ordinance for illicit discharge detection and elimination; and proposed new management strategies for construction site runoff control. These measures would be expected to reduce the pollutant loads to receiving waters, but they are not explicitly considered in this modeling task.

Lake Segment	Existing Conditions					Scenario 1					Scenario 2				
	TP (ppb)	TN (ppb)	Chl a (ppb)	Secchi (M)	HOD (mg/m^3-day)	TP (ppb)	TN (ppb)	Chl a (ppb)	Secchi (M)	HOD (mg/m^3-day)	TP (ppb)	TN (ppb)	Chl a (ppb)	Secchi (M)	HOD (mg/m^3-day)
1	58.7	1925	25.7	0.8	526.7	117.7	2207	34.1	0.5	624.7	66.7	1872	27.0	0.7	537.2
2	58.8	1930	27	0.8	NA	118.2	2212	36.7	0.5	NA	66.9	1877	28.6	0.7	NA
3	59	1936	30.3	0.8	NA	118.9	2220	43.0	0.5	NA	67.1	1882	32.3	0.7	NA
4	61.7	2029	31.3	0.8	NA	124.5	2298	43.7	0.5	NA	69.5	1948	33.1	0.7	NA
5	68.1	2250	38.2	0.7	NA	138.6	2486	54.9	0.5	NA	75.3	2106	40.0	0.7	NA
6	72.1	2387	46.5	0.7	NA	147.7	2604	70.8	0.4	NA	78.9	2203	48.7	0.6	NA
7	126	4273	70.9	0.4	NA	276.6	4212	92.9	0.3	NA	128.3	3518	69.1	0.4	NA
Area Wtd Mean	68.3	2258	36.4	0.7	NA	139.9	2493	51.2	0.5	NA	75.5	2109	37.9	0.7	NA

NA: No prediction were made

Table 7.6-9: BATHTUB Model Predictions by Lake Segment

Lake Segment	Scenario 1				Scenario 2			
	TP	TN	Chl a	HOD	TP	TN	Chl a	HOD
1	101%	15%	33%	19%	13.7%	-2.7%	5.1%	2%
2	101%	15%	36%	NA	13.8%	-2.8%	5.8%	NA
3	101%	15%	42%	NA	13.7%	-2.8%	6.7%	NA
4	102%	13%	40%	NA	12.7%	-4.0%	5.7%	NA
5	104%	11%	44%	NA	10.6%	-6.4%	4.7%	NA
6	105%	9%	52%	NA	9.4%	-7.7%	4.7%	NA
7	119%	-1%	31%	NA	1.5%	-17.7%	-2.5%	NA
Area Wtd Mean	105%	10%	41%	NA	10.5%	-6.6%	4.0%	NA

Table 7.6-10: Predicted Percentage Change in Constituents Concentration by Lake Segments Over Existing Conditions

Scenar io	Conc. (ug/L)	Lake Segment							
		1	2	3	4	5	6	7	Area Wtd Mean
Existing	CHA>1 0	88.7	90.2	93.0	93.7	96.8	98.5	99.8	94.0
	CHA>2 0	53.7	57.0	64.1	66.1	76.9	85.4	95.8	69.6
	CHA>3 0	28.7	31.6	38.4	40.5	53.2	65.5	85.9	46.7
	CHA>4 0	15.3	17.3	22.4	24.1	35.1	47.3	73.0	30.9
	CHA>5 0	8.3	9.6	13.2	14.4	22.9	33.5	60.0	20.7
	CHA>6 0	4.7	5.5	7.9	8.7	15.0	23.6	48.4	14.1
Scenari o 1	CHA>1 0	95.2	96.3	98.0	98.1	99.3	99.8	99.9	97.9
	CHA>2 0	70.9	74.8	82.3	82.9	90.6	95.8	98.5	84.2
	CHA>3 0	45.8	50.6	60.7	61.7	74.7	85.9	93.5	65.8
	CHA>4 0	28.5	32.7	42.4	43.3	57.9	72.9	85.3	49.7
	CHA>5 0	17.7	20.9	29.0	29.9	43.6	59.9	75.4	37.2
	CHA>6 0	11.1	13.5	19.9	20.6	32.5	48.3	65.3	28.0

Table 7.6-11: Predicted Frequency (%) of Chlorophyll a Exceeds te Stated Concentration

Scenario 2	CHA>10	90.2	91.7	94.3	94.7	97.3	98.8	99.8	94.9
	CHA>20	56.9	60.4	67.9	69.2	79.0	87.0	95.5	72.3
	CHA>30	31.6	34.8	42.5	43.9	56.1	68.1	85.0	49.6
	CHA>40	17.3	19.7	25.7	26.9	37.8	50.3	71.6	33.3
	CHA>50	9.6	11.2	15.5	16.4	25.1	36.2	58.4	22.5
	CHA>60	5.5	6.6	9.6	10.2	16.7	25.9	46.7	15.4

CHA>10-60: Percent of time during growing season that chlorophyll *a* exceeds bloom criteria of 10, 20, 30, 40, 50, or 60 ug/L

Table 7.6-11: Predicted Frequency (%) of Chlorophyll a Exceeds te Stated Concentration

Section 7.8 Facility Impact Assessment

The modeling results for Model Scenarios 1 and 2 were qualitatively reviewed for potential impacts to the Pierce-Burch and TCWSP WTP source water quality and treatment plant operations. Under Scenario 1, solids (TSS), nutrients (total nitrogen and phosphorus), chemical oxygen demand, and fecal loading to the lake are estimated to increase (Table Cg-4, Appendix 7.8). These increased contaminant loads present the following primary concerns for the drinking water supply and plant operations:

- Increased solids loading to the plant. An increase in the influent plant turbidity would result in an increase in solids handling requirements. The frequency of filter backwashes could also increase, depending on the degree of particulate removal through sedimentation, resulting in a decrease in overall plant production efficiency. Chemical usage could increase if a higher coagulant dose is required to achieve turbidity goals in the settled water. Increased operational oversight may also be required to monitor turbidity removal to meet the Surface Water Treatment Rule.

- Increased manganese concentrations in the source water. Under current conditions, manganese concentrations in the source water can be over an order of magnitude above the SMCL. The Pierce-Burch and TRA TCWSP WTPs currently remove manganese through oxidation, followed by oxidant sedimentation and filtration. An increase in the manganese concentrations could result in increased oxidant demand and dose, a potential increase in customer complaints, and potential need for additional treatment in the manganese is not adequately removed through current processes.

- Increased MIB and geosmin concentrations in the source water. Geosmin concentrations are currently substantially above the 10 ng/L odor threshold concentration, but are reduced at the Pierce-Burch and TCWSP WTPs through ozonation. A future increased in MIB and geosmin concentrations could result in a need to increase the ozone dose, with potential impacts to bromate formation and mitigation requirements, or need for additional treatment barriers for MIB and geosmin. Increased influent geosmin and MIB concentrations could lead to increased taste and odor complaints if concentrations are not adequately reduced through the WTPs.

- Increased wastewater impacts to the WTPs. Scenario 1 model results predict a 10-fold increase in fecal coliform loading to Lake Arlington. Fecal coliform concentrations serve as an indicator of the potential presence of pathogenic microorganisms, such as *Giardia*, *Cryptospordium*, and viruses, in a water supply. The Pierce-Burch and TCWSP WTPs have been classified as Bin 1 systems under the LT2ESWTR based on grandfathered *Cryptosporidium* data. If *Cryptosporidium* concentrations in the water supply increase in the future, both water treatment plants could be reclassified in higher bins, with subsequent requirements to reduce *Cryptosporidium* concentrations through various potential control measures.

As shown in Table CG-5 (Appendix 7.8), future water quality is not predicted to change substantially if BMPs recommended under Scenario 2 modeling are implemented. The principal source water quality and treatability concerns associated with water quality changes predicted under Scenario 2 are attributed to increased wastewater impacts to the watershed. , Increased wastewater discharges could result in increased concentrations of pathogenic microorganisms in the water supply if the wastewater is not adequately treated prior to discharge. Increased wastewater discharge to the watershed can also be a concern due to potential increased concentrations of unregulated emerging contaminants, such as pharmaceutical and personal care products (PPCPs), endocrine disrupting compounds (EDCs), or nitrosamine precursors. A regulatory determination on n-nitrosodimethylamine (NDMA) and other nitrosamines is expected in the near-term. If nitrosamines are regulated, increased precursor concentrations from wastewater discharges to the watershed will need to be carefully considered from a water supply treatability perspective.

Many micro-pollutants are not currently regulated and are not removed through conventional wastewater treatment processes. Advanced wastewater treatment would be required to reduce concentrations of organic micro-pollutants. Alternatively, various drinking water treatment processes could be implemented as part of a future CIP program if concentrations of micro-pollutants in the source water supply were a concern.

Table CG-4 and Table CG-5 lists some of the mitigations strategies that could be implemented at the Pierce-Burch and TCWSP WTPs in response to future changes in source water quality. Long-term facility planning would need to be conducted to identify optimal approaches to address the following key water quality issues:

- Ammonia. Mitigation strategies include watershed management programs, such as BMPs identified in this report to reduce nutrient loading from wastewater discharges, and public education.
- Manganese. Mitigation strategies include source water control (e.g., hypolimnetic oxygenation or changes to the plant intake structure) or pre-sedimentation with pre-oxidant addition.
- Taste and odor (MIB, geosmin). Advanced treatment such as GAC contactors or advanced oxidation (ozone/peroxide or UV/peroxide) would be required to provide additional barriers for taste and odor. Powdered activated carbon (PAC) could also be used to mitigate intermittent taste and odor events.
- *Cryptosporidium* and emerging pathogens. Treatment alternatives include pre-sedimentation with coagulant addition, UV disinfection, or microfiltration depending on the pathogen size.
- Micro-pollutants. Treatment alternatives include GAC contactors and advance oxidative processes (ozone/peroxide or UV/peroxide).

More than one mitigation approach is possible for the various water quality issues; as part of long-range planning, the City and TRA would need to take into account site-specific considerations (e.g., site layout, operator preferences, integration with existing technologies) to determine the best alternatives.

The paragraphs above focus on the impact of future lake water quality on treatment plant operations. Future changes to water quality in Lake Arlington can also impact downstream uses of the Trinity River. If recommended BMPs (Scenario 2) are implemented, water quality is anticipated to remain similar to current conditions, with the exception of increased fecal coliform concentrations and increased concentrations of other unregulated constituents associated wastewater discharges (e.g., dissolved organic nitrogen, pharmaceuticals and personal care products). To protect water quality in Lake Arlington and in downstream portions of the Trinity River, advanced wastewater treatment processes will need to be carefully considered and implemented as needed. Septic tanks will also need to be maintained to minimize discharge of nutrients, fecal material, and unregulated contaminants to the watershed.

7.9 Existing Watershed Management Practices

The municipalities in the Lake Arlington watershed include the Cities of Arlington, Briar Oaks, Burleson, Cross Timber, Crowley, Edgecliff Village, Everman, Forest Hill, Fort Worth, Joshua, Kennedale, Mansfield and the Rendon CDP. In addition, the Cities of Pantego and Dalworthington Gardens are in the watershed of Village Creek, but downstream of the lake. At the recommendation of the NCTCPG, these two cities were included in the planning process. These cities are in Johnson and Tarrant Counties. In addition to local governments' policies and regulations, the watershed is subject to state and federal regulations with respect to stormwater management and water quality protection.

The purpose of this section is to review the current stormwater and water quality policies and regulations affecting the watershed. Copies of the various ordinances, policies, and regulations were obtained from the governments in the watershed, and appropriate state and federal agencies. The existing ordinances and polices vary from one municipality to another depending on their level of service required, available resources, political commitments, implementation policies, etc. Sometimes these varying requirements may impact the common goal of implementation of management practices for protecting the overall water quality. A Summary of the existing management policies of the municipal governments, of which were made available to the project team, are presented below.

7.9.1 Municipal NPDES Permits

As described earlier in the Section 7.1, the NPDES permit program was established under the CWA to control water pollution by regulating the discharge of pollutants into waters of the United States. The NPDES program covers several pollutant sources that are regulated by permits issued by the TCEQ. Under TCEQ's MS4 permit program, local governments in regulated areas are required to establish a comprehensive SWMP and to develop a plan and program to control stormwater pollution discharges to waters of the State to the maximum extent practical and to prevent non-stormwater discharges from entering the stormwater system. All cities but three in the watershed are permitted by the State MS4 NPDES program, and the existing general permit is scheduled to expire in 2012. For the areas in the watershed that are not currently permitted, evaluations in the State may require they be permitted in the upcoming permit cycle beginning in 2012. The cities and counties and their MS4 NPDES permit type (Phase I and Phase II) are listed below and illustrated in Figure 7.9-1.

Phase I:
1. Arlington
2. Fort Worth

Phase II:
1. Burleson

2. Crowley
3. Dalworthington Gardens
4. Everman
5. Forest Hill
6. Kennedale
7. Mansfield
8. Pantego
9. Tarrant County
10. Johnson County

Un-permitted

1. Joshua
2. Cross Timber
3. Briaroaks

* It is important to note that the Cities of Dalworthington Gardens and Pantego are in the Village Creek Watershed downstream of Lake Arlington

7.9.2 Erosion and Sedimentation Control, Runoff Reduction and Flood Control Requirements

Most cities in the Village Creek watershed have generally adopted floodplain ordinances with a focus on controlling the development near major waterways. Similarly, the construction runoff related ordinances of the municipal governments are primarily focused on the implementation of traditional BMPs such as dry detention ponds in order to meet local peak flow requirements. Such controls may be effective in controlling the increased peak runoff rates, but they do not mitigate the runoff volumes associated with longer storm durations, increased runoff volumes, or decreased infiltration (lack of groundwater recharge). All of the cities which the project team reviewed have an ordinance in place for flood damage reduction or floodplain development. All municipalities in the watershed restrict development in the floodways.

7.9.3 Stormwater Management Regulations

All the Phase I and Phase II permitted cities have developed, or are in the process of developing stormwater management programs in accordance with the NPDES permit. It appears that cities in the watershed are in the process of reviewing their existing ordinances in order to include stormwater management elements. The cities in the watershed have different levels of requirement for stormwater management, and not all cities require an analysis of downstream impacts. For example, the City of Arlington requires the developer to consider post development BMPs that could help reduce potential pollution from the development site, but not all cities in the watershed require this.

7.9.4 City of Mansfield

Mansfield has adopted its Stormwater Quality Protection Ordinance which includes components requiring construction runoff controls, illicit discharge detection and elimination, and post development runoff water quality control requirements. The City controls development within its major waterways through the implementation of the Flood Damage Prevention Ordinance. The City implements public education programs as part of its stormwater management program. The City's practices do not include requirements for runoff reduction from new development and re-development sites.

7.9.5 City of Arlington

Lake Arlington is owned and operated by the City of Arlington. The City also has a Flowage Easement in

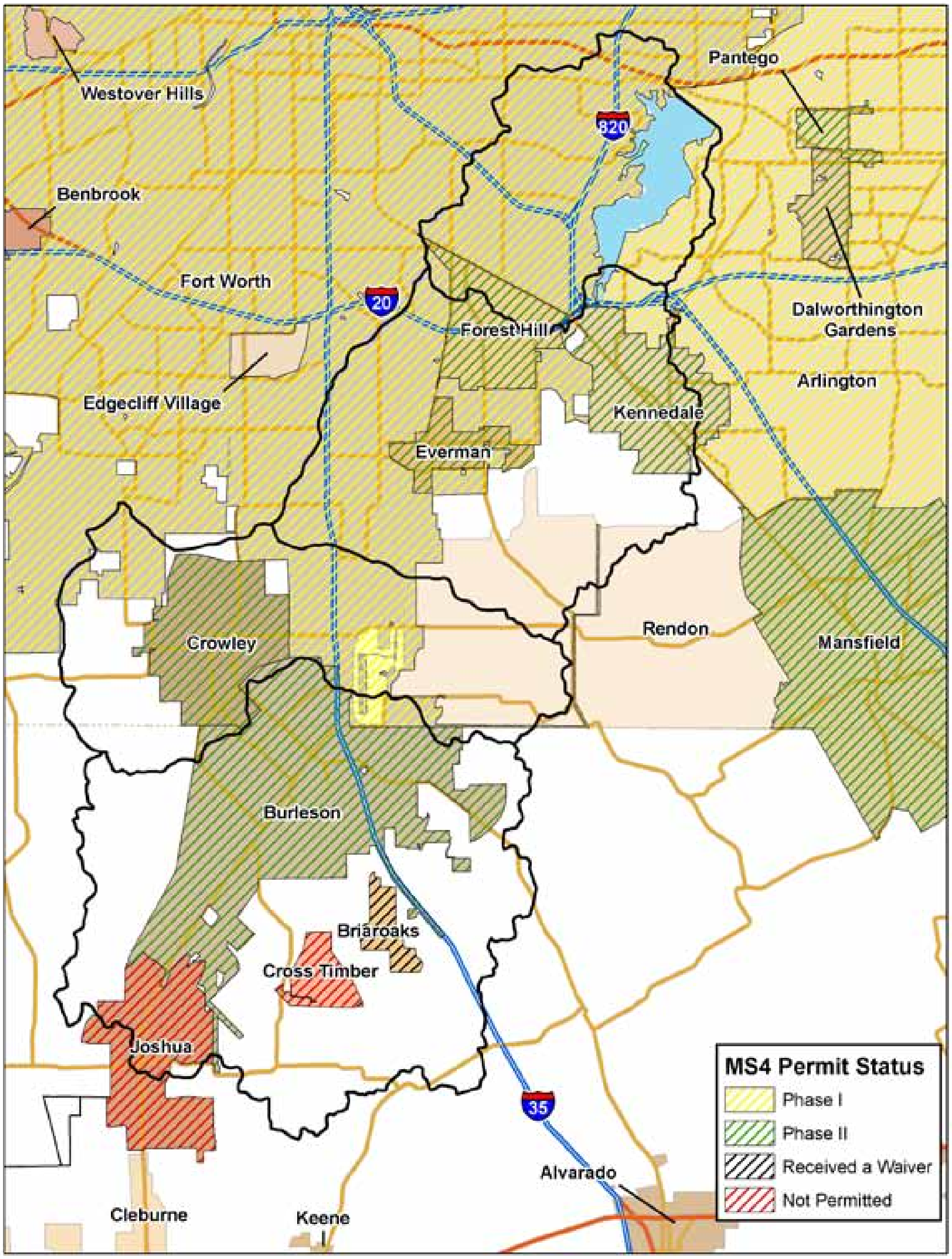


Figure 7.9-1: MS4 Designations in the Watershed *It is important to note that the Cities of Dalworthington Gardens and Pantego are in the Village Creek Watershed downstream of Lake Arlington

the area between elevations 550 and 560. For any earthwork proposed in Lake Arlington or the Flowage Easement, the property owner must obtain permission from the Director of Water Utilities and the USACE. The City controls development in the within major waterways through implementation of its Flood Damage Prevention Ordinance. The City subdivision regulations require developers to implement BMPs that are effective for runoff volume and rate control with no specific requirement on post development runoff quantities. The regulations also require protecting natural creeks and assessing the development plan for possible Low Impact Development (LID) practices. The City requires construction site operators to implement runoff erosion controls through the City Stormwater Pollution Prevention Ordinance. Projects that disturb one acre or more must comply with the requirements in the TCEQ Regulated Construction Projects. Residential projects that disturb less than 12,000 square feet and are not part of a larger plan of development are exempt from these requirements. The City's Gas Drilling and Production Ordinance does not include any specific requirements for runoff control from the gas well sites.

7.9.6 City of Burleson

The City controls development in the floodway and floodplain areas through its Flood Damage Prevention ordinance. The ordinance doesn't restrict development in any part of the floodplain but it does in the major floodway. The City requires developing a Stormwater Management Site Plan for development sites that disturb a surface area of 12,000 square feet or more, and create or add 5,000 square feet or more impervious cover. The City subdivision regulations require developers to implement BMPs that are effective for runoff volume and rate control with no specific requirement on post development runoff quantities. There are no specific requirements for gas well construction sites runoff control.

7.9.7 City of Crowley

The City construction site runoff control regulations require the implementation of temporary controls designed for a ten year storm return frequency. This ordinance also requires developers to install permanent erosion controls. All development within the 100 year floodplain requires a special permit for development from the City. The City also requires gas well construction site operators to submit a SWPP as required by EPA. There are no specific water quality or runoff reduction requirements for site post development conditions.

7.9.8 City of Fort Worth

The City requires construction site operators to implement runoff erosion and sediment controls in compliance with the TCEQ construction general permit; additionally the City requires gas well construction site operators to develop a SWPP. The City has a Stormwater Protection Ordinance which prohibits illicit discharges to its MS4. The City also requires developers to assess the effects on downstream hydrology from proposed development. Peak discharge requirements, runoff controls, and water quality standards in Forth Worth were not determined. At the time of this report, Ft. Worth was using the 2006 iSWM Criteria Manual for development controls and design standards. The 2010 iSWM Criteria Manual was being considered during this same time period.

7.9.9 City of Forest Hill

The City Gas Well Ordinance requires the gas well operator to develop a SWPPP as required by TCEQ. The flood hazard element of the City's Code of Ordinances restricts development in the floodways.

7.9.10 City of Joshua

There were no water quality, peak flow or runoff volume reduction requirements specified in the Development Code Manual reviewed by the project team.

7.9.11 City of Kennedale
The City Code for Planning and Land Development requires that the site developer be responsible for all runoff from fully developed property upstream of the proposed development to the extent that improvements required for the runoff are roughly proportional to the drainage capacity demand created by the proposed development. Similarly, where a drainage study indicates that additional runoff from the developing property will overload downstream drainage facilities and result in hazardous conditions, the developer is responsible for making provisions necessary to accommodate downstream hydrology. Development in the floodway is not allowed in the City. The City requires that gas well site operators develop erosion control in compliance with all local, state and federal requirements, and the operator must file a copy of the site stormwater pollution plan, if required by the EPA. The City does not allow gas well development in the floodplain.

7.9.12 City of Pantego
The City of Pantego restricts development in the floodway and prohibits encroachments until and unless such encroachments are proven not to increase the base flood elevations. It is important to note that the City of Pantego is in the Village Creek Watershed downstream of Lake Arlington.

7.9.13 Tarrant County
Tarrant County requires that detention ponds shall be designed to control drainage from the proposed development area so that the peak discharge rate is equal to or less than when the property was in its natural state. Also it requires a separate permit when the construction is proposed in the floodplain.

7.10 Conclusions and Recommendations
This section outlines the recommended long-term strategies for addressing the watershed and water quality goals and objectives for Lake Arlington. The City of Arlington's goals and objectives have been used to evaluate the impact of various development scenarios on lake water quality and to develop the best management practices (BMPs) that would be needed to maintain the target water quality. The BMPs that make up this collective strategy provide the basis for a comprehensive watershed-wide cooperative effort.

The water quality in Lake Arlington is generally good, with only a few specific issues of concern:

- Temperature. TCEQ's 303(d) report issued in 2002 lists high temperatures for Lake Arlington. TCEQ's 2004 Assessment Report1 states that "additional data are needed to determine whether natural conditions alone can cause elevated temperatures in the lake or whether the Handley Power Plant is a significant contributing factor."
- Manganese. Manganese concentrations increase during the late summer months due to anoxic conditions in the lake hypolimnium. The City of Arlington has the ability to vary intake levels to withdraw source water with lower manganese concentrations for the Pierce-Burch Water Treatment Plant (WTP). Oxidation followed by sedimentation and filtration reduces manganese concentrations in the finished water, however, if manganese concentrations increase and/or anoxic conditions occur at shallower depths, management of manganese in the WTP source water and at the WTP may become more challenging.
- Algae. The Village Creek screening level for chlorophyll-a is exceeded and concentrations in the reservoir indicate significant algal activity. Geosmin concentrations close to two orders of magnitude above the 10 ng/L odor threshold concentration were measured in samples collected at the Lake Arlington intake in 2008.

Other lake water quality issues include trash in the lake from tributary discharges and direct releases to the lake, and sediment loading. With low ammonia concentrations, low nitrate concentrations, and low phosphorus concentrations, nutrient loading does not currently present a significant concern with regard to lake water quality, even though, the lake has significant algal activity.

Future development in the watershed would cause large increases in loads of constituents to Lake Arlington unless control measures are implemented. Both point and non-point loads of most constituents are expected to increase to an extent, even with advanced management measures and controls. However, the increases can be small to moderate with advanced management measures and controls. The segment of Lake Arlington that receives loading from most of the watershed (Segment 7, see Section 7.7) is expected to be more sensitive to watershed development conditions, requiring more advanced pollution controls to prevent significant increases in algal bloom conditions.

The existing pollution control requirements are limited in the watershed, and most are primarily designed to control the peak flows, but not for protecting water quality from new and redevelopment sites. Relying on existing management strategies for future watershed development conditions may not be sufficient to protect the water quality of the lake so that the two water treatment plants can operate economically and meet the treatment levels and standards.

Chlorophyll-a concentrations have long been used as a general indicator of the trophic state of a water body. Lake Arlington is expected to be most sensitive to phosphorus loads. Increases in phosphorus loads could be kept to a moderate level by a combination of stormwater management practices, the establishment of environmentally sensitive areas and a set of standards to be used in those areas, and either advanced wastewater treatment discharge practices or other point source controls. Without control measures, watershed development conditions are expected to cause Lake Arlington to transition from existing eutrophic to elevated eutrophic conditions. The incidence of algal blooms could increase in the reservoir. With pollution control measures, the segment of Lake Arlington near the dam is expected to experience only a slight increase in eutrophication and bloom conditions with buffering conditions of upper segments of the Lake.

Arlington's Pierce-Burch WTP and the Trinity River Authority (TRA) WTP currently meet all microbial and chemical drinking water standards; however, any future drinking water regulations (e.g., Long-Term 2 Enhanced Surface Water Treatment Rule) should be closely monitored within the context of development plans for the lake. Additionally, changes to raw water quality due to watershed development could impact operations at the WTPs (e.g., coagulant and disinfectant doses, etc.) and the continued ability to meet drinking water standards without the addition of new or modified treatment processes. The proposed BMPs for the watershed should assist in minimizing the impact from the future development in the watershed and help maintain and improve the Lake water quality.

To protect and enhance water quality, the following watershed management framework includes several different measures, some of which have already been implemented by municipalities within the Lake Arlington watershed.

- Stormwater Runoff Volume Reduction and Pollution Control Measures
  - Runoff Reduction Requirements for Subdivision/Development Regulations
  - Stormwater Treatment Requirements

- BMPs for Reducing Runoff Volume
- Establishment of Environmentally Sensitive Areas
- Establishment of Floodplain Corridors

• Construction Site Runoff Control
  - Legal Authority
  - BMPs for Construction Sites
  - Controls for Natural Gas and Oil Exploration Sites

• Trash and Litter Control
  - Trash Control and Anti Littering Campaigns
  - Municipal Operations
  - In-stream and Municipal Infrastructure Trash Reduction Methods

• Other Stormwater Management Measures
  - Illicit Discharge Detection and Elimination Programs
  - Public Education and Outreach Programs

As discussed in Section 7.1, these recommended programs provide the municipalities in the watershed with a basic framework that will assist them in the development of their Phase I and Phase II MS4 NPDES permits issued by TCEQ, and compliance with those program regulations. The State is currently evaluating its MS4 program and this may result in cities that are not currently regulated under the Phase II program being issued permits (See Figure 7.1-1). The recommendations made in this document allow for regional cooperation with respect to stormwater management, but it also allows the municipal governments to remain autonomous and manage their own programs.

7.10.1 Stormwater Runoff Volume Reduction and Pollution Control Measures

A. Proposed Runoff Reduction Requirements

Background
In addition to the protection of the water quality in Lake Arlington for purposes of improving treatability, the NPDES Phase I and Phase II regulations require that the municipalities in the watershed develop, implement, and enforce a stormwater management program that reduces the discharge of pollutants from the regulated jurisdiction “to the maximum extent practicable (MEP)”. Using guidance provided in this report, the municipalities of the watershed can achieve the MEP standard by instituting a stormwater management program that implements and requires BMPs designed to protect water quality.

Control measures 2 and 5 of the NPDES Phase I and Phase II permits, respectively, issued to the municipalities in the watershed by the Texas Commission on Environmental Quality (TCEQ) presents the requirements for the control of post-construction (i.e., after development) stormwater runoff.

Quoting directly from the Phase I (large MS4) NPDES permit, the municipalities must:

> *Implement a comprehensive master planning process (or equivalent) to develop, implement, and enforce controls to minimize the discharge of pollutants from areas of new development and significant redevelopment after construction is completed. The goals of such controls shall include:*

1. *New development – limiting increases in the discharge of pollutants in stormwater as a result of development; and*
2. *Redevelopment – reducing the discharge of pollutants in stormwater.*

Quoting directly from the Phase II (small MS4) NPDES permit, the municipalities must,

Develop, implement and enforce a program to address stormwater runoff from new development and redevelopment projects that disturb greater than or equal to one acre of land, including projects less than one acre that are part of a larger common plan of development or sale that will result in disturbance of one or more acres, that discharge into the small MS4. The program must ensure that controls are in place that would prevent or minimize water quality impacts. The permittee shall:

1. *Develop and implement strategies which include a combination of structural and/or non-structural BMPs appropriate for the community;*
2. *Use an ordinance or other regulatory mechanism to address post-construction runoff from new development and redevelopment project to the extent allowable under state and local law; and*
3. *Ensure adequate long-term operation and maintenance of BMPs.*

As a result of these requirements, the municipalities in the watershed should implement regulations within their jurisdictions that include a requirement for new developments and redevelopments to control stormwater quality.

The North Central Texas Council of Governments (NCTCOG's) Integrated Stormwater Management (iSWM) Technical Manual for Site Development and Construction has recommended the following design criteria for site development in North Central Texas, which includes the Lake Arlington watershed:

- Water Quality Protection: Remove pollutants in stormwater runoff to protect water quality. This criterion is based on a volume of 1.5 inches of rainfall, not a storm frequency.
- Streambank Protection: Regulate discharge from the site to minimize downstream bank and channel erosion. This criterion is based on the 1-year, 24-hour storm event.
- Flood Mitigation and Conveyance: Control runoff within and from the site to minimize flood risk to people and properties for the "conveyance storm" as well as the 100-year storm event. The conveyance requirement is for a 25-year, 24-hour storm event.

A recent regulatory trend is to base stormwater control requirements on the total volume of stormwater runoff from a site, rather than on runoff rates or a specific pollutant removal rate. This trend is based on a growing body of research that concludes that volume-based controls attain the concurrent benefits of pollutant reduction, peak flow reduction, and base flow protection. The focus on runoff volume as the common currency for BMP evaluation is gaining wider acceptance across the country. Clearly, the concept of runoff reduction marks an important philosophical milestone that will help define the next generation of stormwater design. The promise of runoff reduction is that the benefits go beyond water quality improvement. If site and stormwater designs can successfully implement runoff reduction strategies, then they will do a better job of replicating a more natural (or predevelopment) hydrologic condition. This not only includes peak rate controls to address runoff volume, but it also addresses duration, velocity, frequency, groundwater recharge, and protection of stream channels from erosion. The following paragraphs describe some of the BMPs being used or considered by utilities and stormwater management entities in the United States.

Some local governments are controlling runoff volumes from new and redevelopment sites by requiring the implementation of low impact development (LID) practices to maximum extent possible. For an example, the DuPage County, Illinois DuPage County Countywide Stormwater and Flood Plain Ordinance, requires developers to incorporate BMPs such as impervious area disconnection to vegetated areas, the use of infiltration techniques and the use of vegetated swales for stormwater conveyance as part of the water quality stormwater treatment to treat the 2 year, 24-hour event (generally 3.04 inch rainfall) over the drainage area for development sites. Such practices are also believed to be effective for runoff volume control along with pollutant loads and discharge rate reduction. Dupage County also has a stormwater release rate standard which must be considered for the 100-year, 24-hour storm when calculating the stormwater storage capacity.

The Runoff Reduction Method was originally developed in tandem with the Virginia Department of Conservation and Recreation (DCR) efforts to update the stormwater regulations and handbook, and the concept is widely applicable to other state and local stormwater planning procedures. Currently, within the Chesapeake Bay Watershed, the States of Delaware, Maryland, Virginia, and the District of Columbia are considering incorporating the concept of runoff reduction into updated stormwater regulations and design manuals (Capiella et al., 2007; DeBlander et al., 2008; MSC, 2008). The Pennsylvania Stormwater Best Management Practices Manual (PA DEP, 2006) already incorporates standards for volume control achieved by structural and nonstructural BMPs.

As described in the Staff Report on a Proposed Amendment to the Dane County Water Plan, Adopting a Volume Control Standard for Urban Service Area Amendments, 2010, there are several examples of approaches to volume control standards. The Capital Region Watershed District in Minnesota requires that the first 1-inch of runoff from impervious areas be controlled (CRWD, 2006). The Pennsylvania Department of Environmental Protection (PDEP, 2006) has a two volume control guideline. The first recommendation where site conditions allow, is to not increase the post-development total runoff volume for any storm equal to or less than the 2-year, 24-hour event. The second recommended requirement, if the first cannot be met, is that at least the first 1-inch of runoff from new impervious surfaces shall be permanently removed from the runoff flow. Another approach that the regulators are considering is to maintain the infiltration rate (groundwater recharge) as a predevelopment condition for the site area, even with post-development conditions. This approach may require increasing the infiltration rates of pervious areas in the site area to compensate for the lost infiltration quantities that are caused as result of development. All new federal facilities are required to maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to the temperature, rate, volume, and duration of flow (US EPA, 2009).

Proposed Runoff Reduction Requirements for the Village Creek – Lake Arlington Watershed
The more runoff reduction that standards require, the harder it is to comply at individual sites, particularly with higher levels of development intensity. Also it will be a challenge for developers to adapt to any sudden changes in the regulatory requirements. With these considerations in mind, the Pirnie Team recommends that municipalities in the watershed require new development and redevelopment projects to maintain predevelopment runoff volumes for rainfall depths equal to 90% of expected rainfall events. Under this proposed requirement, the excess runoff caused by changes in the land cover for a rainfall event with a depth corresponding to 90% of expected rainfall events must be retained on the site by appropriate BMPs. Therefore, the total allowable runoff for the site with post-development conditions would be the sum of: (i) the expected runoff for predevelopment conditions, plus (ii) the additional runoff produced by a change

in land use for rainfall events of more than 90% of the rainfall events depths. The rationale for using the 90th percentile event is that it represents the majority of runoff volume on an annual basis, and that larger events would be very difficult and costly to control for the same level of water quality protection. It is important to note that the proposed 90th percentile (1.46 inch rainfall depth) captures the first flush runoff (runoff corresponding to first 0.5 inch of rainfall is widely accepted as first flush) which is expected to carry most of the runoff pollutant load.
In other words, the required runoff volume retention is equal to the post development runoff volume for the 90th percentile storm event minus the pre-development runoff volume for the 90th percentile storm event.
Advantages of Proposed Requirements

These proposed runoff volume reduction requirements (in addition to recommended treatment volume, flood and conveyance requirements in the NCTCOG iSWM Technical Manual) have several distinct advantages when it comes to evaluating runoff reduction practices and sizing BMPs:

- By capturing the required runoff volume, the proposed requirements provide effective stormwater treatment from the site corresponding to 90% annual rainfall events, and larger storms will be partially captured.
- Since the required runoff reduction is a direct function of impervious cover, this creates incentives to conserve pastures, open space and other natural conditions, reduces mass grading, and provides a defensible basis for computing lower runoff reduction volumes for these practices.
- The 90th percentile volume reduction will help treat all the first flush runoff which is expected to have higher pollutant concentrations (Pitt et al 2005).
- Runoff reduction volumes will help reduce the treatment volumes and therefore the size of BMPs, as well as the volumes of flow for channel protection or flood reduction purposes.
- The requirements help maintain the same ground water re-charge rates as predevelopment.
- The requirements help protect downstream water quality and channel geometry and also minimize the need for downstream flood control measures.

Determining the Required Runoff Volume Reduction
Runoff volumes corresponding to predevelopment and post-development hydrology for a site can be calculated by multiplying the 90th percentile annual rainfall event by the runoff volumetric runoff coefficient (Rv) and the site area.

Rv is defined as:

$$Rv = 0.05 + 0.009(I)$$

Where:
I = percent of impervious cover (%)

A similar procedure has been recommended by the iSWM Technical Manual developed by the NCTCOG for calculating the Water Quality Protection Volume (WQv), and the procedure is detailed in the iSWM Manual.

A frequency distribution of the long term daily rainfall data recorded at the Dallas-Fort Worth International Airport has shown that the 90th percentile annual rainfall (i.e., the storm event that is greater than 90% of the storms that occur) is approximately 1.5 inches (1.46 inches).

Therefore, runoff volume can be calculated using the following formula:

Runoff Volume (acre-feet) = (1.5/12)* Rv* A
where,
Rv = volumetric runoff coefficient
A = total drainage area (acres)

Runoff volume can be expressed in inches using the following formula:
Runoff Volume (inches) = 1.5(Rv) (1.3)

Measuring Impervious Area: The area of impervious cover can be taken directly off of a set of plans or by using appropriate mapping tools. Where this is impractical, the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) Technical Release 55, or NRCS TR-55, land use/impervious cover relationships can be used to estimate impervious cover. "I" is expressed as a percent value, not a fraction (e.g., I = 30 for 30% impervious cover).

Multiple Drainage Areas: When a development project contains or is divided into multiple outfalls, runoff volume should be calculated and addressed separately for each outfall.

Once the runoff volume corresponding to 90th percentile event has been determined for both predevelopment and post-development conditions, the difference (post-development runoff – predevelopment runoff) in the calculated volumes is the runoff volume that needs to be controlled. If the post-development runoff volume is calculated to be less than the predevelopment runoff, no further volume reduction is required.

Recommendations for Implementation of Proposed Requirement
Implementation of the proposed runoff reduction requirements at new development and redevelopment sites can best be accomplished through regulatory enforcement. Regulatory enforcement in the form of an ordinance may require new projects to implement low impact development (LID) practices for controlling and treating stormwater runoff from the site. Low impact development is a comprehensive land planning and engineering design approach with a goal of maintaining the pre-development hydrologic characteristics of developing watersheds.

Additionally, the Pirnie Team recommends that entities periodically review and modify, as necessary, development ordinances to reduce the amount of impervious surface permitted in new development. The review process should evaluate potential changes to the following: (i) roadway width; (ii) parking requirements; (iii) setbacks; and (iv) curb and gutter requirements. As a first step, ordinances for each jurisdiction should be reviewed to identify all requirements that impact the amount of impervious surfaces installed on properties and hence controlling the runoff volume. These requirements will then be compared with model ordinance language that allows for LID and other green infrastructure strategies and therefore greater runoff reduction. The next step is to review the results of these comparisons and develop an ordinance tailored to each of the Lake Arlington watershed counties and municipalities. In particular, these ordinances may include potential changes to minimum street widths, minimum parking requirements, curb and gutter requirements, and minimum setback requirements.

B. Proposed Stormwater Treatment Requirements
The NCTCOG iSWM Technical Manual (the "Manual") includes a recommendation for water quality protection. In addition to the proposed stormwater volume reduction requirement outlined above, it is recommended that the remaining runoff (after volume reduction) be treated in order to comply with the water

quality design standards of the Manual. Those standards are that pollutants in stormwater runoff be removed in order to protect water quality. The criterion is based on a volume of 1.5 inches of rainfall, not a storm frequency. Therefore after the volume has been reduced by infiltration and low impact development, the developer should capture to comply with the standard of removing the pollutants (or treating) the runoff associated with the runoff from up to and including 1.5 inches of rainfall.
Water Quality Protection Volume can be calculated as follows:
WQV = Runoff volume from the developed condition of the site corresponding to 1.5 inch rainfall depth - Runoff volume reduced as part of runoff reduction requirement for developed conditions of the site.

Runoff volumes are calculated as described above in the runoff reduction requirements section of the report.

See Attachment A for a proposed model runoff reduction and treatment ordinance.

Recommended BMPs for Reducing Runoff Volume

Runoff Reduction BMPs: Runoff reduction methods from a post-construction site can be classified as either source controls or structural controls.

Source controls are post-construction control measures that reduce the amount of runoff generated by a reduction of impervious surfaces. Source control of the runoff can be maximized by better design of the site. For better design of the site, the designer has to undergo an iterative process looking for opportunities to reduce the impervious cover. Whenever possible, the designer has to reduce steep slopes to slow down the runoff and give additional time for the runoff to infiltrate. Overall, the designer may need to follow these four steps.

Step 1: Apply Early Standard Practices: During site layout, designers should look at a site map of environmental and soil features to find the easy opportunities to minimize creation of needless impervious cover or mass grading, and maximize protection of permeable soils, forest or grassland cover and other natural features.

Step 2: Compute Post Development Land Cover: Designers then use the resulting impervious cover and determine total runoff reduction requirements at the site.

Step 3: Apply Runoff Reduction Practices: The designer should then experiment with combinations of different runoff reduction practices on the site, such as the use of BMPs, conservation subdivision or landscape designs promoting tree canopy and undisturbed vegetation. In each case, they will estimate the spatial area to be treated by each runoff reduction practice, and "chip away" at the required runoff reduction volume for the site.

Step 4: Determine if Further Reduction is Needed: In the last step, the designer checks whether the runoff reduction has been achieved at the site.

Structural controls and BMPs involve controlling the increase in runoff generated from a developed site. Various BMPs are capable of reducing the volume of runoff based on the post-development condition. Historically, BMP performance has been evaluated according to the pollutant removal efficiency of a practice.

However, in some cases, this under-reported the full capabilities of BMPs to reduce pollutant loads. More recent BMP performance research has focused on runoff reduction as well as overall pollutant removal. One such research project is by the Center for Watershed Protection (CWP), as part of Virginia's Stormwater Regulations and Handbook Technical Assistance. The reduction values presented in the following table will provide expected performance guidelines.

PRACTICE	**RUNOFF REDUCTION (%)**
Green Roof	*45 to 60*
Rooftop Disconnection	*25 to 50*
Raintanks and Cisterns	*40*
Permeable Pavement	*45 to 75*
Grass Channel	*10 to 20*
Bioretention	*40 to 80*
Dry Swale	*40 to 60*
Wet Swale	*0*
Infiltration	*50 to 90*
Extended Detention Pond	*0 to 15*
Soil Amendments	*50 to 75*
Sheetflow to Open Space	*50 to 75*
Filtering Practice	*0*
Constructed Wetland	*0*
Wet Pond	*0*
Range of values is for Level 1 and Level 2 designs	

Table 7.10-1 Runoff Reduction for Various BMPs (Adapted from technical memorandum on the Runoff Reduction Method, CWP (2008)).

Illustrations of the LID practices described in Table 11 are seen below.


Green Roof


Rooftop Disconnection


Raintanks & Cisterns


Permeable Pavement


Grass Channel


Bioretention


Bioretention


Infiltration

A range of values represents the median and 75th percentile runoff reduction rates based on the literature search. Level 1 can be considered a “standard” design (achieves the median value of runoff reduction), and Level 2 an enhanced design (achieves the 75th percentile values).

Considerations

One has to understand that not all sites have same opportunities for runoff reduction. The reduction options may be more limited for an area with high intensity development than the available opportunities for low intensity developments. For sites with high intensity development, the option is to use conventional stormwater practices which usually have limited runoff reduction capabilities. These practices may also help meet some of the regulatory requirements. For an example, depending on the available space a developer may choose to retrofit the site with a wetland or extended detention basin or a dry detention pond. It is advised that the developer chose the retrofit stormwater BMP that can provide maximum runoff reduction and water quality treatment benefits among the possible BMPs for the site. For an example, choosing a wetland over a dry detention pond will help reduce runoff to an extent through infiltration and evapotranspiration, and at the same time help meet to reduce the peak discharges similar to a dry detention pond. Similarly, for the development sites with relatively impermeable soils containing clay and silt, some of the infiltration BMPs such as infiltration trenches are not suitable. For such cases, the developer may choose to implement BMPs with amended soils for higher filtration rates and amended soils in combination with under drain option to reduce runoff. For the sites with relatively impermeable soils the developer may also chose to select BMPs that can be used to store rainwater such as cisterns for roof runoff and use for non-potable purposes and BMPs that reduce runoff through evapotranspiration. The Lake Arlington watershed has mixed group of soils that range high potential for infiltration to very low infiltration potential. The soil groups of the watershed are illustrated in Figure 7.10-1 and following are soil groups as defined by the NRCS.

A = (Low runoff potential) Soils having low runoff potential and high infiltration rates, even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission.

B = (Moderately low runoff potential). Soils having moderate infiltration rates when thoroughly wetted and consist chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

C = (Moderately high runoff potential). Soils having low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine textures. These soils have a low rate of water transmission

D = (High runoff potential). Soils having high runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a hardpan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission

It is important to note that the sites with relatively impermeable soils may require reducing relatively smaller quantities of post-development runoff when compared to a similar size and development site with relatively high permeable soils. This is because the site is expected have high runoff even before its development due to relative impervious nature of the site and hence the relative increase in the runoff for post development conditions will be minimal. Even after selecting all possible LID techniques, if the site is still not meeting the runoff reduction requirements then the developer can demonstrate the fact and choose to go with traditional treatment techniques. Developers are advised to follow the procedure mentioned earlier when selecting traditional BMPs for the site.

Another important consideration for infiltration BMPs for runoff reduction is that the infiltration of polluted stormwater runoff is not always desirable or even possible at some development sites. Therefore, most

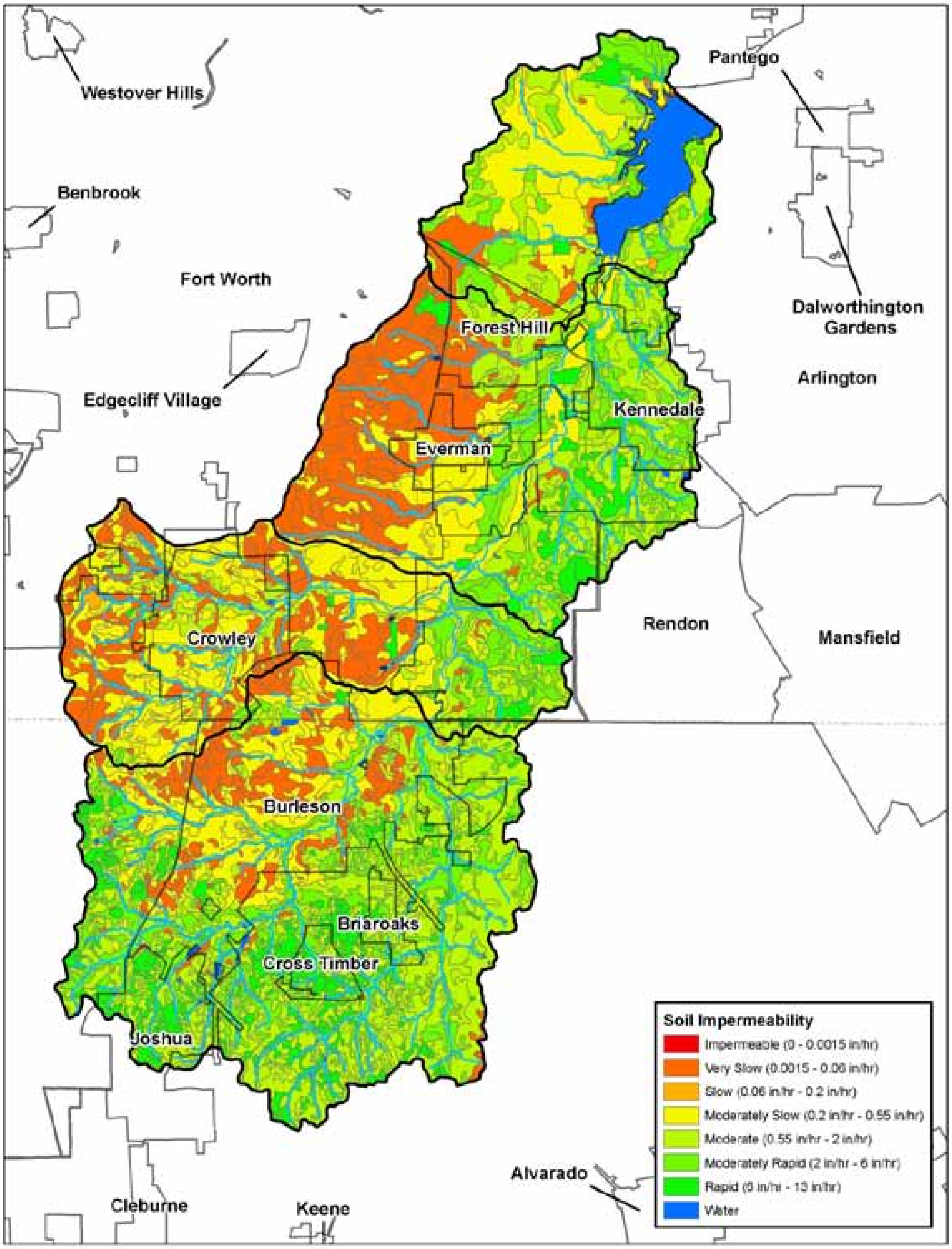


Figure 7.10-1: Soil Impermeability in the Watershed

infiltration management practices include criteria to reflect special site conditions, protection of groundwater quality, and avoiding common nuisance issues. For example, they may require:

- The pretreatment of stormwater runoff prior to infiltration in some land use categories or pollution source areas (e.g. parking lots, roadways).
- That recharge be restricted or prohibited at specific industrial, commercial and transport related operations designated as potential stormwater hotspots.
- That recharge be prohibited or otherwise restricted within the vicinity of wellhead protection areas, individual water wells, structures, and basins.

C. Establishment of Environmentally Sensitive Areas

To further assist in the protection of water quality in Lake Arlington and to achieve the 20% pollutant reduction that was modeled during this Project, environmentally sensitive areas (ESAs) should be designated around the waterways in the watershed. The purpose of the establishment of the ESAs is to not restrict development or other activities, but to give the entities in the watershed an area of focus for the implementation of pollutant reducing activities.

Management practices in the ESAs should include the following:

- Limited use of pesticides, herbicides and fertilizers on public lands.
- Additional recommendations for the implementation of construction site runoff BMPs (as presented below).
- Targeting this area for trash reduction and anti-littering public education campaigns.
- More frequent monitoring of industrial and high risk commercial facilities and operations.
- Development of a conservation subdivision policy for ESAs.
- Signage to designate the watershed as an ESA.
- Additional land conservation.

The proposed definition of ESAs for this project is the 100-year floodplain of the Village Creek watershed upstream of Lake Arlington. The 100-year floodplain is shown on Figure 7.10-2 below.

Conservation Subdivision Policy for ESAs

Conservation subdivision practices is a method that can be employed by developers to assist with achieving the standards proposed for stormwater runoff reduction and stormwater treatment. The general purpose of conservation subdivision policies is to reduce the amount of impervious cover by preserving open space while accommodating the development project. Conservation subdivision practices seek to facilitate development while still maintaining the most valuable natural features and functions of the site.

For the municipalities and counties in the watershed it is recommended that such a policy be developed as part of each entity's subdivision regulations that will require the following:

- The proposed conservation subdivision policy should be applied to all new development and redevelopment sites in the watershed that within 600 feet of the Lake or its tributary banks.
- Within the ESA, a conservation area around the development (natural, undisturbed) should be calculated as 50 feet plus 2 feet per 1 % of slope, as measured perpendicular to the water body and extended to the water bank. Slope can be determined by measuring the difference in elevation between the stream bank and a point approximately 300 feet inland perpendicular to the stream bank.

In 2005 the Lady Bird Johnson Wildflower Center in Austin, Texas published Conservation Development

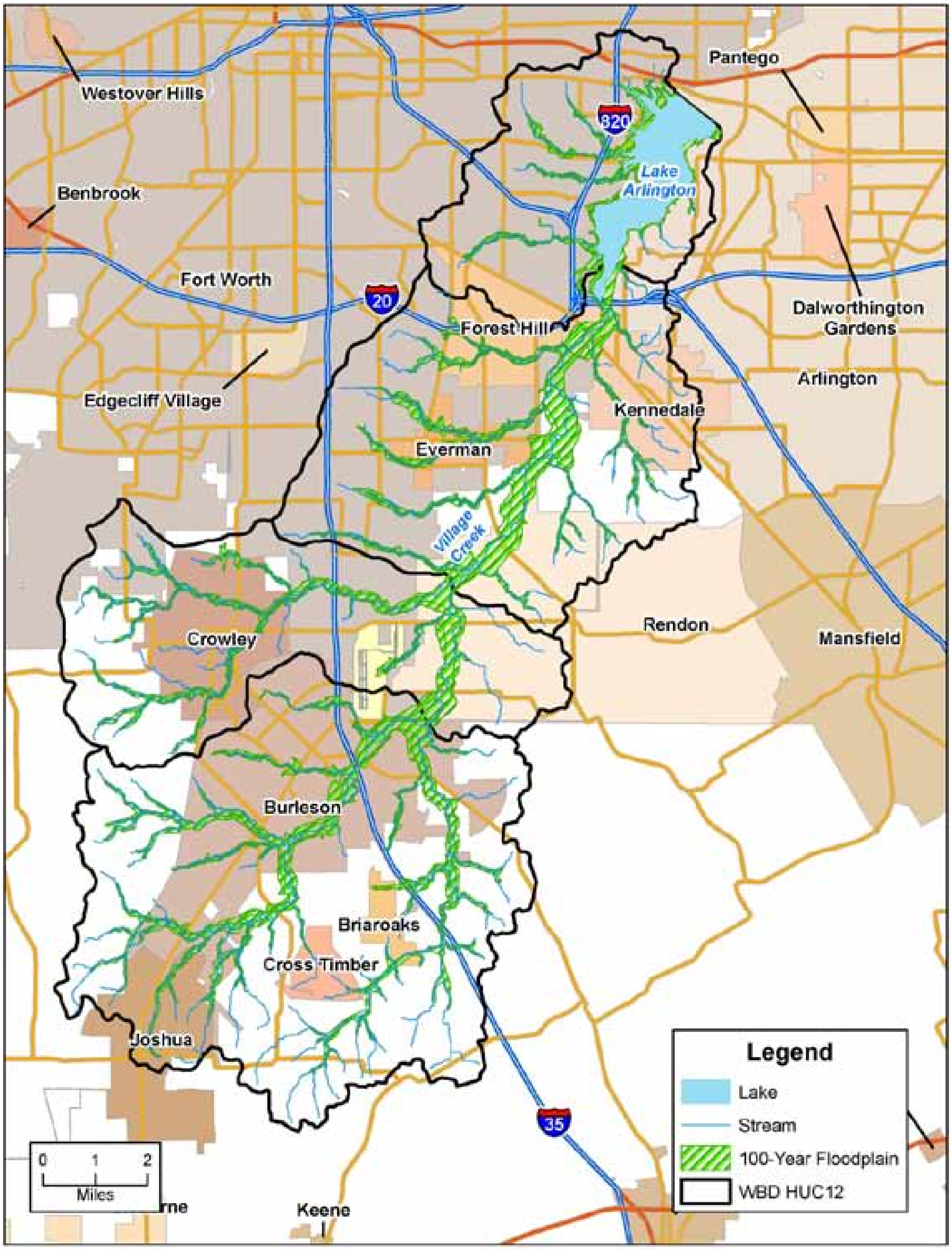


Figure 7.10-2: Proposed Environmentally Sensitive Areas (ESAs)

in Texas: a Primer for Government Officials, Developers and Land Planners. This resource outlines the theory, economic value and legal basis of conservation development. This publication is available on line at http://www.hillcountryalliance.org/uploads/HCA/ConDevelPrimer.pdf.

Conserving lands in the floodplain protect and improve water quality by preventing sediment and nutrient-laden runoff from entering waterbodies because:

- The vegetation helps reduce near and in-stream erosion.
- Plants take up excess nutrient loads.
- The cover soaks up some of the flow, reducing flashiness and restoring base flow conditions.

These undisturbed floodplains are assumed to reduce total phosphorus (TP) and total suspended solids (TSS) concentrations in runoff from adjacent land. The removal efficiency is dependent on the average floodplain width. For these areas to be effective at removing pollutants, runoff from the contributing area must enter the floodplain as sheet flow. This means that only areas near the floodplain are treated. Table 7.10-2 demonstrates the pollutant removal efficiency of buffer areas of various widths.

CORRIDOR WIDTH (ft)	TSS REMOVAL EFFICIENCY (%)[a]	TP REMOVAL EFFICIENCY (%)[b]	NOTES
50[c]	50	20	[a]Values calculated using linear interpolation between 50 and 100 feet as well as between 100 and 200 feet. Corridor widths above 200 feet were assigned a 95% removal efficiency. [b] Values calculated using linear interpolation between 50 and 100 feet. Corridor widths from 110 feet up to and including 200 feet were calculated as a percentage of TSS removal efficiency using the TP/TSS removal efficiency ratio at the 100 foot width. Corridor widths above 200 feet were assigned a 52% removal efficiency. [c]Values given in the Georgia Stormwater Management Manual, Volume 2 for Grass Filter Strips [d]Values given in the City of Newport News, Virginia's Code for undisturbed corridors [e]Value given in "A review of Scientific Literature on Riparian corridor Width, Extent and Vegetation," by Seth Wenger
60	55	24	
70	60	28	
80	65	32	
90	70	36	
100[d]	75	40	
110	77	42	
120	79	43	
130	81	45	
140	83	46	
150	85	47	
160	87	48	
170	89	49	
180	91	50	
190	93	51	
200	95[e]	52	

Table 7.10-2: TSS and TP Removal Efficiencies for Various Corridor Widths

From Table 7.10-2 it is observed that pollutant removal efficiencies for corridors greater than 100 feet in width have a diminished return in value beyond that width.

Additional Land Conservation
In an effort to protect the Central Texas region's water supply lakes, the NCTCOG has partnered with the Trust for Public Land to "Greenprint" the Lake Arlington watershed. Greenprinting is defined as an approach for identifying areas that offer the highest conservation benefit for water quality protection and other regional resource priorities. This project is being funded through a grant provided by the EPA through the TCEQ. The purpose of the Greenprint modeling is to identify areas within the watershed that provide water quality benefits and are the highest priority for protection through the purchase of conservation easements from willing participants, and other methods.

The conservation of natural lands that have been identified in this NCTCOG project will serve as one of the implementation steps to conserve land in the watershed that will provide water quality benefits.

The Greenprinting project was initiated in December 2010. Through March 2011 it is expected that a Technical Advisory Team will meet to refine the Greenprint model framework, identify best data sources, and create the Greenprint model. Afterward stakeholders from the watershed will convene to gather and provide information that will serve to weight the model criteria and discuss parcel scoring considerations. In the months of April and May 2011, the parcel scoring and overlay analysis will be completed and the maps, report and prioritized parcel spreadsheets will be delivered to the NCTCOG.

The City of Arlington has a goal to protect Lake Arlington and aquatic resources from the short and long term impacts of development activities within the watershed. Therefore, the recommended requirements and ordinances should prohibit certain activities within a floodplain. Under no circumstances should any part of a private, on-site sewage system, including field lines, wastewater irrigation, wastewater collection or treatment systems, or golf courses, be located in a floodplain.

7.10.2 Construction Site Runoff Control

A. Construction Site Erosion Control
The objective of construction site runoff control measures is to reduce soil erosion from active development sites and to enforce applicable erosion and sedimentation control provisions to reduce impacts to watershed health. Erosion control measures are required when land-disturbing activities expose the soil and subject it to accelerated erosion.

The NPDES Phase I and Phase II regulations require that the regulated municipalities in the watershed develop, implement and enforce erosion and sediment control requirements for active construction and land disturbance activities. The Phase I NPDES permit requires the following:

> *The permittees shall implement a program to reduce the discharge of pollutants into the MS4 from construction sites. This program shall include:*
> a. *Requirements for the use and maintenance of appropriate structural and nonstructural control measures into the MS4 from construction sites;*
> b. *Inspection of construction sites and enforcement of control measure requirements;*
> c. *Appropriate education and training measures for construction site operators; and*
> d. *Notification, as appropriate, to building permit applicants of their potential responsibilities under the NPDES/TPDES permitting regulations and permits for construction site runoff.*

The Phase II NPDES permit requires:

> *The MS4 operator, to the extent allowable under State and local law, must develop, implement, and enforce a program to reduce pollutants in any stormwater runoff to the small MS4 from construction activities that result in a land disturbance of greater than or equal to one acre of if that construction activity is part of a larger common plan of development or sale that would disturb one acre or more of land. The MS4 operator is not required to develop, implement, and/or enforce a program to reduce pollutant discharges from sites where the construction site operator has obtained a waiver from permit requirements under NPDES or TPDES construction permitting requirements based on a low potential for erosion.*
>
> *a. The program must include the development and implementation of, at a minimum, an ordinance or other regulatory mechanism to require erosion and sediment controls, as well as sanctions to ensure compliance, to the extent allowable under state and local law.*
> *b. Requirements for construction site contractors, at a minimum:*
> *1. implement appropriate erosion and sediment control BMPs; and*
> *2. control waste such as discarded building materials, concrete truck washout water, chemicals, litter, and sanitary waste at the construction site that may cause adverse impacts to water quality.*
> *c. The MS4 operator must develop procedures for:*
> *1. site plan review which incorporate consideration of potential water quality impacts;*
> *2. receipt and consideration of information submitted by the public; and*
> *3. site inspection and enforcement of control measures to the extent allowable under state and local law.*

It is recommended that the municipalities in the watershed adopt the integrated Construction Criteria that is detailed in the iSWM Criteria Manual developed by the NCTCOG. This will serve as the legal authority necessary to implement a construction site runoff control program. Included in this documentation is a checklist for plan preparation and review that should also be used by contractors and city staff. Attachment 5 includes a fact sheet for developers to explain their responsibilities and an inspection worksheet for municipal construction site inspectors.

The municipalities in the watershed should have documented construction site runoff control programs that include adequate erosion and sediment control ordinances to provide the appropriate authority and standard operating procedures for permitting, inspections and enforcement. The standard operating procedures should include the following key items:

- A plan review process, which includes the plan review checklist, and the consideration of the NCTCOG Construction Controls section of the iSWM Technical Manual.
- Notification to permit applicants of their potential responsibilities under the NPDES permitting program for construction site runoff.
- Procedures for conducting site inspections, including an inspection checklist.
- Procedures for providing permittees with written notification of inspection findings.
- Procedures for escalating enforcement actions.

The construction site program should also include an appropriate training and education program for contractors and construction site operators. The education program should inform them of their responsibili-

ties and various options for satisfying permit conditions. In order to maximize participation in any training program, the local watershed municipalities may consider offering an incentive for attending the training each year.
The NCTCOG offers a 6 hour course designed more for municipal inspectors, but is also appropriate for contractors, engineers, and other personnel with responsibility for preventing stormwater pollution during construction activities. Upcoming classes are scheduled for May 5, 2011 and August 22, 2011. Additional information can be found at http://www.nctcog.org/envir/SEEclean/stormwater/program-areas/construction/index.asp. All of the NCTCOG training offerings are posted at http://www.nctcog.org/cs/rtc/admin_services.asp.

The Regional Stormwater Management Program's Public Education Task Force is in the process of developing a field guide designed for the construction site superintendents to help them prevent stormwater pollution at construction sites (mainly homebuilding sites). Over the next few years, the NCTCOG would like to have regional training targeting superintendents and contractors, but the feasibility and logistics of this is yet to be determined.

B. Recommended BMPs for Construction Sites
For all construction sites in the Lake Arlington watershed, developers and contractors shall consult the iSWM Technical Manual for BMPs appropriate for complying with erosion and sediment control regulations and to reduce to the maximum extent practicable the runoff of sediments from disturbed land.

For construction sites located in the environmentally sensitive areas (ESAs), which are defined in Section 7.10.1, there should be consideration of the following BMPs detailed below with the purpose of protecting the water quality of Lake Arlington.

The information outlined below provides general guidance for personnel working on projects being constructed in the ESAs delineated earlier in this document.

The general management practices/operations include:
1. Erosion and Sediment Control
2. Managing Watercourses
3. Managing the Work Area
4. Managing Spoil
5. Ground Stabilization
6. Site Clean Up

1. Erosion and Sediment Control
   Several specific methods of erosion and sediment control are provided below. However, the following general measures should be employed as appropriate:
   - Install erosion and sediment control measures prior to any land disturbing activity, including clearing and grubbing.
   - Sediment control measures are installed both within the work area and on the outside limits of the work area to control runoff from disturbed areas before it leaves the site.
   - Remove erosion and sediment controls measures after the graded project area is complete and stable, which should typically occur within a two year time period.

rosion and Sediment Control BMPs

a. Temporary Silt Fence
The purpose of a temporary silt fence is to intercept water flow from the site, decrease velocity, and cause suspended particles to settle. The use of temporary silt fencing applies below small disturbed areas less than ¼ acre per 100 feet of fence, and where runoff can accumulate behind the sediment fence without damaging the fence or the inundated area behind the fence. This practice shall not be installed across streams, ditches, waterways or areas that have concentrated flow.

b. Special Sediment Control Fence
A special sediment control fence is hardware cloth with sediment control stone at the base and contained by wire mesh fence. Water from the site drains through the sediment control stone causing sediment to be trapped or causing it to settle.


Figure 7.10-4: Sediment Control Fence

The use of special sediment control fencing applies where the volume of water is too extensive for a silt fence, and where inadequate right of way is available for a silt ditch. This practice does not apply where topography forces water to run along the base of the sediment control stone instead of allowing the water to pond up and flow through the stone.

c. Temporary Silt Ditch
This practice is recommended for use in place of a silt fence where room allows, and should be used in conjunction with fiber check dams with polyacrylamide (PAM, with rock sediment dams or other measures to contain sediment at the outlet.


Figure 7.10-5: Temporary Silt Ditch

This practice applies at the toe of fill slopes where fill exceeds 3 feet (1 meter) in vertical height, adjacent to streams to intercept flow and/or divert to a controlled outlet, and along project perimeters to minimize sediment loss from the site. This practice does not apply within jurisdictional waters and wetlands, or when access is difficult due to high fill slope.

d. Fiber Check Dams and Polyacrylamide
On most construction sites, channels are installed to route runoff into sediment control basins. To keep the channels from eroding, check dams are usually installed to pool the water so it moves from pool to pool down the slope. The most common practice is to place large stone in the channel with a weir, or low spot, in the center. The purpose of using fiber check dams (FCD) and PAM is to reduce soil erosion through soil binding.


Figure 7.10-6: Fiber Check Dam

The use of FCD and PAM is applicable when they are installed perpendicular to flow with a weir, or low point, that can pass the design flow without overtopping the channel or circumventing the FCD ends. It is best used when fine silts and clays are present on the jobsite because PAM is a synthetic polymer that acts as a highly effective binding agent with those soil types. PAM-treated runoff should be directed into a sediment basin or similar device prior to discharge in order to trap the flocculated material.

e. Temporary Rock Sediment Dam
Typically, temporary rock sediment dams (or check dams) are used at the outlets of roadside ditches or channels to impound and settle runoff prior to entering streams or exiting the site.

Check dams are most applicable at outlets of temporary diversions, temporary silt ditches, channels, and temporary slope drains, in locations where dam can be cleaned and maintained on a regular basis, in locations where runoff is exiting the construction site, and in small natural drainage turnouts.


Figure 7.10-7: Temporary Rock Sediment Dam

2. Managing Watercourses
The work area must be isolated from the normal flow of a stream and the flow that occurs during minor rainfall events. When a stream must be diverted on a project, the watercourse should be managed to minimize adverse impacts to the jurisdictional waters.

The following general measures should be employed as appropriate:
- The stream's normal flow and flow during minor rainfall events should be maintained near normal downstream flow conditions without mixing with untreated water from the work area. This can be accomplished by diverting the stream around or through the work area.
- Where the construction time is anticipated to be less than one day and little or no base flow occurs in the channel, an impervious dike may be utilized to create an impoundment upstream of the work area.
- The watercourse should be managed to minimize any flooding of the work area.

<u>Flow Diverson</u>

a. Piped Diversion
In a pipe diversion, the operator will install a temporary pipe to divert the flow of the watercourse around the work area without the use of pumping operations. While the cost is higher for this operation, the probability of offsite sediment loss is much lower than with an open diversion channel.


Figure 7.10-8: Piped Diversion

A pipe diversion is most applicable where adequate slope and space exist between the upstream and downstream ends of the diversion. This practice is not applicable when the pipe would adversely impact the aquatic habitat migration.

b. Fabric Lined Diversion Channel
A fabric lined diversion channel is used to divert the normal flow and small storm events around the work area without the use of pumping operations. The diversion channel is typically constructed adja-

cent to the work area and is lined with a poly-fabric to prevent erosion of the diversion channel.

A fabric lined diversion is most applicable when adequate space and slopes exist adjacent to the work area.


Figure 7.10-9: Fabric Lined Diversion Channel

Impervious Dikes

c. Stone with Impervious Fabric
A stone dike encapsulated with a high tensile impervious geotextile fabric material creates a temporary impervious barrier that will either impound or divert water. This barrier can be constructed to the shape of the existing channel.


Figure 7.10-410: Stone with Impervious Fabric

d. Sand Bags
Filter bags filled with sand can be manually stacked to form a temporary impervious dike when encapsulated with an impervious poly-fabric liner. This impervious dike can be used to impound or divert water and can be easily removed.

Sand bag and impervious fabric dikes are best used when low flow rates exist, when the height of the dike is less than 15 feet, and when heavy equipment cannot be utilized.


Figure 7.10-11: Sand Bags

e. Sheet Piles
Sheet piles are flat cross-section piling that is driven into the ground and interlocked to create a wall or bulkhead. Sheet piles can be used to detain water in low-flow situations or coupled with bypass pumps to keep a site moderately dry during construction.

Sheet pile installation is most applicable where minimum channel disturbance is required. It does not apply where there is a small channel with little or no flow, where the access to drive piles requires more disturbance to jurisdictional areas than other impervious dikes, or in locations where rocks and other obstructions prevent piles from being driven.


Figure 7.10-12: Sheet Piles

3. Managing the Work Area
The work area consists of the area necessary to perform the construction or maintenance activity within or adjacent to jurisdictional areas. They include, but are not limited to, excavation and storage of material offsite in upland disposal sites, construction, and the maneuvering of equipment and manpower.

The following general measures should be employed as appropriate:

- All land disturbing activities should be confined to the work area as shown in the permit drawings, including equipment staging and access.
- All runoff from the work area should drain through a sediment control BMP or a dewatering device BMP prior to entering jurisdictional waters.
- BMPs should be maintained throughout the life of the project.
- Multiple small work areas in lieu of one large work area may be established to minimize the disturbance of jurisdictional waters.


Figure 7.10-13: Silting Basins

Dewatering of Work Areas
Stilling basins are used at sites where dewatering of the work area is required to perform work. The effluent is pumped into the stilling basin to allow the heavier particles to settle out prior to being discharged.

Stilling basins are most applicable where there is enough room in the work area to form or excavate the basin. They are not applicable where large volumes of water will be pumped from the work area.


Figure 7.10-14: Temporary Mulch and Seeding

4. Managing Spoil
   Excavated material or spoil should either be:
   - Contained within the work area.
   - Stockpiled near the work area and contained by an appropriate erosion and sediment control BMP.
   - Removed from the site and disposed of properly.

   Spoil material should not be placed in wetlands, protected riparian buffers, or other jurisdictional areas or used for re-establishing ground cover.

5. Ground Stabilization
   After completion of construction or land disturbing activities, all disturbed areas must be stabilized to prevent future erosion. Establishing a good vegetative cover helps protect soil from the impact of raindrops and reduces the erosive forces of runoff. Hard armor such as rip-rap helps protect areas that cannot be stabilized with vegetation.

   The following general measures should be employed as appropriate:
   - When construction/repairs are complete, remove all construction debris, including old concrete, asphalt, and stockpiled material.
   - Notify the seeding crews in advance when final grading is to be performed.
   - Dress and fine grade disturbed areas.
   - Maintain erosion control BMPs until vegetation is well established, which can be highly varied and due in part to the state's diverse regional climates, soils, and plant communities.
   - Perform temporary seeding, which is planting appropriate rapidly growing vegetation on disturbed/

denuded soil areas, or mulching if the project is to remain idle for longer than 15 working days.

Ground Stabilization
To prevent erosion of exposed soil material, cover with mulch and quick germinating seed mixture. Disturbed areas may need planting of woody species, in addition to seeding.

Temporary seeding and mulching is best applied when work areas will not be active for more than 15 days, and prior to anticipated precipitation events which will severely damage work performed on or near jurisdictional areas. This practice is not intended for permanent stabilization or areas permanently under water.

6. Site Clean Up
When temporary fill is approved, it should be completely removed and the affected area restored to the pre-project conditions upon completion of the construction activity. After re-establishment of the groundcover vegetation, all sediment control BMPs should be removed and the ground should be restored to pre-project conditions and stabilized. Where there are exposed, erodible areas, continue to spot seed and mulch those areas.

C. Natural Gas and Oil Exploration Sites
The City of Denton, TX, with the funding from the EPA through a Water Quality Cooperative Agreement [104 (b).3 grant] has researched stormwater runoff associated with natural gas exploration and production, and provided guidance on how to manage these sites from a regulatory standpoint (USEPA 2007). As part of this research, stormwater samples from the gas well sites were analyzed for a variety of water quality parameters and evaluated.

The results show that Event Mean Concentrations (EMC) of total dissolved solids (TDS), TSS, turbidity, conductivity, calcium, chlorides, hardness, alkalinity and pH were higher at gas well sites compared to reference sites, and that differences were statistically significant for all parameters except conductivity. Generally, the presence of metals was higher at gas well sites compared to reference sites and EMCs were statistically significantly greater for iron (Fe), manganese (Mn), and nickel (Ni). A number of storm EMCs at gas well sites were above national drinking water standards and aquatic life criteria for some constituents. The concentrations of metals also tended to be higher at gas well sites compared to nearby reference sites and stormwater runoff from local mixed use watersheds.

Total petroleum hydrocarbons (TPH) were not detected in any of the samples collected at gas well sites or reference sites. The median TSS EMC at gas well sites was 136 times greater than the median EMC at reference sites. Compared to the median EMCs of storm sampled near the outlet of the Hickory Creek Watershed by the City of Denton's Watershed Protection Program, the gas well site median EMC was 36 times greater. These results indicated that gas well site construction activities greatly increase the rate of sedimentation compared to predevelopment conditions, and that these increases are similar in magnitude to typical construction sites that are currently regulated under the federal NPDES program.

The City of Denton established a series of additional environmental regulations for those gas wells located in the floodplain fringe. These regulatory restrictions are required to be supported by an engineering study, and must demonstrate that the proposed activity will have no adverse impact on the carrying capacity of the adjacent waterway and will not cause any increase in the water elevations established for the floodplain.

According to the research report, in general, the slope of a given property, the erodibility of the site's soils, and the proximity of that property to surface water conveyances are all important considerations for minimizing gas well impacts to surface water resources. Flat, heavily vegetated areas that are located long distances from surface water resources tend to be less of a concern than those areas close to streams or lakes, located on highly erodible soils with little vegetation, and situated on steeper slopes. The research also recommended that, regardless of whether a municipality decides to allow drilling in the floodplain fringe or not, management practices should be designed to ensure that areas with greater potential stormwater impact are managed appropriately.

Overall, the findings of the research suggest that gas well sites have the potential to negatively impact the aquatic environment due to site activities that result in increased sedimentation rates and an increase in the presence of metals in stormwater runoff. While these activities do not appear to result in high concentrations of petroleum hydrocarbons in stormwater runoff, accidental spills and leaks are still a potential source of impact. The research team recommended that in lieu of federal stormwater requirements for natural gas exploration and development sites, state and local governments should consider some form of regulation, perhaps similar to current Phase I and Phase II NDPES requirements for construction sites, to reduce the potential impact of stormwater runoff from these sites. According to the research recommendations, regulatory requirements should include stormwater pollution and prevention plans, erosion and sediment control BMPs, provisions for containing spills and leaks, procedures for site inspections and enforcement of control measures, and sanctions to ensure compliance.

Management practices similar to those used at residential and commercial construction sites are often sufficient to meet target sediment reduction goals. The research team also recommended that site operation standards can be used to create a cleaner overall site and hence minimizing the stormwater pollution from the site. Municipalities can consider simple site management standards for incorporation into local regulatory requirements. For example, drip pans or oil absorbing materials should be placed underneath all tanks, containers, and other equipment that has a potential to leak. Chemical materials should be stored on pallets or other appropriate devices to prevent contact between the ground and containers, and should be protected from stormwater and other weather elements. Depending on the type and quantity of materials, secondary containment and other similar strategies may be appropriate. A hazardous materials management plan should be created for all sites, and all materials should be adequately labeled, contained, and have appropriate material safety data sheets available. The overall goal for the site should be to devise a plan that ensures that all chemical materials can be stored as safely as possible on the site, and any accidental spills, leaks, or discharges of materials can be remediated as quickly and safely as possible.

D. Recommended BMPs for Natural Gas and Oil Exploration Sites

According to the Denton report, it is recommended that all municipalities strongly consider addition of erosion and sediment control provisions to local codes. Sediment impacts from gas well development and production sites can be substantial if unmanaged and unregulated. The same BMPs used at construction sites and outlined in the iSWM Technical Manual should be used at all natural gas and oil exploration sites in the watershed. It is also recommended as a consideration to the establishment of Environmentally Sensitive Areas (see Section 7.10.1.C) that no natural gas or oil exploration sites be located within 600 feet of Lake Arlington.

Currently, the municipalities in the watershed that are experiencing oil and gas exploration have ordinances that require the acquisition of a permit. These ordinances generally deal with the methods of drilling allowed, prevention of petroleum and other hazardous material spills and general safety issues. They do not adequately address soil erosion and sedimentation as a result of the exploration.

Drilling sites should be located not closer than 600 feet from the lake. In addition to any Emergency Action Response Plans typically required by the existing gas well ordinances, for natural gas and oil drilling sites located in the ESAs, there should also be consideration of the following BMPs detailed below with the purpose of protecting the water quality of Lake Arlington.


Figure 7.10-15: Earth Dike

<u>Controlling Stormwater Run-On</u>
Stormwater run-on is simply runoff that flows from another property onto the gas well drilling site. Uncontrolled run-on increases the volume of stormwater to be managed on the project. Additional stormwater flowing on the construction site can impact the effectiveness of on-site BMPs and for this reason the methods for managing run-on should be addressed in the erosion and sediment control plans for those sites. The site operator should place BMPs, such as those described below, so that diverted water is safely directed to an inlet, temporary conveyance or infiltrated into a vegetated area.


Figure 7.10-15: Fiber Rolls

1. Earth Dikes/Drainage Swales
   Diversion berms or some other suitable method for controlling run-on should be constructed on the upstream side of all natural gas well or oil drilling sites. Earth dikes and drainage swales are suitable at the base or top of slopes for diverting run-on from adjacent or undisturbed slopes.

   It may be necessary to use other soil stabilization and sediment controls, such as check dams, plastics, and blankets, to prevent scour and erosion in newly graded dikes, swales and ditches.

2. Sand Bags or Fiber Rolls
   A sandbag barrier or fiber rolls are temporary linear barriers consisting of stacked sandbags or properly staked fiber rolls, respectively, designed to intercept sheet flow runoff. They are best applied along the perimeter of a site and at the top or at the base of slopes. The drainage area being diverted by the barrier should be limited to 5 acres.


Figure 7.10-16: Vegetated Filter Strip

<u>Erosion and Sediment Control BMPs</u>
The following methods are recommended for controlling erosion and sedimentation on natural gas and oil drilling sites.

3. Vegetated Filter Strips
   A vegetative filter strip is a band of vegetation located between the gas well drilling site and off-site areas designed to provide runoff treatment of conventional pollutants such as sediments. The key is to use dense vegetation, typically grass, and allowing only overland sheet flow to cross the strip, while avoiding concentrated flows. A vegetated filter strip should not be used for conveyance of larger storms because of the need to maintain sheet flow conditions. They should also not receive concentrated flow discharges as they will be rendered ineffective and the potential for erosion could cause them to become sources of pollution.


Figure 7.10-17: Temporary Seeding

4. Seeding
   To prevent erosion of exposed soil material, cover with mulch and quick germinating seed mixture. Disturbed areas may need planting of woody species, in addition to seeding. Temporary seeding and mulching is best applied when work areas will not be active for more than 15 days, and prior to anticipated precipitation events which will severely damage work performed on or near jurisdictional areas. This practice is not intended for permanent stabilization or areas permanently under water.

5. Special Sediment Control Fence – see the description above

6. Fiber Check Dams and Polyacrylamide – see the description above

7.10.3 Trash and Litter Control

A. Trash and Anti-Littering Campaigns
Educational campaigns must be carefully structured if they are to be effective. A study performed by Los Angeles County in 1997 characterized the residents of the County into six different categories of behavior related to litter and other potential stormwater pollutants. The study identified a category called the “rubbish rebels” as the group most likely to engage in littering. Rubbish rebels are generally single males in their teens and twenties. In Los Angeles, one-third of the members of this group are unemployed and most are not college graduates. In 2002 the City of Los Angeles Stormwater Public Education Program conducted a survey designed to obtain additional information about rubbish rebels and the messages and public education strategies most likely to affect behavior change. That study concluded that the best mode for conveying anti-littering messages is through mass media advertising, and that brochures, leaflets and flyers should be avoided as they have a high likelihood of being littered.

Catch basin marking, which has been universally employed as a public education tool, should also be considered during the development of a public education plan for the municipalities in the watershed. A strategic plan for the placement of no dumping signs in areas of known trash accumulation should be developed. This should include not only areas immediately around Lake Arlington such as parks, docks and piers, but it should also include areas throughout the watershed. The areas in the watershed should be identified using the methods outlined in the illegal dumping discussion in Section 7.10.1.B

Cost and effectiveness may vary depending on the extent of program implementation. It is believed that public education is effective for trash control. Market surveys suggest that media campaigns and intensive training such as workshops can produce a 10 to 20 percent improvement in selected watershed behaviors in targeted populations.[5] Because they are complimentary, both techniques can be used in most watersheds. For example, media campaigns cost just a few cents per watershed reached, while intensive training can cost several dollars per each resident actually influenced. Media campaigns are generally better at increasing awareness and sending messages about detrimental watershed behaviors. On the other hand, intensive training is better at changing individual practices in and around the home and community.

San Bernardino County, California conducted an in-depth survey to measure the impact of the program's messages and educational tips in 2002.[6] The San Bernardino County Stormwater Program released findings from its strategic stormwater research study of county residents and their knowledge and opinions regarding this environmental issue. Some key findings from "2002 San Bernardino County Stormwater Program Study" revealed the following:

- Residents are concerned about water and storm drain pollution. In fact, 58% of those surveyed stated that pollution of local beaches is a serious problem, and 44% said pollution of local storm drains is a serious problem.
- Residents want to learn more. According to the survey, more than 25% of people are very interested in learning how to reduce pollution.
- Sixty-two percent said they would definitely change their behavior if they learned they were polluting waterways.
- Those who recall seeing information and advertising about storm drain pollution were more concerned about pollution. Nearly half (48%) of the adult residents in the county say they have seen, read, or heard something in the past year about the storm drain system and the pollution of local waters. This number has doubled since the last survey in 1997, when the number was 23%.

The Cities of Arlington and Fort Worth bound Lake Arlington and the median age of each city is 30.1 and 31.6 years old respectively. Arlington residents under the age of 19 make up 35% of the population, and Fort Worth residents under the age of 18 make up 28.2% of the residents. Understanding this information, the municipalities in the watershed can certainly begin to tailor their anti-littering campaigns to target the demographic that seems to litter most. It is perhaps a good approach to try reaching citizens while they are in their cars, which is perhaps when most littering occurs. This can be accomplished through billboards, bus stop and bus advertising, posters, brochures, television advertising, radio public service announcements.

B. Municipal Operations

Source controls are aimed at reducing the litter loads entering the drainage system by dealing with pollution at source. Source controls can include any combination of public education, street sweeping, site erosion control, catch-basin modifications and cleaning programs, and industrial pretreatment. The following actions are examples of source controls:

- Upgrade cleaning operations by, for example, the better placement and design of litter bins, more frequent collection of litter, monitoring street sweeping methods to ensure that litter is not swept into catch basins, and ensuring that communal trash collection depots are appropriately placed.

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5 EPA Water Division. EPA Menu of BMPs, Landscaping and Lawn Care Fact Sheet. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=97&minmeasure=1

6 Miller, Lori E. San Bernardino County Stormwater Public Education Program Scores an A With Residents and Bussinesses. Stormwater. ForesterPress: Santa Barbara, CA. March-April 2004.

- Control construction activity by ensuring that site management plans are in place to prevent contaminant spills and rubble from reaching the drainage system. This activity can be coordinated with MS4 NPDES programs.
- Use the industrial and high risk commercial inspection program discussed in Section 7.10.4 to conduct business surveys to determine the nature and extent of activities likely to generate litter that can reach the stormwater system. This could lead to, among other things, encouraging manufacturers to move to more environmentally-friendly packaging, or to charge deposits on containers to encourage their return.
- Run litter education campaigns targeted at businesses and households informing them how the streets, stormwater drainage system, rivers and oceans are interconnected and how daily activities affect stormwater quality. Typical activities include organized clean-ups which serve the dual purpose of creating awareness and reducing the amount of litter, "adopt-a-block" programs, or encouraging the separation of litter into different types. This activity can be coordinated with MS4 NPDES programs.

Illegal Dumping

Coordinated efforts among municipal departments can be a no cost, best management practice for trash and floatables control in the Lake Arlington watershed. Through an innovative program to coordinate existing efforts of the various MS4 NPDES Permits, each municipality's Departments of Public Works and other relevant departments can improve ability to control floatables and possibly other pollutants in the watershed. This type of program can develop a framework for cooperation between previously uncoordinated efforts of city departments and, as such, represents a true best management practice. In short, the program can take advantage of one city department's field presence to garner and transmit valuable information to another city department for enforcement and cleanup.

For an example, agencies and/or departments conducting routine water quality monitoring can look for illegal dumping activities along the waterways, and if any such activities are noticed, the observing employees can notify the proper city department. Best of all, the program is operating at virtually no additional cost to the City. Similar programs have been established to control floatables in New York City, and the information collected formed a valuable resource for the city to monitor and reduce illegal dumping activity. In its first few months, the program was directly responsible for initiating action that is anticipated to reduce the number of illegal dumping sites by 15 percent.[7]

Street Sweeping

The major objective of street cleaning is to enhance the aesthetic appearance of streets by periodically removing litter, debris, dust, and dirt, while preventing these pollutants from entering storm or combined sewers. Common methods of street cleaning are manual, mechanical and vacuum sweepers, and street flushing. A regular street-sweeping program will help to clean and maintain the attractiveness of communities and enhance business viability and residential values. A regular sweeping program will reduce the amount of material accumulating in catch basins and stormwater facilities, reducing the need for frequent cleaning. Along with silt and trash, total suspended solids (TSS), hydrocarbons, excessive nutrients such as phosphorous and nitrogen, and other chemicals from the roadside are removed by street sweeping.

Street sweeping, vacuuming, and flushing, collects and disposes of pollutants before they enter the sewer system at the catch basins. Sidewalks, traffic islands, and congested street parking areas are difficult to

7 Newman, Thomas L. and Robert Gaffoglio. A No Cost, Best Management Practice for Floatables Control in New York City. http://www.hydroqual.com/Papers/tnewman/03/p_tln_03.pdf

clean with a traditional street sweeper, but smaller equipment is available that combines brushing, washing, and vacuum technologies, enabling greater accessibility and cleaning effectiveness. Other alternatives for hard-to-access areas include personal street-sweeping (walk-along) devices and manual cleaning with broom, scoop, and disposal bin.

In a 2005 study produced by HydroQual (Mahwah, N.J.), the Department of Sanitation of New York City examined a 450-ac (182-ha) section of Brooklyn which was swept six times per week. The test used two mechanical sweeps and four manual sweeps per week. Results for a 2-month period showed a 42% reduction in street floatables on an item basis, a 51% reduction on a surface area basis, and a 64% reduction on a weight basis.

Figure 7.10-18: Catch Basin Opening Cover

<u>Cost Considerations</u>
Street-sweeping units come in many different sizes, each with different applications. Small walk behind or ride-on units that clean smaller areas, such as small parking lots and sidewalks, can be purchased for less than $10,000. For larger areas, such as parking lots and small street applications, small truck sweepers are used, at a cost of $70,000 to $90,000 new or $35,000 to $55,000 refurbished. The cost of a standard municipal street sweeper ranges from $100,000 to $170,000. The most expensive models are dustless, which enables the sweeper to meet stringent air quality standards by removing dust, dirt, and debris from the swept surface.

Figure 7.10-19: Catch Basin Insert

In addition to operator labor, there are normal vehicle servicing requirements including checking and replacing the engine oil and filter, cleaning the sweeper engine, checking and replacing hydraulic and water filters, greasing fan bearings and fittings, cleaning the hopper and screen between uses, and other normal truck servicing requirements. On mechanical sweepers, the main broom should be replaced after roughly 200 hours of operation. Brooms on vacuum sweepers should be replaced after roughly 80 to 100 hours of operation.

C. In-Stream and Municipal Infrastructure Trash Reduction Measures

<u>Introduction</u>
No single BMP provides a comprehensive solution for floatables control in stormwater runoff. Most municipalities that are addressing trash and debris in urban runoff are using a combination of structural controls and institutional controls. Street sweeping and public education are the most common non-structural or institutional BMPs for trash and floatables control. There are several categories of structural BMPs that are being used to control floatables and trash, including:

- Catch basin opening covers.
- Catch basin inserts.
- Hydrodynamic separators/vortex separators/nutrient separating baffle

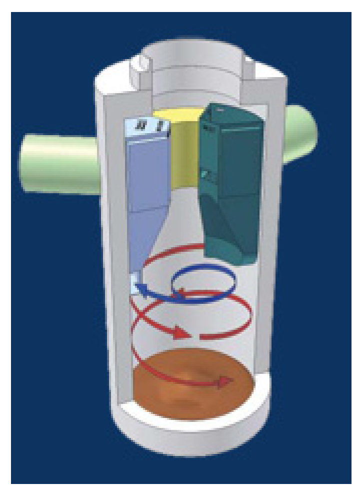

Figure 7.10-20: Nutrient Separating Baffle Box

boxes.
- End-of-pipe screening, basket and netting devices.
- Litter booms.

Figure 7.10-21 End-of-pipe Netting Device

In-System Controls
In-system controls are placed within the stormwater sewer system to capture pollutants at a particular point within the system, such as at a regulator diversion or a grit pit along an interceptor. Baffles, hydrodynamic separators, bar racks are some of the examples of the kind. These kinds are mostly used for solids separation in the stormwater sewer system.

Structural Controls or End-Of-Pipe – Litter Traps
Since it is difficult to prevent all the litter from reaching the drainage system, the balance will probably have to be trapped and removed at the end of pipe or along the watercourse. Nets are most common end of pipe controls. End-of-pipe nets are installed directly at the end of the outfall pipe or on an apron extended from the outfall. Nets on the end of elevated outfall pipes are highly effective as long as velocities are not too high to damage the nets, but they are not as effective on closed level outfalls. Boom controls are the most common trash traps in waterways, although booms may not be effective at high velocities.

Figure 7.10-22: Litter Boom

End-Of-Pipe Controls
Nets and booms are most commonly used by municipalities to control the trash at the end of pipe or in the flowing streams. Containment booms are specially fabricated flotation structures with or without suspended curtains designed to capture buoyant materials. Booms typically are moored to a shoreline structure or to the bottom of the receiving water, and they skim floatables from the surface. Booms can be made of an elastomer or plastic and can include absorbent material to collect fats, oils, and grease.

Boom materials and configurations vary widely but have limited uses, mainly at the head of a dead-end stream with quiescent conditions. Booms do not keep floatables from entering the watercourse. In fact, they use a portion of the watercourse for storage until cleaning can be completed. Therefore, booms may exacerbate the aesthetic issues related to floatables, especially near the collection point. Rough or fast-moving water can submerge a boom for a short period or damage it, allowing floatables to pass. Also, winds can disperse floatables back upstream, depositing them along the shoreline and making removal ineffective.

A two-year pilot study of containment booms conducted for the City of New York Department of Environmental Protection Bureau of Engineering Design and Construction in Jamaica Bay indicated that the booms provided a retention efficiency of about 75%. After a rain event, collected materials can be removed using either a skimmer vessel or a land based vacuum truck. Booms require periodic maintenance to repair damaged or missing sections or to re-anchor at locations that have become unattached from their moorings. Much of the maintenance can be done by tying off one side of the boom to a long rope and pulling the boom over to the other side to perform maintenance.

However, at least a small boat will be necessary if the boom becomes completely severed or if pieces dislodge and have to be retrieved downstream.

Costs of installing and maintaining booms can vary widely. Booms moored to the shore can cost as little as $10,000 each, whereas a system attached to specially sunk permanent piles can cost more than $100,000 each.

<u>In-reservoir Debris Removal Systems</u>
Lake Arlington is not unique in having periodic problems with large debris getting into the reservoir. This debris can include large logs and portions of trees, dead livestock, appliances and other items that come into the lake during high-flow and flood events. During the planning process, the Malcolm Pirnie Team repeatedly heard stakeholders and the public recommend that the City develop a program for removing this debris that creates unique issues, not typical of urban trash and litter management.

Most river systems and reservoirs have some degree of problem with log jams and debris following flood and high-water events. The problems often occur in situations where stream hydraulics create lower velocities, such as the upper end of reservoirs and river segments near the coast. Agencies such as the U.S. Army Corps of Engineers have been involved in “snagging” operations on major rivers such as the Mississippi since before the Civil War. The solutions are seldom easy or inexpensive because of the magnitude, size and weight of the material to be removed, the unique shapes and sizes, and the intermittent nature of these operations. It is difficult to organize for these types of operations, and the required equipment is normally unique and expensive.

Several Texas river authorities and water districts are involved in log-jamming and debris-removal operations. In rural areas, the debris is usually removed from the river bank or shore using heavy equipment such as a track-hoe or dragline, stacked with a bulldozer, and eventually burned or hauled to a landfill. When the debris has accumulated in more inaccessible locations, some type of snagging boat is used to push the debris or move it downstream to an appropriate location for removal.

The following images (provided by the Guadalupe-Blanco River Authority) show examples of such operations. In this case the shallow-draft, hydraulically powered snagging boat is designed in a catamaran shape so that a small trackhoe can reach logs positioned in between the two hulls. The boat was constructed in 2004 by Bollinger Shipyard in Houston, TX at a cost of approximately $300,000. Because of the intermittent nature of these operations, the trackhoe is only rented when the utility is engaged in log jam removal operations.


Log Jam Removal Boat


Log Jam Removal Operations on the San Antonio River in Refugio County, TX


Debris Removed From San Antonio River, Refugio County, TX

1.1 PRACTICE	EASE OF IMPLEMENTATION	1.2 COST	1.3 BENEFIT
Mid-drain Structural device retrofit	Not easy in many situations	H	H
Start-of-pipe structural device retrofit (e.g. catch basin opening screens and excluders)	Moderately easy in many situations	M	H
End-of-pipe structural device retrofit (e.g. trash racks, fabric mesh socks and wire screens)	Very easy in certain situations	M/L	H
Hydraulic disconnection and/or replacement of impervious surfaces	Disconnection: Moderately easy in some situations Repaving: Moderately easy for public areas	M	L/H
Street sweeping	Moderately easy	M	H
Adjustment of street sweeping routes; stricter enforcement of no-parking during street sweeping days; and, encouraging /sponsoring more public cleanup events.	Moderately easy	L	M
Open channel sweeping	Moderately easy	M/H	H
Performance-based open channel trash removal contracts	Easy	L	H
Private and public parking lot sweeping	Moderately difficult for private lots, moderately easy for public lots	M	H
Retrofit of catch basins on private parking lots	Moderately difficult	L/H	H
Increased or focused public education	Moderately easy	M	M
Dedicated hot line and response	Very easy	M	M
No-litter laws prohibiting certain products at recreational areas, such as cigarette butts, styrofoam cups, etc.	Moderately difficult	M	M
Product market-based reduction incentives and product substitution.	Moderately difficult	M	M
Sub-regional trash control facilities	Moderately easy in new development, difficult in developed areas	H	H

Table 7.10-3: Trash Control BMPs Relative Ease of Implementation, Cost, and Benefits

L-low; M-moderate; H-High

(Adopted from County of Los Angeles Department of Public Works Technical Report on Trash Best Management Practices Aug. 5, 2004 Pages 16 &17)

Effectiveness[5]
While the ultimate goal of any BMP is to improve the quality of water bodies which receive stormwater, it can be very difficult to show the linkages between BMP implementation and changes in receiving water quality due to spatial and temporal variability in water quality parameters. Therefore, the measure of effectiveness of a single or combination of BMPs is typically dependent on the BMP and the level of change that the BMP is expected to make in water quality.

For BMPs designed to reduce or prevent trash from entering water bodies, assessments can be conducted on the type BMP implemented. All BMPs can be considered and assessed at Level 1 which shall mean documenting activities. Assessments of Levels 2 and 3, raising awareness and changing behavior respectively, are typical of public education and outreach efforts. Level 4 assessments correspond to reducing pollutant loads at the source and are a result of BMPs that prevent pollutants from entering the storm system. Effectiveness of treatment BMPs (in-system controls or end of pipe) results in a Level 5 outcome which is an improvement in water quality. Changes in receiving water quality (Level 6 assessements) are typically a measure of the effectiveness of an overall pollutant mitigation program, but instream trash collection can be assessed at this level because it immediately changes the quality of the receiving water with respect to trash.

BMP Category	Most Applicable Effectiveness Assessment Outcome Levels					
	Level 1 Documenting Activities	Level 2 Raising Awareness	Level 3 Changing Behavior	Level 4 Reducing Loads from Sources	Level 5 Improving Runoff Quality	Level 6 Protecting Receiving Water Quality
Infrastructure BMPs						
Racks and Screens	X				X	
Hydrodynamic Separators	X				X	
Litter Booms	X					X
Catch Basin Inserts	X				X	
Netting Devices	X				X	
Municipal Operations						
Street Sweeping	X			X		
Education and Outreach	X	X	X			
Regulations	X					

Table 7.10-4: BMP Implementation Effectiveness

With respect to the operation and maintenance of trash removal BMPs there are a few considerations that must be made. It is expected that municipal operations and most infrastructure BMPs would be installed, operated and maintained by the local government. If the local government requires a developer to install infrastructure BMPs or perform street sweeping in and around a commercial development for instance, an agreement would need to be executed between the municipality and the owner of the property to ensure that the BMP will be operated and maintained in to perpetuity by the owner of the property.

4 Santa Clara Valley Urban Runoff Pollution Prevention Program. Trash BMP Tool Box. September 2007.

Structural Control Selection

Unfortunately, the ideal trash control device does not exist. All designs and each type of equipment represent some sort of compromise. It is the utility's task to choose the most appropriate structure to fit the circumstances. Ideally this should form just one part of a total litter removal strategy that also takes into account planning and source controls. The data presented in this section is a result of literature studies and professional experience. The City of Fort Worth, Texas is conducting a trash control pilot study that will offer more empirical data in the area of the Lake Arlington watershed.

The City of Fort Worth initiated the pilot study in October 2010. The study will evaluate retractable screens, lateral screens, booms, sediment traps and bioswales. This is expected to be a two-year study, and quarterly reports will be prepared by the City of Fort Worth.

One of the biggest problems facing the designer of a litter trap is that litter can be just about anything - any size, any shape, any density, and any hardness. Furthermore, the physical characteristics of individual items sometimes changes as they move through the drainage system. Plastic bags deform and tear, bottles break, and aluminium cans fill with water and / or sediment. The high degree of variability in litter characteristics makes it extremely difficult for the designer to design a structure that will cater for every eventuality. Many litter trapping structures work extremely well in low, but not in high flows – or vice versa – or work well with certain types of litter, but not with others. Many litter traps pose major cleaning problems.

The ideal trap would have the following features (Armitage et al, 1998):

- Reliability.
- Reasonable cost to construct, operate and maintain.
- No moving parts.
- No external power source requirement.
- Minimal water head requirement (i.e. it can be used in association with flat gradients).
- Does not increase flood levels in the vicinity of the structure.
- High trash removal efficiency.

The methods typically employed in determining which BMPs to implement in particular locales typically include:

- Identifying the trash "hot spots" and spatial distribution of trash throughout the targeted watershed.
- Determining the land-uses associated with the hot spots and other areas where trash enters the storm drain system.
- Determining the neighborhood characteristics in the areas where trash enters the storm drain system.
- Tailoring the implemented BMPs to the surrounding land-uses and neighborhoods in high trash generating areas.

To select the most appropriate and effective BMPs, it is important to thoughtfully study the specific situation for Lake Arlington. A program plan should be developed to study areas in the Lake Arlington watershed that generate the best results from utilizing trash reduction measures. The first step is to identify the areas where the largest benefit will be realized. The question has to be answered, "Where is most of the trash that ends up in the lake coming from?" Visual observation seems to indicate that most of the trash originates from upstream (the south end of the lake) and from the west side of the lake. However, other areas may also contribute significant amounts.

This question can be answered in several different ways. One is to review the street sweeping routes and records. Which routes are yielding the most trash in terms of weight or volume? These routes can be colored coded in GIS to highlight where most of the trash is coming from.

The next step in the process is to overlay those routes with the stormwater drainage system. Determine the number of inlets and the types, if any. Select the appropriate retrofit device based on inlet type and have those devices installed.

The Attachment 6 presents the list of vendors and the type of BMPs they supply. There is more than one vendor or trademark device available in each type of trash control BMP. This gives us the option to compare and choose the most appropriate device from among them. Attachment 7 also presents comparison matrix for the in-stream trash control BMPs.

7.10.4 Other Stormwater Management Measures

A. Illicit Discharge Detection and Elimination Programs
Federal regulations define an illicit discharge as any discharge to a Municipal Storm Sewer System (MS4) that is not composed entirely of stormwater, with some exceptions. These exceptions include discharges from NPDES-permitted industrial and municipal sources and discharges from fire-fighting activities. Additionally, the illicit discharge detection and elimination (IDDE) program does not need to address the following categories of non-stormwater discharges or flows unless the MS4 identifies them as significant contributors of pollutants to its MS4 (EPA Fact Sheet 2.5, 2000, rev.2005).

- Water line flushing
- Landscape irrigation
- Diverted stream flow
- Uncontaminated ground water infiltration
- Pure pumped ground water
- Discharges from potable water sources
- Foundation drains
- Air conditioning condensation
- Irrigation water
- Springs
- Water from crawl space pumps
- Footing drains
- Lawn watering
- Individual residential car washing
- Flows from riparian habitats and wetlands
- Dechlorinated swimming pool discharges
- Street wash water

Dry weather flows resulting from illicit/inappropriate discharges and connections to the MS4 are a major contributing factor to receiving water pollution. These sources can introduce pollutants such as heavy metals, toxics, oil, grease, solvents, nutrients, viruses, and bacteria. Discharges of high pollutant levels to creeks and streams adversely affect water quality, the ecosystem, and human health (EPA, 2005). The municipalities in the watershed should develop IDDE Programs per the recommendation of EPA to include:

1. Outfall Identification and Investigation: Each municipality should identify and map its stormwater outfalls and inspect 20% of those outfalls each year for extraneous flows during dry weather when no flow should be present. Information regarding the location and physical attributes of these outfalls should be identified on a map or GIS system, and tracked in a database. Outfall inspection activities are documented through an outfall reconnaissance inventory/sample collection field sheet.

2. Regulatory Requirements. A program should be developed for each community in the watershed to effectively identify and eliminate any illicit discharges. Non-stormwater discharges to the MS4 shall be effectively prohibited (and exceptions to the prohibition must be identified). The basis of this program will be an IDDE ordinance. The municipalities should establish the necessary legal authority to implement an effective IDDE program which prohibits illicit discharges from entering the MS4 system, controls disposal of materials other than stormwater into the MS4, and enables the MS4 to requires compliance with conditions and carry out all inspections, surveillance, and monitoring procedures necessary to determine compliance. There also needs to be an escalated enforcement remedy in response to repeat violations against illicit discharges from commercial, industrial, municipal or residential sources. A model ordinance can be found in Attachment 7.

3. Dry Weather Screening. If flow is observed during outfall inspections, field screening analysis of the dry weather discharge should be observed for ammonia, pH, temperature, total chlorine, total copper, total phenol, detergents or surfactants, and turbidity along with a description of the flow rate. Also, when any flow is observed, two grab samples should be collected during a 24-hour period with a minimum period of four hours between samples. The results of these field tests will begin to frame what the source of an illicit discharge, if any, may be. The table below summarizes the potential pollutant sources with respect to pollutants identified during such field testing.

   Follow-up to eliminate illicit discharges may be prioritized based on the magnitude and nature of suspected discharges, sensitivity of receiving waters, and other relevant factors. The municipalities should establish priorities and schedules for screening the entire system at least once every five years. Facility inspections may be carried out in conjunction with other municipal programs (e.g., pretreatment, health inspections, fire inspections, etc...). The investigation of potential illicit discharges should specify the equipment used to find illicit discharges (i.e., video camera, smoke test, etc.). An enforcement response plan should be developed by the municipalities for use when an illicit discharge source has been located to ensure timely and appropriate enforcement. IDDE investigation processes need to be fully documented with a complete paperwork trail for any illicit discharge event observed and for any unusual field observation. Attachment 7 includes an example outfall inspection worksheet.

   The municipality's IDDE programs should allow elimination of illicit discharges as expeditiously as possible and the immediate cessation of improper disposal practices upon identification of responsible parties. If it is not possible to eliminate an illicit discharge within ten days, the municipalities should require an expeditious schedule for removal of the illicit discharge, and in the interim should require the owner or operator to take all reasonable measures to minimize the discharge of pollutants to the MS4.

4. Industrial and High Risk Monitoring Program. The main purpose of the industrial and high risk monitoring program is to identify and control pollutants originating from municipal landfills; other treatment, storage or disposal facilities for municipal wastes (e.g. transfer stations, incinerators, etc.); hazardous waste treatment, storage, disposal, and recovery facilities and facilities that are subject to EPCRA Title

PARAMETER	BENCHMARKS	EVALUATION	FIELD TASK
Ammonia	0.3 mg/L for illicit discharges and 0.5 mg/L (Industrial)	Indicator of sewage, since its concentration is much higher than groundwater or tap water. High ammonia concentrations may also indicate liquid wastes from industrial sites.	Outfalls and Possible Illicit Discharge
pH	The normal pH range for stormwater runoff is between 6 and 8, with 7 being neutral.	pH is a relatively good indicator of liquid wastes from industries, which can have very high or low pH values (ranging from 3 to 12). The pH of residential and commercial washwater tends to be 8 or 9.	Outfalls and Possible Illicit Discharge
Temperature	Elevated baseflow temperatures (compared to baseflows at other sites being screened) could be an indicator of substantial contamination by sanitary wastewater or cooling water.	Useful where the screening activities are conducted during cold months	Outfalls and Possible Illicit Discharge
Flow	Presence/Absence	If flow is present, other parameters have to be taken. If no flow, no illicit charge is present.	Outfalls and Possible Illicit Discharge
Total Chlorine	Presence/Absence	Additional parameter to distinguish between a natural or potable water source. High chlorine levels may indicate a water line break, swimming pool discharge, or industrial discharge such as a chlorine bleaching process.	Possible Illicit Discharge

PARAMETER	BENCHMARKS	EVALUATION	FIELD TASK
Total Phenols	Presence/Absence	Can be stored in oil and petroleum storage tanks or facilities, can result in tainting of fish tissue, and can cause taste and odor (organoleptic) problems in drinking water. In addition, phenol discharged from those facilities could combine with chlorine in water treatment facilities to form chlorinated phenols.	Possible Illicit Discharge
Total Copper	Presence/Absence	High levels of copper may indicate presence of contamination from metal industrial wastes	Possible Illicit Discharge
Detergents (Surfactants)	0.1 mg/L	Detergents may indicate sewage or washwater discharges. The presence of detergents, combined with their absence in natural water or tap water, may signify illegal dumping, an illicit connection, or a leaking sewer. (Sewage and washwater discharges contain detergents used to clean clothes or dishes.) ~ 1 - 20 mg/L in sewage discharge	Possible Illicit Discharge
Turbidity	280 NTUs	Runoff for construction sites of 10 acres or greater.	Possible Illicit Discharge

Table 7.10-5: Outfall Monitoring Parameters[5]

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5 Pitt, Robert and the Center for Watershed Protection. Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments. October 2004.
City of Canon City. Illicit Discharge Detection and Elimination Manual. Engineering Department.
New England Interstate Water Pollution Control Commission. Illicit Discharge Detection and Elimination Manual: A Handbook for Municipalities. January 2003.

III, Section 313; and any other industrial or commercial discharge that a watershed municipality determines has the potential to contribute a substantial pollutant load to the MS4.

This program should have as its foundation language in the Illicit Discharge Detection and Elimination Ordinance that allows the municipal government to inspect and monitor industrial and high risk commercial facilities. The inspections should consist of a brief review of the facility's spill prevention and countermeasures control (SPCC) plan and whether the facility has effectively implemented that plan.

In addition, a training program for municipal staff should be developed on municipal good housekeeping and illicit discharge detection and elimination. The employees that are outside and have the ability to serve as the eyes and ears of the municipal government should be considered as the first line of defense for water quality. This training program should include the identification of illicit discharges identified in the field during routine work assignments, making the determination of sources of discovered illicit discharges and the protocols for illicit discharge elimination. The NCTCOG offers a number of tools for municipalities with respect to training municipal staff on the subject of stormwater management. This material is available on their website at http://www.nctcog.org/envir/SEEclean/stormwater/program-areas/pollution_prevention/CD/Version_1/P2_Training_Materials.asp. The website has presentations for materials storage and spill cleanup; parks and grounds maintenance; fleet maintenance; streets and drainage maintenance; land disturbances; and, solid waste operations. The NCTCOG also has training modules for municipal trainers, quizzes and a stormwater pollution prevention video available.

Sanitary Sewer Overflows. The municipalities should develop protocols within their sanitary sewer departments to identify and track all sanitary sewer overflows. Protocols should also be developed to immediately eliminate those overflows upon discovery to the maximum extent practicable. As the sanitary sewer department tracks those overflows, the causes and the remedies, that data should be shared with the respective stormwater departments for reporting purposes. TCEQ administers a voluntary program aimed at eliminating sanitary sewer overflows. The goals of the initiative are to reduce the number of SSOs that occur each year in Texas and to address SSOs before they harm human health, safety, or the environment and before they become enforcement issues.[6]

5. System Mapping: In order to effectively trace and eliminate any illicit discharge identified, municipalities need a good mapping tool with adequate information on the MS4 connectivity. This may require a comprehensive system survey in order to collect the data needed to develop a mapping tool of this sort.

B. Public Education and Outreach Programs

<u>Proper Use, Storage, and Disposal of Pesticides, Herbicides, and Fertilizers</u>[7]

The stormwater program administered by the TCEQ and EPA requires that municipalities regulated under the Phase I and Phase II MS4 permits must develop public education programs that address the proper use, storage, and disposal of pesticides, herbicides and fertilizers. This is important for the entire water-

6 TCEQ General Information. Field Operations Support Division. GI-389. Sanitary Sewer Overflow Initiative: Information for Prospective Participants. June 2008. http://www.tceq.state.tx.us/publications/gi/gi-389.html/at_download/file

7 University of Michigan, Occupational Safety and Environmental Health, Proper Use of Pesticides, Herbicides and Fertilizers. http://www.oseh.umich.edu/stormwater/Pesticides%20and%20Fertilizers.pdf

shed and it is more critical for the area immediately around Lake Arlington.

The municipalities in the watershed have varying land uses ranging from range land and pasture to industrial, and including many urban open spaces such as athletic fields, golf courses, parks, and residential lawns. More important are the often overlooked small grass surfaces, planting beds, and those small areas of remaining vegetation. Both large and small open spaces are potential sites for contaminated water runoff or infiltration. It is obvious that silt and debris can potentially contaminate stormwater runoff from these areas; however, the less obvious contamination that can result from chemical applications is also a major concern.

Chemicals that can potentially migrate into drinking water supplies are pesticides, herbicides, and fertilizers. In all cases, stormwater runoff containing these chemicals causes problems. Surface runoff of pesticides and herbicides into water bodies changes natural ecosystems by killing or damaging a wide variety of organisms. Fertilizer can also disrupt natural biological communities by increasing plant and microbial growth. This condition, known as eutrophication, can drastically change natural water ecosystems and create new pollution conditions.

Improper application of pesticides, herbicides, and fertilizers can also have an impact on stormwater infiltration into groundwater. When these contaminants dissolve in stormwater they find their way into the groundwater or into surface waters, such as ponds, streams, rivers, and lakes. The infiltration of these chemicals may also contaminate soil and deeper groundwater aquifers. For these reasons, this master plan encourages floodplain corridors adjacent to Village Creek and Lake Arlington (See Section 7.10.1.C) The following information should be the focus of materials distributed to citizens about lawn chemical application, storage and disposal.

<u>Using Pesticides and Herbicides</u>
The risk of using pesticides and herbicides is greatest when the label directions are not followed exactly. Product labels contain information about the persistence and toxicity of the chemical. The words “natural,” “organic,” or “biodegradable” do not guarantee that it is safe. Users should always choose a “pest-specific” pesticide or herbicide that is designed to kill only the pest causing the damage and avoid pesticides with half-lives longer than 21 days.

Integrated pest management techniques are used to reduce pest populations to acceptable levels while minimizing the potential impact of pesticides and herbicides upon humans and the environment.

<u>Mixing and Use of Pesticides and Herbicides</u>
The mixing of pesticides and herbicides is of major concern because this is the time at which many spills occur. It is critical to exactly follow instructions for mixing and use. Be concerned with cleanup and disposal at all times during the use process. Any leftover chemical, the storage containers used in all stages of the application process, and the application equipment must be considered in the cleanup process. Guidance when using pesticides and herbicides should include:

General
- Take precautions to prevent spills. For example, close containers tightly after each use, even if you plan to reopen them soon.
- Know what to do if a spill occurs.

- Mix only the amount needed for the job.
- Follow the directions on the label exactly.

Application and Cleanup
- Avoid spraying over impervious surfaces.
- Do not spray on a windy day.
- Do not apply to bare or eroding soil.
- Reduce cleaning and waste by clustering jobs that use the same solution.
- Reuse rinse water or properly dispose as described below.

Pesticide and Herbicide Storage
Keep pesticides and herbicides in their original containers so you know what they are and how to use them. Mark the date of purchase on each container and use older materials first.

If possible, store pesticides and herbicides indoors in a clearly marked area, designed as secondary containment. Storage areas should be located at least 150 feet from any drinking water well and at least 200 feet from any area that holds water, even intermittently, such as a drainage ditch, dry retention pond, or Lake Arlington.

Cleaning and Disposing of Empty Pesticide and Herbicide Containers
The best method for cleaning containers and equipment is to triple rinse. To triple rinse: allow the concentrate to drain from the empty pesticide container for 30 seconds. Fill one-quarter of the container, replace the lid, and shake the container so that all interior surfaces are rinsed. Drain the rinse water into the spray tank for at least 30 seconds. Repeat the process twice for a total of three rinses. Rinse water must be collected and applied to a compatible site at or below the labeled rate.

In general, small containers that are used in the home can be disposed of in the trash pickup after they have been rendered unusable and then wrapped in plastic.

Using Fertilizers
Applying unnecessary amounts of fertilizer is not only a waste of money; it can also be detrimental to water quality. Excess fertilizers can wash into waterways, stimulating nuisance weed and algae growth. Excessive plant growth can choke slow moving waters, take up oxygen needed by fish and other aquatic life, and release ammonia which is toxic to fish. Before applying fertilizer, the user should have the soil tested to determine what nutrients must be added. Residential soil testing can be done for the homeowner by the Texas A&M System AgriLife Extension (www.soiltesting.tamu.edu). Fertilizers should be applied only in accordance with soil test results and recommendations.

When applying fertilizers, follow the directions exactly and keep fertilizers off paved areas. If a liquid fertilizer is used, be careful to avoid over spray and drift. Sweep granular fertilizer back onto the grass to keep it from being washed into the stormwater drainage system.

For information regarding products that can help protect water quality see the Citizens Guide to Stormwater Pollution Prevention and other printed materials published by the City of Arlington are found in Appendix 7.10-C.

Stormwater Reporting Hotlines

Regulators and authorities often encourage the public to help stop water polluters. Community hotlines provide a means for concerned citizens and agencies to contact the appropriate authority when they see people creating water quality problems. A hotline can be a toll-free telephone number or an electronic form linked directly to a utility or government agency, such as the City or TCEQ. A typical call might report a leaking automobile, concrete wash-out dumped on the street, paint in a creek, or organic debris (including pet waste) in a drainage system or waterway.

Generally, an investigation team promptly responds to a hotline call and, in most cases, visits the problem site. If a responsible party can be identified, the team informs the party of the problem, offers alternatives for future disposal, and instructs the party to resolve the problem. If the issue is not resolved by the responsible party (or if the party cannot be identified), the proper authority takes action to remediate the situation and prevent future violations.

All educational materials should include pollution hotline numbers and information. Typically, hotlines are advertised on materials concerned with water quality, such as flyers, door hangers, and brochures. The hotline could also be publicized on “permanent” materials such as bumper stickers and refrigerator magnets, where the number can be retained and easily located.

A stormwater hotline is effective when its number is easily remembered (i.e., has a catchy name) or is easily accessible. Most important, however, is the responsiveness of the hotline. If a citizen reports an illegal dumping but no action is taken by the appropriate authority, that citizen could lose faith in the hotline and might not call back with future information.

A hotline can serve as a link between the citizens and the municipality’s government. It can be an avenue for citizens to feel more involved in their community. It also can be a great way to catch illegal polluters or to stop accidental spills that might otherwise go unnoticed.

In the City of Arlington a citizen may call 817-459-6599 to report pollution. Other cities in the watershed also have stormwater reporting hotlines and many other public education initiatives similar to those discussed below which are implemented in the City of Arlington.

The City of Arlington has implemented a comprehensive public education program aimed at improving water quality. The programs include curbside recycling, composting and leaf management classes, household hazardous waste collection, and other programs to aid in the education of citizens on the subject of stormwater management. The Citizens Guide to Stormwater Pollution Prevention and other printed materials published by the City of Arlington are found in Appendix 7.10-C.

To date, the effectiveness of pollution prevention programs designed to educate residents on stormwater pollution prevention practices has not been well documented. However, the need for such programs is evident.

Market surveys suggest that media campaigns and intensive training such as workshops can produce a 10 to 20% improvement in selected watershed behaviors in targeted populations.[8] Because they are compli-

8 EPA Water Division. EPA Menu of BMPs, Landscaping and Lawn Care Fact Sheet. http://cfpub.epa.gov/npdes/stormwa-

mentary, both techniques can be used in most watersheds. For example, media campaigns cost just a few cents per watershed reached, while intensive training can cost several dollars per each resident actually influenced. Media campaigns are generally better at increasing awareness and sending messages about detrimental watershed behaviors. On the other hand, intensive training is better at changing individual practices in and around the home and community.

7.10.5 Adaptive Management

Utilizing an adaptive plan management strategy, this set of recommendations aims to implement a watershed management strategy to preserve not only the quality of the watershed area but also the aesthetics of the Lake Arlington watershed with an economically sustainable approach.

Assessing the effectiveness of the implementation of the watershed management strategies over time is important to meeting water quality and ecological protection and improvement goals. Also, by tracking management practices and monitoring water quality changes, the means are in hand to assess and redefine goals and priorities. Some of the other benefits to watershed management provided by monitoring are:

- Enabling water quality managers to further identify existing or emerging water quality issues and concerns.
- Facilitating responses to emergencies such as spills and floods and help water quality managers target specific pollution prevention or remediation programs to address these problems.
- Determining whether program goals, such as compliance with pollution regulation or implementation of effective pollution control actions, are being met.

Adaptive management is a systematic approach for improving management strategies by learning from implementation outcomes[9] (Murray, C.). It involves exploring alternative methods to meet plan objectives, predicting the outcomes of each alternative based on the current state of knowledge, implementing one or more of these alternatives, monitoring to learn which alternative best meets the management objectives (and testing predictions), and then using these results to update knowledge and adjust management actions.

ter/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=97&minmeasure=1

9 Murray, Carol; and David Marmorek (2003). “Adaptive management and ecological restoration”. In in Peter Friederici (ed.),. Ecological Restoration of Southwestern Ponderosa Pine Forests. Washington, D.C.: Island Press. pp. 417–428. ISBN 1-55963-652-1. http://www.essa.com/downloads/Murray_&_Marmorek_Ponderosa_Pine_2003.pdf.

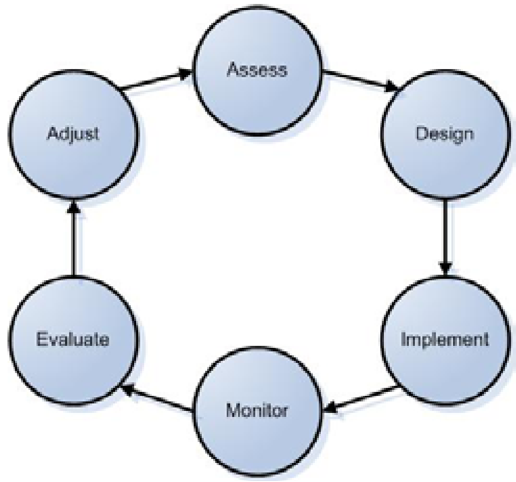


Table 7.10.5: BMP Implementation Effectiveness[10]

The first two steps of adaptive management, assessment of the issues, and design of management alternatives have been addressed in the Lake Arlington Master Plan. The development of implementation strategies has been partially discussed in this document. This section addresses the monitoring, evaluation, and adjustments of management strategy.

A. Monitor the Results

Two types of monitoring are important for accurate interpretation of the results. Implementation monitoring is needed to ensure that the activities were undertaken as recommended. Implementation monitoring documents not only what the municipalities are doing, but also the actions of others where they have the potential to influence the achievement of the management objectives. Effectiveness monitoring is needed to learn whether the activities were effective. It targets the indicators listed in model application and results, and allows an assessment of the actual indicator responses, versus predicted responses, to the management strategies.

In the case of Lake Arlington the most appropriate indicators from the watershed and reservoir are sediments, nutrients, and fecal coliform in the watershed and chlorophyll a and total nutrients in the reservoir. Trash is another indicator that was not included in the model, but there should be some measurement of observed amounts of floatables in the streams and the lake.

Since there will be varying amounts and types of BMPs implemented, the method of evaluating progress towards the goals and objectives of this Master Plan will have to be grouped into categories that can be applied to multiple BMPs. A summary of the evaluation measure for each group of BMPs that aim to meet the goal and objectives of this plan include:

Indirect Measures

- Programmatic Indicators/ BMP Results.
- Photographic Surveys.

10 Nyberg, B., 1999. Implementing adaptive management of British Columbia's forests – Where have we gone wrong and right? In: McDonald, Fraser and Gray (eds). Adaptive Management Forum: Linking Management and Science to Achieve Ecological Sustainability. Ontario Ministry of Natural Resources, Peterborough, Ontario, Canada, pp. 17-20.

- Stakeholder Surveys/Social Indicators.

Direct Measures
- Water Quality Indicators.
- Ecological Indicators.

B. Implementatin Monitoring

Programmatic Indicators/ BMP Results

One of the primary means to measure progress towards the achievement of the long-term goals of this Master Plan will be through the compilation of the total number of BMPs that are implemented by each municipality throughout the watershed. This will be accomplished by tabulating the BMPs that are completed annually. The most efficient way to compile this information will be for each municipality to include that information in their individual MS4 annual reports. For simplicity, only BMPs that have been "completed", meaning that they have been implemented during the review period, should be tabulated.

Photographic Surveys

As projects are implemented and BMPs installed, photographs should be taken to illustrate the "before and after" results that may indicate improved aesthetics, or provide visual indicators of reduced pollutant loadings, such as a reduction in the amount of trash observed in Lake Arlington, reduced algae blooms (reduced nutrient inputs), and/or improved habitat (increased in-stream vegetation or riparian vegetation). This type of media is useful to provide the public a means of visually understanding the aesthetic and water quality improvements that can come from the implementation of watershed management strategies. These photographs should be included with the MS4 annual reports as part of BMP implementation evaluation.

Stakeholder Surveys/ Social Indicators

The politics of the region and the overall public attitude about BMPs and various policies will certainly impact the individual municipality's ability to implement the LAMP. These are external stimuli to the management approach and should be considered in the evaluation of the strategy and adjustments should be made as necessary.

C. Effectiveness Monitoring

Baseline conditions have been established by TCEQ's monitoring program and with the modeling effort. Continued monitoring will certainly assist in the evaluation of any BMPs implemented in the short term. The instream monitoring which may be a part of watershed community MS4 NPDES stormwater management plans is a means to evaluating water quality in the long-term.

D. Adjust the Strategy (Policies and Practices)

This stage most distinguishes adaptive management from traditional watershed management by explicitly prompting changes based on what has been learned. Ideally, the management responses to each possible outcome of the experiment should be pre-planned before the experiment is implemented as part of the design. This will help serve as a "reality check" regarding what types of adjustments are possible.

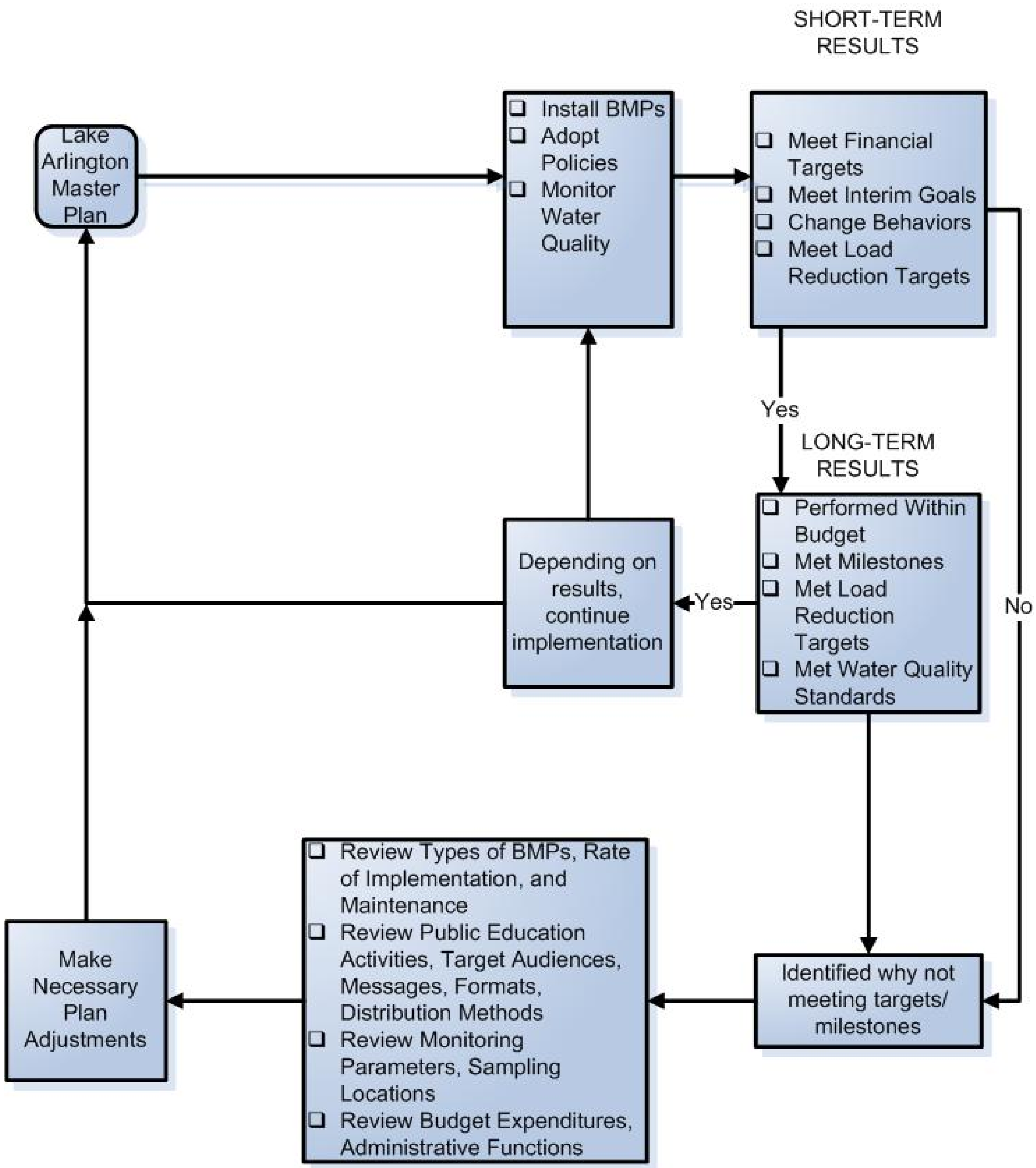
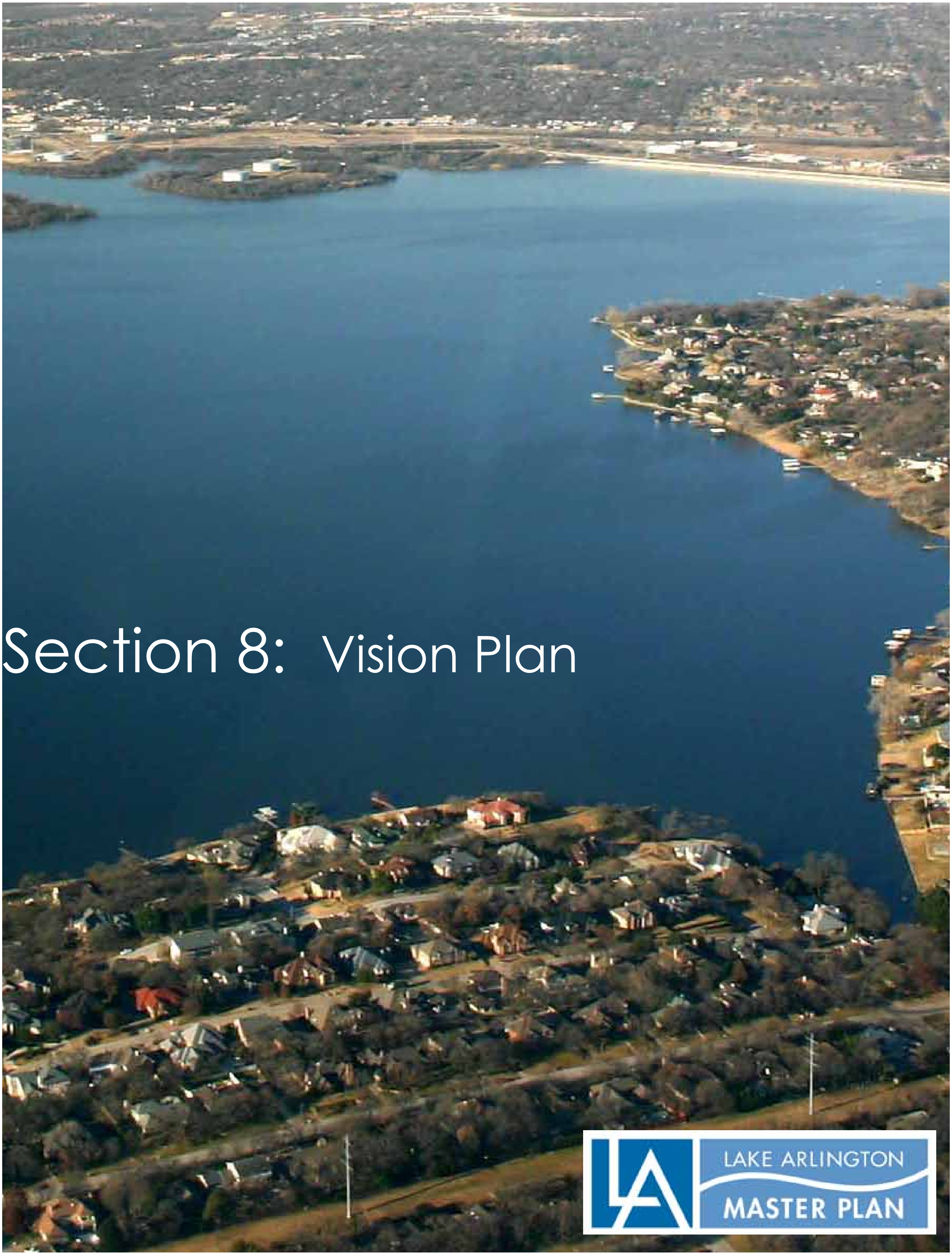


Table 7.10.5D: Watershed Management Strategy Adjustment

Section 8: Vision Plan



8.1 Introduction
The Lake Arlington Vision plan is a two-fold effort to provide recommendations to guide the long term growth of the study, as well as to provide guidelines for improvements within the Lake Arlington Flowage Easement.

The Vision Plan is intended to create a foundation for future growth and to assist the cities of Arlington and Fort Worth and its residents in prioritizing future planning efforts. Additionally, the Vision Plan is meant to provide flexibility to allow for changes over time based upon market realities and/or public need. To that end, the study focuses on the following areas:
- Land Use
- Parks and Open Space
- Trails
- Street Framework

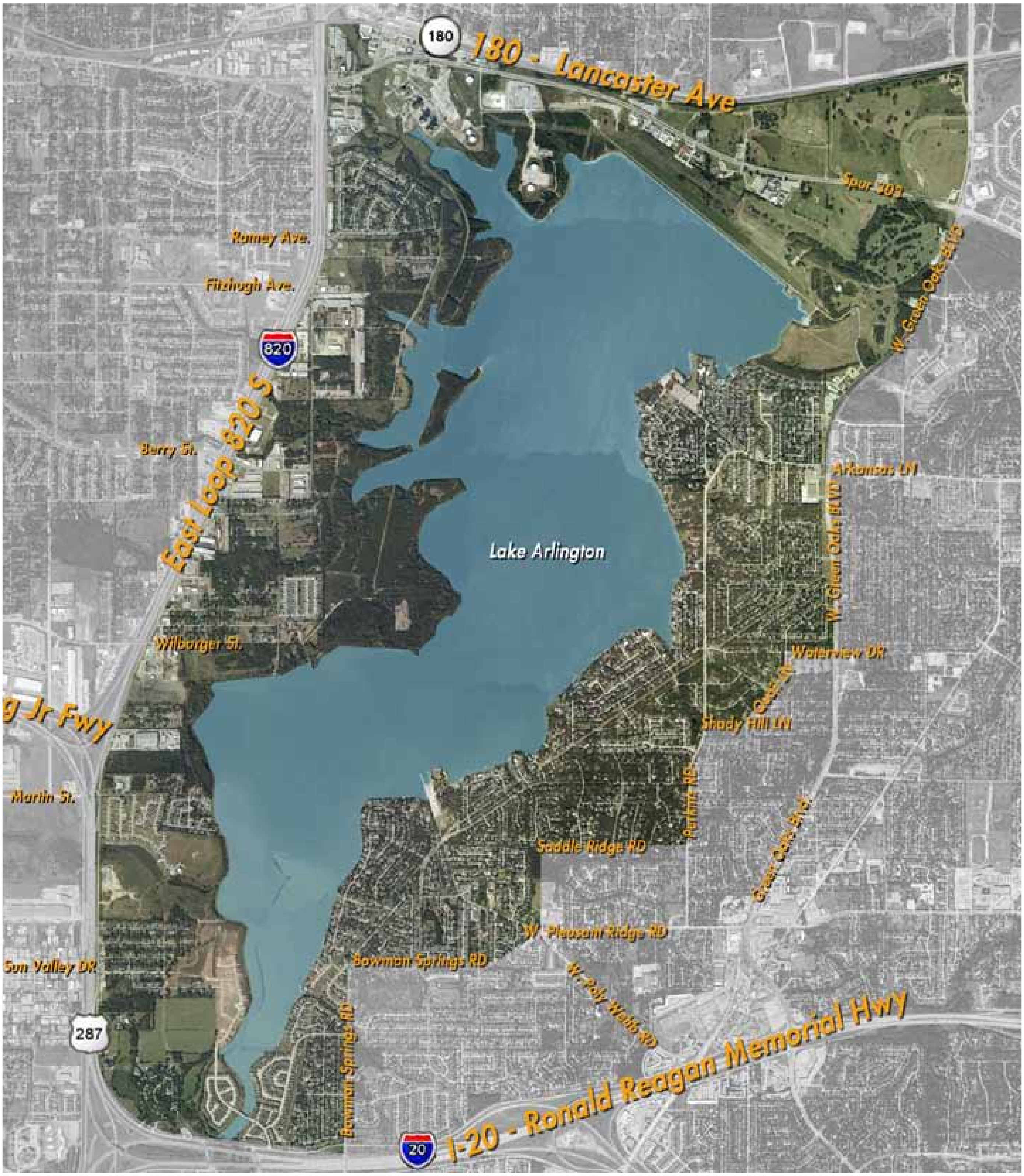
The design guidelines are a set of specific requirements and recommendations that apply to all improvements or additions located within the Flowage Easement. The guidelines will provide a baseline level of quality and sustainability while providing flexibility in design, construction, and price. The design guidelines address the following:

- Retaining Walls
- Docks, Piers and Boathouses
- Marinas
- Trails and Linear Parks

Consensus Building
Essential to the design process was working across city departments, municipalities, and interacting with the public to build a consensus on important issues based upon stated goals and objectives, market-based realities, and sound planning and urban design principles. Section 5, 8.4 and 8.5 describe in detail the methodology behind building a broad-based consensus that provided the base principles for the design effort.

8.2 Determination of the Study Area
The urban planning study area for the Lake Arlington Master Plan was determined utilizing logical boundaries to establish areas directly impacted by the lake. As such, the study area encompasses land that is in both the City of Arlington and the City of Fort Worth.

To define the study area, Lancaster Avenue creates the northern boundary, while Interstate 820 and Interstate 20 form the western and southern boundaries, respectively. The eastern boundary is more complex, utilizing a variety of streets in the City of Arlington to establish a study area that is impacted by development associated with Lake Arlington. The extents of the study area are:
- The intersection of 180-Lancaster Avenue and East Loop 820S marks the northwest corner of the study areas. Moving south along the east line of East Loop 820 S to the intersection of East Loop 820S and I-20 marking the South West corner of the study area.
- East along the north edge of I-20 to the intersection of Bowman Springs Road and I-20 Ronald Reagan Memorial Hwy.
- North along the west line of Bowman Springs Road, turn toward east along the north line of Bowman



8.2: Lake Arlington Study Area

Springs Road to the west end of W. Pleasant Ridge Road.

- North along the north line of W Pleasant Ridge Road to the intersection of W. Poly Webb Road.
- North on W. Poly Webb Road at the intersection of W. Pleasant Ridge Road and W. Poly Webb Road to Saddle Ridge Road.
- East along the north line of Saddle Ridge Road to Perkins Road.
- North from the west line of Perkins Road to the intersection of Shady Hill Lane and Perkins Road.
- East on Quail Lane from the intersection of Quail Lane and Shady Hill Lane.
- North along the west line of Quail Lane to the intersection of Waterview Drive and Quail Lane.
- East along the north line of Waterview Drive to the intersection of W. Green Oaks Boulevard.
- North at the intersection along the west line of W. Green Oaks Boulevard to the intersection of 180-Lancaster Avenue and W. Green Oaks Boulevard; said point being the North East corner of the study area.
- West along the south line of 180 Lancaster Avenue, to the intersection of East Loop 820S and 180 Lancaster Avenue (the point of beginning).

8.3 Analysis of Study Area

8.3.1 Existing Conditions

The Lake Arlington Master Plan site includes land located in the City of Arlington and the City of Fort Worth. For the western edge of the lake at elevation 550' marks the city limits between Arlington and Fort Worth.

Land Use

The eastern and western sides of the lake offer two differing existing conditions. The Arlington side of the lake on the east is dominated by single family neighborhoods that are primarily built out. The northeastern portions of the site are primarily open space, including the Lake Arlington dam and spillway, and the Lake Arlington Golf Course.

The western side of the lake is comprised primarily of large tracts of undeveloped land adjacent to the lake. The southern extent of the site includes single family development adjacent to the lake; moving north, commercial development that transition into single family development has occurred adjacent to Interstate 820, while leaving large tracts of primarily undeveloped land along the lake. Within these vacant tracts natural gas drilling sites have been created. The Exelon Handley Power Station dominates the north west corner of the lake. See Figure 8.3-1.

Parks and Open Space

The Arlington portion of the study area includes two city-owned parks, Richard W. Simpson Park to the north and Bowman Springs Park to the south. These parks represent the only public access to the lake in Arlington. Fort Worth includes one park, Eugene McCray Park, with public access to the lake. The vast majority of Fort Worth's lake frontage is undeveloped land, but offers no access to the water as it is all private property. See Figure 8-3.2.

Street Framework

The neighborhoods located within the Arlington side of the study area include a comprehensive street framework that adequately serves local and regional traffic. Fort Worth's street framework is more disjointed and incomplete, reflecting the lack of development in the area. Individual parcels and neighborhoods


Single family development at southern end of lake


Water's edge at southern end of lake


View of power plant from Richard Simpson Park


I-820 frontage in Fort Worth


Existing development in Fort Worth


Natural gas development in Fort Worth


Vacant land in Fort Worth

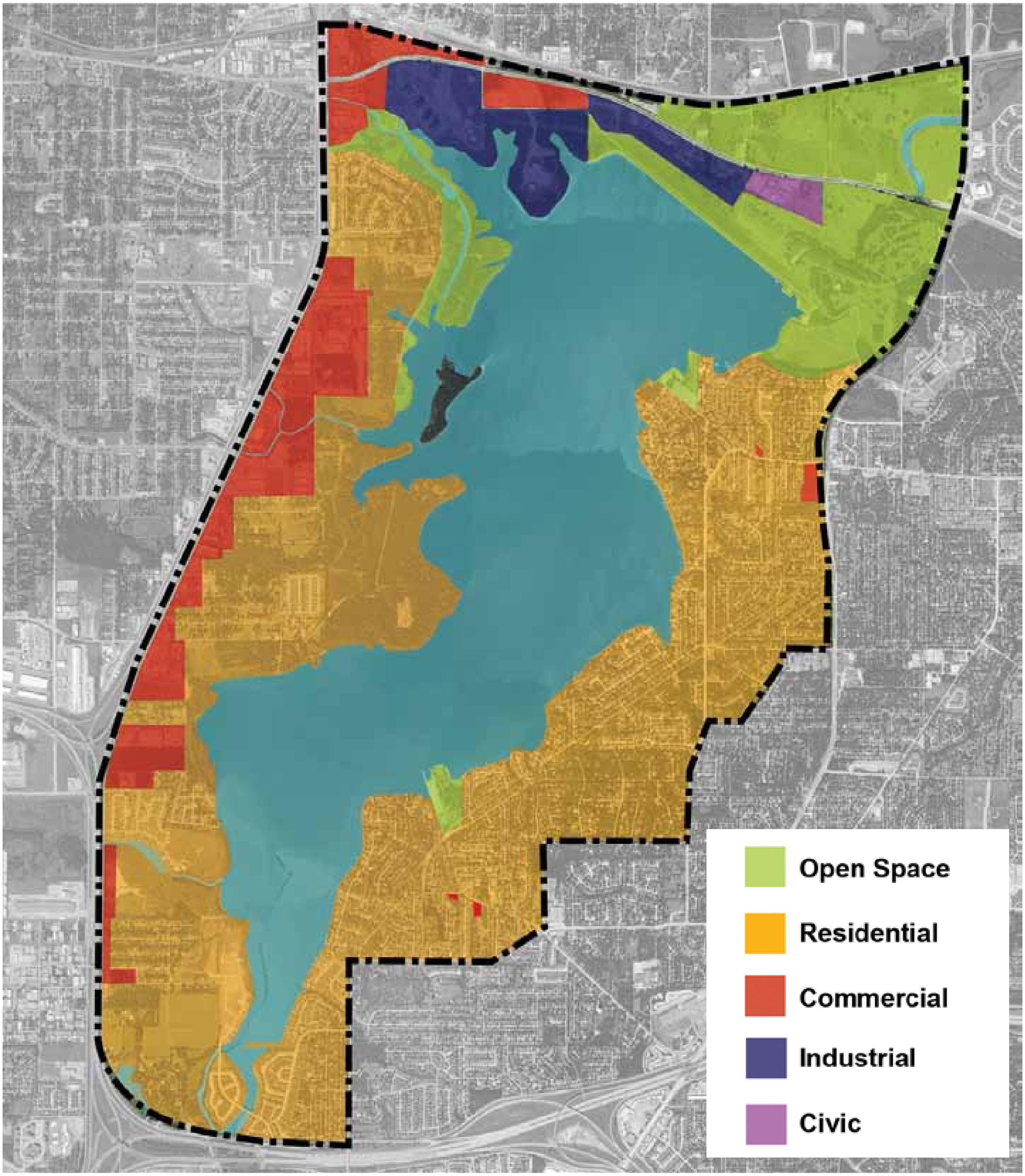


Figure 8.3.1: Existing Land Use

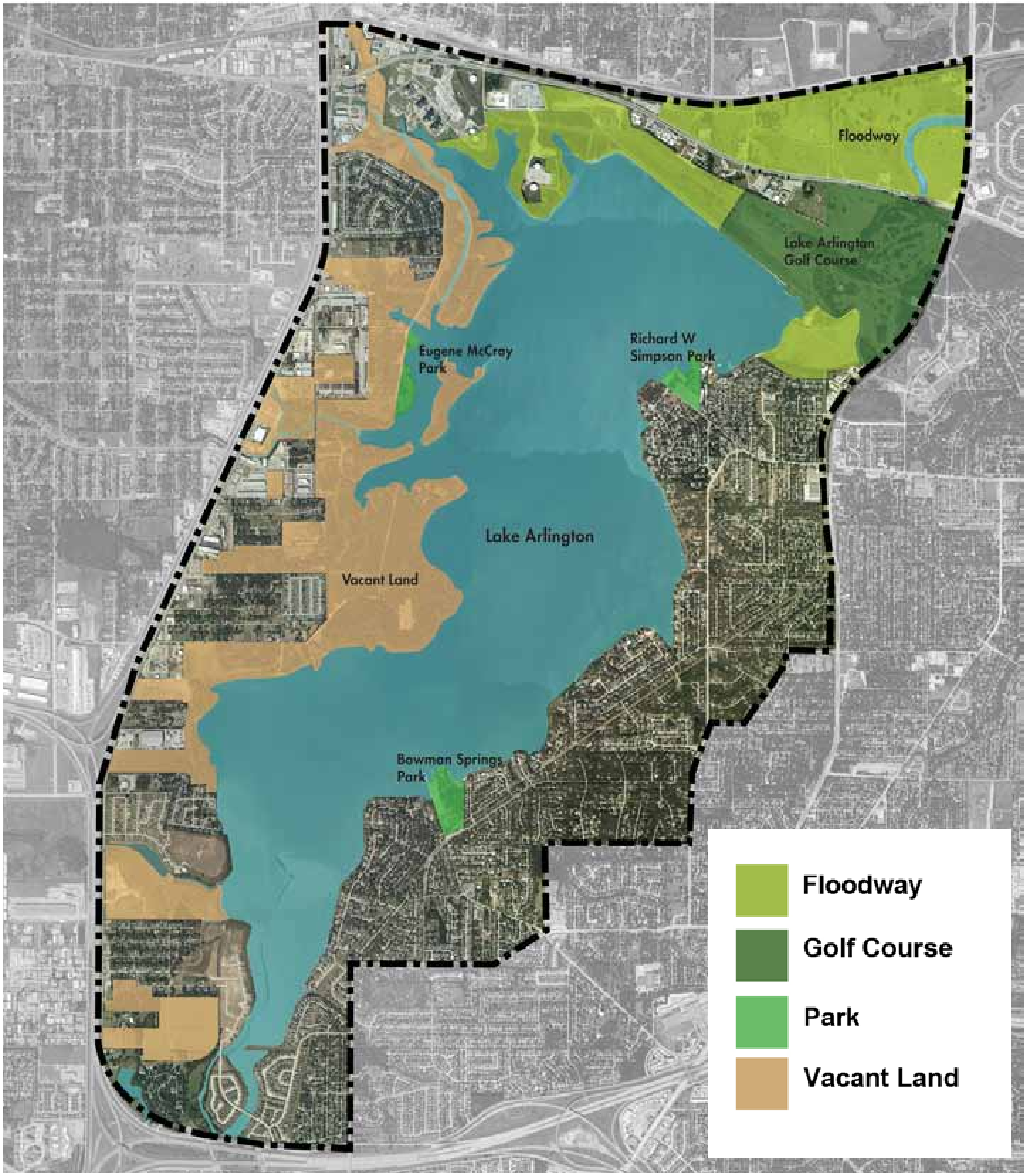


Figure 8.3.1: Existing Parks and Open Space

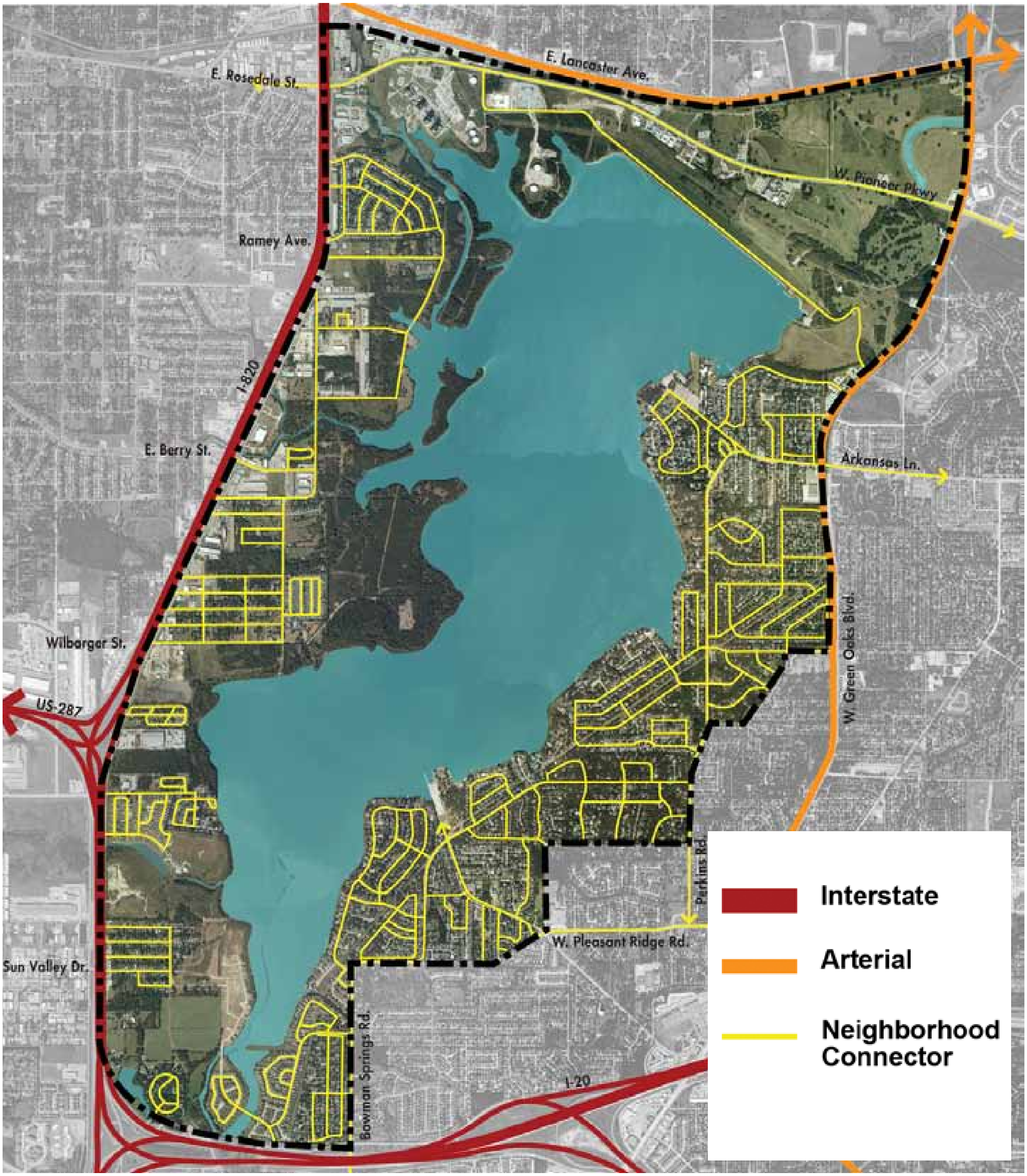


Figure 8.3.1: Existing Street Network

are adequately served, and Interstate 820 offers regional access, but a comprehensive street framework that ties the entire district together is lacking. See Figure 8.3-3.

8.4 Coordination with the City of Forth Worth

8.4.1 Regulatory Relationship between Arlington and Fort Worth

The Lake Arlington Master Plan study area includes the jurisdictions of the City of Arlington and the City of Fort Worth. Lake Arlington is located within the city boundary of Arlington to the 550' elevation and all areas west of this line are located within the City of Fort Worth. The Flowage Easement, located between elevations 550' and 560' fall under the jurisdiction of the City of Arlington Water Utilities Department in both the City of Arlington and the City of Fort Worth.

The complex arrangement between multiple jurisdictions has necessitated coordination between the City of Arlington and Fort Worth. In order to create a master plan vision that has lasting value, the City of Arlington Water Utilities Department focused upon building a consensus between the two cities regarding the long term vision for the area. In order to facilitate this effort, a regularly scheduled coordination meeting was conducted to share information, understand important issues affecting the project, and solidify a vision for the future of Lake Arlington. This coordination effort is described in more detail in Section 5.2.

Ultimately the City of Arlington and the City of Fort Worth will regulate their respective portions of the study area separately. The Vision Plan is meant to provide a tool for both cities to guide development and site improvements in the future.

8.4.2 Fort Worth Planning Efforts

The City of Fort Worth has a long history of studying the areas associated with Lake Arlington. Beginning in 1972 with the Southeast Section Plan, Fort Worth has focused on planning efforts and providing various tools for the development of the lake area. These past studies provided valuable tools and insight into the Vision Plan for Lake Arlington.

Figure 8.4.2A: Southeast Sector General Plan

A. <u>Southeast Sector General Plan - 1972</u>
The Southeast Sector Plan identified the potential for lakeside recreational development along Lake Arlington. Utilizing vast areas of vacant land, the plan recommends a lakefront linear park that creates public access to the water and allows for new development to front onto the park and the lake.

B. <u>Southeast Fort Worth Action Plan - 2000</u>
The Southeast Fort Worth Action Plan, conducted in 2000 recommends the development of residential clusters. These clusters would take advantage of land that is suitable for development, while leaving floodplain and lake front areas to be developed as public amenities. Additionally, the study recommends adding a north/south collector street to organize and unify the district.

C. <u>Council-initiated Zoning Changes - 2001</u>
In 2001, Fort Worth City Council initiated a zoning change at Lake Arlington that rezoned non-consis-

tent zoning districts in accordance with land use recommendations from the Southeast Fort Worth Action Plan of 2000.

D. Lake Arlington Conceptual Residential Plan - 2003
The Lake Arlington conceptual residential Plan recommends developing a range of residential densities in the Lake Arlington Study Area. This study determined that low density residential is the highest and best use of the site. As with previous studies, a recommendation for a north/south arterial between Wilbarger and Ramey is presented.

E. Lake Arlington Neighborhood Empowerment Zone (NEZ)
On February 3, 2004, Fort Worth City Council designated the Lake Arlington NEZ. This study recommends adding residential along Lake Arlington while developing open space areas to include public trails and parks along the water's edge. The study also recommends utilizing commercial developments to define major gateways from Interstate 820 and determining the feasibility of an elementary school at Lake Arlington. Finally, the study recommends a north/south arterial, consistent with previous studies.

Figure 8.4.2D: Lake Arlington Conceptual Residential Plan

8.4.3 Lakeshore Drive

The original Southeast Sector General Plan of 1972 recommended a north/south arterial in the Lake Arlington area. The arterial concept is a strong theme repeated consistently in past studies. The arterial is needed to organize the west side of the study area and to create a logical circulation pattern. Currently, only the Interstate 820 Frontage Road allows north/south travel across the entirety of the Lake Arlington area.

In 2003 Fort Worth City Staff developed preliminary cost estimates to design and construct Lakeshore Drive and in 2008, voters approved $6.9 million in the bond program for this effort. The design consultant, along with the City of Fort Worth and the Arlington Water Utilities Department developed a general consensus on the alignment of the initial phase of Lakeshore Drive as part of this Vision Plan exercise. The alignment is meant to provide a north/south arterial through the Lake Arlington district in Fort Worth, while providing access to undeveloped land and providing a framework for a future linear park and trail system along the lake edge.


Figure 8.4.3: Lakeshore Drive Preliminary Conceptual Layout

8.5 Workshops and Vision Planning

An important aspect of understanding the opportunity associated with the Lake Arlington Vision Plan is gathering input from the community. Working directly with community members living within the study area helped to establish the parameters of the planning exercise and to better understand existing conditions, neighborhood concerns, and how the lake is used by residents.

8.5.1 Visual Preference Exercise

The first round of public meetings focused on a visual preference exercise where the public was asked to evaluate a range of categories dealing with parks, new development, the character of the water's edge, streets, and elements within the Flowage Easement. This process provided a sense of what types of development would be preferred in the study area, and helped to narrow down potential options and opportunities. See Section 4.3 for details of the public meeting process and the outcome of those meetings. The specific categories presented in the public meeting are as follows:

- Docks and Piers
- Marinas
- Water's Edge Character
- Retaining Walls
- Parks
- Streets
- Residential Development
- Commercial Devlopment

The figures on the following pages show the compilation of results from the public meeting in Arlington and Fort Worth. The green dot represents the preferred option for each category.

8.5.2 Visual Preference Analysis

A. Docks and Piers

The Docks and Piers category voting trended toward smaller scale and individual structures suitable for single family applications. Uncovered docks were perceived negatively

B. Marinas

The Marinas Integrated with Commercial category was a clear favorite in Arlington, while the Marina Integrated with Residential was a favorite in Fort Worth. In both meetings strong opposition to a stand-alone commercial marina was expressed.

C. Water's Edge Character

The Water's Edge category trended toward a 'Naturalistic' approach. This implies the desire for lower density, access to water, and a public edge to the waterfront.

D. Retaining Walls

Terraced retaining walls were voted upon favorably, implying a desire to see retaining walls that have a reduced visual impact on the lake front.

E. Parks

Parks that are geared toward community gathering and passive recreation were favored. Voter preference trended toward parks similar to existing parks in the study area.

F. Streets

The strong appeal of the Commercial Street category was a reaction to the desire for gathering places and small, village-scale commercial development.

G. Residential Development
The majority of votes in favor of the Single Family category implied a desire to continue development patterns with a similar scale and density as existing neighborhoods in the study area.

H. Commercial Development
The selection of the Lifestyle Retail category suggest that a new development that focuses upon the creation of a destination rather than a traditional, auto-oriented retail center is preferred.

8.5.3 Opportunities and Constraints Workshop
After the Visual Preference Exercise voting results were tallied and analyzed, a discussion regarding the opportunities and constraints of the study area was facilitated with the public. The purpose of this discussion was to develop a greater understanding of the public's perception of the Lake Arlington study area, and to better understand the public's desire for the future of the area.

In addition to the Opportunities and Constraints categories, the public was presented and asked to comment on a Vision Statement for Lake Arlington.

"The VISION for Lake Arlington is to provide a safe drinking water supply and to protect the lake and its surroundings by identifying and promoting sustainable uses and watershed management practices that enhance the beauty and the value of Lake Arlington to the community."

Each opportunity or constraint was presented to the public in order to facilitate a conversation. The public was asked to comment according to the following parameters:
- Please comment on the draft vision.
- What are your thoughts on the opportunities and constraints?
- Are there specific issues of concerns you have about the opportunities and constraints?
- What do you think the top priority should be for the City of Arlington?
- Additional Comments?

The following opportunities and constraints categories were presented to the public:
- Improve and update existing parks
- Unify shoreline standards
- Improve street access
- Create hike and bike trails
- New development
- Wildlife preservation areas
- New development to buffer freeway
- Stormwater BMPs and trash management
- Increase lake storage capacity
- Maintain protection of intake structures
- Marina/Commercial development
- Expand paddling trail
- Improve fish habitat

Figure 8.5-1: Visual Preference Results - Docks and Piers

Figure 8.5-2: Visual Preference Results - Marinas

Figure 8.5-3: Visual Preference Results - Water's Edge Character

Figure 8.5-4: Visual Preference Results - Retaining Walls

Figure 8.5-5: Visual Preference Results - Parks and Open Space

Figure 8.5-6: Visual Preference Results - Streets

Figure 8.5-7: Visual Preference Results - Residential Development

Figure 8.5-8: Visual Preference Results - Commercial Development

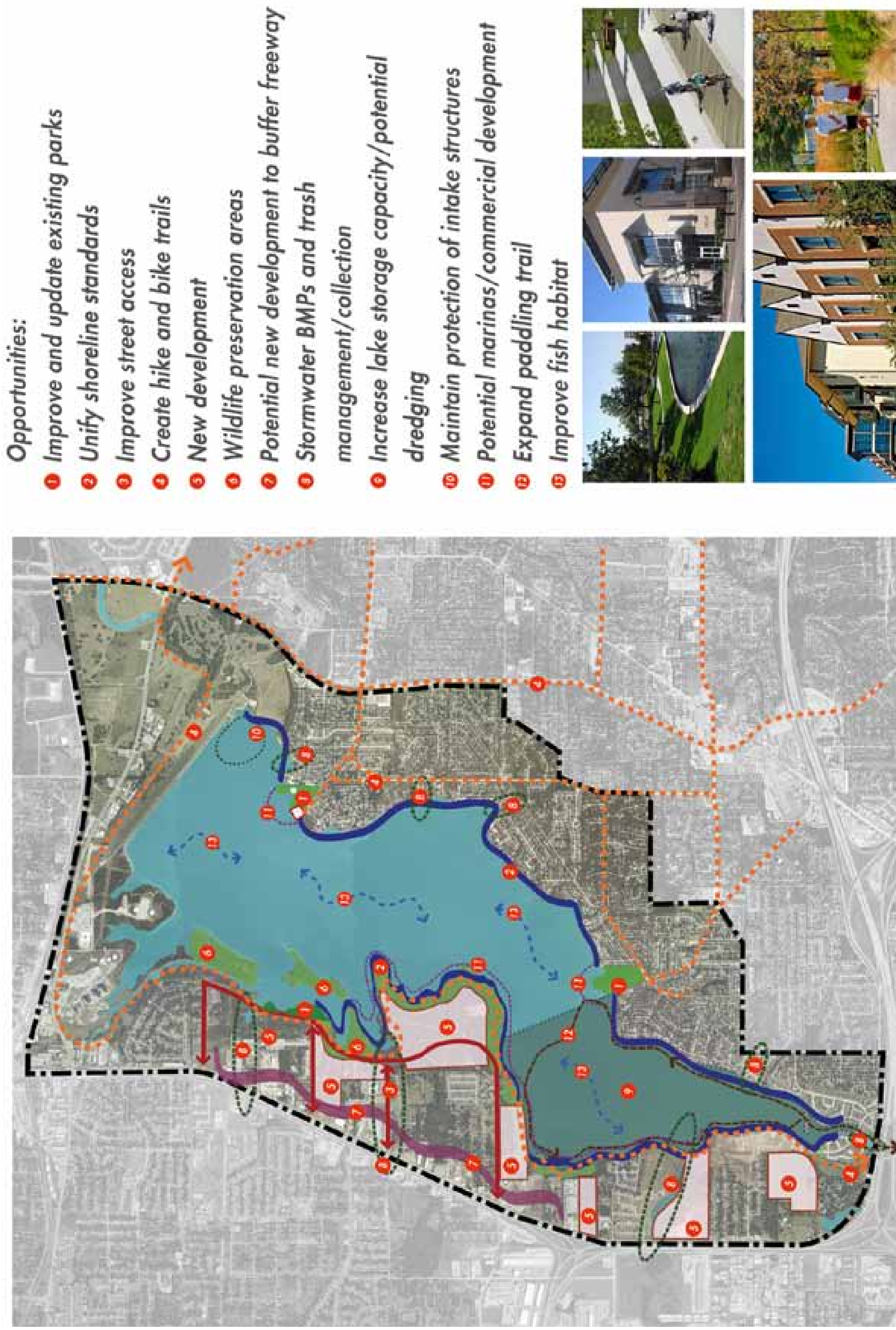


Figure 8.5-2: Opportunities and Constraints

8.6 Land Use Strategy

The Land Use Strategy for Lake Arlington primarily affects the Fort Worth side of the study area. The Fort Worth side of the study area contains large undeveloped tracts of land and development that represents a 'piece meal' approach over time. Existing development is often isolated and divided by vacant areas. The Arlington side of the study area consists of well established residential neighborhoods and will not be affected by land use recommendations

The Land Use Strategy makes the following recommendations:

<u>Arlington</u>

- Do not change existing land use patterns

<u>Fort Worth</u>

- Keep residential land use for existing neighborhoods.
- Utilize vacant land primarily for new residential development
- Strategically locate an area for waterfront development
- Utilize Berry Street as a gateway into study area. Allow mixed use, village scale development to create a 'center' of the community.
- Utilize Flowage Easement and Shoreline Protection areas along the waterfront as a linear park and trail system.
- Transition freeway fronting uses to local and regional commercial development

8.6.1 Highway Frontage Mixed-Use

The Highway Frontage Mixed-Use areas adjacent to Interstate 820 offer an opportunity to reposition the existing commercial tracts in the study area. Currently, these commercial properties are made up of predominately small warehouses, light manufacturing, and other distribution type uses. The land use plan recommends transitioning these uses into regional and local retail establishments, small office, hotel, and other commercial uses that take advantage of the visibility and access afforded by proximity to the interstate. These new uses will serve the regional market and create a suitable transition from the activity of the interstate to the residential neighborhoods and parks adjacent to the water's edge.

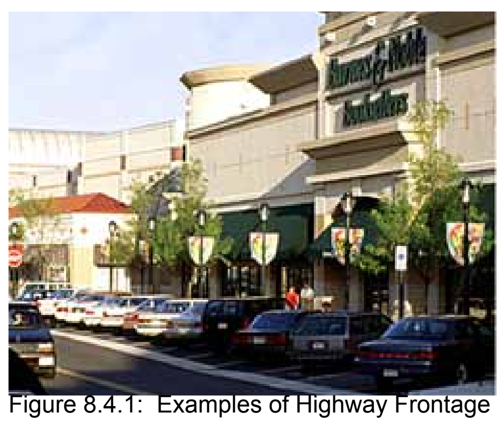


Figure 8.4.1: Examples of Highway Frontage Mixed-Use

8.6.2 Berry Street Mixed Use

Berry Street presents an opportunity to create a gateway into the Lake Arlington study area and to create a village scaled center for the community. In order to achieve a village center, buildings should be organized in order to address the street. Buildings should be sited toward the street while parking and other service uses should be located at the back of the site.

Berry Street should be designed to accommodate automobile traffic, allow for on-street parking on either side of the street, and ample sidewalks to support commercial uses. Areas for outdoor dining, outdoor retailing and public gathering should be accommodated

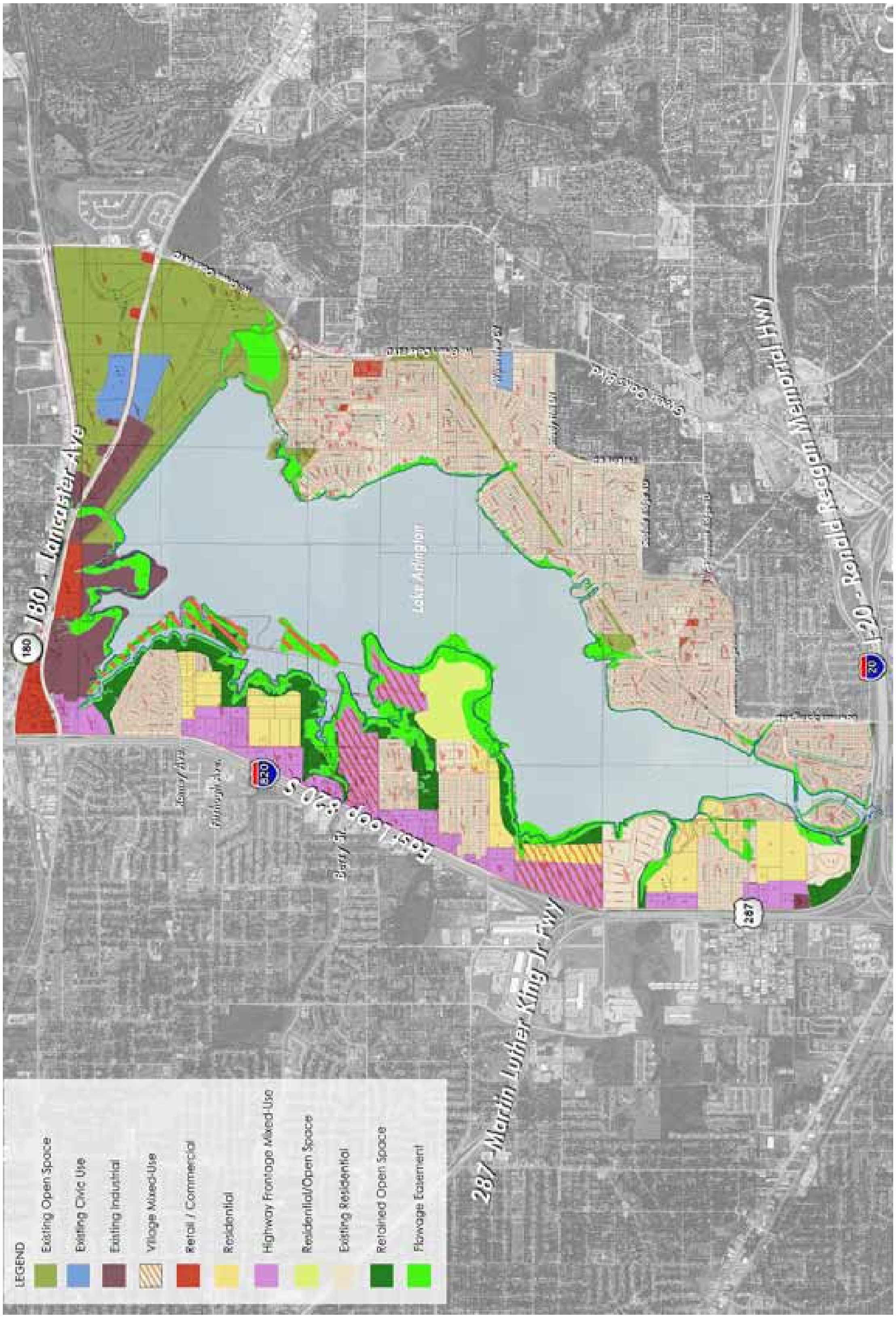


Figure 8.6-2: Concpetual Land Use Plan

Figure 8.6-3: Concpetual Plan for Berry Street Village Center and Waterfront Development

within the street-space as well.

The buildings should be designed to accommodate multiple uses (i.e. retail, restaurant, office, and residential) in order to provide a diversity of use and users within the center. New residential uses should be placed at the south of the site to create a transition between the village center and existing residential.

8.6.3 Waterfront Development

Across Lakeshore Drive and to the south of Berry Street is the proposed location for a waterfront development. This site is ideal for a development with increased density and height because of the direct adjacency to Berry Street. Additionally, due to the configuration of the lake edge at this location, the development's impact on views from across the lake will be minimized.

The waterfront development could be integrated with a small, 20 slip marina. The shops, restaurants, and small office make up the ground floor of the buildings and are accessed from a waterfront promenade. This promenade creates a transition zone between the marina and the development. The upper floors of the buildings should be designed to accommodate residential, office or hotel uses.

Figure 8.6-4: Conceptual Plan for New Residential Development and Linear Park

8.6.4 New Residential Development

The vacant land on the Fort Worth side of the study area offers an opportunity for new single family residential development. This new development will create an opportunity to solidify linkages, fill 'holes' in the urban fabric, and unify the west side of Lake Arlington into a cohesive neighborhood.

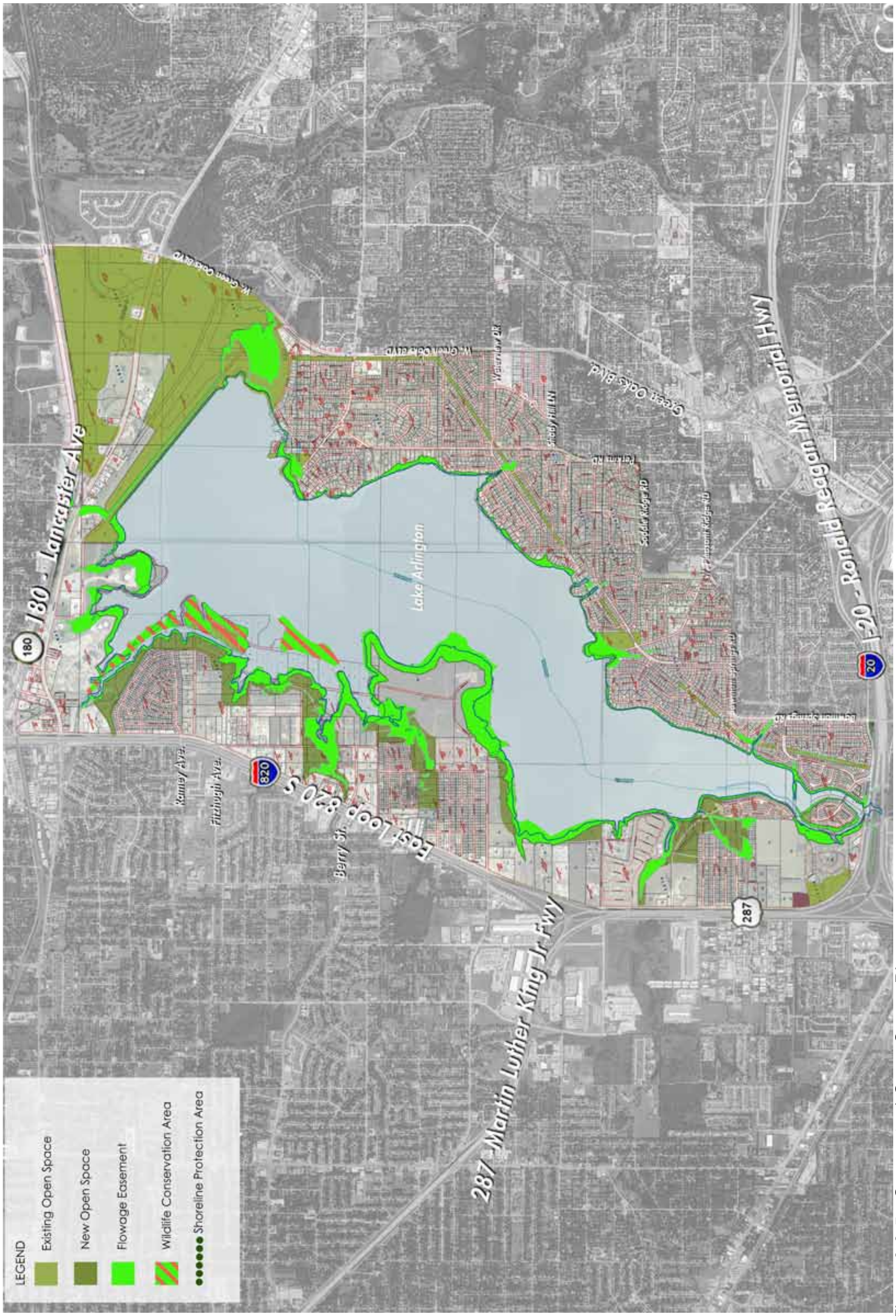


Figure 8.6-5: Concpetual Open Space Plan

An important key to this new development is the treatment of the water's edge. The linear park and trail system described in Section 8.8 will create a public edge to the water. New residential uses should take advantage of this park frontage by siting homes to face the park rather than back up to it. By facing homes toward the park, utilizing alleys to serve garages from the rear of the lot rather than the front, and adding porches or other features to the front of the house; views to the lake will be preserved as a public resource.

8.7 Parks and Open Space

Arlington has two parks (Richard W. Simpson and Bowman Springs Park) on Lake Arlington that serve as the only public access to the water front in Arlington. The parks are an important resource to the community for that reason and should be redesigned to accommodate a wide range of use and amenity. Additionally, the City of Arlington owns a piece of land on the northern tip of Enchanted Island that should be utilized for a neighborhood park.

8.7.1 Richard W. Simpson Park

The following are recommendations to consider when redesigning Richard Simpson Park:

- Construct a new multi-purpose lake house out of the Flowage Easement
- Close connection of Royaloak Drive and Arkansas Lane to eliminate park traffic in neighborhoods to the south
- Build a new fence and landscape buffer to screen Lake Arlington Yacht Club boat storage
- Utilize land between the yacht club and existing residential for a playground and improved access to the water.
- Add landscape features and bioswales in parking lot to reduce the visual scale of the lot and filter rainwater
- Add a limited access gate to eastern edge of parking lot and repave that section of the lot with grasscrete. Utilize the lot for overflow parking and temporary boat storage in flood event. The grasscrete paving will capture run-off and provide a visual buffer for existing residential
- Reduce the pavement width of Arkansas Lane and use special pavement or a raised crosswalk to slow down vehicular traffic.

8.7.2 Bowman Springs Park

The following are recommendations to consider when redesigning Bowman Springs Park:

- Consider siting a future community multi-use building in the park
- Add landscape features and bioswales in parking lot to reduce the visual scale of the lot and filter rainwater
- Create a community garden to create a new entrance to the park and to break down the visual scale of the parking lot and the boat ramp
- Provide a landscaped area near the western pier for a fishing area
- Add a texas native or adapted garden near the waterfront to provide a low maintenance buffer for storm water run-off into the lake

8.7.3 Enchanted Island Park

The City of Arlington owned land at the northern tip of Enchanted Island should be utilized as a neighborhood park with a focus on passive recreation.

- Add a covered seating area that takes advantage of lake views.

Figure 8.6-6: Conceptual Plan for Richard W. Simpson Park

1. New multi-purpose Lake House built out of the Flowage Easement.
2. Lake Arlington Yacht Club
3. New fence and landscape buffer for Yacht Club boat storage.
4. Park area redesigned for playground and seating area at lake front.
5. Landscaped parking areas break down the visual scale of the lots and capture storm water.
6. Fenced grasscrete parking area to be used for temporary boat storage during flood events and special event parking.
7. Special paving slows traffic and connects Lake House to park.

Figure 8.6-7: Conceptual Plan for Bowman Springs Park

1. Site for future community multi-use building.
2. Landscaped parking areas break down visual scale and capture storm water.
3. Landscaped fishing area.
4. Community garden breaks down scale of parking and boat ramp, and creates a new entrance to the park.
5. Texas native planting walk showcases native plants and provides low maintenance buffer for storm water runoff into the lake.

Figure 8.6-8: Conceptual Plan for Enchanted Island Park

1. Covered seating area.
2. Trail to the lake front.
3. Lake front seating area designed to withstand periodic flooding.
4. Landscape buffer to existing homes.
5. Natural lake front stabilized for erosion control.
6. Nature area.

- Provide a lake front seating area that is designed to withstand periodic flooding
- Provide natural landscape areas to buffer existing residential and stabilize the water's edge
- Provide on-street parallel parking

8.7.4 Eugene McCray Park

Eugene McCray Park, located within the City of Fort Worth, was not included in the scope of work for evaluation or recommendation.

8.8 Trails and Linear Parks

In 2010 the City of Arlington completed the city-wide Arlington Hike and Bike Trails System Master Plan. This plan includes the Lake Arlington study area and is reflected in Figure 8.7-1. It is important to the success of this system master plan in the Lake Arlington study area to logically connect to trail systems in Fort Worth and Kennedale to create a comprehensive system around the lake. Because this trail system will be constructed through both existing neighborhoods and vacant properties, a variety of trail types must be utilized. A system that utilizes off-street trails and bike lanes built within existing street rights-of-way will be the most effective means of creating a comprehensive trail system. See Section 8.11.5 for more information on trails and trail types.

8.9 Street Network

As with issues relating to land use, the street network strategy deals with differing issues between Arlington and Fort Worth. Arlington's street network within the study area is comprehensive and needs no additional streets to serve the community. Fort Worth on the other hand, requires new streets to better interconnect existing development and to unlock the development potential of vacant sites.

In Arlington, the recommendations pertaining to the street network revolve around reconfiguring existing streets to reduce vehicle speeds and to create more room devoted to pedestrian and bicycle traffic. Figures 8.9-2 - 8.9-5 show how typical arterial streets within the study area can be reconfigured within the existing right-of-way to better balance the needs of automobiles, pedestrians, and bicycles.

In the Fort Worth side of the study area, a detailed street network plan should be established to create a comprehensive street system. Figure 8.9-1 presents a strategy of improving existing streets and creating new streets to improve access and connections within the study area. Important to achieving this goal is Lakeshore Drive. This arterial will provide the main north/south connection through the study area and will become the organizing street that creates future development opportunities. Figure 8.9-6 shows a typical section through Lakeshore Drive. Figure 8.9-8 shows improvements to Berry Street that accommodate a the village center concept described in Section 8.6.1.

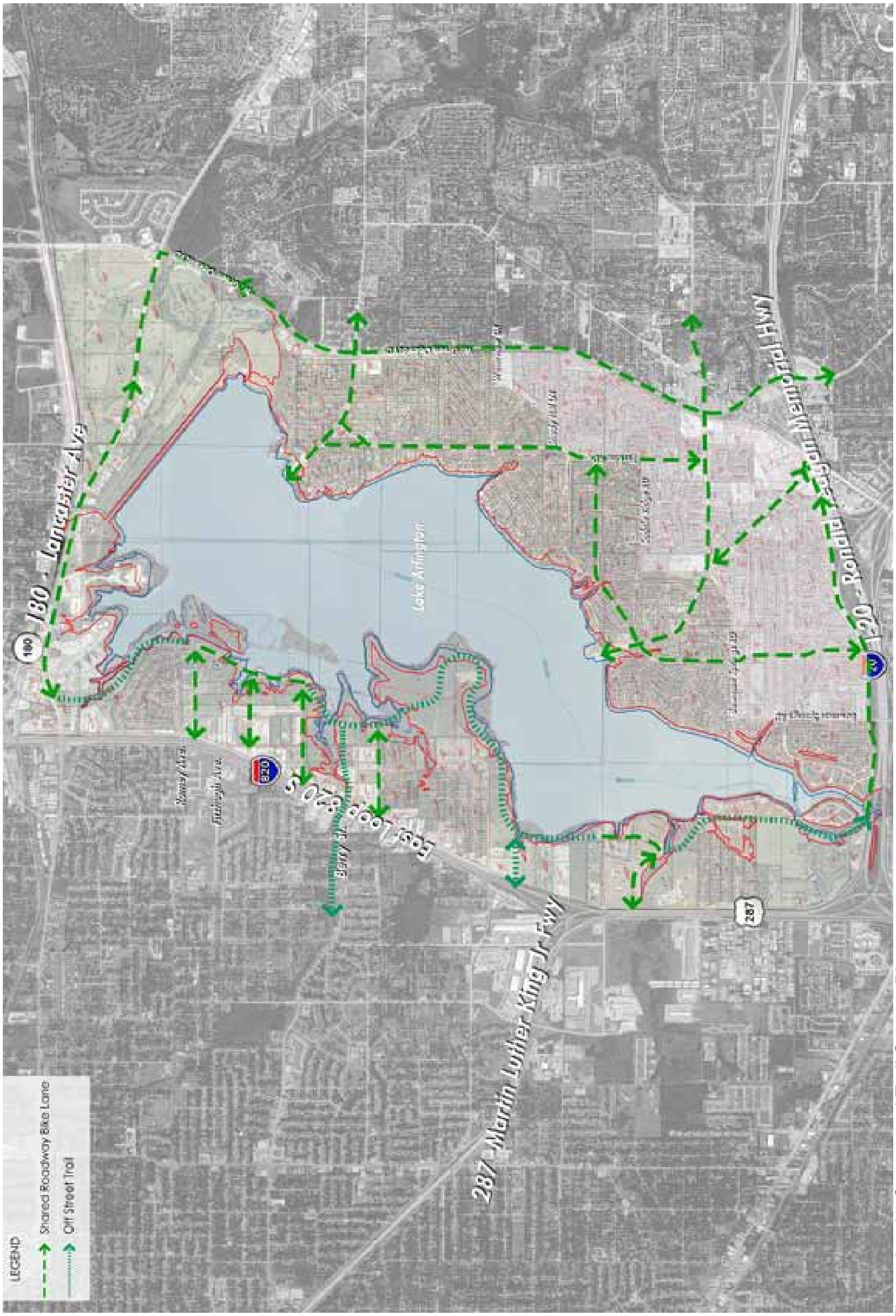


Figure 8.7-1: Concpetual Trail System Plan

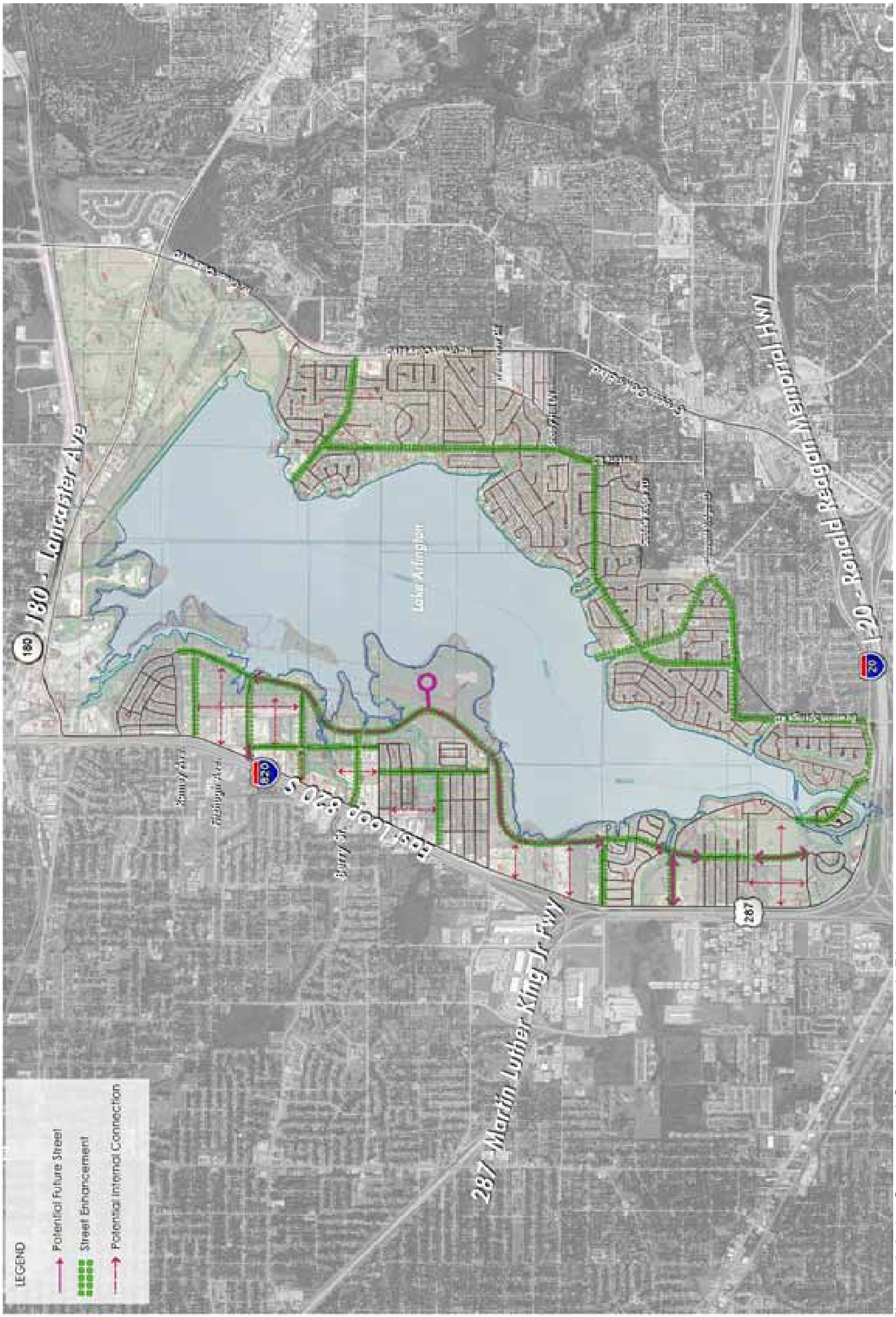


Figure 8.9-1: Concpetual Street network Plan

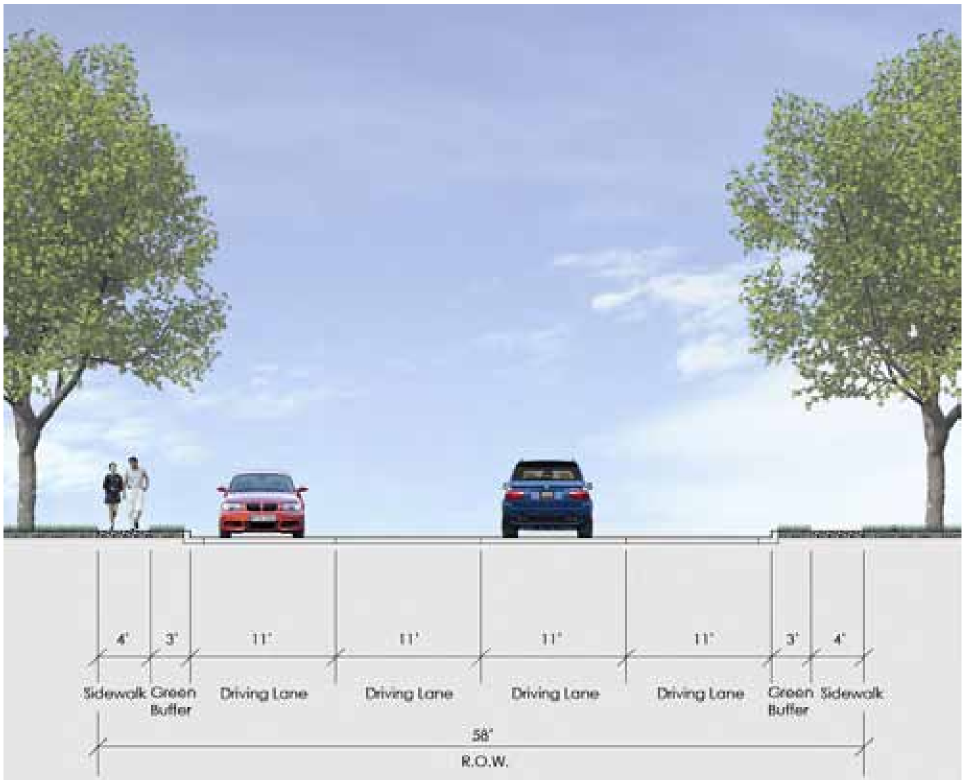


Figure 8.9-2: Existing Street Section - Typical 4 Lane, Undivided Arterial Road - Arlington

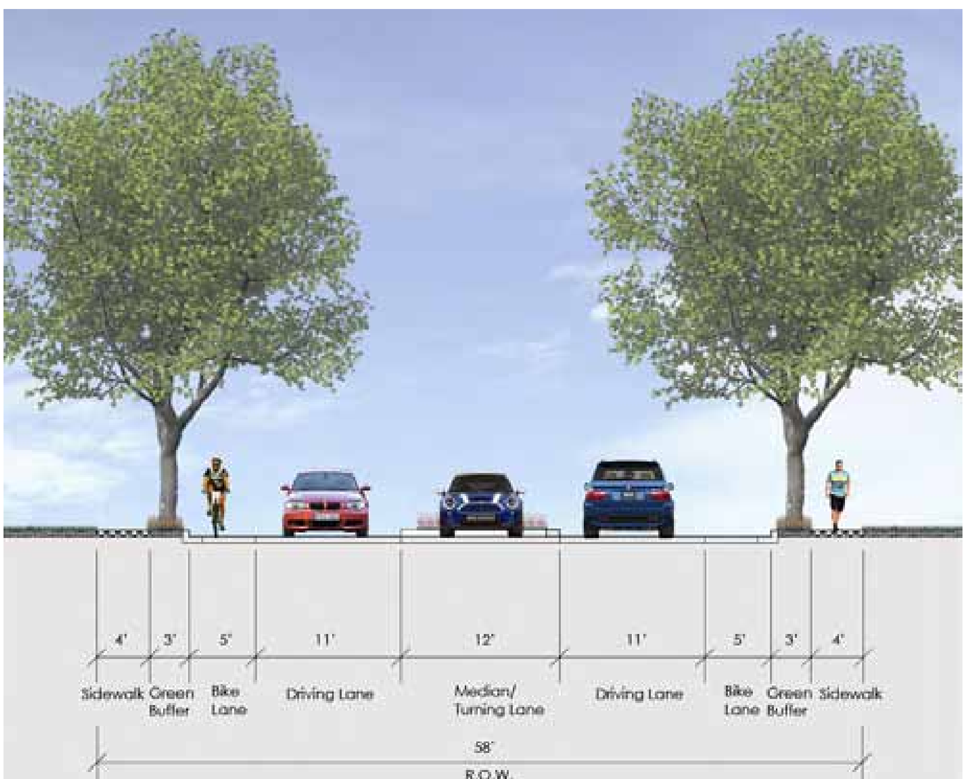


Figure 8.9-3: Proposed Street Section - Typical 4 Lane, Undivided Arterial Road - Arlington

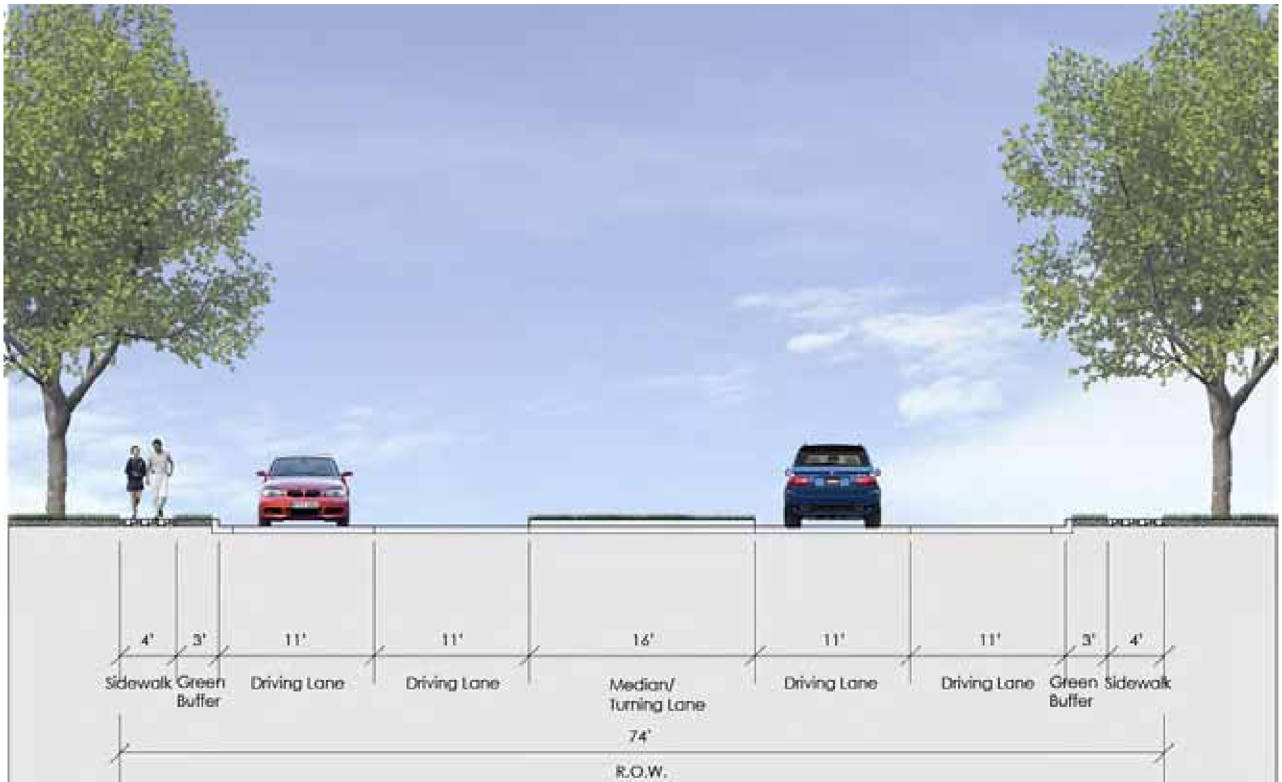


Figure 8.9-4: Existing Street Section - Typical 4 Lane, Divided Arterial Road - Arlington

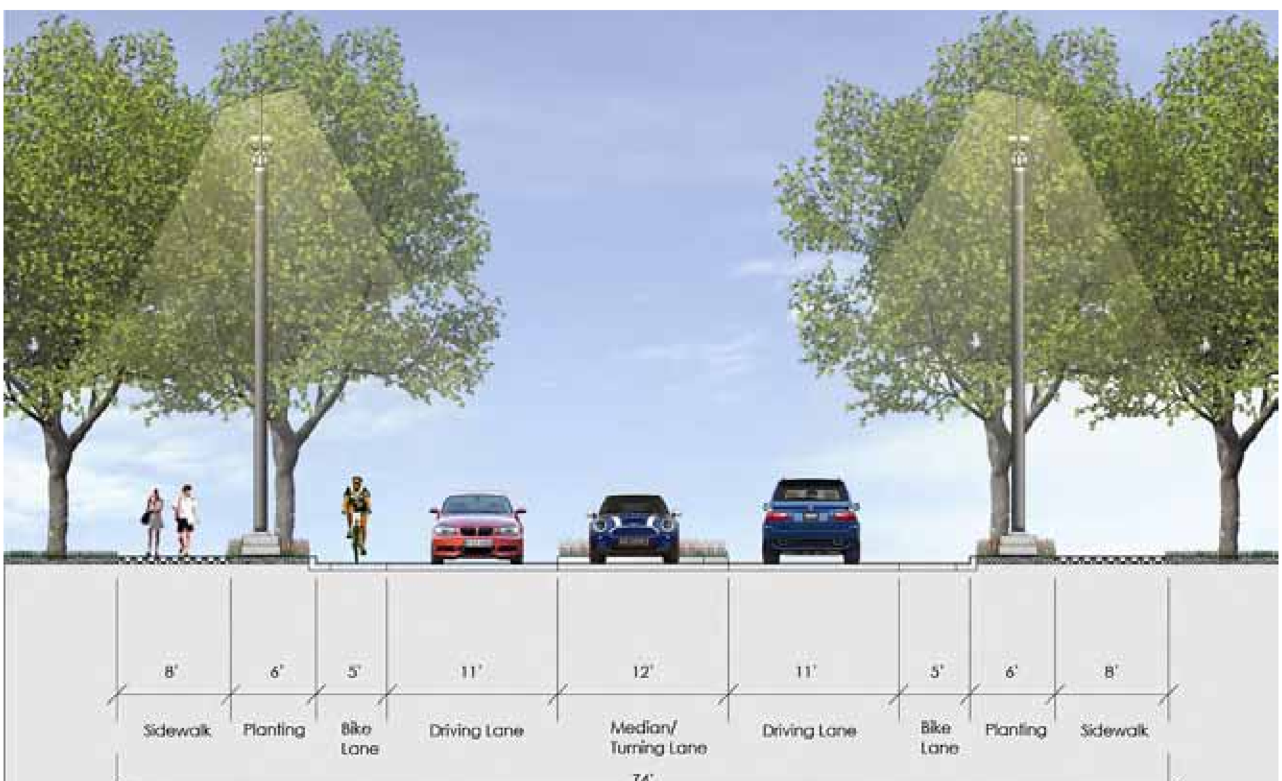


Figure 8.9-5: Proposed Street Section - Typical 4 Lane, Divided Arterial Road - Arlington

Figure 8.9-6: Proposed Street Section - Lakeshore Drive - Fort Worth

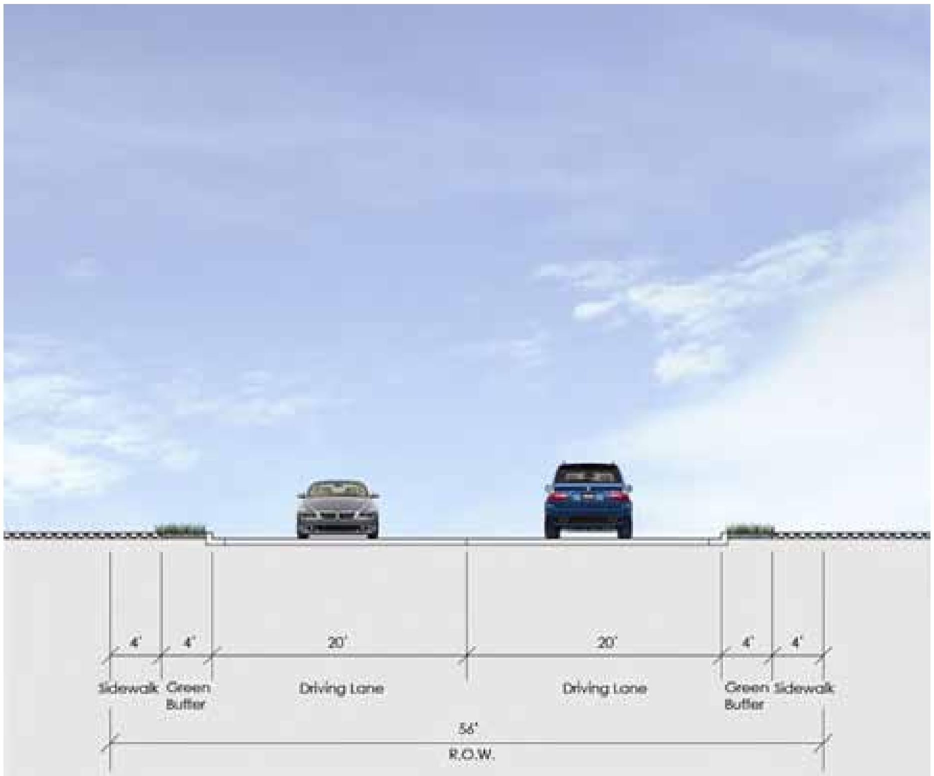


Figure 8.9-7: Existing Street Section - Berry Street - Fort Worth

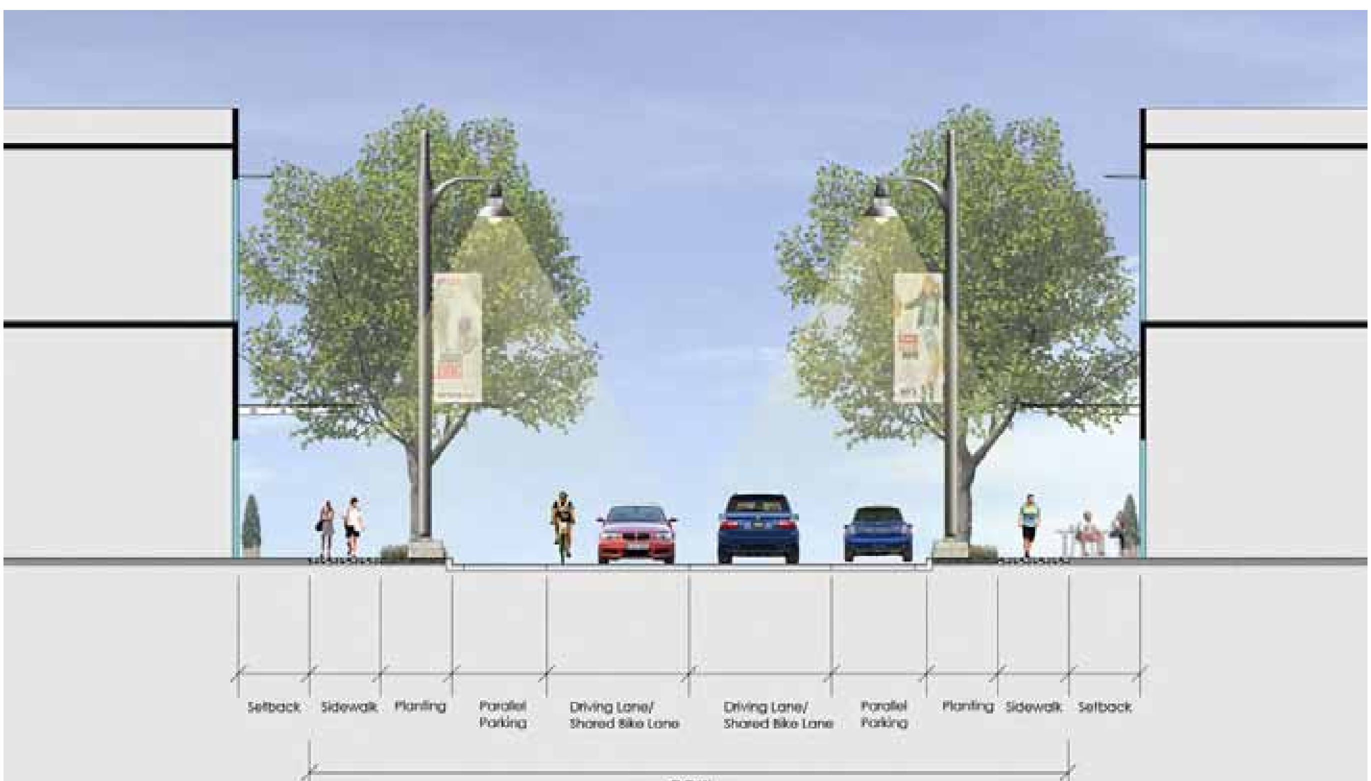


Figure 8.9-8: Proposed Street Section - Berry Street - Fort Worth

8.10 Dredging

8.10.1 Applicable Regulations

The regulations applicable to, and the authorizations required for, dredging and disposal of material from inland freshwater lakes such as Lake Arlington are discussed below.

The permitting requirements associated with the removal of accumulated sediments from Lake Arlington are dependent upon the regulatory status of the lake and the sediments to be removed. This summary assumes the most stringent requirements - that Lake Arlington is classified as a Navigable Waterway and a Water of the United States, and that the accumulated sediments in the upstream end of the lake at the mouth of Village Creek could meet the criteria as federally-regulated wetlands. As part of any dredging project, a wetlands delineation study should be one of the first tasks performed in the preliminary analysis.

A. Regulations that apply to work in Waters of the U.S.:

1. Section 404 of the Clean Water Act – Regulates the deposition of fill or mechanized land clearing in Waters of the U. S., including wetlands

2. Section 401 of the Clean Water Act – Water Quality Certification from the State of Texas through the Texas Commission on Environmental Quality (TCEQ)

3. Section 10 of the Rivers and Harbors Act – regulates “all work” below the Ordinary High Water Elevation (OWHE) of a Navigable Water

B. Activities to be performed to determine regulatory jurisdiction will include the following tasks:

1. Identification of the OHWE of Lake Arlington
    - Review of long-term lake level monitoring data
    - Field identification of indicators of the OHWE
    - Determine if accumulated sediment removal will occur below the OHWE

2. Determine if accumulated sediments are regulated wetlands
    - Evaluate soil, vegetation, and hydrology characteristics of the accumulated sediments to determine if they meet the federal criteria for wetlands
    - If not wetlands, the work will be regulated under Section 10
    - If wetlands:
        - Determine the size and environmental functions of the wetland to be excavated
        - Identify areas in the watershed to mitigate the lost functions and values. Such mitigation could include:
            - Restoration of wetlands on lakeshore
            - Creation of wetlands on lakeshore
            - Enhancement of wetlands on lakeshore
            - Preservation of existing wetlands in danger of loss
            - Restoration, creation, or enhancement of wetlands in the Lake Arlington watershed

3. Determine if there are any cultural resources associated with the accumulated sediments

4. Determine if accumulated sediments support or provide habitat for rare, threatened or endangered plant or animal species, or critical habitats.

5. Develop a wetland mitigation plan for impacts resulting from dredging activities.
   - Identify and delineate boundaries of existing wetlands, or endangered species or cultural resources in mitigation location
   - Develop water budget for mitigation wetland (Such a water budget would include an evaluation of and technical support for the designed hydrology of the mitigation wetland. It is a critical component of the wetland design. The water budget defines the quantity and duration of water in the proposed mitigation wetland based on: (i) water table fluctuations; (ii) precipitation; (iii) wetland water elevation fluctuations; (iv) inlet and outlet elevations; and (v) evaporation.)
   - Develop grading plan and construction drawings for mitigation wetland
   - Prepare bid documents to obtain construction bids
   - Select contractor
   - Construct mitigation wetland
     - Grading
     - Seeding
     - Planting

6. Monitor mitigation wetland for 5 years for the following:
   - Vegetation survival and development
   - Hydrologic characteristics
   - Weed evaluation
   - Performance of annual maintenance activities

C. Identify the location(s) for final disposition of dredged sediments, and permits and authorizations required for disposal

1. Determine if wetlands, endangered species, or cultural resources are present in the proposed disposal location.

2. Determine if a temporary TCEQ permit (NPDES/TPDES) is required for discharge of leachate from the dewatering of the dredged material.

8.10.2 Project Tasks
The issues and factors to be considered, and the typical steps to be taken by the City of Arlington (or a private developer authorized by the City) in permitting and implementation of an inland dredging project are discussed below.

The evaluation of a potential dredging project involves several strongly interdependent components, including:
- an engineering and environmental assessment of the site and sediment conditions,
- the selection of dredging equipment and operational approach,
- evaluation of complex processes such as sediment resuspension, and
- development of monitoring and management plans for implementation.

A recent United States Army Corps of Engineers (USACE) document entitled *Technical Guidelines for Environmental Dredging* (USACE, 2008) provides a good source of information related to the evaluation of dredging projects. The paragraphs below are a summary of the ten-step process described in that document for environmental dredging projects.   While potential dredging from Lake Arlington may not be "environmental dredging," many of the same principals apply. The process described below has been revised to be pertinent to Lake Arlington.

Define Dredging Objectives - The first step in the dredging evaluation sequence is to define the project objectives. This begins by identifying the processes and defining the objectives of importance for the City of Arlington. These processes, described in more detail in the USACE document, would include sediment removal, resuspension of sediments, and generation of residuals. Objectives would include sufficient accuracy in the evaluations, reasonable time for completion, impact on the public during operations, compatibility with on-site disposal, quantity and rate of resuspension to the water column and the quantity of residual sediment.

Conduct Initial Evaluations - An early initial evaluation of the feasibility of dredging portions of Lake Arlington should be conducted in order to collect necessary data for further evaluation of dredging. The initial evaluations would include comparison of known site conditions, sediment characteristics, and project requirements to those conducive to a dredging project. More detailed evaluations can then be conducted including identification of major constraints such as non-availability of on-site disposal, the presence of hard substrate, boulders and debris, or the presence of endangered species.   If site conditions or institutional constraints indicate that full dredging is not feasible, a reduced dredging project may also be considered.

Identify Data Gaps - The initial evaluations described above would also provide a basis for determining any data gaps pertaining to the feasibility evaluation and for the preparation of cost estimates. Data gaps can be identified by comparing the existing information to the information needed to develop a proper dredging plan. These data gaps would need to be filled in order to complete the evaluations.

<u>Understand Site Conditions</u>: During the collection of data it is important to gather information on physical characteristics of the water body, water body uses, the presence and nature of major infrastructure such as pipelines and electric transmission towers, the presence and nature of debris in the sediments, and geotechnical information. The process of filling data gaps may be iterative in that several tiers or phases of investigations may be needed in order to fully understand the site conditions.

<u>Characterize Sediments</u>: Sediments under consideration for dredging and any sediment layers adjacent to or below the target material must be characterized. This evaluation includes the physical and chemical characteristics of the sediments. These characteristics should be determined both horizontally and vertically. The results of the characterization will determine the potential areal extent and depths to be dredged.

Determine Dredgeability and Removal Requirements - Based on the previous tasks, the feasibility, constraints, and dredging prism requirements can be determined. [The dredging "prism" is the three-dimensional volume of sediment identified for removal, including the cut depth and the side slopes.] Dredgeability evaluations focus on the ability of various equipment types to effectively remove the sediments, and include consideration of factors such as the presence of and extent of debris, the shear strength, and density of sediments, the presence of underlying hardpan or rock bottoms. A separate debris removal operation may be considered at this point. The removal requirements include accurately defining areas slated for dredging; thicknesses of sediment layers to be dredged; water and sediment depths, over burden, slopes, need for step cuts, side slopes, and overdredge allowance; limits on precision removal; and an estimate of the total volume of material to be dredged.

Develop Preliminary Performance Standards - Performance standards may include applicable water quality and air quality standards; limitations on or minimum requirements for productions; limitations related to quality of life considerations (noise, light, traffic, etc.); limitations on resuspension; and goals for effectiveness.

Select Equipment Type for Evaluation - There are two primary types of equipment used for dredging of inland water bodies—mechanical and hydraulic. The City should select the type of equipment based on the pertinent equipment capabilities and the compatibility of equipment with site and sediment conditions, transport and rehandling requirements, and disposal options. In most cases, both mechanical and hydraulic dredging approaches should be evaluated and compared.

Evaluate Production Rate, Project Duration, and Transport Needs - Dredging "production" refers to the rate of sediment volume removal, and it is usually measured in terms of in-situ sediment removed per unit of time. An evaluation of production rates will determine the size and number of dredges needed to meet the removal objectives, duration, and transportation needs. Estimates of the average operating production rate will depend on the equipment characteristics, site conditions, sediment properties, thickness or face of material to be removed, continuity of sediment removal areas, location, and the type of disposal site(s) and needed rehandling facilities. If there are no specific production-related performance standards, the project duration can be evaluated in terms of reasonable time frame for completion.

Evaluate Sediment Resuspension - Once the size and number of dredges are selected, an evaluation of sediment resuspension is possible. Resuspension evaluations usually rely on an estimate of the resuspension sources and "source strengths," which include the estimated production rate, sediment characteristics, dredge size and type, removal mechanism (bucket, cutterhead, or open suction), and operating characteristics. The source strength is expressed as the mass of sediment resuspended per unit time throughout the water column. The source strengths are coupled with a model for prediction of suspended solids concentrations in the water column as a function of distance and time. Results can then be compared to performance standards for resuspension or water quality standards for suspended sediments and turbidity. The need for control measures (such as restrictions on the rate and timing of operations or deployment of silt curtain containment) can then be determined.

Evaluate Residuals - "Residuals" refers to the mass (thickness and density) of sediments left in or adjacent to the dredging footprint at the completion of the dredging operation. Residuals can be generated by the dredging operation as "fallback," sloughing from the dredge cutface, and/or resettlement of the resuspended solids. Residuals can also include potentially undredged inventory. Although there are presently no standardized methods, prediction of residual amounts can be based on field experience at other inland lake sites with similar dredging operations, and the characteristics of the sediment profile to be dredged. An estimate of residuals can also determine the potential need for additional dredge passes.

Determine the Need for and Effectiveness of Control Measures - The results of the evaluations of sediment resuspension and residual sediments should be compared with any pertinent performance standards to determine if control measures are needed. Operational controls can include those associated with the dredging itself, as well as engineering controls such as structural containments. If controls are determined to be necessary and potentially effective, such controls should be included in the design, and the impacts to the operational plan and schedule should be considered.

Develop Operations Strategy - At this stage, a formal written Operations Plan should be developed. The plan should include a detailed dredging prism or sediment layer trace (the specific layer of sediment or geologic formation); delineation of dredging management units; description of dredge cuts and side slopes; a sequence of operations; a detailed mobilization – demobilization and construction timelines; complete description of all equipment to be used; design and use of control measures; and methods for monitoring progress and payment.

Develop Monitoring and Management Plans - Written Monitoring and Management Plans should be developed to verify that performance standards are met. Elements of the plans should address processes related to both short-term and long-term effectiveness. The Monitoring Plan should be a detailed document including monitoring equipment and techniques to be used; the protocols for sampling, handling, and testing of samples; and a description of how the monitoring data will be interpreted. The Management Plan should describe specific actions to be taken based on the results of the monitoring. Management actions would typically be developed in a tiered fashion depending on the monitoring results, and may include provisions for additional or more intensive monitoring, a slow-down or cessation of operations or implementation of control measures.

Summary and Integration - The overall success and acceptability of the dredging design can be evaluated in terms of meeting performance standards, being implementable, and providing effectiveness. If evaluations indicate that the proposed dredging design is not feasible, other dredging designs or options could be evaluated.

8.10.3 Problems and Challenges
The problems or challenges that should be anticipated, and typical means to mitigate these problems or issues are briefly discussed below.

Dredging project problems or challenges are discussed along with typical mitigation measures in the ten steps described above. In addition, sediment disposal represents a large uncertainty related to cost. If the material is clean it may be able to be beneficially reused as an agricultural soil amendment. If the dredged material meets certain geotechnical requirements, it may be able to be beneficially reused for purposes such as daily cover for a landfill. These alternatives are the least expensive disposal alternatives. However, if the sediment does not meet geotechnical requirements and no nearby agricultural uses are identified, construction of an onsite confined disposal facility (CDF) must be considered. This alternative represents the moderate cost disposal alternative. If the material is contaminated, it may need to be stabilized onsite and sent to an approved off-site landfill. This represents the greatest cost alternative.

8.10.4 Potential Unit Costs
The unit cost (in $ per cubic yard) for typical dredging projects varies considerably depending primarily on dredging method, transportation, and disposal location. According to the USACE Dredging Information System, during Fiscal Year 2009, the average cost of new dredging work using a non-hopper dredge (i.e., mechanical or hydraulic dredge) was $23 per cubic yard (cy). However, this cost assumes onsite trans-

port and placement of sediment on land adjacent to the water body. If chemical analysis determines that the sediment will require transportation to and disposal at an offsite facility, the cost per cubic yard would increase substantially. Unit costs ranging from $100 to $500/cy are not uncommon.

8.11 Development of Design Guidelines and Standards

8.11.1 General

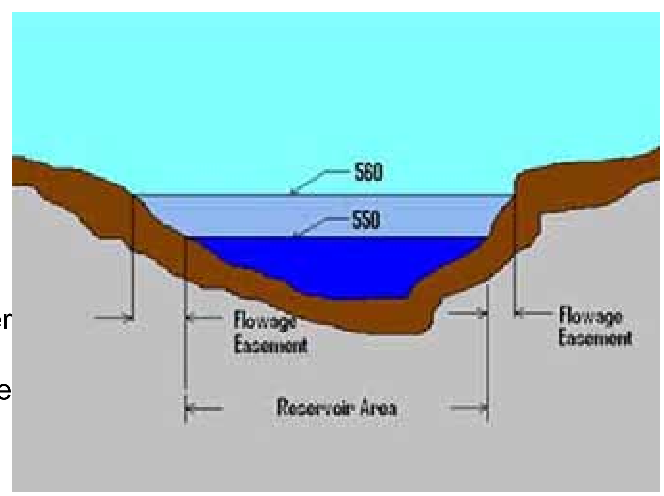
This Master Plan provides general guidance on the Design Guidelines and Standards that should be used for the development of specific permit requirements and ordinances related to Lake Arlington. The provisions of the Lake Arlington Master Plan Design Guidelines and Standards apply to structures located within Lake Arlington and the Lake Arlington flowage easement (the "Flowage Easement"). The Flowage Easement is generally defined as land adjacent to Lake Arlington that lies between elevations 550' and 560'. For the purposes of these guidelines and standards, the "shoreline" of the Lake is at elevation 550'.The purposes of the Guidelines and Standards are to protect the water quality of Lake Arlington; to maintain or enhance the storage capacity of Lake Arlington; to protect the integrity of the Lake's shoreline by only permitting structures and improvements that are well-designed and capable of being properly maintained; to promote a sustainable lake habitat; and to protect the value of private and public property. Areas outside of the Flowage Easement on the west side of the lake is largely within the City of Fort Worth jurisdiction.

The City recognizes that water quality is enhanced by retaining or enhancing natural areas immediately around Lake Arlington. Within these Guidelines and Standards there are incentives for landowners to keep natural areas and/or replace retaining walls with more natural shorelines.

All structures constructed within Lake Arlington and the Flowage Easement are subject to permitting by the City of Arlington (the "City" or "Arlington"). Persons seeking to construct or maintain a structure in Lake Arlington or within the Flowage Easement must submit to the City an application and any project plans. The applicant will also pay any required fees.

When an existing structure within the Flowage Easement will be used as part of the newly proposed improvements, the project plans must include a complete description of the existing structure(s). If more than 50% of the length of a retaining wall or volumetric area of other existing structures, such as docks and piers, are to be repaired, extended, or replaced, then the existing structures must also be brought into compliance with these regulations. This requirement generally follows the guidelines for modifications of existing structures used by the Federal Emergency Management Agency (FEMA) and others.

The project plans must include a description of the site that shows the location of the primary lot, the extension of property lines out into the water area (if applicable), a survey depicting the 550' and 560' elevation (the extent of the Flowage Easement), and a key plan, either included on the site plan or on a separate sheet, to show the location of the property and its relation to Lake Arlington.



8.11.1: Flowage Easement Diagram

Improvements in and adjacent to Lake Arlington will be in accordance with the normal pool elevation and flowage easement elevation, see Figure 8.11.1. Lake Arlington's normal pool elevation is listed at elevation 550' and the flowage easement elevation is listed at 560' from the Lake Arlington design plans of 1950.

In consideration of the fact that surveyors, engineers and developers could use various elevation benchmarks to survey, design and construct improvements, the normal pool elevation of the lake and flowage easement elevation should be determined by a qualified Registered Professional Land Surveyor and tied to one standard. It is recommended that the top of the Lake Arlington Morning Glory (lake elevation control and discharge structure) be surveyed with high order survey equipment and tied to the current National American Vertical Datum (NAVD).

A review of FEMA floodplain and floodway maps of the creeks connecting to Lake Arlington show 100-year flood elevations in excess of elevation 560. Improvements in and adjacent to Lake Arlington must also consider that flowing water during a significant flood event is expected to be higher than the flowage easement elevation and the crest of the emergency spillway. Designers, surveyors, engineers and developers of improvements must consider the flood elevations as shown on FEMA maps.

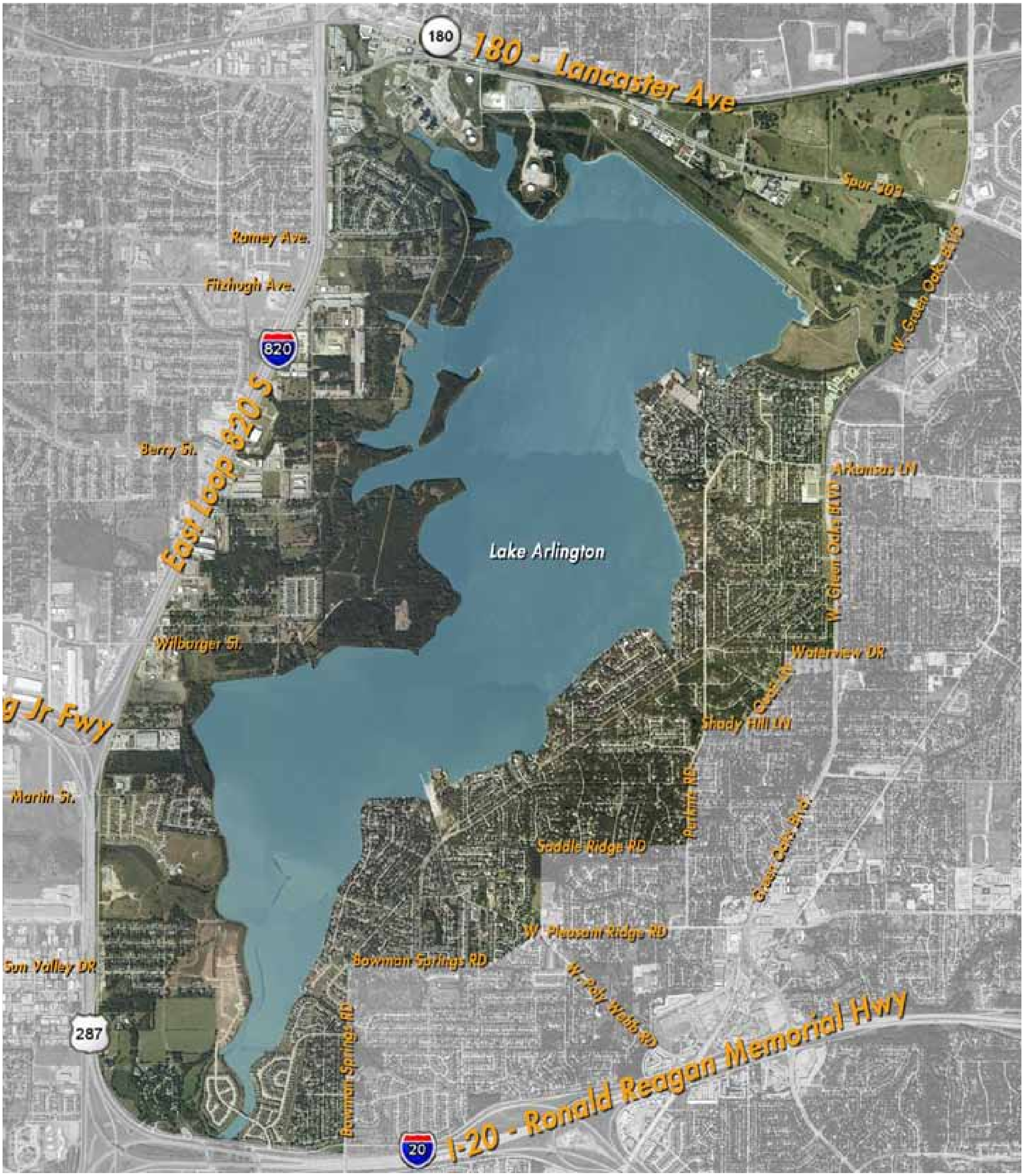
Project plans must be signed and sealed by a Texas State Licensed Engineer and contain a statement that the proposed improvements comply with the specifications set forth in this section. Any and all structural designs must comply with the provisions in the City of Arlington's building code (the "Building Code").

Each project plan set must also include a copy of the manufacturer's certified plans for any components that will be part of the improvements, such as decking, railing, or awning systems.

The project plans and manufacturer's certified plans must be based upon the actual conditions at the site of the proposed improvements.

A person may not begin construction of any improvements until a permit for the structure or activities has been issued by the City.

Once all of the required information is submitted on a permit, it shall be reviewed for compliance. All structures, modifications and maintenance activities shall be installed and/or performed in compliance with the City's regulations and with the information shown on the approved site plan and wall construction permit. The applicant shall contact the City to request a final inspection upon completion of the structure and/or improvements. If the inspector determines that the activities were performed in accordance with the requirements contained in this section and the approved permit, a Certificate of Occupancy or final inspection approval will be issued to the applicant. If the structure and/or improvement does not pass the inspection, the inspector shall prepare an inspection report detailing the deficiencies.


180
180 - Lancaster Ave
Spur 303
W. Green Oaks BLVD
Rumey Ave.
Fitzhugh Ave.
820
East Loop 820 S
Berry St.
Arkansas LN
Lake Arlington
W. Green Oaks BLVD
Wilbarger St.
Waterview DR
g Jr Fwy
Shady Hill LN
Martin St.
Saddle Ridge RD
Green Oaks Blvd.
W. Pleasant Ridge RD
Bowman Springs RD
Sun Valley DR
W. Poly Webb RD
287
Bowman Springs RD
20
I-20 - Ronald Reagan Memorial Hwy

Study Area

8.11.2 Retaining Walls

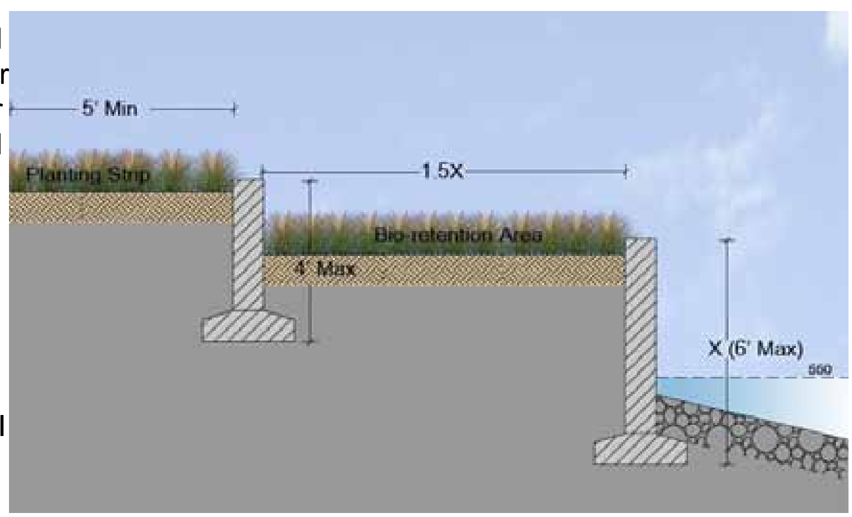

8.11.2.A1: Example of terraced retaining wall

A. Guidelines
Over the long-term, the design of retaining walls should be consistent with the character of retaining walls described in this section, which ultimately should be similar on contiguous parcels surrounding the lake. Retaining walls should provide a strong visual element which unifies the waterfront currently characterized on the east (Arlington) side of the reservoir by a variety of architectural styles. The intent is to encourage the construction of retaining walls which are divided into a series of less visually-prominent monolithic structures (i.e. terraced to reduce the wall's visual prominence and provide space for appropriate landscaping and storm water detention and filtration).

1. Retaining walls should ideally be constructed in stepped or terraced fashion with a maximum height for the wall segment closest to the water's edge of no more than six (6) feet, and all other terraces no more than four (4) feet in height, unless physical limitations on the site or structural engineering conditions make terracing unfeasible. Any single retaining wall in excess of a total six (6) feet vertically is prohibited, unless otherwise approved by the City.

2. The height of a retaining wall shall be measured from the bottom of the footing/pier to the top of the proposed retaining wall.

3. When walls are terraced, the upper wall should be located a minimum of five feet (5') from the lower wall. A wall built in tiers shall be considered a single wall in developed height when the base of the upper tier is set back from the base of the lower tier less than 1.5 times the developed height of the wall section below.



8.11.2.A3: Retaining wall standard dimensions

4. To help filter stormwater and improve water quality in the lake, a bio-retention planting strip is required in the areas between terraced retaining walls, and behind the top of the retaining wall. The planting strip shall extend a minimum five feet (5') from the back of the retaining wall and shall be planted with deep rooted native or adapted grasses, ground cover, and/or shrubs. See Appendix

8.11 - Approved Plant List.

a. Plantings between retaining wall terraces or in the planting strip above the top retaining wall shall be spaced according to nursery standards for the specific plant species, and planted in sufficient number to stabilize soils and provide consistent coverage across the length of the retaining wall.

b. The slope of natural or re-graded ground behind the top retaining wall shall be no steeper than 4:1 (horizontal:vertical) unless specifically approved by a Texas state licensed engineer.


8.11.2.A5: Rip-rap wall

5. The following materials are allowable for the construction or veneer of retaining walls:
    - Interlocking masonry, stone, or brick
    - Poured concrete designed specifically for shoreline retaining wall applications. The Lake-side design must be aesthetically pleasing and approved in advance by the City.
    - Aesthetic sheet piling designed specifically for shoreline retaining walls. See figure 8.11.2.A5.
    - Rock gabion walls or rip-rap (Allowed to extend only one vertical(1) foot above and/or below normal water level (elevation 550')


8.11.2.A5: Masonry retaining wall

6. Concrete bags, commercial sheet piles, other metal, or wood retaining walls are prohibited.

7. In order for Lake Arlington to serve its water supply function, the storage capacity of the reservoir must be protected. The capacity of the Flowage Easement must also be maintained. Therefore, retaining walls shall not normally be constructed into Lake Arlington at its normal pool elevation (below elevation 550'). If a portion of a retaining wall is required to be located within the reservoir shoreline at normal water level, an equal amount of area (by volume) on the same property must be dedicated by the property owner. Such trade-offs will be determined by the City on a case-by-case basis.

    The City recognizes there are times when it may be appropriate for the City to approve a permit for construction activities that encroach into the Flowage Easement or into the reservoir below elevation 560 feet. However, placing


8.11.2.A5: Aesthetic sheet wall

fill material into the Flowage Easement or lake reduces the flood storage capacity and cross-sectional area of the reservoir. Additionally, retaining walls on the lake reduce the water supply storage capacity of the reservoir and increase velocities and wave action. Retaining walls can also degrade fish habitat and other ecosystems within the lake. The loss to the City from such activities is both: (i) monetary from a property or asset perspective; and (ii) operational in terms of the velocity with which flood waters will flow through the reservoir and the rate at which water supply capacity must be added to the lake. The loss from a few individual activities is minor, but the cumulative effects of long-term encroachment must be considered. Therefore, it is appropriate for the City to be compensated for such activities.

If the City decides to permit encroachments into the Lake and its flowage easement, it is appropriate for the City to establish a fee for such encroachment as compensation for its losses. Compensation should be determined by calculating the volume of fill placed below elevation 560’, and establishing a fee approximately equal to the cost of removing the same amount of material from the Flowage Easement and lake. The cost to remove this material could be determined using data from sources such as the U.S. Army Corps of Engineers (USACE) Dredging Information System. In 2009 the USACE reported that dredging costs nationwide ranged from approximately $25 to $500 per cubic yard. Therefore, an average cost for replacing lost Flowage Easement or lake storage capacity by dredging is approximately $260 per cubic yard. This rate should be applied to any approved encroachment into the volume of Lake Arlington and/or its Flowage Easement. Each encroachment should be evaluated and permitted individually, and the City may deny the encroachment. The rate should be reviewed periodically and revised as necessary to reflect changes in the cost of dredging. Any revision of the fee should be established in the city’s standard fee schedule. In addition, the maximum allowable volume of any approved encroachment should be limited. Initially, it is recommended that the volume be limited to 0.5 cubic yards per front foot of private property adjacent to the lake.

B. Shoreline Restoration & Preservation

In order to protect water quality, improve fish habitat, and control storm water run-off; the restoration or preservation of “natural” shoreline areas at Lake Arlington is strongly encouraged, provided that any restoration project does not:

- Remove storage volume from the reservoir or the Flowage Easement
- Increase sediment run-off into the lake (during construction, interim periods while plants are being established, or after the project is complete)
- Increase soil erosion of the shoreline

1. Shoreline restoration may be achieved utilizing a number of approved techniques for erosion control depending on the severity of the slope. For slopes greater than 2:1, shoreline tie-backs or other erosion control systems will be required in addition to planting.

2. In cases where a shoreline is to be preserved, existing trees and other plant material may be thinned to create view corridors, remove invasive plants, or provide access to the lake provided that soils are stablized utilizing plantings or other means.
   a. Within fifty feet (50’) of the shoreline, no more than 50% of all existing trees may be removed.

b. In areas where existing trees are removed, sufficient plantings to stabilize soils and prevent erosion must be provided.

3. Appendix 8.11 - Approved Plant List applies to both shoreline restoration and shoreline preservation

4. For property owners agreeing to remove existing retaining walls in favor of natural shoreline restoration, an additional 25% of dock space will be allowable on the affected property. See Section 8.11.3.2 Size and Setback Limitations for more information.

C. Permitting Processes and Requirements
For terraced retaining walls, each tier is considered to be a separate retaining wall as long as the horizontal distance between the upper tier and the lower tier is equal to or greater than 1.5 times the height of the wall segment closest to the Lake. See Figure 8.11.2.A3. However, only one permit is required for such terraced walls constructed on the same property.

8.11.2.B: Natural shoreline

8.11.3 Docks, Piers, and Boat Houses

The photographs in this section are for general example only. They do not necessarily reflect design standards or City Building Code requirements in all cases.

8.11.3.A5: Single story boathouse

8.11.3.A5: Boathouse With sundeck

A. General Provisions

1. No person shall erect, construct, enlarge, alter, or remove any dock, pier, boathouse or walkway in Lake Arlington or the Flowage Easement without the approval of the City. The requirements in Section 8.11.1 apply to all applications for approval.

2. A person who wishes to erect, construct, enlarge, alter, or remove any dock, pier, boathouse or walkway in Lake Arlington shall comply with all design and construction standards provided in this section and shall also comply with any applicable sections of the Building Code. If there is a conflict between the Building Code and a provision in this section, the more restrictive requirement shall apply.

3. Any person who wishes to erect, construct, enlarge, alter, or remove any dock, pier, boathouse or walkway in Lake Arlington shall have liability insurance or use a private contractor with liability insurance. The coverage limitation of such insurance shall be established by the City from time to time in its permit requirements.

4. On private property, all docks, piers, boathouse or walkways in Lake Arlington shall be considered accessory structures. A primary structure must be present on the lot to which a dock, pier, boathouse and/or walkway is attached.

5. A boathouse is a structure on or adjacent to a body of water used to store boats and boat equipment. Boathouses shall be limited to a single story (lower deck) and a sundeck (upper deck) or roof.

   a. All roof structures shall have a maximum vertical clearance of thirteen (13) feet from the top of the decking.

   b. Sloped roofs shall have a roof pitch no greater than 3:12.

   c. Upper level sundecks shall have a minimum of 1/2:12 pitch for drainage and include a safety railing. The upper deck may not have a permanent roof or covering. A deck shall be constructed in accordance with the Building Code.

6. Enclosed boathouses with side walls are prohibited. Boathouses must be open on all sides as shown

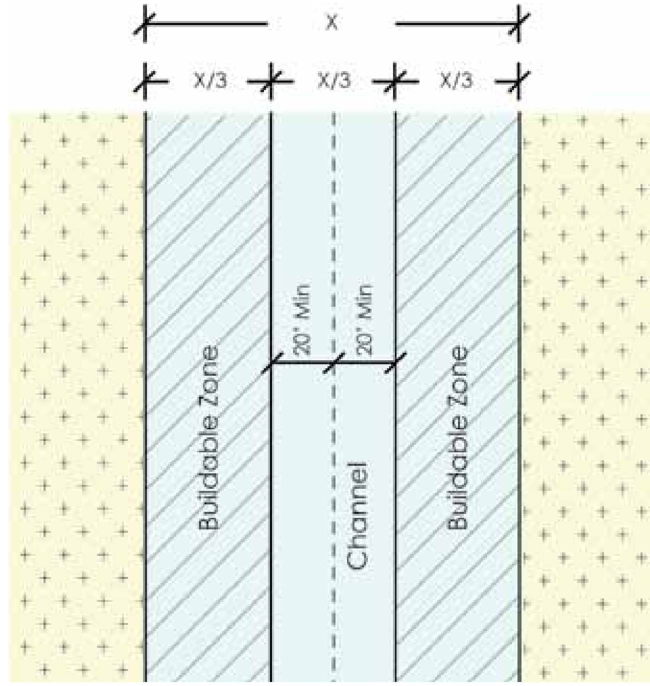
in Figure 8.11.3.A5. To protect a raised boat within a boathouse from the elements, solid sides on the boathouse are permitted at a maximum of two (2) feet downward from the point where the ceiling joist meets the top plate. No additional materials (i.e. lattice, fencing, bars, screen fabric, doors, glass, etc.) may be installed below the two (2) foot sidewalls. Safety railings attached to the deck may extend upward a maximum of thirty nine (39) inches.

7. No toilet facilities of any type shall be allowed on any boathouse or structure built on Lake Arlington or within the Flowage Easement. A potable water supply can be plumbed to the first floor (lower deck) provided that backflow prevention devices are installed and inspected in accordance with the applicable Building Code.

8. Fuel containers exceeding 2 1/2 gallons are not allowed on structures within Lake Arlington or in the Flowage Easement. No fuel containers shall be stored in the Flowage Easement.

9. Structures may extend to a maximum point 100 feet into Lake Arlington (measured from the normal elevation of 550'), or to the point at which the elevation of the land lying under Lake Arlington is not less than 545', But in no instance shall permitted improvements be allowed to extend further than 150 feet from the shoreline into the waters of Lake Arlington. In narrow areas of the reservoir, no structure shall occupy more than one-third (1/3) of the channel width and in no case shall a structure extend out into the reservoir to a point that is more than 20 feet from the centerline of the channel. For the purposes of this provision, the channel width is measured from water's edge at the normal lake elevation of 550'.

   a. Property owners who remove existing retaining walls and undergo a shoreline restoration effort or those that choose to preserve existing natural shoreline areas to the standards provided in Section 8.13.2.2 shall be allowed to extend structures to a maximum point 125 feet into Lake Arlington (measured from the normal elevation of



8.11.3.9: Allowable buildable area in a narrow channel

8.11.3.9: Areas of the lake with narrow channels.

550').

10. All docks, piers and boathouses must have reflectors on both sides of the structure. On each side, one reflector shall be at the ends of the structure. Any boathouse that extends into Lake Arlington more than 75 feet from the shoreline at the normal elevation of the reservoir shall be equipped with a white photocell light of no less than 200 lumens that operates continually from dusk to dawn. Such lighting shall be provided with a cover on the top of the light to minimize light dispersion upward. The City may require that similar lighting be placed on structures less than 100 feet from the shoreline when the City decides it is warranted to ensure boating safety. It is the Dock owner's responsibility to ensure that all required reflectors and lighting are properly maintained and operational at all times.

11. All structures must have an address placard stating the street address and street name of the primary residence associated with the structure. The lettering shall be a minimum of 6" high and be made of reflective material so that the address can be read at night. Placards shall be made of cast aluminum and be rectangular in shape. The placard shall be mounted to be clearly visible from the lake side of the structure.

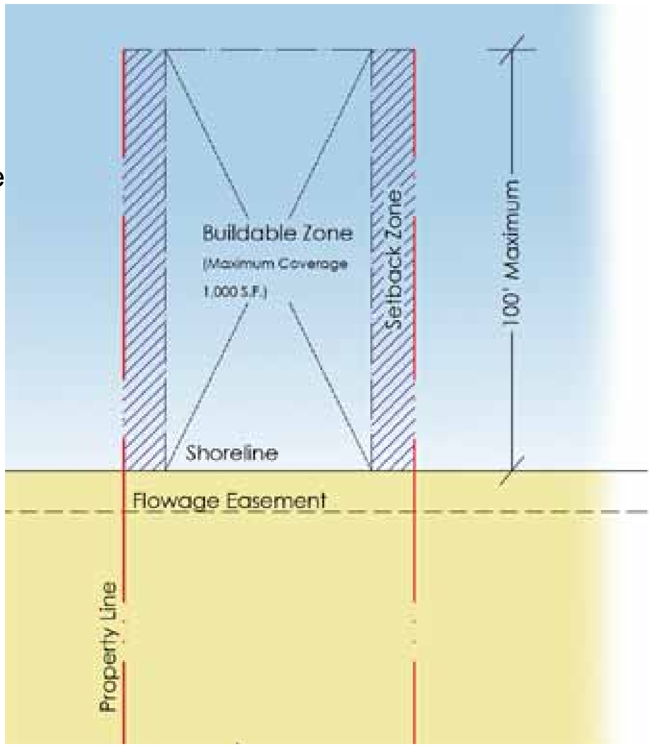
B. Size and Setback Limitations
1. Permitted structures on a single property shall be allowed a maximum coverage area of 1,000 square feet, excluding walkways.

2. Property owners who remove existing retaining walls and undergo a shoreline restoration effort or those that choose to preserve existing natural shoreline areas to the standards provided in Section 8.13.2.2 shall be allowed a maximum coverage area of 1,250 square feet, excluding walkways.

3. The minimum setback from a side yard line (as projected into the lake) shall be based on the width of the property at the Flowage Easement as follows:

8.11.3.A10: Illuminated boat dock

8.11.3.A11: Address placard



8.11.3.B: Dock placement relative to property lines.

Lot Width	Setback
Less than 50 feet	5 feet
50-69 feet	10 feet
70-99 feet	15 feet
100 feet or more	20 feet

Site setbacks may be adjusted to address specific site constraints. All adjustments to site setbacks are subject to approval by the City.

4. All walkways shall be a minimum four (4) feet wide and a maximum of six (6) feet wide.

C. Design Loads
In addition to the provisions of this section, the applicant must comply with any additional provisions of the Building Code. Where there are conflicts, the more restrictive regulations shall apply. The applicant's engineer shall apply the appropriate loads when doing calculations related to the design of structures to be permitted under this section. Such factors shall include, but not be limited to:

- Dead load;
- Live load;
- Roof load; and
- Wind load and wave action; which should be considered as simultaneously applied.
- When intended to have boats attached to a dock for storage, the effects of such estimated loads, such as wind and wave, on the boat that are transferred to the dock shall also be considered.
- Surface areas at and above the water line, when authorized.

D. Design Minimums
In addition to complying with the Building Code (unless otherwise stated herein), all docks, piers, boathouses or walkways shall comply with the following provisions:

1. Wood piles are prohibited.

2. All docks, piers, boathouse or walkways (or combination thereof) shall be designed to withstand the Loads as specified in the Building Code, based upon the occupancy classification as assigned by the City's building official.

3. Structures must withstand a minimum of four (4) foot high wave action. Floating docks must be designed with anchorage footing and piers to remain in place without floating above elevation 562'.

4. Cables and chains used in anchoring systems shall be designed with a minimum working load safety factor of 3.0 for cable and 2.0 for chains.

8.11.3.E1: Metal piles

5. Walkways and Bridges shall have a maximum slope under dead Load of a 4:1 ratio to any direction at the lake level of 560'.
6. Flotation devices for Boathouses, Walkways and Bridges shall be designed to support the Dead Load and Live Load as a fixed Structure.

E. Dock and Pier Construction
The proposed design shall incorporate the following minimum provisions:

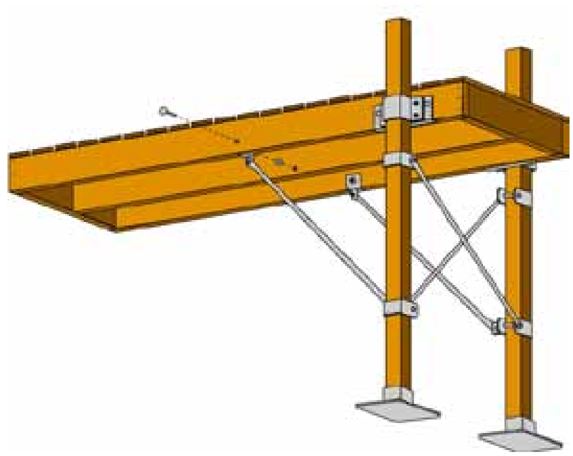
1. Metal piles shall be a minimum of three (3) inches inside diameter (ID) pipe. Such piles shall be driven to a minimum depth of twenty-four (24) inches below the lowest layer of silt and resistence is felt. Such piles shall be driven in pairs, one on either side of the platform, and braced as required by section 8.11.5.A-C. Such piles shall not be spaced apart more than ten (10) feet center to center.


8.11.3.E4: Wood decking

2. Beams: Beams shall be defined as those members which connect to piles to support the stringers. All beams when of wood shall be a minimum 2-inch material.

3. Stringers: Stringers shall be defined as those members usually supporting the decking. All stringers when of wood shall be of a minimum 2-inch material. Pipe stringers shall be a nominal 2-1/2-inch I.D. and spaced not more than eighteen (18) inches O.C.

4. Decking: Wooden platform decking shall be of a minimum nominal 2-inch thickness. Other materials, to include lightweight concrete, metal, or composite decking may be used when approved by the City. Such decking shall meet the load requirements of the Building Code.


8.11.3.E5: Cross or "X" bracing

5. Bracing: All wooden bracing shall be of a minimum nominal 2-inch material. Bracing shall be accomplished by one or more of the following methods:

   a. Cross or "X" bracing may be used on each set of piers.

   b. Beams may be used as bracing, provided the connections give sufficient support to resist horizontal forces equivalent to that of cross or "X" bracing.

   c. Knee bracing shall be used on each pier attached to and paralleling the platform deck. Pipe knee bracing


8.11.3.E6: Dock connection to pile

shall be a nominal 2-1/2 inch I.D.

6. Attachment of Deck: Attachment of the platform deck to beams and piles shall be accompanied by one or more of the following methods:

    a. By attaching the beams to the piles by corrosion resistant lag bolts.

    b. By caps: Wood caps shall be a minimum nominal 4-inch material and anchored by corrosion resistant bolts and welded.

7. Flotation structures shall be anchored with solid units that will provide the following anchorage:

    a. Docks and piers less than fifty (50) feet in length: An anchor on each corner that will support one-fourth of the total dead load plus one-eighth the total live load.

    b. Docks and piers fifty (50) feet or more in length shall include anchors at the midpoint of the piers.

    c. All docks and piers shall be anchored to the shoreline.

    d. All anchors shall be of masonry, concrete, or steel and shall be securely fastened to the dock or pier by cable, chain, or other approved methods.

8. Required Water Proofing: All wood below one (1) foot above Flowage Easement elevation (560') shall be treated lumber. Creosote is not allowed. All metal, including all bolts and fasteners, shall be galvanized or painted with paints of similar materials approved for immersion in water.

    Construction of boathouses or other structures shall meet or exceed the requirements for framing and coverage as specified in the Building Code. When, in the opinion of the City's building official, the load of the intended use exceeds the capability of the minimum construction design, plans and specification may be required to be designed by a Texas state licensed engineer.

8.11.3.F: Floating dock

8.11.3.F3: Encased flotation material

F. Floating Structures and Flotation Material

1. Floating piers and docks are permitted. Flotation material shall be extruded polystyrene, expanded polystyrene, or a copolymer of polyethylene and polystyrene and shall have a minimum density of 0.9 pounds per cubic foot, and be of consistent quality throughout the float. Beads shall be firmly fused together,and there shall be no voids inside the encasement. Flotation material shall have a water rate absorption of less than 3.0 pounds per cubic foot over seven (7) days when tested by the Hunt Absorption Test. Other flotation material may be considered if it meets all of

the requirements set forth in this section.

2. Flotation material shall be encased in solid polyethylene or a polyurethane type coating, both of which shall be watertight and have a nominal thickness of 0.125 inches.

3. Drums made of plastic, whether new or recycled, or metal shall not be used for encasements or floats.

4. All floats shall be warranted for a minimum of fifteen (15) years against sinking, becoming waterlogged, cracking, peeling, fragmenting, or losing beads, and shall not be prone to damage by animals.

5. Floats that are punctured, exposing the foam to erosion or deterioration, shall be replaced immediately.

6. Because floating structures are more prone to damage, the City may require that such structures be removed periodically for maintenance by the owner and possible re-permitting by the City. The City may initiate an annual fee for the inspection and repermitting of floating structures.

8.11.4 Marinas

A. Purpose
The purpose of this section is to provide minimum standards for the design, construction, operation and maintenance of marinas on Lake Arlington. These minimum standards are intended to protect water quality, public use, access and safety. For purposes of these standards, a marina is defined as a public or commercial facility with docks or berthing structures for six (6) boats or more.

B. Location and Configuration

1. The City of Arlington shall have sole discretion in determining when and where to permit marinas on Lake Arlington, how far a marina may extend into the main body of the reservoir, and the total number of slips.

2. No marina shall extend into Lake Arlington to such a distance that such would constitute a navigational hazard, a safety hazard, a flood management hindrance or would occupy more than the following amount of surface area:

   a. No marina, at anytime, shall extend such a distance so as to preclude the maintenance of navigable passage of a cove or arm of the reservoir. The facility shall not be within forty (40) feet of the centerline between parallel or converging shorelines. The City reserves and shall have sole discretion in interpreting this provision.

   b. No structure within a marina shall be constructed so that it can extend to a height of more than thirty five (35) feet above the normal surface of the water (measured at 550' elevation).

3. Marinas shall be located over property which is owned or leased by the commercial facility owner or operator. The City retains the right to review and approve the provisions of any lease used for the construction, operation and maintenance of a marina.

4. No marina shall be nearer than twenty (20) feet to any property line of the lot or parcel of land on which the facility is located.

5. Relocation or alteration of a marina must be permitted by the City.

6. If the marina developer intends to dredge any portion of the reservoir for the marina or for access channels a separate dredging permit must be obtained from the City in addition to any other authorizations needed from regulatory agencies.

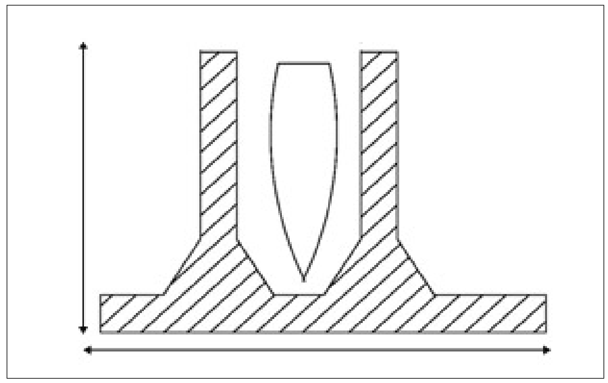
C. Water Areas

1. Channel Design: The design depths and widths of structures and water areas within a marina must take into consideration the following factors: the sizes and types of boats expected to use the marina; wave action; currents; water level fluctuations; boat traffic; silt deposition rates; and anticipated frequencies of dredging needed to maintain design water depths. Recommended design depths are exclusive of site-specific requirements for additional depths necessary to store estimated silt accretion that occurs between scheduled dredging intervals.

a. Channel Design Criteria
- Design depths for a marina must be based on a design low water elevation determined from water level data obtained from the Arlington Water Utilities Department.
- Required minimum depths below design low water must be determined on the basis of the type (power or sail), length and draft of the boats expected to be berthed in a marina. The City accepts no responsibility for accessibility to any permitted marina, and the City reserves the right to alter the water elevation of the reservoir at any time, and from time to time.
- Channels shall be designed based upon local, state, or national standards. The depth and width of channels should accommodate the largest anticipated boats, while providing additional room for maneuverability and safety.

D. Berthing

1. Due to fluctuations in water levels at Lake Arlington, floating berths are required. Floating moorings are usually pontoons arranged to provide walkways to vessels. These walkways may be located by means of guide piles or cables/chains (attached to anchor blocks), allowing free vertical movement. The boats may be moored in either single or double berths, separated by finger pontoons.


8.11.4.D: Berth orientation

2. The design and layout of berthing areas should consider the following:

   a. Berthing areas shall be designed based upon local, state, or national standards, The length and width should accommodate the largest anticipated boats while providing adequate room for maneuverability, safe berthing, and safe access from the boat to the marina.

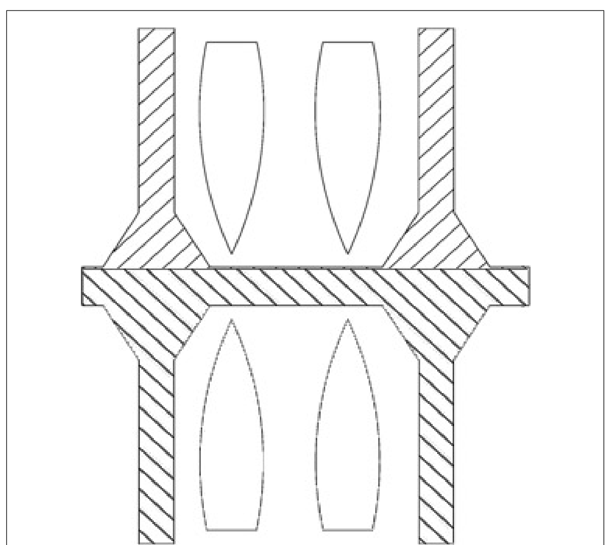
   b. Turning areas should be provided, particularly adjacent to dead-end channels.

   c. Water area for turning, entering and leaving berths should be 2.25 times the length of the longest boat.

   d. Berths should be orientated at right-angles to the walkway to reduce maneuvering difficulties.

   e. Berths should be arranged so that, wherever possible, fingers are symmetrically located on opposite sides of the walkway.

   f. Smaller berths should generally be located closer to the shore.


8.11.4.D: Finger location

3. Dimensional Criteria: Recommended berth dimensions are:

   a. Fingerfloats – Fingerfloats are floating structures that attach perpendicular to a main walkway, and provide direct access to and from a boat in the berth.

Minimum Width	Length of Fingerfloat
5.0 ft	all accessible finger floats
2.5 ft	less than 20 ft
3.0 ft	20 ft & over
4.0 ft	36 ft & over
5.0 ft	60 ft & over

   Minimum fingerfloat width dimensions are considered to be “clear” widths. Cleats or rings along the top edge of a fingerfloat, and hoses and power cords connected to utility pedestals, should not be considered to be reductions of the clear width of fingerfloats.


8.11.4.D3: Fingerfloat

   b. Main Walkways – Maximum Length: No main walkway shall exceed 300 feet in length. Clear width of the walkway shall be a minimum eight (8) feet.

   c. Marginal Walkways – Maximum Lengths: No marginal walkway shall exceed 400 feet in length. Clear width of the walkway shall be a minimum 6 feet.

   d. Maximum cross slopes of any walkways shall not exceed ¼ inch per foot.

4. Structural Requirements
   a. All structures shall comply with applicable portions of all local, state, and national building codes, and shall have structural integrity capable of withstanding prolonged exposure to wave action and winds associated with Lake Arlington. It is the marina developers responsibility to research the necessary data to determine the design criteria for marina components.

   b. All structures shall be securely anchored or moored at all times in such a manner that will insure stability and integrity during prolonged exposure to wave action and high winds normally associated with Lake Arlington.

   c. All flotation devices must comply with applicable Local, State, and Federal regulations, and must be


8.11.4.D3: Main walkway

capable of withstanding prolonged exposure to wave action, UV rays or customary and foreseeable weather conditions. The flotation devices, at a minimum, will comply with the provisions of Section 8.11.3 (floating docks section).

5. Loading Requirements

a. Dead Load (DL): The total dead load of a floating dock system is the combination of concentrated and uniformly distributed weights of all framing, decking, nuts, bolts, washers, connectors, flotation pontoons, and all permanently attached equipment such as pipes, lines, pumps, utilities, fire suppression systems, gangways, lighting, storage boxes, and utility cabinets. The determination of total dead loads should also include the estimated weight of items that will be stored in storage boxes, and the weight of the fluids in various utility lines and related equipment.

- Care must be taken in locating various dead load elements to insure that flat and reasonably level deck surfaces are maintained throughout the service life of the dock system. Overloaded storage boxes or large diameter water lines on only one side of a dock can alter the freeboard and deck slopes.

- Cross slopes under dead load only shall not exceed 2% (1:50) on docks that are part of an accessible route.

- The dead weight of lumber and wood timbers utilized in a floating dock system should be assumed to weigh not less than 35 lbs. per cubic foot at specified moisture contents following pressure treatment.

b. Uniform Live Load (ULL) shall be 25 pounds per sq ft minimum.

- Floating docks in marinas should meet all freeboard and deck slope guidelines under the minimum ULL.

- ULL of forty (40) pounds/square foot may be necessary for design purposes if floating dock systems are subjected to regular and repeated high volumes of pedestrian traffic.

c. Live Point Load (LPL) shall be 400 pounds minimum. Floating docks in marinas are to meet all freeboard and deck slope requirements under a minimum LPL of 400 pounds, applied at any point on the deck not closer than 12" from any edge. This addresses the center of gravity of the general array of heavy objects that may be rolled over the surface of, or temporarily placed upon a marina dock.

d. Lateral Loads: Lateral loads on a dock system may result from winds, currents, waves, and impacts. Such loads may be imparted to docks, boats tied up to docks, or both concurrently. All proposed marinas must take into consideration the following conditions and the respective loads calculated accordingly:
- Wind loads
- Current loads
- Wave loads

- Impact loads

e. Freeboard Under DL only: Minimum Freeboard when floatation devices are fully loaded is 10 inches. Maximum freeboard is 24 inches.

8.11.4.D5e: Freeboard dimensions allow safe access to marina from boats

6. Pontoons: Pontoons in floating marina berthing systems are the components that provide the flotation capacity to support all loads that may occur during the service life of a marina. The heavier the combined loadings, the greater the required pontoon capacity to maintain required freeboard, cross slopes, etc.

a. Pontoons may be constructed using the following materials:
- concrete,
- polyethylene plastic,
- fiberglass,
- aluminum
- steel

The following materials are prohibited:
- Metal drums
- Non-encapsulated polystyrene or Styrofoam
- Hollow containers

8.11.4.D6.a: Polyethylene pontoon

b. Pontoon material selection must include consideration of environmental influences, the nature of the berthing frame system, pontoon flotation characteristics, availability and cost. Environmental influences include water, currents, waves, flooding, wind, storms, extreme temperatures, ultraviolet exposure, and impacts.

c. Pontoons must be selected and designed to be compatible with the dock frame regarding fastening details, ease of repair and/or replacement if necessary, flexibility/stiffness, and performance.

d. Where polyethylene pontoons are used, the following guidelines shall be used in the specifications:
- Method: Roto-Cast
- Material: Linear Low Polyethylene
- Nominal Wall Thickness: 0.150 inches

7. Decking
   a. Decking can be attached to a structural frame, or it can be part of the structural frame as in the case of cast concrete floats.

   b. Allowable decking materials include:
      - pressure treated wood
      - recycled plastic lumber products
      - metal extrusions
      - fiberglass
      - concrete

   c. Decking shall be chosen that allows for traction in wet conditions. Materials that are slippery in wet conditions should not be considered.

8.11.4.D7: Plastic composite decking

8.11.4.D7: Metal decking

E. Guide Piles
Marina guide piles must be provided at appropriate locations and in sufficient numbers to reliably retain a floating dock system in place under all design loadings, conditions and circumstances. It is important to determine in advance exactly what these factors are for a given site. Consideration must be given to forces applied to the floating berths, guide piles and the boats occupying the berths. These forces include wind, waves, currents, flood flows, impacts from boats underway, and debris. Some of these forces may occur concurrently.

1. Design Criteria
   a. Marina guide piles must be placed at the ends of all fingerfloats adjacent to channels.

   b. Cut-off elevations for guide piles must be not less than 4 ft above the deck of a floating dock at an elevation of 560’, not including the height of pile caps.

   c. Guide pile caps must be provided. Acceptable materials include: fiberglass, polyethylene or other ultraviolet resistant plastic materials.

2. Material Pile Types
Marina guide and mooring piles shall be concrete, steel, or composites.

8.11.4.E: Concrete guide pile

F. Lighting

1. All structures extending more than fifty (50) feet from the shoreline at normal reservoir elevation (550') shall provide continuous and adequate lighting from thirty (30) minutes before sunset to thirty (30) minutes after sunrise.

2. A minimum of one (1) light station is required along each exterior side of a marina, except that side which faces the shore. Some circumstances may require additional lighting as determined by the City in its sole discretion.

3. If only one (1) light station, per exterior side, is required, the light station shall be on the end of the structure farthest from the shoreline.

8.11.4.F: Lighting

4. The wiring method shall be one or more of the following, per the National Electric Code:
   - Rigid conduit.
   - Seal-tight flexible conduit with appropriate fittings and boxes.
   - Direct-burial UF cable, in protected areas.

5. The lighting fixtures must be installed so that they do not cast beams of light outward from the structure in such a manner as to constitute a hazard to safe boating or a nuisance to the general public.

6. Low voltage (24 volt or lower AC or DC) lighting may be used on commercial facilities. Low voltage lighting shall be wired in accordance with the more stringent of the National Electric Code (NEC) or the Building Code.

7. Weatherproof lamp holders and weatherproof junction boxes shall be used for placement of the light fixtures at each light station.

8. The City may require that marina lighting shall focus illumination downward and follow recommendations of the International Dark Skies Association.

G. Utilities

1. General
   a. The City reserves the right to review the design of landside utility design and construction standards within the Flowage Easement as such utilities relate to the marina. Utility design and construction shall follow the Building Code.

   b. Utility lines on shore within the Flowage Easement must be located underground.

2. Sewer and Trash Facilities
   a. On-site facilities shall be provided for the collection of any garbage and trash that might be generated at the marina, and arrangements for the timely removal of such collections shall be

made by the commercial facility owner or operator.

b. All trash and service facilities must be screened from parking areas, marina facilities, the waterfront, and adjacent properties by a minimum six (6) foot high solid masonry wall.

3. Fueling Facilities
   a. The City must specifically approve the design and installation of fueling facilities adjacent to or on Lake Arlington. The City reserves the right to decline to approve such facilities in its sole discretion. If the City decides to approve a fueling facility, it must be located such that it is easily accessible, without the need for access through the main berthing area of the marina, and fuel tanks must be located outside the Flowage Easement.

   b. All fueling facilities shall comply with the currently-adopted International Fire Code with amendments (the “Fire Code”).

   c. Fire extinguishers of a minimum rating of 20 B:C shall be visible in convenient, accessible locations near the fueling facility. All extinguishers shall be U.S. Coast Guard approved and maintained fully charged.

   d. Fuel storage areas shall be clearly marked.

   e. Fuel facilities shall be isolated from mooring docks and shall be, if necessary, protected by adequate breakwater facilities.

   f. Fuel dispensing nozzles shall not be equipped with trigger locks.

   g. Underground storage tanks at marinas and in the Flowage Easement are prohibited.

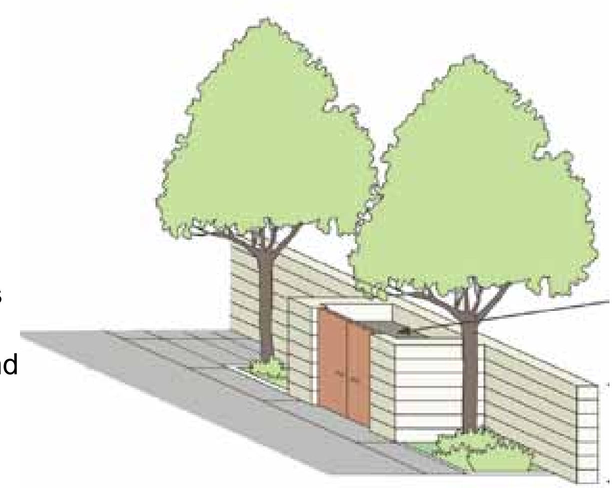
   h. Above Ground Storage Tanks
      - In all Above Ground Storage Tanks (AST) installations there must be a solid, impermeable containment structure surrounding the tank designed to hold 1.5 times the volume of the tank.
      - If the dispenser on the AST system is housed outside of the bermed area, there must be a solenoid valve or a manual disconnect/shutoff device on the line prior to the point at which the line leaves the berm.
      - In all fuel installations there must be a pullaway type valve located in the flexible hose between the dispenser and the nozzle, as close to the nozzle as possible.
      - Tank fill ports will be located above the Flowage Easement elevation (560’) of Lake Arlington. (The dispenser for the tanks may be located below the Flowage Easement elevation).
      - Product lines which may not be located outside the bermed area.

4. Utilities in Marina Berthing Structures
   a. All utility lines in marina berthing structures must be installed to provide maximum public safety as well as protection from impacts, mechanical wear and damage, and environmental elements such as heat, water and rodents.

   b. No utility lines shall be located on and attached to the deck surface of marina docks. Electrical outlets and water supply hose bibbs are usable only with lines, cords and hoses that are connected between utility boxes and berthed boats.

c. Utility lines in a floating dock system shall have at least 6 inches minimum clearance above the water surface.

d. Where utility lines pass through structural members within a floating dock system, the holes in the structural members must be free of rough edges and abrasive surfaces that will cause accelerated wear on the utility lines.


8.11.4.G4: Trash screening

5. Potable Water Service on Marina Docks
   a. Potable water piping that is attached to docks, walkwalks and boat slips shall be galvanized steel material with appropriate fittings and valves. The piping shall be clearly marked as “Potable Water”.

   b. All potable water lines on marina docks shall be equipped at the shore end with appropriate anti-siphon devices to prevent back flows.

   c. Dedicated potable water and fire suppression lines shall be provided on marina dock systems. Potable water and fire suppression lines shall not be combined.

   d. Utility hoses and/or lines, whether permanent or temporary, shall not be allowed across the deck of main walkways or marginal walkways.

   e. Where a fingerfloat is part of an accessible route, utility hoses and lines shall not be allowed across the fingerfloat.

   f. Backflow prevention devices shall be installed and inspected in accordance with the applicable Building Code.

6. Fire Suppression Systems on Marina Dock Systems
   It is required that marinas have equipment, systems and sustainable water resources to suppress, control and extinguish fires on boats, docks, buildings, fueling stations and other marina service centers. All such facilities shall comply with the Fire Code. It is recommended that the City fire marshal be included in all stages of marina design.

7. Electrical Power Services on Marina Dock Systems
   a. Marina electrical systems must be adequate to supply


8.11.4.G7: Utility boxes

the power demands for boat slips (if provided), lighting, fuel stations, and maintenance and repair-work.

b. Marine grade electrical outlets designed and manufactured for reliable use in water environments shall be used.

c. Electrical outlets shall be installed in dock storage boxes or electrical power centers located along the edge of walkways and at the head of fingerfloats. Water supply and electrical services shall not be installed in the same dock storage box.

H. Shoreline Structures

1. Piers

a. Piers and gangways that are used only for pedestrian access to gangways and floating docks shall be designed to support a minimum live load of 50 pounds per square foot.

b. Appropriately-designed guard railings shall be provided on all piers which are more than 30 inches above grade.

c. The height of the top rail of guard railings shall be not less than 39 inches, measured from the finished deck surface to the top of the top rail.

d. Openings in guard rails shall not permit the passage of a 4 inch diameter sphere. This shall be accomplished by use of intermediate rails, pickets and/or ornamental components.

2. Gangways

a. For any marina over 25 berths, two gangway exits shall be provided for emergency access.

b. Uniform Live Loads
   - 100 pounds/square foot minimum ULL shall be used for gangway structural design.
   - 50 pounds/square foot minimum shall be used for ULL transferred to floating docks.

c. Loadings transferred from a gangway to a floating dock system include appropriate portions of both the gangway DL and ULL.

d. The minimum clear gangway width is 36 inches.

e. Gangway Railings shall have a minimum height of 42 inches. Openings in guard rails shall not permit the passage of a 4 inch diameter sphere. This can be accomplished by use of intermediate rails, pickets and/or ornamental components.


8.11.4.H2: Gangway


8.11.4.H2e: Gangway railing

Handrails shall be provided on both sides of all gangways.

f. Gangway decks must have a durable non-skid surface to provide traction, especially when wet, and when gangways are at steeper slopes.

g. The use of cleats on gangway decks to improve traction is to be avoided. However, where gangways remain at steep slopes for long periods of time, gangway cleats may be deemed necessary to develop improved traction.

Gangway cleats shall meet the following criteria:
- be attached perpendicular to the long axis of the gangway
- spaced on 12 to 16 inch centers
- maximum width of 1 inch
- maximum height of ½ inch
- greater than ¼ inch high, all edges above ¼ inch to be beveled at 45 degrees

h. Maximum gangway slopes shall be 2:1.

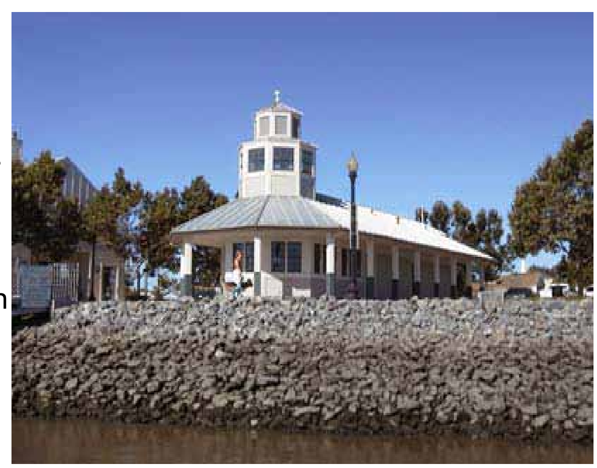
i. All marina facilities at Lake Arlington, including gangways, are required to comply with federal and state accessibility guidelines which apply to each newly designed or newly constructed marina facility.

3. Vehicle Parking
    a. Adequate parking for the number of boat slips shall be provided. Parking shall accommodate both single vehicle parking and parking for vehicles with boat trailers.

    b. Accessible spaces shall be provided for both types of parking spaces that are provided in a marina, including van accessible parking spaces.

    c. Marina parking areas shall be located outside the Flowage Easement.

    d. Large visual expanses of paved areas shall be avoided. Parking areas shall be designed with a minimum 10' landscape bioswale located between parking aisles. Drainage from paved areas shall be routed to the landscape bioswale for retention and natural percolation of stormwater. A minimum of one (1) shade tree, with a minimum four (4) caliper inches at the time of planting, will be planted per parking space provided. The tree may be clustered within the bioswale area or planted within the parking grid. Use of permeable pavement approved by the city with jurisdiction is encouraged.


8.11.4.H4: Restroom facility

4. Restroom Facilities
    a. Restroom facilities shall be provided at any marina with more than 20 berths. Restrooms may be shared

or combined with restrooms required for other uses on site.

b. Restroom facilities must comply with all public health and safety requirements of local, state and federal agencies.

5. Boat Launching Facilities
   a. Boat launching facilities that are a component of a marina complex should be located so as to minimize conflicts in vehicle and boat traffic, as well as boater use patterns.

   b. Boat ramps shall be located away from sensitive areas such as fish or wildlife habitat. Preferred areas are shorelines without wetland vegetation and adjacent to waters with adequate navigation depths.

   c. Ramp slope shall be 1:10. Lane width minimums are 14 feet (single lane) and 12 feet (multiple lanes).

   d. Adequate water depths at the toe of the ramp at low water should allow boat launching.

I. Licenses

1. General
   All required licenses and permits shall be obtained, renewed and displayed in open view to the public by the owner of the marina.

2. Operating License
   a. The operator of the marina shall obtain an Operating License from the City, and such License shall be renewed annually. The Operating License is required to operate a marina on Lake Arlington.

   b. The Operating License may be issued by the City after:
      - the required application has been completed and reviewed;
      - the marina, has been inspected by the City and found to be in compliance with the initial marina permit, and all applicable City regulations; and
      - the required fee has been paid.

   c. The City requires that the marina be maintained in a clean and attractive condition and appearance and that operational facilities be in a good and safe working condition, as determined by the City in its sole discretion. Marinas failing to meet such standards will be classified by the City as noncompliant with the terms of its regulations and the Operating License may be revoked.

8.11.5 Trails and Linear Park Facilities

A. Purpose

The purpose of this section is to recommend standards for the design and construction of linear parks, trails, and bike paths in areas adjacent to and near Lake Arlington. These standards are intended to promote the development of a comprehensive trail system around Lake Arlington while protecting water quality, and enhancing public recreational use, and public access and safety. These standards are intended to supplement previous studies conducted by the cities of Arlington, Fort Worth, and Kennedale. If a conflict arises between these standards and any regulations set forth in previous studies, the most applicable standard from the AASHTO Guide for Development of Bicycle Facilities may be used as an alternative to either competing local standard. Where bicycle facilities are to be constructed on land owned by the City of Arlington or on land within its flowage easement, the City of Arlington will have the right to review and approve such bicycle facilities at its own discretion.

In addition to hike and bike trails, there has been interest expressed in the development of equestrian trails on the west side of the lake. That opportunity should be studied in more detail during the implementation phase.

8.11.5.B1.a: Off-Street Trail

B. Routing and Design

Trails shall comply with the Design Guidelines included in Arlington's Hike and Bike System Master Plan. Trail designs shall comply with the requirements of the Americans with Disabilities Act (ADA).

1. Hike and Bicycle System: In order to develop a comprehensive trail system at Lake Arlington, trails must be designed to address a variety of existing conditions. Trails at Lake Arlington most likely will fall into three categories: off-street trails, bike lanes on existing or new streets, and signed shared roadway routes. In addition, sidewalks should be constructed on new road ways.

   a. Off-Street Trails: Off-street trails are most appropriate where sufficient right-of-way can be aquired. Around Lake Arlington, these areas are typically located where there is limited or no existing development, or where off-street trails are preferred for pedestrian and/or bicycle use. These trails and linear parks should focus priority on creating access to the lake, providing overlooks and rest areas in strategic locations, and linking larger parks and open spaces.

   b. Bike Lanes: Bike lanes should be utilized on new or existing streets in areas of existing development where an off-street trail is not feasible or desired. Adequate right-of-

8.11.5.B1.b: Bike Lane

way must be in place on existing streets to provide a bike lane without negatively impacting existing vehicular movement.

c. Signed Shared Roadway: A Signed Shared Roadway is a new or existing street that utilizes the right-of-way to share between automobile and bicycle traffic. These integrated routes should be utilized only when an off-street trail or bike lane is not possible. In these cases shared roadways shall only occur on streets with limited automobile traffic. Existing traffic volume and patterns must be studied to ensure that the route is appropriate and safe for trail users. All Shared Roadway routes should follow guidlines for signage placement included in the Hike and Bike System Master Plan.


8.11.5.B1.c: Signed Shared Roadway

2. Design Speed
   a. All trails shall be designed for speeds up to 15 miles per hour in order to provide a safe layout for the hike and bike trails. By designing for faster speeds than required, gentle curves, increased sight distances, and reduced slopes will reduce trail accidents and increase user security.

   b. All minimum standards for curve radii, vertical curves (hills), lateral clearances on horizontal curves, and stopping sight distances should be designed in accordance with the recommendations of the American Association of State Highway and Transportation Officials (AASHTO) Guide for the Development of Bicycle Facilities - 1999.

3. Drainage
   a. Trails should be designed to prevent the pooling of water and the flow of stream across the trail. Ideally, water should flow across the trail in sheets.

      - Swales should be used on all hillside trails and cross sections where a hill intersects with a trail and shall have a maximum slope of 1:4 (vertical:horizontal).

      - Culverts should be used to drain small streams, swales, and low places under the trail and shall be made of galvanized steel or concrete with a minimum slope of two (2) percent.

   b. To minimize storm water run off from flowing across the trail, drainage swales should be placed on the higher side and designed to adequately store all run off. Using swales in this situation will also require culverts that are designed to handle the water flow, are safe (relative to the trail users), and have low maintenance.

   c. Care should be taken in designing stormwater collection systems that do not negatively impact Bike Lanes and Shared Roadway conditions with back up and pooling of water within the bike lane areas.

   d. Where storm drainage elements occur, recessed curb inlets are preferred over drain grates. If grates must be used, they must be bicycle- and wheelchair-safe with openings no wider than 1 by 2 inches.

e. Grates and manhole covers should be flush with the surface and be maintained in a flush state when the roadway is resurfaced.

C. Trail Elements
All trails, linear parks, and bike lanes will have a variety of elements and amenities depending on the type and configuration of the route. Where possible, amenities should be clustered together and located for ease of use and maintenance. The following criteria only apply if the referenced element is utilized.

1. Trail Head Location: Trail heads should be located at the beginning and end of a linear trail, or associated with other (existing or new) parks and open spaces in a loop trail. Trail heads shall be located in areas that are convenient to access by automobile, bicycle, or on foot and should allow enough area to include the following amenities:
   - Paved Parking (appropriate permeable pavement is encouraged)
   - Bicycle Racks or Lean-rails
   - Lighting
   - Drinking Fountain
   - Kiosk or Information Board
   - Trail System Map with Mileage Chart
   - Landscaping/Shade Trees
   - Restroom Facilities (optional – should be monitored)

2. Parking
   1. Parking requirements will vary depending on use patterns, location, and overall development of the trail system. Where possible, locate shared parking with existing park facilities or provide on-street parking (provided the parking does not negatively impact adjacent neighborhoods).

   2. All off-street parking areas will be concrete, asphalt is prohibited. Appropriate permeable pavement is encouraged

   3. For any off-street parking area created exclusively for trails, one tree (4 inch caliper at the time of planting) will be required for every five (5) parking spaces. Trees should be placed so as to maximize shade on the parking area and to support long-term tree health.

3. Bicycle Parking
Secure bicycle parking shall be provided at all trailhead locations and any other location that provides for an extended stop. Bicycle racks should be located adjacent to other trail elements.

4. Lighting
   a. All off-street trails should include lighting at all at-grade crossings. Bike Lanes and Shared Roadways should include lighting at all intersections. If proper lighting does not exist as a part of a vehicular thoroughfare, lighting should be installed prior to the creation of a bike route.

b. On all trails and routes, areas of steep slopes, tight corners, steep drop-off from the edge of the trail, or any other existing condition that might pose a hazard to bicyclists or joggers should be illuminated by pedestrian scale lighting.
c. The horizontal illumination levels should maintain an average between 0.5 and 2 foot candles. Where special security concerns exist (e.g., tunnels, underpasses), a photometric study is required indicating a minimum average of 1 foot candle.

d. Light poles and fixtures should be in scale with bicyclists and joggers except at at-grade street crossings.

e. At street crossings, light poles shall be a minimum ten feet (10') in height.

f. All trail lighting should conform to the "Dark Skies" ordinance.

g. All light fixtures should have sharp cut-off or side cut-off features to prevent spill-over of light into neighboring properties.

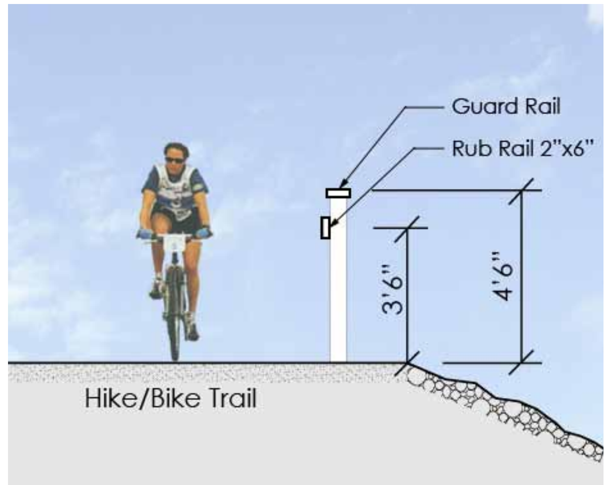
5. Railings
   a. Railings should be provided for bridges, overlook areas and steep drop-offs from the edge of the trail.

   b. All railings shall be a minimum of four and one half feet (4.5)' in height and have a smooth "rub rail" attached to it. The rub rail should be of 2 inch x 6 inch rectangular tubing (12 gauge steel) placed three and one half feet (3.5') above the surface of the trail.

   c. The use of chain-link fencing is prohibited.

6. Water Fountains
   a. Water fountains, faucets, and other water sources should be located on the downhill side of the trail to eliminate water flow across the trail that could create a slipping hazard.

   b. Water fountains should be located every 1 to 2 miles for trails in linear parks. The water fountains



8.11.5.C5: Railing

8.11.5.C6: Water fountain

8.11.5.C7: Bench

should be “freeze-proof” with a top spigot at two levels per ADA requirements and a lower faucet for water bottles and animals. The lower faucet needs to be spring-loaded to ensure that it shuts off after use.

7. Benches
   a. Benches are not required, but if they are used they shall be located in areas that trail users would logically stop (e.g. near water fountains, overlook areas, parks); or located every 1 to 2 miles along a trail.

   b. Benches should be designed to prevent people from laying down.

   c. Benches should be made of metal, concrete, or other durable materials.

   d. Bench seating should be of a typical height of 18 - 19 inches.

8. Trash Receptacles
   a. Trash receptacles should be located in areas that are convenient for users and easy to maintain.

   b. Trash receptacles should be made of metal, concrete, or other durable materials; and shall be designed to prevent tipping over by animals.

8.11.5.C8: Trash receptacle

8.11.5.D1.a: Warning sign and traffic sign

D. Signs
   Signage should be utilized to communicate to trail users and motorists the appropriate regulatory messages, to warn of potential conflicts, and to designate routes in Shared Roadway conditions.

   All trail signs must conform to the Texas Manual of Uniform Traffic Devices – Part 9 Traffic Control for Bicycle Facilities.

1. Signage Types: Trail signage should include the following types:

   a. Warning Signs: Warning signs shall be used to alert trail users of a safety threat such as sharp curves, approaching intersections, or steep drop-offs. Typically, these signs are yellow and diamond-shaped with black lettering.

   b. Information Signs: These signs typically provide the trail user with useful or important information.

   c. Regulatory Signs: These signs shall be white and rectangular with black lettering. Regulatory signs give instructions on trail use and etiquette.

d. Identification Markers: These signs identify trails and streets that cross the trails. All intersections and street crossings should have a sign identifying the street for trail users and a sign identifying the trail for road users.

e. Trail Maps and Mileage Markers: Trail maps and the name of the trail should be located at the beginning and end of each trail, adjacent to parking lots and other trail facilities, and at major street intersections along the trail.

   a. Mile markers shall be located every 0.25 mile on off-street trails and bike lanes.

f. Directional Markers: Directional markers should use arrows or wording to indicate which direction to travel in the following conditions:
   - At the intersection of multiple trails
   - At street intersections
   - At points where trail types converge (e.g. an off-street trail transitions to a bike lane)
   - Along Shared Roadway Trails

g. Kiosks: Information bulletin boards or kiosks should be located near parking areas, water fountains, restrooms, or other areas where people have a reason to stop.

h. Information Signs: Information signs shall be placed within the first 150 feet of the trail. Specific trail names, length of the trail, and regulations concerning trail use are included on information signs.

i. Route Signs: Route identification signs are required for all Bike Lanes and Shared Roadways. The following criteria should be used to develop these signs:
   - Bike route signs should be W11-1 diamond shaped, bicycle warning sign with a W16-1 or W16-7p companion rectangular shape SHARE THE ROAD sign, color, and size shall conform to Texas MUTCD.
   - All bike route signage should adhere to Texas

8.11.5.D1.e: Example of trail map

8.11.5.D1.h: Information sign

8.11.5.D1.i: Route sign

Manual on Uniform Traffic Control Devices - MUTCD (Global) standards.

- All bike route signage should be reflectorized.
- Bike route signs should be placed wherever bike routes cross other bike routes and major thoroughfares and at the beginning and end of each route.
- To confirm that the bicyclist is still on the bike route, signs are provided every 0.5 to 1 mile intervals.

8.12 Boating Capacity Study

8.12.1 Boating Capacity Study

The scope of work for the Lake Arlington Master Plan included an assessment of the carrying capacity of the lake, specifically directed at evaluating boating activity. The specific technical nature of this task required expertise in two areas: water-related recreation use assessment; and the use of appropriate survey techniques. For this purpose, Malcolm Pirnie engaged Texas AgriLife Research, a division of the Texas A&M University System. The study team included professionals from the Human Dimensions of Natural Resources Lab in the Department of Recreation, Park and Tourism Sciences at Texas A&M University.

The study is summarized below. The entire study report is found in Appendix 8.12-A.

8.12.2 Study Objectives

The objectives of the Lake Arlington boating capacity study were to:

- Characterize existing use occurring on Lake Arlington;
- Identify areas of use, conflict, and displacement across the lake and among boating groups;
- Identify areas on the lake that might require new or additional managerial attention; and
- Identify areas around the lake for potential shoreline development projects.

8.12.3 Methology

A. Site Visit
On February 26, 2010 the Texas AgriLife Research study team conducted a boat tour of Lake Arlington and a site visit of the surrounding area. The team also met with staff members of the City of Arlington to kick off the study effort, clarify the scope of work, and initiate data collection. The site visit and tour also provided an opportunity to make professional observations and develop perceptions of Lake Arlington's size and configuration, shoreline characteristics, recreation and access facilities, and geographic nature.

B. Study Area
The study area included Lake Arlington and the immediate area within a five-mile radius.

C. Sampling
The major basis for this study effort and the findings was a survey of lake users and potential users. The survey examined how recreationists are currently using the lake, their perceptions of future development and lake management, and their future needs. Data for the survey were collected from two sources: 1) a City of Arlington-supplied mailing list of 2009 permit holders, and 2) a random sample of lakeshore property owners and residents living near the lake.

The City of Arlington provided names and postal addresses for 1,471 people who had purchased a day use or annual boating permit for Lake Arlington in 2009. The entire list was included in this sample. The second portion of the sample was drawn from the 2010 Certified County Appraisal Rolls for Tarrant County using a random systematic method. The county tax roll was filtered to identify residential property owners to create a 100 foot buffer around Lake Arlington in order to target shoreline property owners. From this list, 191 residents were selected. The tax roll was also used to create a five mile buffer to target a wider potential user group (1,200 of these names were selected).

From this sample group, potential respondents were given the option of completing a survey online or receiving a hard copy survey in the mail. A total of 454 completed surveys were returned for an overall response rate of 16.4%. Final calculations indicated that 21.5% of lake permit holders responded, 26% of lakeshore property owners responded, and 9% of property owners within five miles responded. Within the overall 454 returned surveys:

- Lake Arlington boat permit holders made up 65.5%
- Property owners within five miles of Lake Arlington made up 23.5%
- Property owners within 100 feet of Lake Arlington made up 11%

Response rates were consistent with past research targeting the "general population" and offer reliable estimates of the target population within plus/minus five percent (5%). A blank copy of each version of the survey form is found in the full report.

8.12.4 Analysis and Results

The surveys were tabulated and analyzed by professionals from Human Dimensions of Natural Resources Lab at Texas A&M University. There were several questions that asked about boating experiences on Lake Arlington. Most respondents (83%) had boated on Lake Arlington and had been boating on the lake for an average of just over 12 years. Respondents indicated they had boated an average of approximately 27 days on Lake Arlington in the past 12 months.

A. Boating Experience

There were a number of different types of watercraft used on the lake. Fishing and/or bass boats were the most common, followed by ski boats, personal watercraft (PWC) such as jet skis, kayaks and sail boats. Most respondents said their boating activity related to fishing (42%), with the next highest use being cruising up and down the lake (20%).

Almost two-thirds (63%) of the respondents indicated they were not boating as often as they would have liked. Lack of available time and work commitments appear to have been the main reasons. Two other factors also inhibited some users. These factors were water depth and litter. Forty-four percent (44%) of respondents believe that the lake is too shallow and 32% believe that there was too much litter in the water.

On average respondents travelled about five miles to use Lake Arlington and 63% of the respondents used the lake with family and friends in a group size that averaged between three and four people.

More than 50% of the users enjoyed Lake Arlington because of how "close" the lake was to home which made using it "convenient" and "easy to access." Many residents clearly see the lake as a local resource and appreciate that it is close to home. There were also a number of responses related to the lack of crowds, feeling safe while boating, appreciation for the no alcohol policy, enjoying socializing with friends and family, and fishing.

Answers to the "what you like least" question were more varied. However, there were many responses related to the small size of the lake, the shallow and/or fluctuating water level, and litter and other debris on the shore and floating in the water. Fifteen (15) respondents commented that the no swimming rule was something they did not like.

When asked about the number of people encountered on the lake, most (72%) felt there were neither too many nor too few. This suggests that the number was acceptable. About 19% of the respondents would like to have seen fewer people. The number of people they encountered was also what most respondents (60%) expected to encounter, while 20% indicated that there were fewer people on the lake than they had expected. Most respondents also indicated that the number they saw either had no influence on their enjoyment (62%) or that it “detracted a little” from their enjoyment (22%).

The number of boats on the lake does not appear to have made people feel unsafe because 96% of the respondents indicated feeling at least “moderately safe” with 68% feeling very to “extremely safe.” Most respondents (66%) did not feel there was an area of the lake where they felt unsafe. The 34% who did feel unsafe indicated they felt unsafe in the far western and southern zones of Lake Arlington (Zones 1 and 6 on the map shown below).

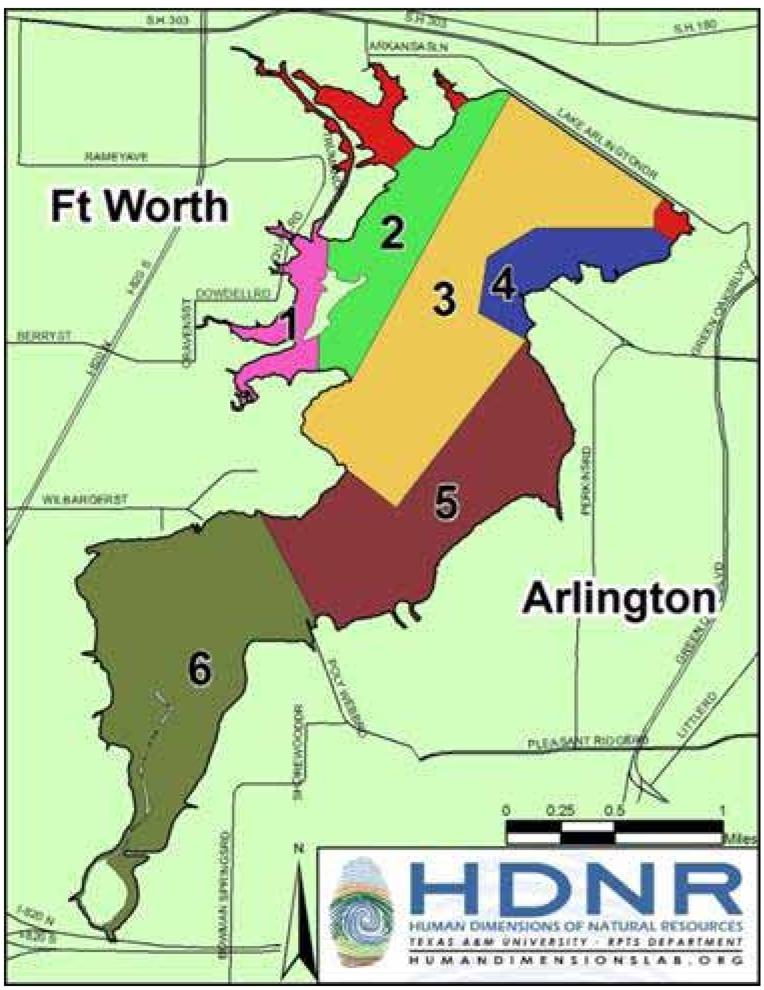


Figure 8.12-1: Lake Arlington Use Zones

B. Use of Lake Arlington

In general respondents did not feel that activities should be restricted to certain areas of Lake Arlington. Seventy-one percent (71%) said they would not want activities restricted by zone. Among the 29% who did feel that activity should be restricted to zones, there was support for restricting jet skis, high performance boats and skiing/wakeboarding across all zones with the highest counts related to Zone 6. Zone 6 is the shallowest area of Lake Arlington and is currently a no skiing zone. Most respondents (78%) also felt that Lake Arlington should be managed for all types of recreational boating. Among the 22% who felt there was some need for restriction, almost all (82%) felt that high performance boats were not suitable on the lake. There was almost no opposition to canoeing/kayaking, sailing or fishing as lake activities.

Respondents did not feel that conditions were crowded out on the water or at access points on Lake Arlington. Over 75% felt that conditions on the water were only moderately crowded or less, and 65% felt that conditions were moderately crowded, or less so, at access points

C. Management Issues

Respondents were asked to score 16 items on a scale from "strongly oppose" to "strongly support" related to possible management actions on Lake Arlington. The actions that received the most support were related to developing the fish stock and dredging the lake to improve depth. Respondents also tended to agree that training should be required for operating PWC and that development standards should be set for shoreline retaining walls, docks and piers. On the other hand, respondents were not supportive of restricting activities. With regard to marina development as a management action, there was no strong consensus for or against development, with 22% of the respondents being neutral. There was also no strong support of the installation of more boat ramps.

While a small majority (55%) of respondents felt that current facilities were adequate, many (45%) felt that some additional services and facilities should be available to users. A large majority (80%) would support up to a 20% increase in the fees to support services and upkeep of Lake Arlington. Litter pick up, park amenities and code enforcement were all seen as reasonable ways to spend additional fee revenues. A small majority (57%) felt that marina development was acceptable on Lake Arlington. Among those who felt it was acceptable, just over 60% felt that 40 slips or less would be an acceptable capacity size for a marina.

Respondents were asked about 17 possible issues (developed through input during public meetings and previous research) and to what extent each may present a problem associated with Lake Arlington. The major issues identified were fish habitat improvement, change in the lake's water level and litter on shoreline. Poorly constructed bulkheads and polluted water were scored as moderate problems, while pulling inflatable toys, engine noise and public access were identified as slight problems.

D Shoreline Property

Property owners adjacent to the lake were asked about issues that would apply only to them. Seventy (16% of total) respondents indicated that they had a home on Lake Arlington and, for all 70, it was their primary residence. Homes had been owned an average of 10 years, and thirty-nine respondents (56%) had a bulkhead, dock or slip associated with their property. Twenty (51%) of the 39 who had a bulkhead indicated that it had been damaged sometime in the past. However, there was little detailed information about the nature or cause of that damage.

Related to two homeowner issues, questions were asked about whether they displayed a home address on their dock or slip, and if they were aware of the "flowage easement" that extends into lake front property. Of the 23 who indicated having a dock or slip, only three (8%) said that they have their street address posted on the structure. Awareness of the "flowage easement" was split evenly among the shoreline property owners, with 52% indicating that they were not aware of the easement.

8.12.5 Conclusions and Recommendations

A. Conclusions

1. Respondents' Use of Lake Arlington

   a. Most respondents had boated on Lake Arlington. Of those who had, most had boated within the last 12 months.

   b. The most popular watercraft used by respondents were fishing or bass boats, ski boats, and personal watercraft (PWC).

   c. The most popular activities on the lake were fishing, cruising, towing inflatables, and wakeboarding.

   d. Respondents most often boated with family and friends.

2. Areas of Use, Conflict and Displacement

   a. Overall, there was little indication of crowding, conflict and/or displacement in the use of Lake Arlington by boaters.

   b. Areas that respondents most often avoided were Zone 6 and Zone 1, the far south and west segments.

   c. Areas that respondents most often felt unsafe were Zone 6 and Zone 1, the far south and west segments.

   d. Respondents indicated the depth of the water, submerged obstacles, and "rowdy" people as reasons for avoiding these areas of the lake and/or for feeling unsafe.

   e. In response to encountering others on Lake Arlington over the 2009 boating season, for the most part, respondents indicated not feeling crowded. Additionally, they indicated that the number of other boaters encountered was:

      - Consistent with what they had expected;
      - Had little effect on their enjoyment; and
      - Did not significantly impact their perceived safety.

f. When asked if some activities should be restricted to certain areas of the lake, most respondents indicated that they were comfortable with the current activity use patterns occurring on the lake. The only boat type considered inappropriate was “high performance boats”.

3. Areas of Lake Arlington Requiring Potential Managerial Action

   a. Most respondents did not feel additional controls were required to manage conflict on or damage to the lake.

   b. The most salient issues that respondents felt were problematic on the lake were:

      - Litter along the shoreline;
      - Shallow water
      - Changes in the lake’s water level; and
      - Fish habitat.

   c. Potential management actions receiving strongest support focused on:

      - Requiring training for the operation of PWC;
      - Developing fish stock to improve fishing on the lake; and
      - Dredging the lake to improve depth.

   d. There was strong support for up to a 20% increase in permit fees that would generate revenue to be spent on litter collection, upgrading park amenities, and code enforcement.

   e. There was no strong opposition to the development of standards or guidelines for shoreline structures such as retaining walls, docks and piers.

4. Suitable Development on Lake Arlington

   a. Respondents were somewhat split on the issue of providing additional facilities or services on Lake Arlington. Specifically, with regard to marina development, a slight majority were accepting of the proposition. Of these, most were in favor of a development that had a capacity of 40 boat slips or less. the City may decide to start with approval of fewer slips.

B. Recommendations
Based on the survey and analysis described above, the site visit to Lake Arlington, and the team’s professional experience on similar projects, the following recommendations are offered for consideration:

1. Overall, the current management practices being used for Lake Arlington are providing a satisfactory recreational experience and a safe environment for users of the lake. At this time, it does not appear necessary to implement additional zoning or more intensive use restrictions (except with regard to two types of watercraft as discussed below).

2. We recommend that the best management practices (BMPs) discussed elsewhere in this report be implemented in order to minimize litter. We also recommend that the City increase its litter and trash

disposal activities around the lake, such as adding more "no dumping" signs and more trash cans at access points. We also recommend that related public education be increased. This education could include signs directly around the lake and within the watershed.

3. In the survey, lake users indicated a willingness to pay higher user fees, if the related revenues were used for the direct benefit of Lake Arlington. We recommend that the City implement regular, periodic user fee rate increases in order to fund at least a portion of the improvements and enhancements described below. These rate increases should be based upon a cost-of-service approach that clearly describes and defines the funded activities, as well as the beneficiaries.

4. In order to fund projects and enhancements that have more broad-based beneficiaries, the City should consider using money from its General Fund or other sources. The survey showed that users and residents appreciate the proximity and quality of Lake Arlington. The City might also consider the implementation of a "flowage easement" fee associated with the land around the lake where additional operations or enforcement activities are needed.

5. The survey identified the need to make improvements and enhancements to the three existing parks on Lake Arlington. We understand that the Arlington and Fort Worth parks departments have, or are in the process of developing, master plans for these parks. We recommend that improvements be made in accordance with those plans, as funds permit.

6. Logs and other large debris were identified as safety hazards and detrimental factors affecting recreational boating on Lake Arlington. We recommend that the City consider the implementation of a program to periodically patrol the lake, remove such debris, and properly dispose of it.

7. We recommend that the City work with Texas Parks & Wildlife Department (TPWD) to continue conducting periodic fish habitat studies of Lake Arlington. Such studies would identify means and methods for improving the fishing by enhanced construction of structures (such as rock placed along the bottom of retaining walls) and public education. Although State funding for stocking programs is becoming more limited, many lake owners develop cooperative agreements and stocking programs with fishing organizations such as Trout Unlimited and bass clubs.

8. The survey determined that lakeshore owners are not generally opposed to development of uniform standards for structures such as piers, docks and retaining walls. Other members of the Master Planning team are developing recommended standards and templates. We recommend that the City adopt policies and procedures implementing those standards in order to enhance the recreational experience by boaters and other lake users, and to protect the investment made by the City and private property owners. We also recommend the City actively educate property owners about the flowage easement, and communicate to lakeshore property owners the standards governing the construction of shoreline structures and shoreline improvements.

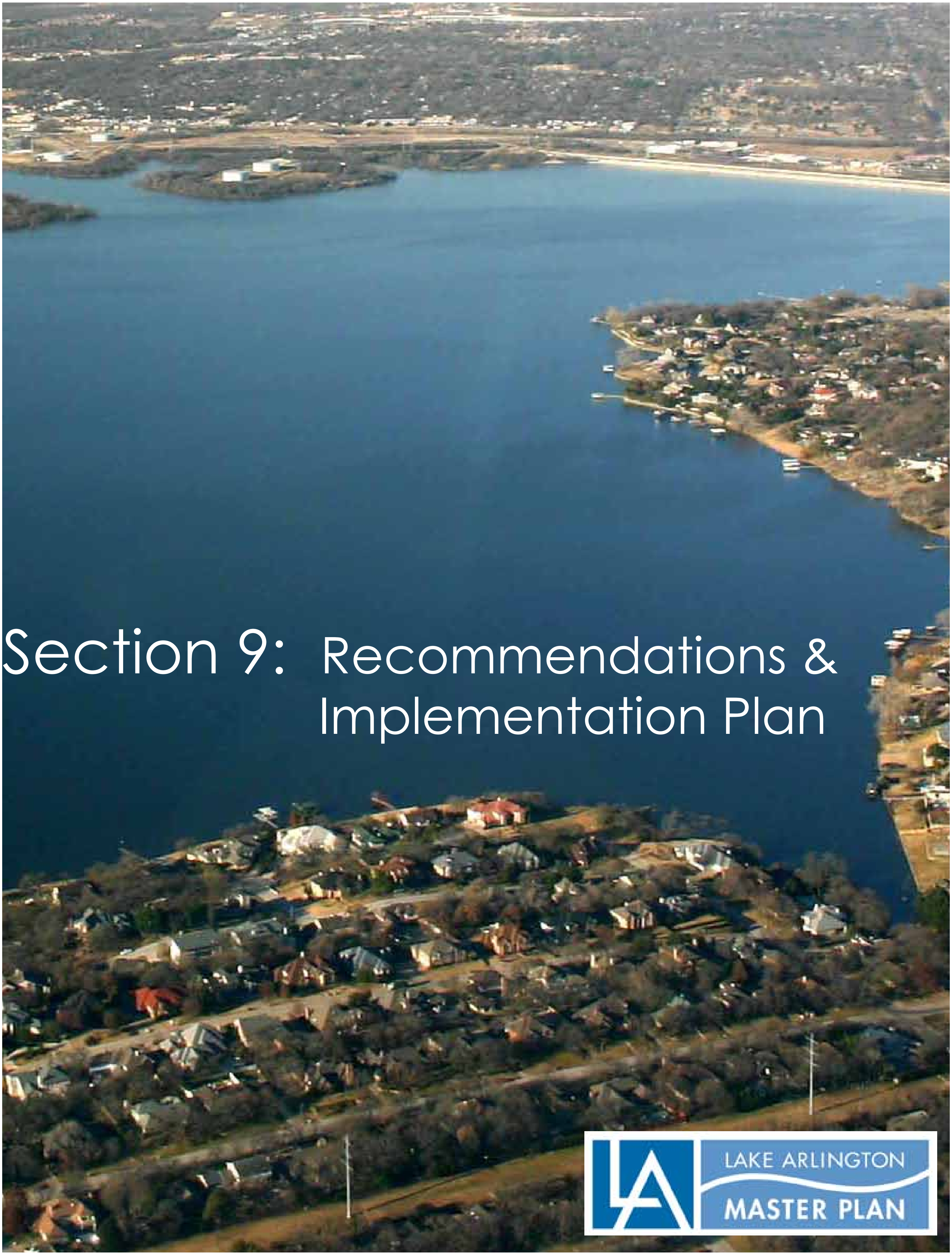
9. We understand that the water level of Lake Arlington is determined by the amount of water diverted from the lake for treatment purposes, and the City's contract with the Tarrant Regional Water District (which operates a regional system of reservoirs), and possibly others. Per that contract, the City does not have control over the lake level. We recommend that the City continually look for opportunities to keep a more stable lake level.

10. The south end of Lake Arlington has been identified as an area that is very shallow, especially when the lake is below elevation 543.0 feet. Although this shallow depth and debris lodged in the area produce safety issues, the area also exhibits some beneficial characteristics. We understand that during some months, waterfowl inhabit the area, and the shallow areas are enjoyed by kayakers, canoeists and fishermen. Dredging activities are very expensive because of the costs associated with permitting, materials handling and spoil disposal. Unless there are significant water quality or quantity reasons, it may not be practical or advisable to dredge a large portion of Lake Arlington. However, the City should study the feasibility of dredging access lanes or canals in the southern portion of the lake in order to improve access and water flow.

11. The only new regulations or use restrictions that were widely supported in the survey relate to "high performance boats" and training for PWC operators. We recommend that the City study such a regulation in consultation with City police and/or TPWD game wardens that would be responsible for enforcing a related ordinance. We also recommend that the City work with TPWD and the US Coast Guard Auxiliary on the establishment of educational programs, training programs and possibly licensing for PWC operators.

12. The survey results indicate that there is little opposition to, and possibly some justification for, the development of a marina on Lake Arlington, especially if that marina provides additional services to boaters using the lake. The most logical location for a new marina would be on the west side of the lake. If the marina is located on the southwest side of the lake in the shallower areas, we recommend that the developer be required to dredge and maintain a safe access channel from the marina into open water. The City should maintain its authority to approve the number, location and size of marinas located on the lake. Because of the speculative nature of marinas, we also recommend that the City approve and permit such facilities on an incremental basis so that each phase proves its viability before a new phase or increment is approved. If requested, we recommend that the City consider approving a marina within a range of 20 to 40 boat slips as a logical first phase of development.

Section 9: Recommendations & Implementation Plan



9. Recommendations and Implementation Plan

9.1 Principles, Recommendations and Implementation Plan

Specific technical recommendations for each project task are found within the previous sections of this Master Plan, including recommended programs, BMPs, standards, and design guidelines. Those detailed recommendations are not repeated in this section. This section describes the principle segments of the recommended programs and projects, and the guidance required to implement the detailed recommendations.

9.1.1 Principle: Organizational Structures and Processes

Develop organizational structures and on-going processes/programs that assure the protection and enhancement of Lake Arlington's water quality. To implement this principle, the following recommendations are provided:

A. Within the City of Arlington, establish a permanent Lake Arlington Task Force that will meet on a monthly basis to address the implementation of this Master Plan and the management of Lake Arlington. The Task Force should be chaired by the Director of the Water Utilities Department. The following departments should be included: Water Utilities; Community Development and Planning; Community Services; Parks & Recreation; Police; and Public Works.

B. The City of Arlington and the City of Fort Worth should continue to meet regularly as a continuation of the regular Coordination Meetings held during this planning process. The meetings should be held quarterly for the first few years at which time, the meetings can be scheduled biannually. The major issues to be addressed include: shoreline standards and permitting; development within the Flowage Easement; detailed planning within the area around the lake, including development of trails systems and natural areas; and the implementation of the Lakeshore Drive Project.

C. In conjunction with the NCTCOG, the City of Arlington should develop a Watershed Council for the Lake Arlington watershed for the purposes of implementing the Master Plan recommendations related to BMPs, storm water planning and MS4 permitting, and the purchase and maintenance of conservation easements. The representatives on the Council should include the cities and counties within the watershed, TRWD, and TRA. The Council may also want to periodically coordinate with the Tarrant County Mayors Council.

D. The Cities of Arlington and Fort Worth should consider establishing a non-profit group to support the management and enhancement of Lake Arlington by advocacy, fund raising, education, and promotion. Such a "Friends of Lake Arlington" type group could serve an advisory role, similar to the focus groups used in the planning process. The group could also raise awareness about lake issues and needs, and raise funds for projects that cannot be funded by the cities.

E. Public involvement and education is a critically important aspect of implementing the Master Plan. The following paragraphs summarize the key recommendations.

Within the Watershed

<u>BMP Education Program</u> – Work with the NCTCOG to develop and implement a comprehensive public education program designed to inform citizens within the watershed about BMPs that they can be

responsible for in their daily personal and work activities. The public education program should be ongoing and can emphasize “good partners” through some type of recognition program.

Events and Celebrations - Celebrate worthy activities that are a result of the planning and collaboration from the Master Plan. For example, plan a groundbreaking and dedication of the Linear Park System and include officials from throughout the North Central Texas Region.

Signage – Post signage throughout the watershed to educate citizens that they are within the Village Creek/Lake Arlington watershed.

Public Officials Information Packet – Develop an informational packet about the Master Plan for elected officials for all cities and counties in the watershed. The packet can include a cover letter, project fact sheet, and project summary newsletter.

Immediately Around the Lake
Create a “Friends of Lake Arlington” group and possibly “adopt-a-shoreline” groups – Develop citizen led groups that can take ownership of the ongoing collaboration and community support necessary to effectively implement a long-term vision plan. Members of the existing business, community, and parks roundtables are a good database from which to draw.

Fort Worth
Provide regular updates to the Fort Worth City Council – Provide Master Plan updates to the City Council.

Arlington
Assign a Staff Person to LAMP Public Involvement Implementation – As part of the Task Force, designate staff time and responsibility to person(s) who can provide leadership and coordination of public involvement related activities.

Signage – Make sure that the Lake Arlington Master Plan logo is included on construction signage for any new development and redevelopment projects within the study area.

Provide regular updates to Arlington City Council – Provide Master Plan updates to the City Council. Updates should be provided every three months.

Property Owners and Affected Residents

Bill Stuffers – Include periodic updates on the progress of the Master Plan in Arlington and Fort Worth utility bills.

School Outreach Programs – Coordinate with local schools in the Lake Arlington area to develop a learning opportunity centered on water quality, the Master Plan recommendations, and park activities.

Maintain the existing website and update materials including:
- Project Talking Points – Write key messages and informational points for city staff to use when discussing the implementation. These should be updated monthly.

- Project Fact Sheet – Update the brief final summary of the Master Plan, process, timeline, recommendations, and contact information. This fact sheet can be placed at local businesses and used in the media kit and Public Officials Information Packet.
- Project Summary Newsletter – Update the final summary of the Master Plan, process, timeline, recommendations, and contact information. This can be sent to all contacts via email from the Project database, with copies provided for cities in the watershed.
- Update Library Display – Update the library display with recommendations, final overview/summary of the Master Plan process. Provide fact sheets that individuals can take with them at this display.
- Content for City Webpage – Provide contacts for the City of Arlington website related to the project and recommendations. This should be updated every three months.
- Mailing List/Database – Research and compile updated stakeholder databases to include elected officials, key influencers, and property owners affected by the Master Plan. This should be updated monthly.
- Email/Hotline Monitoring and Response – Set up and monitor an email and hotline for interested parties to leave questions or comments about the Master Plan.

Traditional Media and Social Media

Host Editorial Board Meetings – Periodically sit down with the editorial boards and or reporters to brief them on the results of the Master Plan and ask them to take a position of support of the Plan.

Media Kit – Develop a media kit for local media outlets to provide them with information on findings, recommendations, the Master Plan process, and contact information. This kit should include the Fact Sheet and Project Summary Newsletter.

Lake Arlington Facebook Page – Create a facebook page for Lake Arlington. By this means the City can provide information on the Master Plan process, updates, contact information, and it can serve as a way for stakeholders to post questions, comments, etc.

9.1.2 Principle: Area of Primary Influence

Within the Area of Primary Influence (API) immediately around and within 1,000 feet of Lake Arlington, implement projects, processes, and programs that protect and enhance the quality of the lake. To implement this principle, the following recommendations are provided:

A. The City of Arlington should continue to monitor the Fort Worth trash collection and management pilot program over the next two years. The data collected in that study will provide implementation guidance for the development of such systems in Arlington and within the watershed. In addition the City of Arlington should monitor the Lakeshore Drive Project to insure that the recommended BMPs are included in the final design.

B. The Cities of Arlington and Fort Worth should document with photographs, GIS mapping, and data collection the sections of the cities most affected by trash and debris. This documentation can then be used to guide the efficient implementation of BMPs.

C. As soon as practical, the City of Arlington should adopt the latest versions of the NCTCOG Integrated Storm Water Management (iSWM) Program for Construction and Development. As a cooperative initiative that assists cities and counties within the watershed to achieve goals of water quality and streambank protection, and flood mitigation, the program can serve as an incentive to get participation throughout the watershed. The program can also help communities meet their construction and post-construction obligations under state stormwater permits.

D. The Cities of Arlington and Fort Worth should develop requirements for the proper application of recommended herbicides and pesticides on public land within the API. With regard to the application of herbicides and pesticides on private property, the cities should develop educational programs to promote the proper use of chemicals that will prevent degradation of the lake.

E. The City of Arlington should immediately adopt the standards and design guidelines recommended in this Master Plan. Following such adoption, the city should begin training the staffs of both Arlington and Fort Worth, as well as developers, contractors, and the public. At that time, the city can begin to implement a code enforcement process (using the city's new GIS photo database).

F. Using the coordination meeting process recommended in the prior section, the Cities of Arlington and Fort Worth should begin more detailed comprehensive planning for development within the study area, for improvements at existing parks, and for the development of the trails systems recommended in the Master Plan. These planning efforts should be coordinated with Kennedale and other communities that could be linked to the hike and bike trails system. Such detailed planning documents can then become the basis for funding efforts.

G. Based on the BMPs and potential enhancements recommended in the Master Plan, the cities of Arlington and Fort Worth should develop amended permit requirements for future gas drilling activities within the API.

H. If the City of Arlington desires to implement dredging projects in the lake, more detailed studies are recommended. Dredging within selected areas of Lake Arlington is one of the enhancements recommended in the public meetings and the Boating Capacity Study. Dredging can be implemented in two ways: by the City of Arlington as part of a general program to increase the depth and storage capacity in the upstream end of the lake; or by private individuals or developers interested in improving access to specific shoreline properties.

In either case, dredging must be approached cautiously because of potential water quality issues and because of the high cost of permitting, implementation, and maintenance. Detailed sediment sampling and water quality analysis will be needed in any areas proposed for dredging. In addition, it is important to implement sediment transport BMPs within the watershed in order to protect the investment made in any dredging projects.

I. In order to implement specific recommendations from Boating Capacity Study, the Pirnie Team provides the following guidance:

- The City of Arlington should work with Texas Parks & Wildlife Department (TRWD) to continue conducting periodic fish habitat studies of Lake Arlington.
- The City of Arlington should continually look for opportunities to keep a more stable lake level. This could be achieved by continually discussing the issue with TRWD, and by exploring other sources of inflow such as dedicated highly treated water from upstream water reclamation plants.
- We recommend that the City study the regulation of high performance boats in consultation with

City police and/or TPWD game wardens. We also recommend that the City work with TPWD and the US Coast Guard Auxiliary on the establishment of educational programs, training programs, and possibly licensing for PWC operators.

J. The City's Lake Arlington Task Force should meet regularly with Exelon to look for additional opportunities to involve the electric generator in the implementation of the Master Plan. There is the potential to work collaboratively on the implementation of trash and debris collection and management because we know that Exelon has experienced its own problems. Working on this mutual issue should serve as an avenue to get other initiatives implemented, such as using parts of the Exelon property for trails and/or protecting natural habitat.

K. The City of Arlington should continue to work with Kennedale and the USACE on the Village Creek eco-restoration study. The two cities should play an active role in the study process, and they should consider negotiating a management role in the implementation of any projects that result from the studies.

9.1.3 Principle: Watershed

Within the remainder of the Lake Arlington watershed, work collaboratively with other cities, the counties, and other entities to implement projects, processes, and programs that protect and enhance the quality of the lake. To implement this principle, the following recommendations are provided:

A. The City of Arlington should work collaboratively with the NCTCOG and its Stormwater Council to use the Master Plan as a guidance document for MS4 permitting with cities and counties within the watershed. This communication and coordination process should include the development of programs to educate watershed entities on the benefits of working collaboratively and using the BMPs recommended in the Master Plan.

B. The City of Arlington should consider using an adaptive management approach to implementing BMPs within the watershed. This approach would involve monitoring and documenting water quality within the watershed, documenting the implementation of BMPs within the watershed, and funding periodic studies to evaluate the cost effectiveness of the programs and standards being implemented.

C. The City of Arlington should continue to use the data developed in the Master Plan process to assist the NCTCOG and the Trust for Public Land in the Greenprinting project for the Lake Arlington watershed, and then use the results of the Greenprinting modeling to guide the acquisition of conservation easements within the watershed. Develop agreements for acquisition and maintenance by the appropriate agencies. Funds from the TWDB SRF loan can be used to purchase the easements or to obtain development rights by other means.

D. It is very important that the City of Arlington continues to stay actively involved in the TCEQ processes related to the permitting and renewal of industrial and municipal wastewater discharge permits within the watershed. The water quality modeling performed in the planning process has documented the importance of nutrient removal in order to minimize potential treatability problems. Therefore, the primary objectives should be nutrient renewal with a phosphorus limitation of 1.0 mg/L; compliance with TCEQ's requirements for the "Lake Arlington water quality area" as found in 30 TAC 311.61-311.66 (including filtration); and plant operations by a competent entity, ideally one of the municipalities in the watershed or the TRA.

Although each permit process must be assessed individually, the city's involvement should generally follow these steps:

- Validate and document the proposed permit conditions or permit changes for flow rate, constituents regulated and permit limits (max month, annual);
- If there are major concerns based on the new or proposed conditions, the City should model the load increases to determine the potential impacts on Lake Arlington;
- In that modeling effort, the City should estimate and document the impact to water quality with the assumption that the City might need to use this information in a contested hearing process before TCEQ and/or the State Office of Administrative Hearings (SOAH);
- Compare the impacts against the lake's assimilative capacity threshold levels for the permit parameters of concern; and
- Elevate concerns within the City and with key stakeholders for additional action, if the new limits exceed the assimilative capacity.

E. The City of Arlington should continue to be a participant in the TCEQ's Source Water Protection program and update the Detailed Survey of Pollution Sources at least once every five years.

F. The City of Arlington should work with TxDOT to erect watershed protection signs on major roads throughout the watershed. If the signs meet TxDOT criteria, TxDOT will pay for the manufacture and installation of the signs. However, if Arlington wants a more unique sign of its own design, it will have to pay for the signs and work with TxDOT for installation.

G. The Pirnie Team recommends that the Cities of Arlington and Fort Worth initiate a program to educate developers, engineers, planners, and watershed cities on methods related to conservation development and low impact development (LID). These educational programs can be coordinated with environmental organizations such as the Sierra Club and the Audubon Society, as well as public entities such as NCTCOG and the USDA Natural Resource Conservation Service.

9.1.4 Principle: Funding

Continue to pursue funding from a variety of sources in order to expeditiously implement projects, processes, and programs that protect and enhance the quality of Lake Arlington. To be successful, it is recommended that the City tailor its funding efforts to specific agencies and sources, while continually looking for new programs. To implement this principle, the following recommendations are provided:

A. The City of Arlington has applied to the TWDB for funding through SRF. In this current application the funds are to be used for specific Lake Arlington projects such as dredging and debris removal, and for future projects such as acquisition of conservation easements. The TWDB, under both the Clean Water and the Drinking Water programs will continue to be a good source of low interest loans (and possibly grants from time to time) for source water protection projects.

B. CWA Section 319 funding through the SSWCB is also available for conservation easements and for the implementation of watershed BMPs.

C. TPWD is the most likely source of funding (typically matching 50% grants) for parks improvements, trails projects, and for the purchase/protection of natural areas around the lake and within the watershed.

D. The City of Arlington should continue to work with Fort Worth and other entities such as Kennedale on potential sources of federal funds. For example, Arlington and Kennedale should continue to pursue the USACE eco-restoration project for Village Creek. There may also be federal funds available because Fort Worth has an established Neighborhood Empowerment Zone on the west side of the lake. Federal programs such as the USACE projects can be frustrating because of the time and initial expense involved during the study phases. The payback comes in the form of federal funds for implementation, but that often requires specific appropriations.

E. The Pirnie Team recommend that the City of Arlington implement regular, periodic user fee rate increases in order to fund at least a portion of the improvements and enhancements described above.

F. In order to fund projects and enhancements that have more broad-based beneficiaries, the City should consider using money from its General Fund or other sources such as the Tomorrow Fund Foundation. The City might also consider the implementation of a "flowage easement" fee associated with the land around the lake where additional operations or enforcement activities are needed.

G. The City of Arlington should continue to work collaboratively with entities that have a vested interest in the protection and enhancement of Lake Arlington. These entities include TRWD, TRA and Exelon.

9.2 Implementation Plan

9.2.1 Emergency Plan

This Master Plan provides short-term and long-term strategies and recommendations for the protection of the water quality in Lake Arlington, such as the implementation of BMPs within the watershed to reduce potential pollution. However, water quality problems can result from activities and actions that occur more rapidly than more gradual changes such as land uses moving from rural to urban. Emergencies such as a train derailment or overturned truck can be catalysts for pollution of the lake if hazardous chemicals are discharged into Village Creek or one of its tributaries. Therefore, emergency planning must be mentioned as one component of overall water quality protection.

The Arlington Water Utilities Department has a Water Resource Services Division that manages a watershed protection program for Lake Arlington and Village Creek. As a part of this program Division staff members conduct regular surveillance of the watershed. These employees conduct visual inspections and field sampling of the main tributaries to detect active and potential sources of pollution. The Division also coordinates its activities with state, county, and local regulatory agencies, as well as the Tarrant Regional Water District. It works to stop illegal or improper dumping through educational activities and by reporting violations to Tarrant and Johnson County officials, and TCEQ.

The City has established emergency procedures that include protocols for protecting the water supply in case of potential contamination. At the current time, the policy states: "In case of contamination – or articulated threat of contamination with unspecified materials – of the source water, sampling should be increased at or near the system intakes and, if possible, the source water should be isolated."

As part of the City's emergency planning, the Water Resource Services Division also maintains a list of contact telephone numbers so that emergencies can be quickly reported to the proper regulatory authorities, as well as other Water Department personnel. This list is periodically updated. Appendix 9.2 provides a recommended protocol for handling reported emergencies.

The City also has considered the possibility of needing to isolate a source of upstream contamination in an emergency. For example, it might be necessary to install booms, absorbent materials or temporary earthen coffer dams to prevent a source of contamination from flowing downstream during a rain event. The Arlington Fire Department has containment booms on hand, and the City's Environmental Services Department has a contract with a hazmat/clean-up firm. The City also has an established dispatch procedure.

9.2.2 Organizational Structure

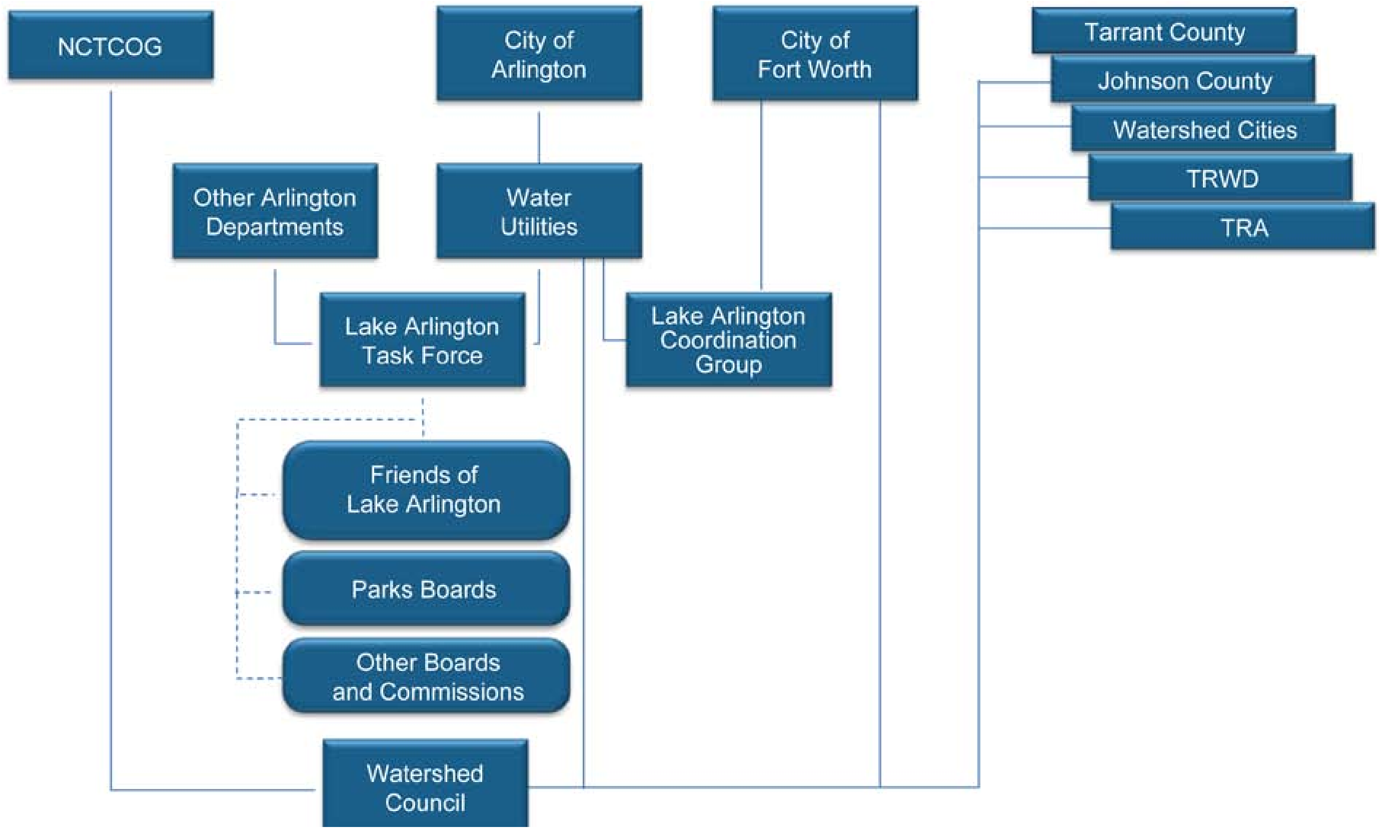


Figure 9.2-1: Organizational Structure

9.2.3 Implementation Steps and Action Plan

Because of the integrated nature of this Master Plan and the various tasks involved in the planning process, the implementation of the Plan can seem overwhelming. Therefore, the Pirnie Team recommends that the City of Arlington work in a logical manner on the most important projects and programs that will have the greatest immediate benefit to Lake Arlington. The Team recommends that the following key tasks be implemented first:

- To keep the momentum of the Master Plan process, the Cities of Arlington and Fort Worth should implement the recommended organizational structures and processes found in Section 9.1.1 above. Each of the groups and processes plays an important role in overall implementation of the various technical recommendations found in the Master Plan.
- In the Master Plan, there are a number of recommendations related to trash and debris collection and management. These recommendations range from monitoring the Fort Worth pilot project to

purchasing a boat to begin removing logs and large debris from the lake. The trash and debris collection recommendations are extremely important even though they may not seem as critical to water quality as other measures. Trash and debris issues were continuously mentioned during public meetings, in the Boating Capacity Study survey, and by study team members. Some trash and debris has the potential to cause degradation of water quality, and it definitely affects the public's perception of its water supply reservoir.

- The shoreline standards and design guidelines should be adopted by the Arlington City Council as soon as possible. Not only do these standards affect the ability of City residents to move ahead with modifications and improvements around the lake, they also serve to protect water quality and safety.
- Within the watershed, it is important to begin implementing BMPs and measures to protect water quality. The implementation of some of these BMPs will require the cooperation and participation of other municipalities and/or the two counties, and it is important for the City of Arlington to begin working cooperatively with the NCTCOG to achieve this cooperation, as described above. However, the City of Arlington is in a position to implement other important programs, such as the purchase of conservation easements, and the involvement in the permitting processes for wastewater discharges in the watershed.

9.2.4 Responsibilities

The organizational chart in Section 9.2.2 describes the overall structure necessary to implement this Master Plan. Within the City of Arlington, the overall responsibility resides with the Water Utilities Department. However, the cooperation of many other city departments is absolutely essential to successful implementation. Because of the nature of watershed protection, all of the entities, and ultimately those who reside in the watershed, must be involved. The Master Plan provides guidance on how to get cooperation and involvement from these other participants in the process.

9.2.5 Potential Funding Sources

The following sections describe potential funding sources (grants and/or low interest loans) for implementation of the Master Plan.

<u>A. Source Water Protection</u>

The following Table 9.2-1 shows a list of state and federal funding programs that are designed to prevent pollution of source waters. Public entities in Texas such as the City of Arlington and the communities in the watershed are eligible to apply for all of these funding sources.

The following paragraphs describe in more detail some of the referenced funding sources that might have direct applicability to the implementation of the Lake Arlington Master Plan.

1. Brownfields Cleanup Revolving Loan Fund:
   The objective of the Brownfields Cleanup Loan Fund program is to capitalize loan funds that can make loans or grants to facilitate cleanup of brownfield sites contaminated with hazardous substances or petroleum products, as well as 'drug labs.' Eligible organizations include businesses, nonprofit groups, local governments, state/territorial agencies, or tribal agencies. For more information, see: http://www.epa.gov/brownfields.

		Polluted Runoff Control						Resource Protection and Restoration						Wastewater Treatment	
		Agriculture	Forestry	Mining	Brownfields	Storage tanks	Landfills	Hydromodification / Habitat Modification	Wetlands / Riparian Zone	Land Acquisition / Conservation Easements	Groundwater Protection Measures	Land Use Controls	Public Education	Stormwater	On-Site Sewage
Funding Sources															
	Brownfields Cleanup Revolving Loan Fund Pilots			•	•								•		
	Clean Water State Revolving Fund Loans	•	•	•	•	•	•	•	•	•	•		•	•	•
	Drinking Water State Revolving Fund Set-Asides	•	•	•	•	•	•	•	•	•	•		•	•	•
	Nonpoint (319) Source Implementation Grants	•	•	•	•	•	•	•	•	•	•	•	•	•	•
	Pollution Prevention Incentives for States										•	•	•		
	Water Pollution Control (106) Program Support	•									•	•	•	•	
	Water Quality Cooperative Agreements	•	•	•	•	•	•	•	•		•		•	•	•
	Watershed Assistance Grants										•		•		
	Wetlands Program Development Grants		•					•	•				•	•	
USDA	Watershed Processes and Water Resources Program	•	•												
USDA	Watershed Protection and Flood Prevention Program	•						•	•		•	•	•		
	Land and Water Conservation Fund	•	•	•				•	•	•		•			
	Partners for Fish and Wildlife Program	•	•						•	•			•		

Table 9.2-1: State and Federal Funding Programs

2. Clean Water State Revolving Fund Loans:
   Funds are used to make low interest loans to communities, individuals, and others for water-quality improvement activities. Traditionally the funds have been used for wastewater treatment facilities, however loans are used increasingly for other water quality management activities including nonpoint source and estuary projects (Nonpoint Source Pollution Loan and Estuary Program). In Texas, this program is administered by the Texas Water Development Board (TWDB), and the City is familiar with the application procedures.

3. Drinking Water State Revolving Fund Loans:
   Under the Safe Drinking Water Act, up to 15% of the DWSRF funds may be used for set-aside activities including loans for the acquisition of land or easements for source water protection or for implementation of source water protection measures, or direct assistance for wellhead protection programs. This program is also administered by the TWDB, however source water protection applications are ranked by the Texas Commission on Environmental Quality (TCEQ). The current TCEQ contact for source water programs is Mr. Sean Ables (512-239-1758). Projects must be consistent with the State Water Plan.

   The City has submitted an application to TWDB for projects related to protecting the water quality of Lake Arlington and implementing this Master Plan. A more detailed description of that application is discussed below.

   On January 7, 2010, the City submitted information to the TWDB in order to be included in the 2011 DWSRF Intended Use Plan for Capital Improvements Projects. In response to a request from TWDB, the City submitted on October 27, 2010 TWDB Form 0163 (Green Reserve Information Worksheet) with a list of proposed projects totaling $8,963,120. The following paragraphs describe the projects proposed by the City for implementation of this Master Plan.

a. Bioretention Structures and Wetlands. Bioretention structures and constructed wetlands are recommended for new construction of roads and major infrastructure projects. The most beneficial locations will be determined by detailed, site specific studies. The wetlands will be maintained by public entities or through landowner cooperative agreements. Requested: $1,763,120.

b. Dredging. Dredging in selected areas of Lake Arlington could improve water quality in the lake. The exact location, design, and cost will be determined by site specific studies. The City or private cooperators will maintain the dredged channels and areas. Requested: $2,800,000.

c. Riparian Corridors. Permanent riparian areas would be acquired from willing landowners through conservation easements. The most beneficial locations could be selected during the "Greenprinting" modeling process currently being conducted by the North Central Texas Council of Governments and the Trust for Public Land. Based on subwatershed data developed in the Master Plan process, the TPL will use the Greenprinting model to select the most beneficial properties for conservation easements. The easement areas will be maintained by public entities or through cooperative agreements with the landowners. Requested: $2,000,000.

d. Debris Removal Equipment. A significant quantity of debris and trash with potential contaminants currently enters the lake. BMPs will be recommended to collect and reduce the quantity of debris and trash, however the problem cannot be completely eliminated. A debris collection and removal boat could be used on the lake to continually remove potential sources of contamination from the water. Requested: $400,000.

e. BMPs. A major component of this Master Plan is the implementation of watershed BMPs to reduce potential sources of nonpoint pollution. Because most of these BMPs will be implemented within the watershed but outside the City of Arlington, the City may need to provide financial incentives to other entities. For example, under interlocal agreements, the City may construct BMPs in areas of the watershed outside of its jurisdiction. The maintenance of the BMPs will be provided by public entities or under cooperative agreements with landowners. Requested: $2,000,000.

4. Nonpoint [Clean Water Act 319 (h)] Source Implementation Grants:
   This program provides grants to states to implement nonpoint source projects and programs. These include Best Management Practices (BMP) installations for animal wastes and sediment, pesticide and fertilizer control, stream bank restoration, lake protection/restoration, septic system restoration, and management. Beneficiaries are generally required to provide 40% of the total project or program costs.

   In Texas, the program is administered through the Texas State Soil and Water Conservation Board. The Board periodically requests proposals for watershed assessment, planning, implementation, demonstration, and education projects seeking funding under the program. Proposed projects should focus on agricultural and/or silvicultural nonpoint source pollution prevention and abatement activities within the boundaries of impaired or threatened watersheds but may also include unimpaired watersheds. Proposals must focus on the restoration and protection of water quality, and a competitive proposal process is used for selection.

   Specific activities that can be funded with §319(h) grants include: development of detailed watershed protection plans including the formation and facilitation of stakeholder groups; surface water quality monitoring; data analysis and modeling; implementation of nine-element watershed protection plans and the nonpoint source portion of total maximum daily load implementation plans; demonstration of innovative BMPs; technical assistance to landowners for conservation planning; public outreach/education, and monitoring activities to determine the effectiveness of specific pollution prevention methods.

   More information is available at: http://www.tsswcb.state.tx.us or by contacting the Board at (254) 773-2250.

5. Pollution Prevention Incentives for States:
   This program provides grants focused on institutionalizing multimedia (air, water, land) pollution prevention techniques. Eligible entities include state and local agencies, universities, nonprofit organizations, and private business. Projects include technical assistance, data collection, education and outreach, training, environmental auditing, demonstration projects, and the integration of pollution prevention into state regulatory programs. For more information, see: http://www.epa.gov/p2/grants/.

6. Water Pollution Control (106) Program Support:
   This program provides grants to states, tribes, and interstate water pollution control agencies to sup-

port the prevention and abatement of surface and groundwater pollution from point and nonpoint sources. Eligible activities include water quality planning, monitoring, permitting, surveillance, enforcement, advice, and assistance to local agencies, etc. for the purpose of establishing and maintaining water pollution control programs. For more information, see: http://www.epa.gov/owm/cwfinance/pollutioncontrol.htm.

7. Water Quality Cooperative Agreements [104(b)(3) Grants]:
   This program provides grants to support innovative demonstration projects for addressing stormwater, combined sewer overflows, sludge, pretreatment, mining, animal feeding operations, and other sources relating to the National Pollutant Discharge Elimination System (NPDES) program. This includes research, investigations, experiments, training, surveys, and studies related to the causes, effects, and prevention of pollution. For more information, see: http://www.epa.gov/owm/cwfinance/waterquality.htm.

8. Watershed Assistance Grants (WAG):
   The purpose of this program is to build cooperative agreements between nonprofit organizations and other eligible entities to support watershed partnerships and long-term effectiveness. Funding then supports organizational development and capacity building for watershed partnerships with a diverse membership. Grants will be distributed to a pool of applicants, which are diverse in terms of geography, watershed issues, the type of partnership, and approaches. For more information, see: http://www.rivernetwork.org/howwecanhelp/index.cfm?doc_id=94#wag.

9. Wetlands Program Development Grants:
   Provides financial assistance to states, tribes, and local governments to support development or enhancement of wetland protection, management or restoration programs. Projects must demonstrate a direct link to an increase in the states, tribes, or local governments' ability to protect wetland resources. Funding may only be used to enhance and develop new and existing state wetlands programs, not for their operational support. For more information, see: http://www.epa.gov/owow/wetlands/grantguidelines.

10. Watershed Processes and Water Resources Program: These programs sponsor research that address two areas: 1) understanding fundamental processes controlling source areas, the flow pathways of water, and the fate of water, sediment, and organisms within forest, rangeland, and agricultural environments as they are influenced by watershed characteristics; and 2) developing appropriate technology and management practices for improving the effective use of water and water quality for agricultural and forestry production. For more information, see: http://www.reeusda.gov/.

11. Farmland Protection Program: This program provides matching funds to existing farmland protection programs for the purchase of conservation easements. Eligible property includes farm or ranch lands that have prime, unique, statewide, or locally important soil and includes all cropland, rangeland, grassland, pasture land, incidental forest land, or wetlands. For more information, see: http://www.usda.gov/farmbill.

12. Watershed Protection and Flood Prevention Program: The 'Watershed,' or 'PL 566,' program provides technical and financial assistance for water resource challenges on a watershed basis. Projects related to flood mitigation, water supply, water quality, erosion and sediment control, wetland creation

and restoration, fish and wildlife habitat enhancement, and public recreation are eligible for assistance. Technical and financial assistance is also available for planning new watershed surveys. While this program has been severely underfunded in recent years, there are periodic opportunities. Therefore, it is recommended that the City maintain continual contact with the U.S. Department of Agriculture's Natural Resource Conservation Service. For more information, see: http://www.nrcs.usda.gov/programs/watershed/.

13. Land and Water Conservation Fund (LWCF): LWCF uses offshore oil leasing revenues to support grants to States, and through States, local units of government for the acquisition and development of state and local park and recreation areas that guarantee public use in perpetuity. All funded projects must be available for public recreational use. Texas Parks & Wildlife is the administrative agency in Texas, and the City is familiar with this program.

14. Partners for Fish and Wildlife Program: Since 1987, the program has partnered with more than 28,725 landowners to restore over 639,000 acres of wetlands; 1,070,000 acres of prairie, native grassland, and other upland habitats; and 4,740 miles of in-stream aquatic and riparian habitat. In addition, the program has reopened more than 300 miles of stream habitat for fish and other aquatic species by removing barriers to passage. For more information, see: http://partners.fws.gov/.

B. Studies, Capital Improvements and Operations

1. U.S. Army Corps of Engineers Programs: In recent years the U.S. Army Corps of Engineers (USACE) has placed special emphasis on stream restoration and flood mitigation studies and projects, with cooperation and financial contributions from local non-Federal interests. In most cases, the federal share during the study phase of a project is 50%, but funding is dependent upon federal appropriations or inclusion within general legislation related to the USACE. With regard to Village Creek, a federal effort would be authorized under previous Trinity River legislation, but it would be dependent upon the actual appropriation of funds. The study effort for Village Creek is referenced in the NCTCOG's Vision North Texas Plan.

   Over the last year, the City of Kennedale and the City of Arlington have been in discussions with the USACE regarding a water quality enhancement study of Village Creek. If those studies are funded and show a positive benefit-cost ratio, implementation funding could be appropriated in order to implement one or more projects. To date, there has been no appropriation.

   While the federal contribution during the design and construction phases is greater than 50%, using the Corps as a funding source is a long and complicated process.

2. Arlington Tomorrow Fund Foundation: In 2007, the City of Arlington created a non-profit foundation to invest, manage, and distribute revenues generated from natural gas leases on City property. The foundation receives 90% of the bonus payment and 50% of the royalties. Twice each year, the foundation makes matching grants to city departments, non-profit agencies, and eligible community groups. As of January 2010, the foundation was managing a $55 million endowment.

   Given the importance of Lake Arlington as a multi-purpose resource, it is logical for the City to use grants from the Tomorrow Fund for important projects related to implementing the Master Plan.

3. Cooperative Agreements with Fort Worth, TRWD, TRA, and NCTCOG: Many of the recommendations developed in the planning process, provide benefits beyond the City of Arlington. Watershed and storm water planning and management, and the implementation of BMPs in the Village Creek watershed are closely aligned with the purposes, goals, and objectives of the City of Fort Worth, Tarrant Regional Water District (TRWD), the Trinity River Authority (TRA), and the NCTCOG. It makes sense for the City to develop cooperative agreements with these three agencies to produce mutual benefits and funding arrangements that take advantage of economies of scale.

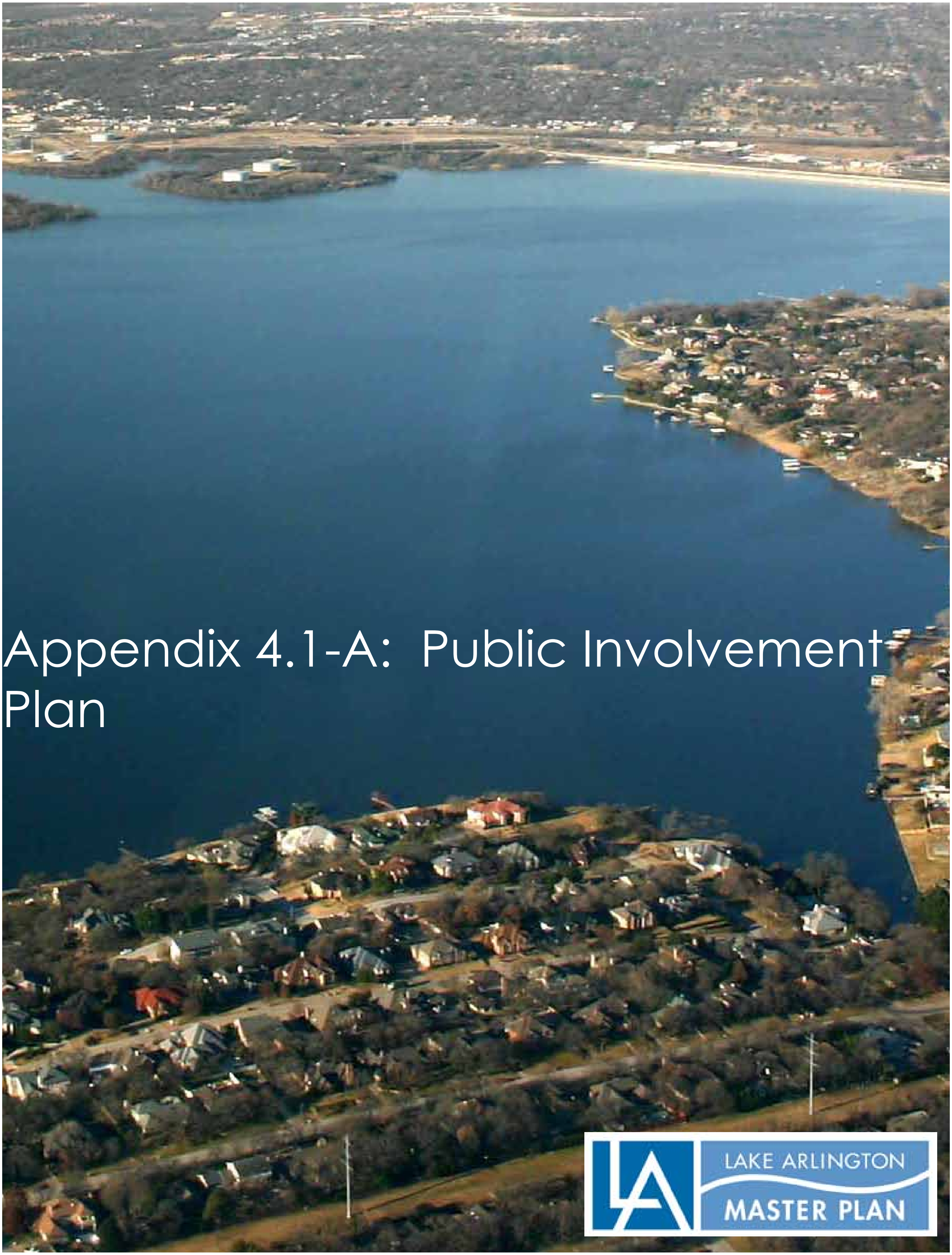
4. Rate Increases for Permit Fees: The Boating Capacity Study effort found that there was general acceptance of rate increases when the additional revenues were used directly for the benefit of Lake Arlington and "…to assist in the upkeep of the lake." Eighty percent (80%) of the respondents supported an increase of 20% in the permit rates. Those who supported a rate increase recommended the following uses for the additional revenue: litter pickup; upgrading park amenities; code enforcement; fish stocking; dredging; removing trees and stumps.

   In order to make efficient use of rate increases, it is important to show users and constituents that the new revenues are being used effectively and efficiently. It is also recommended that regular, smaller increases in rates be implemented rather than infrequent large increases.

5. Special Service Fees: If the City implements the recommendation such as the purchase and operation of a "snagging" boat for the removal of large debris such as logs, there may be an opportunity to establish a special service fee for certain activities. When the City assists shoreline residents by removing large debris from their private property, the City is actually providing a specific service using very specialized equipment. It might be appropriate to establish a special fee for such services, especially on the Fort Worth side of the reservoir where Arlington does not benefit from any tax revenues. There may be other examples of ways to generate additional revenue from ancillary activities related to the operation of the lake.

9.2.6 Future Costs

Within each section of the Master Plan, there are cost ranges for implementation of specific technical recommendations. Given the breadth of this Master Plan, it is not possible to determine an overall total cost estimate to achieve the objectives of protecting the water quality of Lake Arlington. However, it is well known that source water protection is much cheaper than treatment of degraded water supplies. The most cost effective recommendations within the Master Plan include protection of natural areas around Lake Arlington and within the watershed, and incorporation of nutrient removal in future wastewater treatment plant permits. Protection of natural areas can best be achieved by the purchase of conservation easement on selected areas and maintenance of riparian corridors along major tributaries. Shown above is a description of the process that is recommended for the City of Arlington's continued involvement in the permitting and renewal of wastewater discharges within the watershed.



Appendix 4.1-A: Public Involvement Plan

LAKE ARLINGTON MASTER PLAN

Pour Yourself Into Its Future.

PUBLIC INVOLVEMENT PLAN
FOR THE
LAKE ARLINGTON MASTER PLAN

February 4, 2010
Updated May 25, 2010
Updated November 2, 2010

adisa

TABLE OF CONTENTS

PROJECT DESCRIPTION

The City of Arlington is developing a Master Plan for Lake Arlington. The Master Plan is a way for policy makers and citizens to plan appropriately for potential development and growth in and around this important water resource. The Master Plan will be used by the City of Arlington as a short and long-term planning tool to:

- Protect the city's water supply
- Protect the city's water quality
- Optimize recreational opportunities
- Identify future land uses and potential for development
- The final plan will include a vision for Lake Arlington, a set of guidelines and standards for protection of water quality, development, beautification, recreation and open space opportunities and a way to implement the vision.

About the City of Arlington and Arlington Water Utilities

Incorporated in 1884, the City of Arlington was named after the Arlington, Virginia birthplace of Robert E. Lee. The current population is nearly 370,000 residents and it is home to several international attractions including The Ranger's Ballpark, the original Six Flags Over Texas, and the new and unparalleled Cowboy's Stadium.

Arlington Water Utilities, through its management of Lake Arlington, serves over half a million customers in the city and watershed. It currently operates and maintains two water treatment plants: Pierce-Burch, which has the capacity to produce 100 million gallons per day, and John F. Kubala, which has the production capacity of 65 million gallons per day.

It is the mission of Arlington Water Utilities to protect public health by providing high quality water and safely disposing of wastewater in a cost competitive manner, while continuously improving service to our customers and planning for future needs. This commitment is reflected in their ongoing development of community service events and educational workshops, such as free landscaping seminars provided throughout the year. The department also sponsors the Annual Lake Clean-Up Project and participates in relevant studies and projects regarding these areas.

Arlington Water Utilities has also identified several key areas of importance: infrastructure (system), investment in the human resources that support the Department, establishing protocols to maintain long-term water supply for the customers, competitive services and financial stability by utilizing current technology and interactive fiscal management, and compliance with regulatory and community organizations.

About Lake Arlington

Lake Arlington covers about 2,000 surface acres (three square miles), and was built in 1957 at the end of the 1950s drought. It is located on Village Creek, a tributary of the West Fork Trinity River, just north of Interstate 20 in Arlington. The primary purpose of the lake is to store water to be treated for drinking, and the lake serves the City of Arlington and other cities in Tarrant County. Lake Arlington is owned and managed by the City of Arlington.

The lake is also used for power plant cooling and for recreational purposes, including fishing and small watercraft, and is home to the first lake paddling trail in the Dallas-Arlington Water Utilities Metroplex.

The tributaries (streams and creeks) that feed into Lake Arlington flow in a northward direction. This means that the cities and towns in the watershed that impact Lake Arlington are located south of the lake. The entire watershed is 143 square miles and includes Quill Miller, Deer Creek, and the Village Creek and Wildcat Branch watersheds.

Lake Arlington is home to several species of game fish including the Florida largemouth bass, white bass, white crappie, and the channel and flathead catfish.

GOALS AND OBJECTIVES

The primary purpose of developing a Master Plan for Lake Arlington is to protect the lake as a water resource. Public officials and residents agree that the Water Utilies Department has a responsibility to plan appropriately for growth in the watershed and around the lake and potential uses of this important water resource to ensure that the water quality is protected as development occurs.

One of the goals of the Public Involvement Plan is to gather public input and participation in the development of the Lake Arlington Master Plan. We will inform and engage Arlington and Fort Worth citizens and stakeholders directly affected by the Master Plan. An additional goal is to provide timely, factual information to the general public about the Master Plan.

The following objectives have been identified in support of this goal:

- Foster a relationship with the community to engage them in the planning process
- Host a series of Roundtable Discussions with stakeholders in the Development/Business Community, Parks and Recreation Advocates, and Neighborhood and Adjacent Property Owners
- Host Public Meetings in Arlington and Fort Worth
- Create handouts and visual presentations for meetings
- Create a web page to provide public information and receive public feedback
- Establish a local phone number to receive community feedback

Communications Principles

Based on this approach, Adisa suggests the following Communications Team Guiding Principles to create transparency and openness in our planning and decision making processes:

Principle 1: Openly Communicate
Everything is on the table – The Master Plan process must be transparent. Every piece of data must be vetted through the filter of the values and perspective of community and the potentially affected audiences. We will provide information early and often.

Principle 2: Keep It Simple
Technical/Legal Jargon is not an acceptable way to present information to the Community – Our information has to be shared in clear, simple language. No exceptions.

Principle 3: Seek to Understand
We will learn from each other as we go – The focus of the study is to learn as much as we can about the lake and potential impacts of economic development, open space and recreation. We will use this same framework to learn as much as we can about our potentially affected audiences; then we will the share information of the potential impacts as we learn them. If we follow this approach, we will be able to better communicate because we understand the points of view that need to be addressed.

Principle 4: Exceed Quality Expectations
Our work and quality exceeds requirements for public involvement – We have outlined a campaign that establishes and maintains widespread community involvement in the study process through the media, meetings, Internet, face-to-face discussions and events.

Principle 5: Give Constant Feedback
We must show the community how their input is incorporated during the study process – Our approach will continually give feedback to the community to show that we are listening and that we have incorporated their ideas and input as appropriate.

Past Issues Related to Lake Arlington

Arlington Water Utilities is committed to providing quality drinking water and remaining innovative in the tools, programs, and methodologies used to support this initiative. In working toward this purpose, several issues have arisen from the community which required a response or acknowledgement from the department. Some of these issues identified from local newspaper articles are:

Pharmaceuticals in Drinking Water
- A study released in 2008 identified 24 US metropolitan areas with very small amounts of drugs in the drinking water. Five microconstituents were identified in the pretreated water of Lake Arlington and one identified in a trace amount in the treated water.

Natural Gas Drilling
- Energy companies are drilling for natural gas stored in the Barnett Shale. There is concern regarding the levels of cancer causing chemicals emitted due to this process and possible contaminants in runoff from drilling sites.

Trash
- Trash buildup and dumping of trash in Lake Arlington has been an issue. Arlington Water Utilities hosts an annual Lake Clean-Up Day which engages the community to take ownership and shared responsibility for the lake.

Boating Capacity, Economic Development, Open Space and Recreational Uses
- There is a current need to understand the capacity of Lake Arlington to support the proposed development of the lake.

Extreme Weather Temperatures
- Consistent days with temperatures over 100 degrees increased the temperature of the lake, resulting in hundreds of small fish dying and washing onto shore. Parks and Wildlife officials responded that the fish died due to depleted oxygen in the water caused by the high temperatures.

Dredging
- Dredging has been presented as a possible solution to limited lake access in some areas when water levels are low.

Increased Water Costs for Public
- Increased temperatures resulted in increase water usage (to maintain lawns, etc.)
- Residents were continually encouraged to conserve water and adhere to scheduling guidelines for maximum benefit of water usage

Success at Lake Arlington
- Community support and buy-in of maintaining the aesthetic beautification of the lake
- Arlington Water Utilities, developers, business leaders, and community alliance to minimize chemical and pharmaceutical runoff in Lake Arlington

- The establishment of a plan to maximize access to Lake Arlington when low water levels exist
- Clear understanding of activities/developments the lake can support while maintaining water quality
- Community commitment to conservation and responsible landscaping/water usage

Challenges at Lake Arlington

- Inadequate support/commitment by all groups of stakeholders of water conservation and protection and lake beautification
- Development or ongoing delay of development of Lake Arlington without scientific knowledge of lake capacity
- Lack of communication with community and stakeholders regarding the planning and evaluation process

Potential Consequences of an incomplete planning process

- Underuse of the lake resulting in disenfranchised business and residential communities
- Overuse of lake resulting in a negative impact on water quality
- Ongoing public concerns regarding accessibility of lake, trash, dredging

The Vision for the Master Plan Process

The Master Plan will be shared with the community in a manner that ensures they understand their vision, concerns, and ideas are fully welcomed and needed. The message will be communicated that the Master Plan is in process in order to understand the opportunities present for Lake Arlington that will enhance their experience as Arlington residents and leaders while ensuring that quality of the lake will continue to be maintained throughout and after the completion of the plan. It is important that the community remains engaged and kept fully informed of the progress, findings, and opportunities to participate in the planning process.

INTERNAL COMMUNICATIONS AND PROTOCOLS

Adisa Communications is part of the Malcolm Pirnie project team responsible for providing public involvement services. Adisa reports directly to Malcolm Pirnie's Project Manager Fred Blumberg. All materials will be reviewed and approved by the client prior to distribution to the public.

Coordination with Arlington Water Utilities and the City of Arlington Communication Department

Information submitted for the development of the Web page will be submitted to the city's Office of Communication's Director, Gerald Urbantke. The timeframe to develop the webpage will be one week. All updates are to be submitted to a staff member with the Communication Department for updates within 24 hours. Arlington Water Utilities will approve all press releases and will have a staff member available for media response at all public meetings.

Protocol for submitting webpage content, press releases to the City of Arlington's Office of Communication Department, etc:

- Document/information submitted to Fred Blumberg and Malcolm Pirnie project team for review, comment, and revision
- Draft submitted to Arlington Water Utilities (Julie Hunt, Brandon Ballew)
- Revised document submitted to Arlington Water Utilities for approval (if revision required)
- Final document submitted to Communication Department for approval, posting, and/or release.

All information submitted to the Communication's Department will be first approved by Julie Hunt and will be ready for publication including:

- Web page content
- Press Releases
- Public Meeting Materials
- Focus Group Materials
- Fort Worth Materials

The City of Arlington Water Department will provide input and assistance on the following aspects of the Public Involvement Plan:

- Messaging
- Stakeholder Identification and management
- Meeting locations for both Arlington and Fort Worth
- Staffing needs at public meetings
- Mailings for focus groups and public meetings

GENERAL AUDIENCES

Internal Audiences

- City Council
- City Manager and Deputy City Managers
- Water Utilities
- Public Works
- Parks & Recreation
- Code Enforcement
- Community Development & Planning
- Office of Communications

External Audiences

- General Public
- Affected Businesses and Property Owners
- Parks and Recreational Users
- Business Community
- Political Entities/Subdivisions
- Neighborhood Groups

Media

- Local media outlets including print, radio, online and TV

A LIST OF SPECIFIC REPRESENTATIVES IS KEPT ON A STAKEHOLDER DATABASE WHICH IS UPDATED CONTINUALLY BY ADISA COMMUNICATIONS.

MESSAGING AND IDENTITY

Logo - LA Wave

The simple letterforms of the L and A where they overlap and fit together signifying the how various ideas, thoughts and proposals shared during the development of the Master Plan will work together to form a cohesive, unified outcome. The simple wave shape signifies water and represents the future vision of Lake Arlington.

Pour yourself into its future.

Tag Line - Pour yourself into its future.

When someone pours themselves into something, they are doing it full-on, i.e., not taking it lightly. This tagline is a call to action; a call or request for inclusiveness as we proceed with the project. By using the word yourself, we are identifying that we need the help of the community.

Messaging

The following messaging has been developed for the Lake Arlington Master Plan to be used by the City of Arlington and the project team during the life of the project:

1. **OUR PRIMARY REASON FOR DEVELOPING A MASTER PLAN FOR LAKE ARLINGTON IS TO PROTECT THE LAKE AS A WATER RESOURCE.**
    a. Built in 1957, Lake Arlington covers three square miles and is primarily used as a water supply, storage and cooling lake.
    b. Public officials and residents agree that all have a responsibility to plan appropriately for growth and potential uses of this important water resource.
    c. By developing a Master Plan for Lake Arlington, we can protect the water supply and guide future development around the lake and the immediate area.
    d. Long-term planning also gives the City of Arlington the chance to review questions and concerns of constituents and stakeholders.

2. **PUBLIC INPUT AND IDEAS WILL BE SOUGHT DURING THE 15-MONTH MASTER PLANNING PROCESS.**
    a. Public input is encouraged as the City of Arlington explores the potential impact on water quality in relation to proposed uses of the lake and related economic development.
    b. The public and stakeholders will be engaged through public meetings and presentations and a Web site.
    c. The Lake Arlington Master Plan will assess the community's desires including uses of the lake, recreation, economic development and other issues.

3. **MAINTAINING WATER QUALITY IS A HIGH PRIORITY FOR CITY LEADERSHIP.**
    a. Arlington Water Utilities is responsible for maintaining the drinking water quality for more than a half a million people that depend on water from Lake Arlington.

b. Streams and lakes that feed into Lake Arlington flow northward, so the watershed areas are west and south of the lake and cover 143 square miles.
c. A full environmental review is being conducted by Malcolm Pirnie, one of the nation's largest firms providing environmental engineering, science and consulting services.

STRATEGIES AND DELIVERABLES TIMELINE

Early-January

1. Internal Team Planning Meeting – with MP team to discuss scope, deliverables and communication protocols.
2. The Pirnie Project Manager is required to give Brandon Ballew a status report and updated schedule every two weeks. The schedule must be provided in a computerized scheduling program compatible with the city's system. Caroline Russell is preparing a draft schedule (ongoing)

Mid-January

1. Kickoff Meeting with Arlington Water Utilities and Malcolm Pirnie Planning Team, Jan 19th
2. Databases for Focus Groups
3. Content Outline for Website
4. Schedule for the project, including the Public Meetings and Focus Groups
5. List of facilities for public meetings and community meetings
6. Draft meeting Presentation Materials developed
7. List of data needs from the City of Arlington and other agencies
8. Discussion of regional MS4 issues

Early-February

1. Public Involvement Plan Meeting with Arlington Water Utilities

Mid-February

1. Website launch
2. Fact Sheet
3. FAQs
4. Press Release
5. Presentation in a Box
6. Meeting with NCCOG, including discussion on MS4 permitting (1)

Early-March

1. Presentation to City Staff (per scope of work [SOW] in prep for first public meeting)

Mid-March

1. City/ Staffs on MS4 Permitting Process (2)

Late-March

1. Workshop follow up with Arlington and Fort Worth staff to discuss results of workshops, progress to date, findings, and recommendations
2. Public Meeting Prep with Arlington Water Utilities
3. Stakeholder Focus Group Meetings
   - Developers/Business Community Focus Group (1)
   - Parks and Recreation Advocates Focus Group (1)
   - Neighborhood and Property Owners Focus Group (1) – Fort Worth and Arlington
4. Public Meetings #1– Project Overview and Vision (Arlington and Fort Worth)
5. Update materials and Web site

6. Meeting with the City of Fort Worth

April

1. Public Meeting #2 in Fort Worth
2. City-COG Watershed Meeting with Cities/Counties in Watershed – co hosted by NCTCOG

June

1. Prepare for Public Meeting #3
2. Update materials and Website
3. Meeting with the City of Fort Worth

August

1. Stakeholder Focus Groups (second round)
   - Developers/Business Community Focus Group (2)
   - Parks and Recreation Advocates Focus Group (2)
   - Neighborhood and Property Owners Focus Group (3)
2. City/County Staffs on MS4 Permitting meetings with NCCOG
3. Meeting with the City of Fort Worth

Early-September

1. Public Meeting #3 – Consensus/Findings (Arlington, invite Fort Worth attendees)
2. Update materials and Website

Mid-September

1. Workshop follow-up with City of Arlington and City of Fort Worth staff to discuss results of workshops, progress to date, findings, and recommendations
2. Update Website
3. Meeting with the City of Fort Worth

Early-Feb 2011

1. Public Meeting #4/5 – Design Guidelines and Vision (Arlington and Fort Worth)
2. Update materials and Website

Mid-Feb 2011

1. Workshop follow-up with Arlington and Fort Worth staff to discuss results of workshops, progress to date, findings, and recommendations
2. Update materials and Website
3. Meet with the City of Fort Worth

* City of Arlington Presentations to City Council – need input from City staff on scheduling these

APPENDICES

STAKEHOLDER DATABASE

The most current stakeholder database can be found at the following link:

ftp://sftp.pirnie.com/Lake%20Arlington%20MP/Lake%20Arlington/Project%20Deliverables/Public%20Involvement

FOCUS GROUP INVITE LETTERS

ARLINGTON

June 10, 2010

Name
Address
City, State Zip

Re: Lake Arlington Master Plan

Dear Friend:

The City of Arlington is developing a Master Plan for Lake Arlington. The Master Plan is a document that will be used by the City as a short and long-term planning tool to:

Protect the city's water supply
Protect the city's water quality
Optimize recreational opportunities
Identify future land uses and potential for development

The Lake Arlington Master Plan will evaluate the present standards, policies and guidelines, and impact of current and planned development on the lake. The final plan will include a vision for Lake Arlington, a set of guidelines and standards for the protection of water quality, development, beautification, recreation and open space opportunities and a way to implement the vision.

You are invited to participate in a roundtable discussion regarding the Lake Arlington Master Plan with the Planning Team. As a leader in the business community, we would like to hear from you about how you use the lake and to gather your input on a vision for its future. The roundtable discussion will be held Thursday, March 25, 2010, at 11:30 a.m.

MEETING:	LAKE ARLINGTON MASTER PLAN ROUNDTABLE DISCUSSION
DATE:	THURSDAY, MARCH 25, 2010 • TIME: 11:30 A.M. – 1:00 P.M.
LOCATION:	ARLINGTON CHAMBER BUILDING 505 E. BORDER STREET, ARLINGTON, TEXAS 76010

To RSVP, please e-mail your reply to kjohnson@makingthingsclear.com by noon, Thursday, March 18, 2010, and include your full name, title and organization represented. For more information or if you have any questions, please contact Kaylah Johnson at 817-877-9978 ext 1.

Thank you for your interest in the Lake Arlington Master Plan. The City welcomes your participation and the sharing of your insights throughout the development of the plan.

We look forward to working with you.

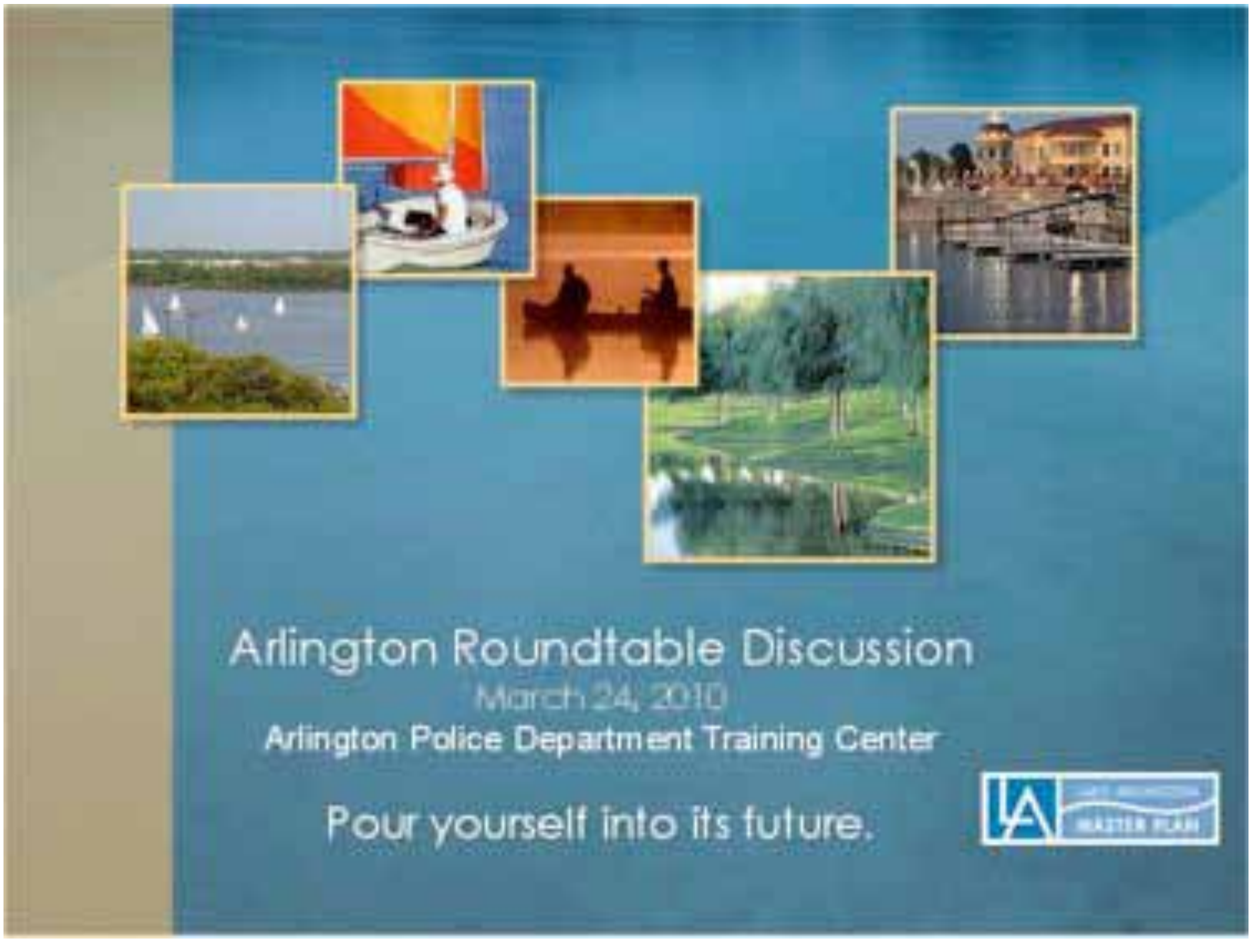
Sincerely,

Julia J. Hunt, P.E.
Director of Water Utilities

FOCUS GROUP PRESENTATION

To view the full PowerPoint presentation from the Focus Group Meetings, please go to:

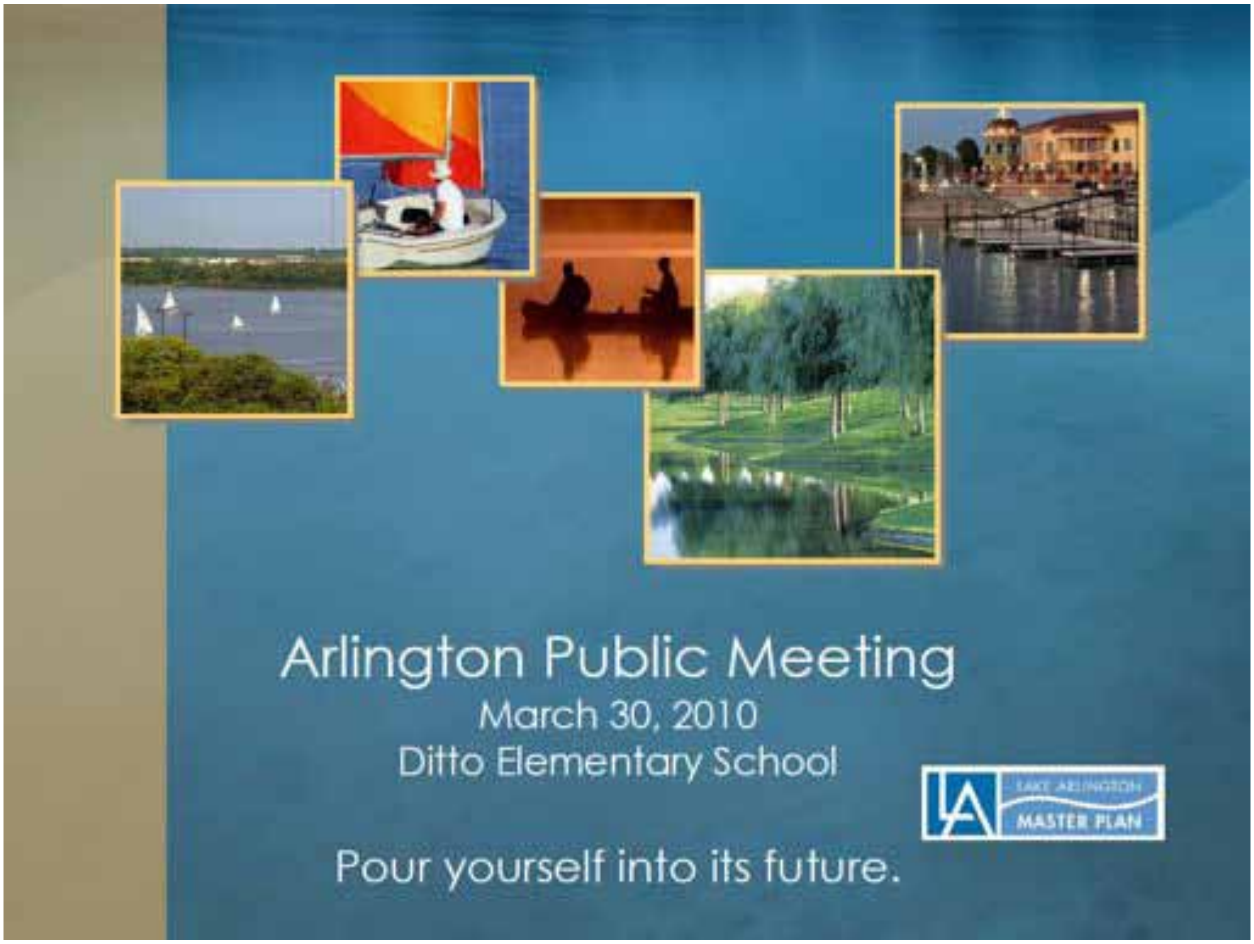
ftp://sftp.pirnie.com/Lake%20Arlington%20MP/Lake%20Arlington/Project%20Deliverables/Public%20Involvement/



PUBLIC MEETING PRESENTATION

To view the full PowerPoint presentation from the Public Meetings, please go to:

ftp://sftp.pirnie.com/Lake%20Arlington%20MP/Lake%20Arlington/Project%20Deliverables/Public%20Involvement



PUBLIC MEETING NOTICES

PUBLIC MEETING

LAKE ARLINGTON MASTER PLAN
APRIL 5, 2010
6:00 p.m.
TARRANT COUNTY COLLEGE
OPPORTUNITY CENTER
5901 FITZHUGH AVENUE

MEETING AGENDAS

ARLINGTON

LAKE ARLINGTON MASTER PLAN

Lake Arlington Master Plan Roundtable Discussions

Developers and Business Community
Thursday, March 25, 2010
11:30 a.m. – 1:00 p.m.
Arlington Chamber Building, GM Room
505 E. Border Street
Arlington, Texas 76010

AGENDA

1. Welcome and Introductions .... Julia Hunt, P.E., Director, Arlington Water Utilities

2. Purpose of Meeting .... Erich Dohrer, Planning Team Lead
   - Introduce Lake Arlington Master Plan
   - Understand current perceptions of Lake Arlington
   - Gather input regarding vision for Lake Arlington

3. Overview of Lake Arlington Master Plan .... Erich Dohrer, Planning Team Lead

4. Dialogue and Questions

5. Wrap Up .... Julia Hunt, P.E., Director, Arlington Water Utilities

6. Upcoming Public Meeting
   Arlington Public Meeting
   March 30, 2010
   6:00 p.m.
   Ditto Elementary
   3001 Quail Lane

FACT SHEET

Page 1

Quick Facts About the Lake Arlington Master Plan

About the Master Plan

The City of Arlington is developing a Master Plan for Lake Arlington. The City of Arlington will use the Master Plan as a short and long-term planning tool to:

- Protect the city's water quality
- Protect the city's water supply
- Optimize recreational opportunities
- Identify impacts of future development

The final plan will include a vision for Lake Arlington, a set of guidelines and standards for protection of water quality, beautification, recreation and open space opportunities and recommendations on how to implement the vision. The Master Plan will also explore development opportunities on and around the lake.

The project includes modeling water quality and how the various forms of development may impact water supply and quality. Best management practices will be prioritized based on the results of the water quality modeling.

About Lake Arlington

Lake Arlington was built in 1957 at the end of the 1950s drought. The Lake covers about 2,000 surface acres (three square miles). It is located on Village Creek, a tributary of the West Fork Trinity River. Lake Arlington is on the western border of Arlington just north of Interstate 20. The primary purpose of the lake is to store water to be treated for drinking. The lake serves the City of Arlington and 11 additional communities. Lake Arlington is owned and operated by the City of Arlington. The lake is also used for power plant cooling.

LAKE ARLINGTON MASTER PLAN

Pour yourself into its future.

COMMUNITIES IN THE WATERSHED:

ARLINGTON
BRIAROAKS
BURLESON
CROSS TIMBER
CROWLEY
DALWORTHINGTON GARDENS
EVERMAN
FOREST HILL
FORT WORTH
JOHNSON COUNTY
JOSHUA
KENNEDALE
MANSFIELD
PANTEGO
RENDON CDP
TARRANT COUNTY

ARLINGTON

V2

Page 2

Quick Facts About the Lake Arlington Master Plan

recreational purposes, and is home to the first lake paddling trail in the Dallas-Fort Worth Metroplex. Additionally, Lake Arlington is home to several species of game fish including the Florida largemouth bass, white bass, white crappie, and the channel and flathead catfish.

The Master Plan Project Team

The City of Arlington Water Utilities Department is leading the Master Plan effort with participation from Parks and Recreation, Community Development and Planning and Public Works Storm Water Management. City staff are working collaboratively with municipalities within the watershed and other stakeholders.

Project Timeline

The Master Plan process began in December 2009 and will last for about 15 months. A final document is expected to be completed spring 2011.

For More Information

The City of Arlington is seeking input and ideas from everyone in the watershed. Here's how you can learn more, give input and get involved:

- Attend a public meeting
- Visit our website at: www.arlingtontx.gov/water/lakearlingtonmasterplan.html
- Give us your comments online
- Send a letter to the contacts shown on the website
- Call us at 817.877.9978 ext 1

LAKE ARLINGTON MASTER PLAN

Pour yourself into its future.

WE REALLY WANT TO HEAR YOUR IDEAS ON:

- RECREATION
- OPEN SPACES
- BEAUTIFICATION
- SHORELINE DEVELOPMENT AND PROTECTION
- ENVIRONMENTAL PROTECTION
- TYPES OF DEVELOPMENT – RESIDENTIAL, COMMERCIAL, MIXED USE
- OTHER ISSUES IMPORTANT TO EACH STAKEHOLDER

www.arlingtontx.gov/water/lakearlingtonmasterplan.html
817.877.9978 ext 1

V2

FREQUENTLY ASKED QUESTIONS

Page 1

Frequently Asked Questions About the Lake Arlington Master Plan

1) What is the Master Plan and what is its purpose?
The City of Arlington is developing a Master Plan for Lake Arlington. The Master Plan will be used by the City of Arlington as a short and long-term planning tool to:

- Protect the city's water quality
- Protect the city's water supply
- Optimize recreational opportunities
- Identify impacts of future development

The Master Plan is also a tool for policy makers and citizens to plan appropriately for the potential impacts of development and growth in and around this important water resource.

2) What is the timeline for the Master Plan?
The Master Plan process began December 2009 and will last for about 15 months. A final document is expected to be completed in spring 2011.

3) Why is the City of Arlington developing a Master Plan?
It is a priority for the City of Arlington to protect the water quality of the lake in order to protect the city's water supply. Arlington and other communities receive their drinking water supply from Lake Arlington. The Trinity River Authority's Tarrant County Water Supply Project water treatment plant provides water to five cities. Completing the Master Plan will allow the city to establish best management practices that are beneficial in protecting the watershed. Communication with cities in the watershed upstream from Lake Arlington will be included. The Master Plan process will explore recreation, open space ideas and land development enhancements. This will benefit all users of Lake Arlington.

4) Who is leading the Master Plan?
The City of Arlington Water Utilities Department is leading the Master Plan effort. The city has also formed a team of city departments including Parks & Recreation, Community Planning and Development, and Storm Water/Public Works. City staff is working collaboratively with municipalities within the watershed and other stakeholders. An engineering consultant, Malcolm Pirnie, was hired in Dec 2009 to provide engineering, planning and public involvement services for the Master Plan project.

LAKE ARLINGTON MASTER PLAN

Pour yourself into its future.

5) What is the expected outcome of the Master Plan?
The final plan will include a vision for Lake Arlington, a set of guidelines and standards for protection of water quality, impact of future development, beautification, recreation and open space opportunities and recommendations on how to implement the vision. The Arlington City Council will make the final decision to adopt the guidelines and recommendations of the Master Plan.

6) How is the Master Plan being funded and what are the costs?
The total cost of the current project is approximately $542,000. It is initially being paid for by the City of Arlington; however, the city is pursuing grant funding alternatives and working relationships with potential partners.

7) Which local entities will be involved in the Master Plan process?
The City of Arlington Water Utilities Department is responsible for maintaining the drinking water quality from Lake Arlington for more than a half-million people who receive their treated drinking water from the lake. The planning process will include collection of data from the fourteen municipalities and two counties in the watershed.

They include:

Arlington	Fort Worth
Briaroaks	Johnson County
Burleson	Joshua
Cross Timber	Kennedale
Crowley	Mansfield
Dalworthington Gardens	Pantego
Everman	Rendon CDP
Forest Hill	Tarrant County

V2

Frequently Asked Questions
About the Lake Arlington Master Plan

8) What does the Master Plan include?
Developing the Master Plan involves evaluating existing water quality data, assessing current standards, methodologies and processes, gathering input from stakeholders, and developing new standards and best management practices. Specifically, the Master Plan Team will:

- Collect and review relevant policies, ordinances and master plans from the cities and towns in the watershed
- Collect and analyze water quality and environmental water quality data
- Collect and analyze physical data – i.e. open spaces, wetlands and roads
- Evaluate likely pollutant sources
- Review current best management practices
- Perform watershed modeling
- Develop appropriate standards, guidelines and best management practices
- Identify open space and recreational improvement opportunities
- Identify development opportunities
- Develop construction standards for development on and adjacent to the lake
- Perform a boating capacity study for Lake Arlington
- Conduct a pro-active public involvement process

9) Will water quality be negatively impacted because of the Master Plan process?
No. The Master Plan will actually provide recommendations on additional Best Management Practices for maintaining or enhancing the water quality of Lake Arlington.

10) What does the temporary suspension of all new construction permits around Lake Arlington mean and why has it been implemented?
The temporary suspension of new construction permits applies to all structures and earthwork in Lake Arlington or in the lake's adjacent flowage easement (such as docks, pools and retaining walls). The temporary suspension will enable the Arlington City Council to make informed decisions concerning the future improvements that should be allowed in the flowage easement based on the input received during the master planning process. However, during the suspension period, necessary repairs to legal existing structures and earthwork will be allowed with the approval of the city. Any repairs to existing structures will follow the standard permitting process.

11) Will Lake Arlington be available for recreational use during the planning process?
Yes. Boating, fishing, and other recreational activities on and around the lake will remain available.

12) How can I contribute to the Master Plan process?
Your input is welcomed and encouraged. The City of Arlington is seeking opinions and ideas from everyone in the watershed and from users of the lake. Here's how you can learn more, provide input to the master plan team, and get involved:

- Attend a public meeting
- Provide us with your comments online
- Send a letter to the contacts shown on the website described below

We encourage your opinions and ideas on the following:

- Recreation on and around the Lake
- Open space opportunities and uses
- Beautification opportunities
- Shoreline development and protection
- Environmental protection
- Types of development – residential, commercial, mixed use
- Other issues that are important to you and your family and friends

13) How can I obtain more information about the Master Plan?
For more information or questions on the Lake Arlington Master Plan, please visit our website at: www.arlingtontx.gov/water/lakearlingtonmasterplan.html, or contact us at 817.877.9978 ext 1.

ARLINGTON

v2

PUBLIC MEETING WELCOME GUIDE

Welcome!

Thank you for joining us to learn about the Lake Arlington Master Plan. The City of Arlington Water Utilities Department wants your input on the Master Plan.

Please visit each of the information stations to learn more about the Master Plan and to ask questions and give us your comments. In addition, we invite you to write down what you think the vision should be for Lake Arlington. The City of Arlington staff and planning team are here tonight to answer questions. They are wearing white shirts.

Visit Each Information Display

ABOUT THE MASTER PLAN

Learn about what a Master Plan is, why it is being developed, and its purpose. Learn more about the timeline of the Master Plan, who is leading the project, and how you can become involved in the process.

VISION & PREFERENCES (VOTING STATION)

View pictures of how other regions have developed their waterfronts. Help us define a vision for this important water resource. Give us your ideas on topics such as recreational uses for the lake, open spaces, lake beautification, shoreline development and protection, types of development, and other issues important to you and your family and friends.

WATER QUALITY & SOURCE WATERSHED PROTECTION

Find out how water is treated for drinking and kept suitable for human recreational uses and fish and wildlife that also live in the lake.

Additionally, see what can contribute to pollution in the watershed and how you and others can help keep the lake healthy for all users.

For more information on the Lake Arlington Master Plan, please visit our website at: www.arlingtontx.gov/water

LAKE ARLINGTON MASTER PLAN

Pour yourself into its future.

LAKE ARLINGTON MASTER PLAN
PUBLIC MEETING
TUESDAY, MARCH 30, 2010
6:00 P.M.

RUTH DITTO ELEMENTARY SCHOOL
3001 QUAIL LANE
ARLINGTON, TEXAS

Thank you for joining us this evening!

On the following page is a comment card that we ask you to please fill out and leave with us in the comment box. Your comments are appreciated and will assist the project team throughout the development of the Lake Arlington Master Plan.

ARLINGTON

PM1

COMMENT CARD

Give Us Your Feedback!

The City of Arlington wants to know your thoughts on the Master Plan for Lake Arlington.
Please describe what you think plans for Lake Arlington should include and avoid:

How do you currently use the lake?

What would you like to not see happen on the lake? Or as a result of development on the lakefront?

What's your vision for the future of the lake?

Additional comments:

PM1

PRESENTATION IN A BOX

PUBLIC OFFICIALS PACKET

PRESS RELEASES

ARLINGTON

City of Arlington
Office of Communication
Contact: Cheryel Carpenter
817-459-6404 or 817-832-3470
Cheryel.Carpenter@arlingtontx.gov

FOR IMMEDIATE RELEASE
March 29, 2010

Public Meeting on Lake Arlington Master Plan is March 30

Who: City of Arlington

What: Public meeting about Lake Arlington Master Plan

When: 6 p.m. Tuesday, March 30

Where: Ditto Elementary School, 3001 Quail Lane 76016

Why: To inform surrounding neighborhoods about the development of the Lake Arlington Master Plan, which is being led by the Water Utilities Department. Other participating city departments include Parks and Recreation, Community Development & Planning and Public Works & Transportation. City officials say the Master Plan will be a short and long-term planning tool for protecting water quality, supply and recreational opportunities on and around the lake. The plan will also explore economic development opportunities. A final document is planned for Spring 2011.

To view facts and additional information about the Master Plan, visit www.arlingtontx.gov/water.

To provide additional input, Arlington residents are invited to attend a public meeting or provide online comments. To learn more about the Master Plan and Tuesday's public meeting, call 817-677-5978 Ext. 1.

Background:

Lake Arlington is located on the western boundary of the city, on Village Creek, which is a tributary on the West Fork of the Trinity River. It was built in 1957 at the end of the 1950s drought. The lake covers about 2,000 surface areas or approximately three square miles, and is owned and operated by the City of Arlington.

-30-

The City of Arlington Press Room has news and information about the city designed especially for news reporters, assignment editors and photographers. Make it your source for news leads, photos, articles and more.
Click here www.arlingtontx.gov/newsroom

WEBSITE CONTENT

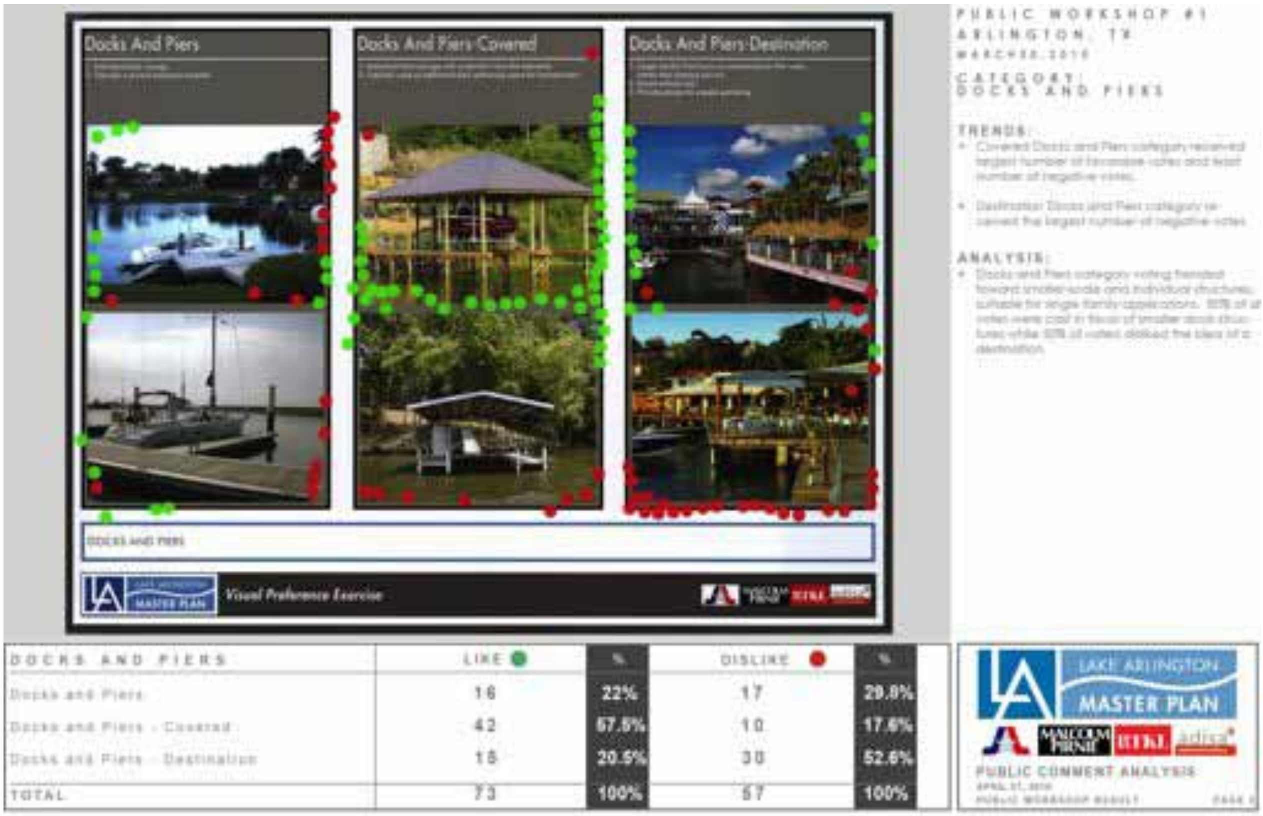
Please visit www.arlingtontx.gov/water/lakearlingtonmasterplan.html to view the Lake Arlington Master Plan website.

ONLINE SURVEY

MEETING SUMMARIES

The meeting summaries from the Roundtable Discussions and the two Public Meetings can be found at:

ftp://sftp.pirnie.com/Lake%20Arlington%20MP/Lake%20Arlington/Project%20Deliverables/Public%20Involvement/



PUBLIC MEETING #3 EMAIL ANNOUNCEMENT

Dear Friend,

You are invited to attend a public meeting on the Lake Arlington Master Plan:

Monday, September 13, 2010
6:00 p.m. to 8:00 p.m.
Ruth Ditto Elementary
3001 Quail Lane, Arlington, Texas 76016

Attached is a flyer announcing the meeting. To find out more information about the project please visit our website at: www.arlingtontx.gov/water/lakearlingtonmasterplan.html.

Thank you for your interest and participation in the Master Plan for Lake Arlington.

The Planning Team

PUBLIC MEETING #3 FACT SHEET

Page 1

Quick Facts About the Lake Arlington Master Plan

About the Master Plan

The City of Arlington is developing a Master Plan for Lake Arlington. The City of Arlington will use the Master Plan as a short and long-term planning tool to:

- Protect the city's water quality
- Protect the city's water supply
- Optimize recreational opportunities
- Identify impacts of future development

The final plan will include a vision for Lake Arlington, a set of guidelines and standards for protection of water quality, beautification, recreation and open space opportunities and recommendations on how to implement towards the vision.

The project includes modeling water quality and how the various forms of development may impact water supply and quality. Best management practices for protecting water quality will be prioritized based on the results of the water quality modeling.

About Lake Arlington

Lake Arlington was built in 1957 at the end of the 1950s drought. The lake covers about 2,000 surface acres (three square miles). It is located on Village Creek, a tributary of the West Fork Trinity River. Lake Arlington is on the western border of Arlington just north of Interstate 20. The primary purpose of the lake is to store water to be treated for drinking. The lake serves the City of Arlington and 13 additional communities. Lake Arlington is owned and operated by the City of Arlington. The lake is also used for power plant cooling.

LAKE ARLINGTON MASTER PLAN

Pour yourself into its future.

CITIES IN THE WATERSHED:

ARLINGTON
BRIAR OAKS
BURLESON
CROSS TIMBER
CROWLEY
EDGECLIFF VILLAGE
EVERMAN
FOREST HILL
FORT WORTH
JOHNSON COUNTY
JOSHUA
KENNEDALE
MANSFIELD
RENDON CDP
TARRANT COUNTY

ARLINGTON

V2

Page 2

Quick Facts About the Lake Arlington Master Plan

recreational purposes, and is home to the first lake paddling trail in the Dallas-Fort Worth Metroplex. Additionally, Lake Arlington is home to several species of game fish including the Florida largemouth bass, white bass, white crappie, and the channel and flathead catfish.

The Master Plan Project Team

The City of Arlington Water Utilities Department is leading the Master Plan effort with participation from Parks and Recreation, Community Development & Planning and Public Works Storm Water Management. City staff are working collaboratively with municipalities within the watershed and other stakeholders.

Project Timeline

The Master Plan process began in December 2009 and will last for about 15 months. A final document is expected to be completed spring 2011.

For More Information

The City of Arlington is seeking input and ideas from everyone in the watershed. Here's how you can learn more, give input and get involved:

- Attend a public meeting
- Visit our website at: www.arlingtontx.gov/water/lakearlingtonmasterplan.html
- Give us your comments online
- Send a letter to the contacts shown on the website
- Call us at 817.877.9978 ext 1

LAKE ARLINGTON MASTER PLAN

Pour yourself into its future.

WE REALLY WANT TO HEAR YOUR IDEAS ON:

- RECREATION
- OPEN SPACES
- BEAUTIFICATION
- SHORELINE DEVELOPMENT AND PROTECTION
- ENVIRONMENTAL PROTECTION
- TYPES OF DEVELOPMENT – RESIDENTIAL, COMMERCIAL, MIXED USE
- OTHER ISSUES IMPORTANT TO EACH STAKEHOLDER

www.arlingtontx.gov/water/lakearlingtonmasterplan.html
817.877.9978 ext 1

v2

PUBLIC MEETING #3 FREQUENTLY ASKED QUESTIONS

Frequently Asked Questions About the Lake Arlington Master Plan

LA LAKE ARLINGTON MASTER PLAN

Pour yourself into its future.

1) What is the Master Plan and what is its purpose?
The City of Arlington is developing a Master Plan for Lake Arlington. The Master Plan will be used by the City of Arlington as a short and long-term planning tool to:

- Protect the city's water quality
- Protect the city's water supply
- Optimize recreational opportunities
- Identify impacts of future development

The Master Plan is also a tool for policy makers and citizens to plan appropriately for the potential impacts of development and growth in and around this important water resource.

2) What is the timeline for the Master Plan?
The Master Plan process began December 2009 and will last for about 18 months. A final document is expected to be completed in spring 2011.

3) Why is the City of Arlington developing a Master Plan?
It is a priority for the City of Arlington to protect the water quality of the lake in order to protect the city's water supply. Arlington and other communities receive their drinking water supply from Lake Arlington. The Trinity River Authority's Tarrant County Water Supply Project water treatment plant provides water to five cities. Completing the Master Plan will allow the city to establish best management practices that are beneficial in protecting the watershed. Communication with cities in the watershed upstream from Lake Arlington will be included. The Master Plan process will explore recreation, open space ideas and land development enhancements. This will benefit all users of Lake Arlington.

4) Who is leading the Master Plan?
The City of Arlington Water Utilities Department is leading the Master Plan effort. The city has also formed a team of city departments including Parks & Recreation, Community Development & Planning, and Storm Water/Public Works. City staff is working collaboratively with municipalities within the watershed and other stakeholders. An engineering consultant, Malcolm Pirnie, was hired in Dec 2009 to provide engineering, planning and public involvement services for the Master Plan project.

5) What is the expected outcome of the Master Plan?
The final plan will include a vision for Lake Arlington, a set of guidelines and standards for protection of water quality, impact of future development, beautification, recreation and open space opportunities and recommendations on how to implement the vision. The Arlington City Council will make the final decision to adopt the guidelines and recommendations of the Master Plan.

6) How is the Master Plan being funded and what are the costs?
The total cost of the current project is approximately [illegible]. It is initially being paid for by the City of Arlington; however, the city is pursuing grant funding alternatives and working relationships with potential partners.

7) Which local entities will be involved in the Master Plan process?
The City of Arlington Water Utilities Department is responsible for maintaining the drinking water quality from Lake Arlington for more than a half-million people who receive their treated drinking water from the lake. The planning process will include collection of data from the fourteen municipalities and two counties in the watershed.

They include:

Arlington	Fort Worth
Briar Oaks	Johnson County
Burleson	Joshua
Cross Timber	Kennedale
Crowley	Mansfield
Edgecliff Village	Rendon CDP
Everman	Tarrant County
Forest Hill	

1/2

Page 2

Frequently Asked Questions About the Lake Arlington Master Plan

8) What does the Master Plan include?

Developing the Master Plan involves evaluating existing water quality data, assessing current standards, methodologies and processes, gathering input from stakeholders, and developing new standards and best management practices. Specifically, the Master Plan team will:

- Collect and review relevant policies, ordinances and master plans from the cities and towns in the watershed
- Collect and analyze water quality and environmental water quality data
- Collect and analyze physical data – i.e. open spaces, wetlands and roads
- Evaluate likely pollutant sources
- Review current best management practices
- Perform watershed modeling
- Develop appropriate standards, guidelines and best management practices
- Identify open space and recreational improvement opportunities
- Identify development opportunities
- Develop construction standards for development on and adjacent to the lake
- Perform a boating capacity study for Lake Arlington
- Conduct a pro-active public involvement process

9) Will water quality be negatively impacted because of the Master Plan process?

No. The Master Plan will actually provide recommendations on additional Best Management Practices for maintaining or enhancing the water quality of Lake Arlington.

10) What does the temporary suspension of all new construction permits around Lake Arlington mean and why has it been implemented?

The temporary suspension of new construction permits applies to all structures and earthwork in Lake Arlington or in the lake's adjacent flowage easement (such as docks, pools and retaining walls). The temporary suspension will enable the Arlington City Council to make informed decisions concerning the future improvements that should be allowed in the flowage easement based on the input received during the master planning process. However, during the suspension period, necessary repairs to legal existing structures and earthwork will be allowed with the approval of the city. Any repairs to existing structures will follow the standard permitting process.

11) Will Lake Arlington be available for recreational use during the planning process?

Yes. Boating, fishing, and other recreational activities on and around the lake will remain available.

12) How can I contribute to the Master Plan process?

Your input is welcomed and encouraged. The City of Arlington is seeking opinions and ideas from everyone in the watershed and from users of the lake. Here's how you can learn more, provide input to the master plan team, and get involved:

- Attend a public meeting
- Provide us with your comments online
- Send a letter to the contacts shown on the website described below

We encourage your opinions and ideas on the following:

- Recreation on and around the Lake
- Open space opportunities and uses
- Beautification opportunities
- Shoreline development and protection
- Environmental protection
- Types of development – residential, commercial, mixed use
- Other issues that are important to you and your family and friends

13) What is the flowage easement and how do I find out if my property is within the flowage easement?

A flowage easement is the land adjacent to Lake Arlington that is reserved to handle high water levels that occur when floodwater enters the lake from upstream. For Lake Arlington, the flowage easement is located between elevation 550 feet and elevation 560. In order to find out if any portion of your property is located within the flowage easement, you would need to have a surveyor conduct a topographic survey.

15

Page 3

Frequently Asked Questions About the Lake Arlington Master Plan

14) I live in Fort Worth and want to know who to contact to build a dock, pier or retaining wall.

Since Lake Arlington is owned and operated by the City of Arlington, all development that occurs within the Lake Arlington reservoir and flowage easements requires approval and issuance of a permit by the City of Arlington. This includes all construction activity that occurs at or below the 560 mean sea level elevation. Fort Worth residents should also contact the City of Fort Worth for any requirements. Residents can contact the City of Arlington's Community Development & Planning Department at 817.459.6502.

15) Why are Fort Worth and other cities involved in the Master Plan?

The water that flows into Lake Arlington comes from a 143 square mile area surrounding the lake. A large portion of this area is south of Arlington. The 13 communities and two counties within the drainage area are being asked to participate in the Lake Arlington Master Plan because their policies and planning decisions could affect the water quality in Lake Arlington.

16) Can I do work on my property that is located within the flowage easement?

The Arlington City Council has temporarily suspended the processing of all applications for site plan review for earthwork and permits for structures on and around Lake Arlington. This temporary suspension will remain in effect until the Arlington City Council has acted on the Master Plan, which will be completed in March 2011.

17) How do I get a permit for repairs to existing structures during the suspension?

Only necessary repairs to permitted, existing structures will be allowed if there is an imminent threat to public health or safety as determined by the City of Arlington Administrator, or as necessary due to an imminent threat to public health or safety as determined by the Arlington City Council. Applications for such repairs will be reviewed on a case-by-case basis. Any repairs to existing structures will follow the standard permitting process. Both Arlington and Fort Worth residents should contact the City of Arlington's Community Development & Planning Department at 817.459.6502, and ask for the Engineer of the day. Each request will be evaluated on a case-by-case basis and will be determined if the request is a matter of life safety and will be processed accordingly.

18) How can I obtain more information about the Master Plan?

For more information or questions on the Lake Arlington Master Plan, please visit our website at www.arlingtontx.gov/water/lakearlingtonmasterplan.html, or contact us at 817.877.9978 ext 1.

15

PUBLIC MEETING #3 WELCOME GUIDE

PUBLIC MEETING #3 COMMENT CARD

Give Us Your Feedback!

The City of Arlington wants to know your thoughts on information from the stations at this public meeting.

Please comment on the following:

Please comment on the Draft Vision:	What are your thoughts about the opportunities and constraints?
Are there specific issues or concerns you have about the opportunities and constraints?	What do you think the top priority should be for the City of Arlington?

PM3

Page 2

Give Us Your Feedback!

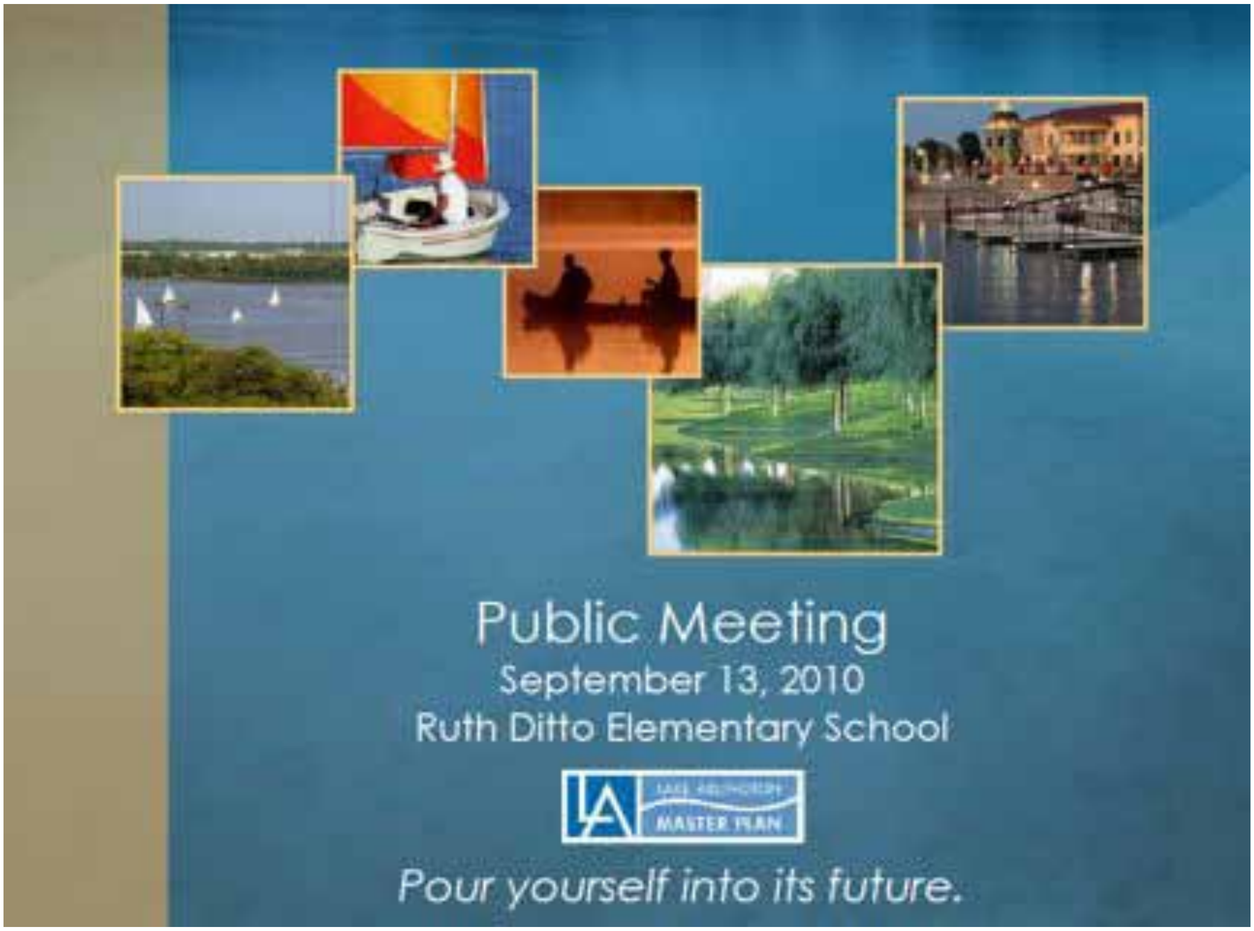
The City of Arlington wants to know your thoughts on the Master Plan for Lake Arlington.
Please use this page to provide any additional comments, opinions, or ideas for Lake Arlington.

Additional Comments:

PM2

PUBLIC MEETING #3 PRESENTATION

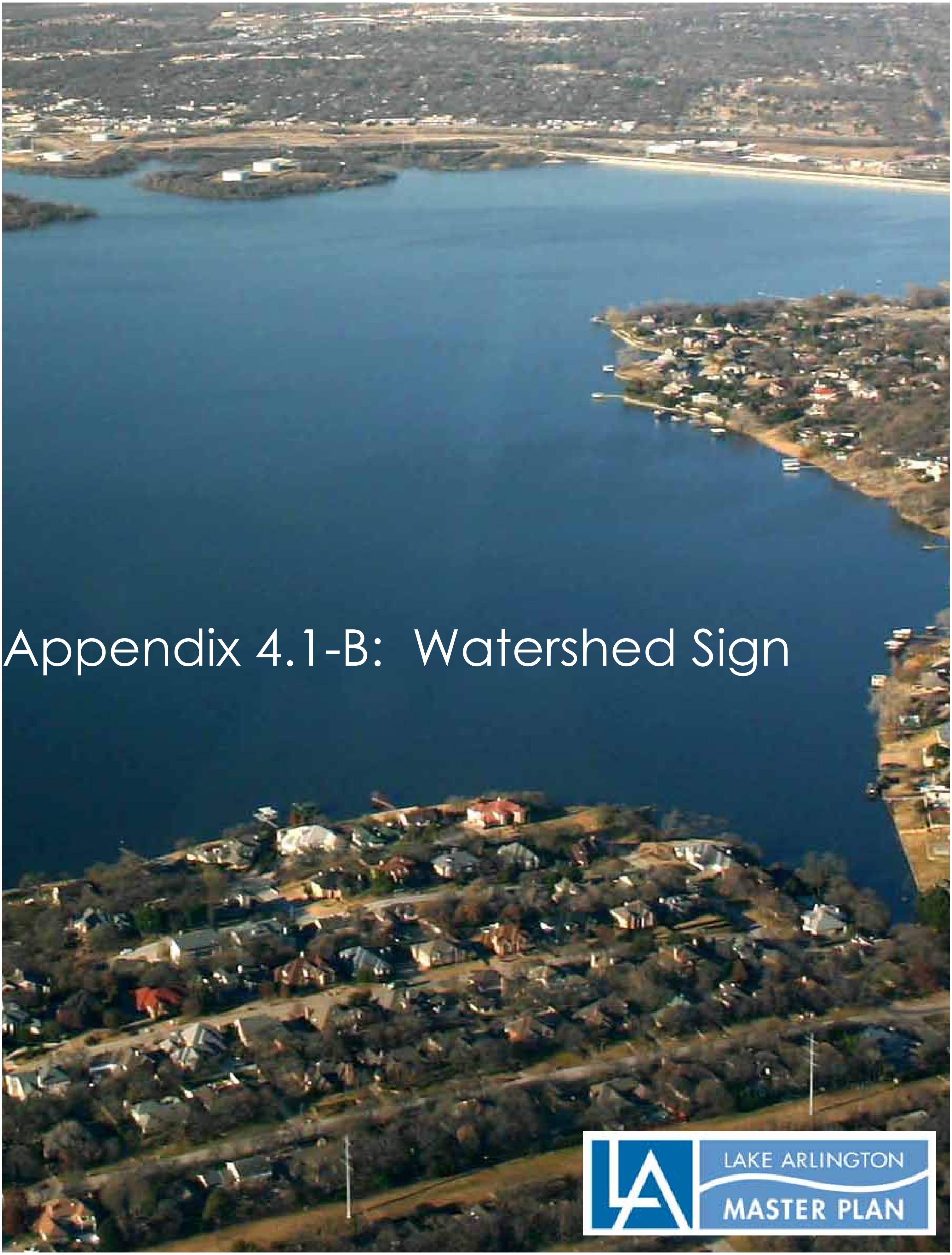
To view the full PowerPoint presentation from Public Meeting #3, please go to:
ftp://sftp.pirnie.com/Lake%20Arlington%MP/Public%20Meeting%20%233%20Final%20Documents/



PUBLIC MEETING #3 PRESENTATION BOARDS

To view all presentation boards from Public Meeting #3, please go to:
ftp://sftp.pirnie.com/Lake%20Arlington%MP/Public%20Meeting%20%233%20Final%20Documents/

Appendix 4.1-B: Watershed Sign



LAKE ARLINGTON MASTER PLAN

A Typical Watershed Awareness Sign

Appendix 4.1-C: Comment Log/E-mail Log

MALCOLM PIRNIE
LAKE ARLINGTON MASTER PLAN
EMAIL/PHONE LINE LOG
01.12.2011

Correspondence	Date	From	Subject	Follow Up / Resolution
Email	01.11.11	J.T. Evans (Tom) charandtom@sbcglobal.net	Mr. Evans emailed the study team to express his concern about all the trash he saw at Lake Arlington, in Panther Creek.	Joe Gildersleeve, with the City of Austin, responded to Mr. Evans' email. Please refer to Appendix M for all email correspondence.
Email	11.08.10	Dick Kahle dick@kahle.org	Mr. Kahle emailed the study team about his concerns for Lake Arlington. He believes that Lake Arlington must be treated like a park, and have the funds to keep it clean. Mr. Kahle also provided photos of the debris he has seen at Lake Arlington.	Mr. Kahle's email can be found in Appendix L. His information will be considered in the Lake Arlington Master Plan process, and his contact information has been added to the Master Plan database.
Email	10.18.10	Chris Stinson	Mr. Stinson emailed the study team about his thoughts on a Fish Habitat on Lake Arlington.	The study team will consider this information throughout the LAMP process. This email can be found in Appendix K.

Correspondence	Date	From	Subject	Follow Up / Resolution
Mail	9.09.10	Carole Underwood	The LAMP team received a letter from Mrs. Underwood regarding the LAMP.	Letter can be found in Appendix J. Content will be considered during the LAMP process.
Email	9.30.10	James Kincannon 5545 Granada Drive Fort Worth, Texas 76119	Mr. Kincannon emailed the study team a copy of his completed comment card from Public Meeting #3.	Comment card can be found in Appendix I.
Email	9.30.10	Mile Williams mwilliams@pursol.com Waterwood Estates Neighborhood Association 2316 Woodson Trail Arlington, Texas 76016	Mr. Williams sent an email to the study team regarding an event in the Waterwood Estates Neighborhood.	Ms. Hunt responded to Mr. Williams in an email. Please refer to Appendix H for email correspondence.
Email	9.30.10	James and Susan Emmons Saemmons03@yahoo.com 6005 Lakehurst Drive Arlington, Texas 76016 Waterwood Estates	Mr. and Mrs. Emmons sent an email to the study team regarding their opinions on the LAMP.	Comments documented in the LAMP study. Email can be found in Appendix G.
Voicemail	9.24.10	Mr. Phelan 800.256.8857, x1105 vphelan@cmik.com	Mr. Phelan left a voicemail requesting more information on the LAMP.	Elaine Brown emailed Mr. Phelan a copy of the FAQs, and provided him with a link to the project website from the project email account.

Correspondence	Date	From	Subject	Follow Up / Resolution
Email	9.20.10	Jerry Duck	Mr. Duck responded to Ms. Carmichael's email requesting that she forward to Field Operations the fact that the entrance to Enchanted Lake Estates at Shorewood and Lake Mead is in disrepair on the ramp. Crack filling did not remedy and should have a replacement of the pavement. This is a heavily used main entrance to the subdivision and needs a permanent repair.	Ms. Carmichael forwarded this information to the Field Operations team.
Email	9/16	Jerry Duck	Mr. Duck responded to the study team requesting street improvement plans for his specific area.	Ms. Carmichael responded to Mr. Duck and said that after checking with the Field Operations Division, they indicated that they performed crack sealing in his area this year. They have no plans for additional roadwork in the future.
Email	9/16	Jerry Duck jcdservices@swbell.net 3706 Big Bear Lake Drive	Mr. Duck emailed the study team regarding the issue of street improvements in the Lake Arlington area.	Mindy Carmichael, with the City of Austin, replied to Mr. Duck's email with more information. Her email can be found below, in Appendix F.

Correspondence	Date	From	Subject	Follow Up / Resolution
Email	9/20	Solonya McKinney solonya@sbcglobal.net	Ms. McKinney emailed a photo to Mr. Blumberg of the duck boat that was discussed at the public meeting on 9/13.	Photo of the duck boat can be found below in Appendix E. Contact information also added to database.
Email	9/20	Demetrica Williams Demetrica.williams@sbcglobal.net	Ms. Williams emailed the study team with questions about a barrier free playground.	Valery Jean-Bart responded to her email, which can be shown below in Appendix D.
Email	9/19	Pat and Sharon Hollabaugh hollabaugh@earthlink.net	Email received from Mr. and Mrs. Hollabaugh regarding the use of decorative sheet piling. They also provided a link to the ideas they want to be considered by the LAMP team. Email can be found below in Appendix C.	Recorded in the email/phone log, and will be considered throughout the LAMP process.
Email	9/18	Becky Fuentes bafuentes@sbcglobal.net 972.839.9979	Email received from Ms. Fuentes about her thoughts after attending the public meeting on 9/13.	Email shown below, in Appendix B. Contact information added to database.

Correspondence	Date	From	Subject	Follow Up / Resolution
Email	9/15	Sharon Sholden ssholden@statenational.com 6201 Woodlake Drive Arlington, TX 76016 817.429.1275	Ms. Sholden emailed the study team to let them know that she is on lakefront property and a portion of her retaining wall is very close to falling into the lake with a major sinkhole in the backyard. However, she does not think they qualify as a safety risk because they do not have small children. After attending the public meeting on September 13th, she would agree that the aesthetics of the two brick walls were preferable to plain cement; however, she does question the engineering. She is concerned about the retaining walls being strong enough for flooding, and wave erosion.	Email response sent on 9.15 stating that the tapered or terraced retaining walls that were shown in the photos can be designed and constructed to meet the requirements you described. They are used on lakes and shorelines across the country, including larger bodies of water than Lake Arlington. While a Master Plan will not include detailed design specifications or drawings, it will recommend best management practices and standards that will certainly include processes for making certain that the retaining walls, docks and piers are properly designed and constructed. Contact information also added to database.

Correspondence	Date	From	Subject	Follow Up / Resolution
Comment Card/Email	9/13	George Shelton 4124 Kingsferry Drive Arlington, TX Gshelton4124@yahoo.com	If Poly Webb Rd from Pleasant Ridge to Bowman Springs Park needs to be widened to 4+ lanes to accommodate access to the Park and bike/walk trails, will the city use eminent domain to take the land along Poly Webb?	Follow up via email from Alicia Winkelblech on 9/16: The City of Arlington is currently wrapping up efforts to update our Thoroughfare Development Plan (the document that dictates what our future roadway system will look like). The current draft recommendations show Poly Webb between Pleasant Ridge and Bowman Springs as remaining as a two-lane roadway. We are also in the process of creating a Hike and Bike System Master Plan. That draft Plan currently includes recommendations to stripe bike lanes on this portion of Poly Webb. It appears that we have enough right-of-way that we will not need to acquire additional land in order to add the bike lanes. Contact information added.

Correspondence	Date	From	Subject	Follow Up / Resolution
Email	9/13	Jerry Johnson	Mr. Johnson responded to SR's email asking if he could obtain a copy of the Scope of Work for the project. He has a background in this department and would like more details. He also recommended this information be posted on the website.	SR responded on 9/15 with a copy of the FAQs, and pointed out question 8, which lists all of the scope tasks.
Email	9/12	Jerry Johnson jerryjohnson72@yahoo.com	Mr. Johnson emailed the study team because he had just visited the project website. He has lived near the lake since 1984 and commends the city for taking the effort to develop the plan. He also wants to know if the study will evaluate potential pollution sources for the entire watershed that runs into the lake or is it limited to the study map that was made available on the website? In his opinion the entire watershed should be included in the study.	The study team responded to his question via email, and let him know that his comments will be included in the LAMP process.
Email	9/11	Susan Eaves, Parks and Recreation Board Member	Ms. Eaves emailed the study team to RSVP for the public meeting.	RSVP added to the database list.
Email	9/08	Councilmember Wolff, City of Arlington	Councilmember Wolff emailed to RSPV for the public meeting.	RSVP added to the database list.
Email	9/02	Kenneth Flannery, Island at Enchanted Bay HOA	Mr. Flannery emailed to RSVP for the public meeting.	RSVP added to the database list.
Email	9/01	Melinda Hamilton, Carver Heights East Neighborhood Association	Ms. Hamilton emailed to RSVP for her and her neighborhood for the public meeting.	RSVPs added to the database list.

Correspondence	Date	From	Subject	Follow Up / Resolution
Email	9/01	Howard Hamilton, Stakeholder	Mr. Hamilton emailed to RSVP for him and his wife for the public meeting.	RSVPs added to the database list.
Email	9/01	Gerald Urbantke, City of Arlington	Mr. Urbantke emailed to RSVP for the public meeting.	RSVP added to the database list.

Correspondence	Date	From	Subject	Follow Up / Resolution
Email	8/30	Kelley Earnest: kearnest@ti.com	Ms. Earnest emailed the study team to ask which of the 15 entities in the plan have committed to supplying funds to support the final master plan project. She does not support additional tax dollars from only the Arlington residents as they can't even get Bowman Springs repaved.	The study team replied that the City of Arlington is collaborating with the NCTCOG and other local communities, including the City of Fort Worth on the Master Plan. Currently, the City of Arlington is funding the Master Plan in order to protect the water quality of Lake Arlington. Implementation of the recommendations and BMPs will occur once the plan is adopted by the Arlington City Council. As the recommendations and BMPs are implemented over a period of years, a wide variety of funding sources will be used by the entities within the watershed. Her comments and those related to Bowman Springs will be included in public input.

Correspondence	Date	From	Subject	Follow Up / Resolution
Email	8/30	Michelle Hardin, City of Arlington	Ms. Hardin emailed to RSVP for the public meeting.	RSVP added to the database list.
Email	8/30	Jerry Roberts, Halff Associates	Mr. Roberts emailed to RSVP for the public meeting.	RSVP added to the database list.
Email	8/30	Greg Vines, Exelon	Mr. Vines emailed to RSVP for the public meeting.	RSVP added to the database list.
Voicemail	8/27	Darion Fields, Stakeholder 817.451.0485 sylvfie@aol.com	Mr. Fields is a homeowner in the Lake Arlington area and wants to know how the LAMP will affect him and what development is anticipated for the area. He lives in Fort Worth, cannot attend the public meeting, and would like more information.	9-5 SR emailed stakeholder to provide him with information, or following public meeting.
Voicemail	8/09	Carol Underwood: 817.446.5678, stakeholder	Ms. Underwood contacted the LAMP team to request a mailing address. She has a card she would like to send the LAMP team with her ideas and suggestions, and wants to know what address she can mail it to?	The LAMP team contacted Ms. Underwood and provided her with the following address for mailed comments: 101 West Abram Street, PO Box 90231, MS01-0200, Arlington, TX 76004.

Correspondence	Date	From	Subject	Follow Up / Resolution
Voicemail	8/06	Kelly Weeks: wkweeks@sbcglobal.net, stakeholder	Ms. Weeks called to say that she would like to receive a report on the progress of the LAMP thus far. She is a resident of Waterwood Estates and is very concerned. She is concerned about a marina, and feels that any development will increase traffic and noise, and will decrease her property value. She feels Lake Arlington is fine the way it is.	The LAMP team sent an email to Ms. Weeks to thank her for her comments, and to provide her with the project website address so that she can stay up to date with progress of the LAMP. She was also notified that her contact information was added to the stakeholder database so that she can learn about upcoming meetings.
Voicemail	8/06	Todd: 817.808.2308, stakeholder	Todd left a voicemail to say that he is completely in favor of improvements through the LAMP. He said that he owns a speedboat and believes that the lake has potential for more opportunities than what is currently at the lake. He is in favor of the LAMP.	Note made in the voicemail call log.

Correspondence	Date	From	Subject	Follow Up / Resolution
Email	8/06	Raphael Brock, TPWD	Mr. Brock emailed the LAMP team stating that he talked to Brett Johnson, a DFW area wildlife biologist, who said that he had not done any surveys concerning the bird and wildlife populations on Lake Arlington. He will try to get him on the lake in the next month after the weather cools to determine the status of the birds and wildlife. Mr. Brock also has some comments concerning the fish habitat and how they could be impacted by shoreline development (bulk head construction). Once he gets his recommendations organized he will send them to the LAMP team.	Note made to the call log. The LAMP team will review the recommendations once they receive them from Mr. Brock.

Correspondence	Date	From	Subject	Follow Up / Resolution
Meeting Concerns	8/06	There was a meeting held in Arlington regarding gas drilling at two locations in West Arlington. Councilman Wilemon asked the LAMP team to follow up with the following two stakeholders and their concerns.	1. Howard Hamilton, hdh4@earthlink.net, 817.572.5939: Mr. Hamilton believes that we will enhance the lake experience by adding noise abatement around the interstates along Lake Arlington. Mr. Hamilton believes future development will want a more stable lake elevation (less fluctuation in lake level. 2. Nancy Connaway, nconnaway@aol.com, 817.235.4031: Ms. Connaway believes that we should consider increasing the amount of water in Lake Arlington. She has frontage on the lake, pays additional taxes for the recreational access but the recreational access is unavailable when the lake is low.	The concerns were noted in the log for additional consideration throughout the LAMP process. Both stakeholders' information was added to the database for future notification of meetings and roundtable discussions.
Voicemail	8/05	Rachel Roberts, City of Kennedale	Ms. Roberts contacted the study team to confirm her RSVP for the roundtable meeting; however, Mr. Bob Hart with the City of Kennedale would no longer be able to attend the meeting.	RSVP notes made to the database list.

Correspondence	Date	From	Subject	Follow Up / Resolution
Email (2)	8/05	Coby Denham, Quicksilver Resources, Inc.	Mr. Denham emailed to say he would not be able to attend the meeting, and then emailed again stating that he would attend the meeting.	RSVP notes made to the database list.
Letter	8/03	Vasant Prabhu	Mr. Prabhu sent a letter to the LAMP team regarding his concerns for safety issues for boating and code enforcement. Letter can be found in Appendix A of this document.	Ms. Hunt and the LAMP team wrote a response to Mr. Prabhu, and will continue to study/work on this issue throughout the LAMP process.
Voicemail	8/03	Shelley Jordan for Jay Burress, Arlington Convention and Visitors Bureau	Ms. Jordan left a voicemail to inquire about the location of the 5:30 roundtable discussion meeting.	Shuronda Robinson emailed the address and location of the 5:30 meeting to Ms. Jordan.
Voicemail	8/03	Martha Dent	Ms. Dent left a voicemail to RSVP for the roundtable discussion meeting.	RSVP added to the database list.

Correspondence	Date	From	Subject	Follow Up / Resolution
Voicemail	8/03	Sara Bahari	Ms. Bahari left a voicemail to request that Julie Hunt contact her. She is going to write an article about the LAMP and wanted more information for her article.	Shuronda Robinson contacted Ms. Bahari via email on 8/10/10 saying that she spoke with Julie Hunt, who said that another reporter from the Telegram has already been in contact with her about the same story. Ms. Robinson asked if Ms. Bahari knew about the other reporter, and said that Ms. Hunt would look into the contact info of the other reporter.
Email	8/03	Michael Cramer	Mr. Cramer emailed to RSVP for the roundtable discussion.	RSVP added to the database list.
Email	8/03	Shelley Jordan for Jay Burress, Arlington Convention and Visitors Bureau	Ms. Jordan emailed to state that Mr. Burress would now be attending the 5:30 roundtable meeting and not the 11:30 meeting.	Note made to the RSVP database.

Correspondence	Date	From	Subject	Follow Up / Resolution
Email	8/03	Coby Denham, Quicksilver Resources, Inc.	Mr. Denham emailed the LAMP team to see if it was too late to RSVP for the roundtable discussion.	LAMP team responded that he could still RSVP, and that he would be added to the database list. Mr. Denham stated he would attend in place of Chris Mundy, also with Quicksilver.
Email	8/01	JoAnn Duman, Arlington Conservation Council	Ms. Duman emailed to RSVP for the roundtable discussion.	RSVP added to the database list.
Voicemail	7/30	Ross Calhoun, Centurion	Mr. Calhoun left a voicemail to RSVP for the roundtable discussion.	RSVP added to the database list.
Email	7/30	Lynn Healey	Ms. Healey emailed to RSVP for the roundtable discussion. She also noted that she no longer serves on the Parks and Recreation Board; however she does live on Lake Arlington.	RSVP added to the database list and noted to possibly move to Neighborhood List.
Email	7/29	Jeff Williams, Arlington Chamber of Commerce	Mr. Williams emailed to let the LAMP team know that he will not be able to attend the roundtable discussion meeting.	Note made to the RSVP database list.
Email	7/29	Lee Hitchcock, City of Arlington	Mr. Hitchcock emailed to RSVP for the roundtable discussion meeting.	RSVP added to the database list.
Email	7/29	Lisa Monk, Bay Club HOA	Ms. Monk emailed to RSVP for the roundtable discussion meeting.	RSVP added to the database list.

Correspondence	Date	From	Subject	Follow Up / Resolution
Follow Up Call	7/28	Julie Hunt to Pennie Ellis	Ms. Hunt called Ms. Ellis to follow up on a phone call Ms. Ellis had left on the project phone line. Ms. Ellis said she had a buyer and wanted to send them an update on the dock/pier moratorium. Ms. Hunt told her that she would be glad to speak to the potential buyer for her. If she is out of the office, the buyer can speak with Terry. Ms. Ellis has their phone numbers and will pass it on to her buyer.	The LAMP team will speak with the buyer when he/she calls in to speak with Ms. Hunt.
Voicemail	7/28	Ken Flannery, Island at Enchanted Bay HOA	Mr. Flannery left a voicemail to RSVP for the roundtable discussion meeting. He will attend in place of Joyce Baker.	RSVP added to the database list.
Voicemail	7/28	Sue Phillips	Ms. Phillips left a voicemail to RSVP for the roundtable discussion meeting.	RSVP added to the database list.
Email	7/28	Susan Emmons	Ms. Emmons emailed to RSVP for the roundtable discussion meeting.	RSVP added to the database list.
Email	7/28	Pennie Ellis	Ms. Ellis emailed to RSVP for the roundtable discussion meeting.	RSVP already noted in database list.
Email	7/28	Rachel Roberts, City of Kennedale	Ms. Roberts emailed to RSVP for herself and for Bob Hart, City Manager, for the roundtable discussion meeting.	RSVPs added to the database list.

Correspondence	Date	From	Subject	Follow Up / Resolution
Email	7/28	Ben McGahey, Halff Associates, Inc.	Mr. McGahey emailed to let the LAMP team know that Ann Kovich, Halff's Director of Business Development, will attend the roundtable meeting.	RSVP added to the database list.
Email	7/28	Mark Woolsey, Fort Worth Parks and Community Services	Mr. Woolsey emailed to let the LAMP team know that he will not be able to attend the roundtable discussion meeting.	Note made to the RSVP database list.
Email	7/28	Ellen McDonald, Alan Plummer Associates, Inc.	Ms. McDonald emailed to RSVP for the roundtable discussion meeting.	RSVP added to the database list.
Email	7/27	Roger McInnis, Mycoskie McInnis Associates	Mr. McInnis emailed to let the LAMP team know that he will not be able to attend the roundtable discussion meeting.	Note made to the RSVP database list.
Email	7/27	Pat Hollabaugh, Arlington Yacht Club	Mr. Hollabaugh emailed to RSVP for the roundtable discussion meeting.	RSVP added to the database list.
Email	7/27	Kevin Williams, Arlington Yacht Club	Mr. Williams emailed to RSVP for the roundtable discussion meeting.	RSVP added to the database list.
Email	7/27	Shelley Jordan, Assistant to Jay Burress, Arlington Convention and Visitors Bureau	Ms. Jordan sent in an email to RSVP for Mr. Burress for the roundtable discussion meeting.	RSVP added to the database list.
Email	7/27	Raphael Brock, TPWD	Mr. Brock emailed to RSVP for the roundtable discussion meeting.	RSVP added to the database list.
Voicemail	7/27	Ron Tomato, Trinity River Authority	Mr. Tomato called to RSVP for the roundtable discussion meeting.	RSVP added to the database list.
Email	7/26	Pete Jamieson, Director of Parks and Recreation	Mr. Jamieson emailed to RSVP for the roundtable discussion meeting.	RSVP added to the database list.

Correspondence	Date	From	Subject	Follow Up / Resolution
Voicemail	7/26	Penny Ellis	Penny Ellis called to confirm that she will be attending the roundtable discussion meeting on August 5^{th} . She also requested that Julie Hunt, or another LAMP team member, contact her. Her property is on the market and she wanted to know about the potential dock planned for the area. She can be reached at 817.915.8530.	Message and number forwarded to the LAMP team for a call back. Penny Ellis also added to RSVP list. Julie Hunt and Terry Benton responded to Ms. Ellis' questions.
Email	7/24	Glenn Troutman, WeCAN	Mr. Troutman emailed to RSVP for the roundtable discussion meeting.	RSVP added to the database list.
Email	7/23	Larry Jackson, Jackson Construction, Ltd.	Mr. Jackson emailed to RSVP for the roundtable discussion meeting.	RSVP added to the database list.
Email	7/23	Larry Evans, EMR Elevator, Inc.	Mr. Evans called to RSVP for him and his wife, Hope Evans, for the roundtable discussion meeting.	Hope and Larry Evans added to the RSVP database list.
Email	7/23	Cornell Gordon, Jr., Fort Worth Parks and Community Services	Mr. Gordon sent in an email to RSVP for the roundtable discussion meeting.	RSVP added to the database list.
Voicemail	7/23	Marian Zagadlo	Mr. Zagadlo called to follow up on his previous voicemail. He would like someone to call him on his cell phone at 817.233.2737.	Message and cell number forwarded to the LAMP team for a call back.
Voicemail	7/21	Marian Zagadlo	Mr. Zagadlo called to request a team member contact him for more information on the LAMP. He has a client who is looking to move to the area and had a few questions. He requested that someone call him at 817.735.4848.	Message forwarded to the LAMP team for a call back.

Correspondence	Date	From	Subject	Follow Up / Resolution
Email	06/24/10	Beth Cusack	Ms. Cusack is a resident of Euless and recently learned that their water supply comes from Lake Arlington. She requested to be added to the project email list to be informed of upcoming events.	Ms. Cusack's contact information was added to the database for future correspondence.
Email	06/01/10	Sonny, Fisherman37@sbcglobal.net	An email was sent by this stakeholder stating that there is currently a "NO FISHING" sign on the dock sidewalk at the park at Poly Web Road; however, he saw people fishing at the dock, and 4 or 5 Arlington employees were also present and did not say anything to the people fishing.	City staff spoke with Michael Debrecht and he said that the sign was spray painted by someone who remains anonymous and that fishing is allowed there. B Ballwe emailed Sonny and let him know that the sign was removed and that fishing is allowed at the dock.
Email	05/28/10	Jan Miller	Would like to be added to the project database to be notified of upcoming meetings and the progress of the Master Plan	Contact information was added to the project database
Email	04/27/10	Patrina Newton, City of Fort Worth	Cannot attend COG Meeting	Removed from RSVP List
Email	04/27/10	Ryan Brooke, Office of Senator Chris Harris	RSVP for COG Meeting	Added to RSVP List
Email	04/27/10	Paul Bounds, City of Fort Worth	RSVP for COG Meeting	Added to RSVP List
Email	04/22/10	Patrina Newton, City of Fort Worth	RSVP for COG Meeting	Added to RSVP List
Email	04/22/10	Joe Smolinski, City of Mansfield	RSVP for COG Meeting	Added to RSVP List

Correspondence	Date	From	Subject	Follow Up / Resolution
Email	04/21/10	Bob Hart, City of Kennedale	RSVP for COG Meeting for himself and for Rachel Roberts and Larry Ledbetter, City of Kennedale	Added to RSVP List
Email	04/21/10	Rumanda Young, USACE	RSVP for COG Meeting for herself and for Rob Newman, Chief, Planning Section, USACE	Added to RSVP List
Email	04/20/10	Michael Taylor, Office of Representative Joe Barton	RSVP for COG Meeting	Added to RSVP List
Email	04/20/10	Tina Ptak, Tarrant Regional Water District	RSVP for COG Meeting	Added to RSVP List
Email	04/19/10	Greg Saunders, City of Joshua	RSVP for COG Meeting	Added to RSVP List
Email	04/16/10	Maylor Mike Moncrief, City of Fort Worth	RSVP for COG Meeting *unable to attend*	Added to RSVP List
Email	04/16/10	Bianca Chafin, City of Burleson	RSVP for COG Meeting	Added to RSVP List
Phone	04/14/10	Helen Reeves, Property Owner	Has undeveloped lot at 6209 Tiffany Park Court; wanted to know if the seller of the property could receive a letter from the City of Arlington that the pending buyer will be guaranteed that the temporary suspension will be lifted.	
Phone	04/14/10	Patricia Bostic	Wanted to be added to the LAMP Database	Added to database
Email	04/07/10	Larry Brunell, Wells Fargo	Mr. Brunell sent an email to Caroline Russell regarding his thoughts/comments on the Public Meeting at Ditto Elementary.	The project team responded to his email/concerns, and took note of various issues for upcoming public meetings.
Email	03/28/10	Steve Bean, City of Arlington	RSVP for PM #1	Added to RSVP List
Email	03/25/10	Gerald Urbantke, City of Arlington	RSVP for PM #1	Added to RSVP List

Correspondence	Date	From	Subject	Follow Up / Resolution
Email	03/24/10	Bob Byrd, City of Arlington	RSVP for PM #1	Added to RSVP List
Email	03/24/10	Melissa Mitchell, City of Fort Worth	RSVP for PM #2	Added to RSVP List
Email	03/23/10	Joyce Baker, Enchanted Bay HOA	RSVP for Roundtable Discussion	Added to RSVP List
Email	03/22/10	Jon Weist, Arlington Chamber of Commerce	RSVP for Roundtable Discussion *unable to attend, but will send representative in his place*	Added to RSVP List
Phone	03/22/10	Albert Wralings	RSVP for PM #1 *unable to attend*	RSVP List Updated
Email	03/19/10	Charles Davis, Cheapeake Energy	RSVP for Roundtable Discussion	Added to RSVP List
Email	03/19/10	Larry Jackson, Jackson Construction	RSVP for Roundtable Discussion	Added to RSVP List
Email	03/18/10	Ellen McDonald, Alan Plummer Associates, Inc.	RSVP for Roundtable Discussion	Added to RSVP List
Email	03/17/10	Shirley Asgharian, Property Owner	RSVP for Roundtable Discussion for herself and for Bahram Asgharian	Added to RSVP List
Email	03/16/10	Hope Evans, Property Owner	RSVP for Roundtable Discussion	Added to RSVP List
Email	03/16/10	Bob Loeb	RSVP for Roundtable Discussion	Added to RSVP List
Email	03/15/10	Lynn Healy	RSVP for Roundtable Discussion	Added to RSVP List
Email	03/15/10	Grace Darling, Arlington Conservation Council	RSVP for Roundtable Discussion	Added to RSVP List
Email	03/12/10	Bruce Payne, City of Arlington	RSVP for Roundtable Discussion	Added to RSVP List
Email	03/10/10	Roger McInnis, Mycoski McInnis Associates	RSVP for Roundtable Discussion	Added to RSVP List
Email	03/10/10	Pete Jamieson, City of Arlington	RSVP for Roundtable Discussion	Added to RSVP List
Email	03/10/10	Glenn Troutman, WeCAN	RSVP for Roundtable Discussion	Added to RSVP List
Email	03/09/10	Raphael Brock, TPWD	RSVP for Roundtable Discussion	Added to RSVP List
Email	03/08/10	Jack Hattendorf	RSVP for Roundtable Discussion	Added to RSVP List

Correspondence	Date	From	Subject	Follow Up / Resolution
Email	03/08/10	Alan Plummer, Alan Plummer Associates	RSVP for Roundtable Discussion	Added to RSVP List
Email	03/08/10	Oscar Carmona, City of Arlington	RSVP for Roundtable Discussion	Added to RSVP List
Email	03/05/10	Steve Lindsey, Quicksilver Resources	RSVP for Roundtable Discussion for himself and two other representatives	Added to RSVP List
Email	03/05/10	Mark Woolsey, City of Fort Worth	RSVP for Roundtable Discussion	Added to RSVP List
Email	03/05/10	Jeff Williams, Arlington Chamber of Commerce	RSVP for Roundtable Discussion	Added to RSVP List
Email	03/04/10	Susan Emmons, Property Owner	RSVP for Roundtable Discussion	Added to RSVP List
Email	03/04/10	Dan Cooper, Southwest Securities	RSVP for Roundtable Discussion	Added to RSVP List

Appendix A - Letter from Vasant Prabhu, Received 8/03/10

Vasant K. Prabhu

3516 Lake Powell Dr, Arlington, TX 76016   817-561-5769/817-889-1640(w)   Email: prabhu@uta.edu

July 31, 2010

10 AUG -3 PM 3:31

RECEIVED AWU

Ms. Julia J. Hunt, P.E.,
Director, Arlington Water Utilities
Arlington City Hall
101 W Abram St
Arlington, TX 76010

Re: Pontoon Boat and Large Tree Hazard, Lake Arlington

Dear Director:

At several forums held by your department about Lake Arlington, we had the opportunity to discuss with you several issues that affect the safety of Lake Arlington. Our property abuts the lake and we once again wish to bring to your attention certain matters that need to be addressed.

Frequently after storms, large logs and sometimes entire trees (with their limbs sticking out of the water) arrive at the shore of our property (see Picture A). The trees are so big, that we have no way of removing them from the lake. Even though a lot of driftwood, tree limbs, plastic, styrofoam and other debris also end up on our shore, we have cleaned it , as we have for the last several years. However, we are in no position to clean up 50 ft trees with limbs sticking out of the water. These trees are a safety hazard as was illustrated on July 18 when a jet ski hit one of the trees injuring the rider. The lake patrol, Arlington Police and Fire Departments participated in rescuing the rider and removing the damaged vehicle. We would like to know how this problem of large trees can be addressed to make Lake Arlington safe and what some of us can do to address this situation.

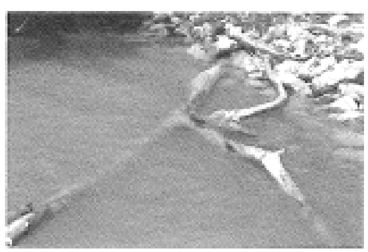
By the way, in our area of flowage easement, we also have a large (metal) pontoon (see Picture B) floating in the water. We have reason to believe that a contractor who repaired a dock in the neighborhood "abandoned" this pontoon to save his costs. This pontoon is also a safety hazard. Can the City of Arlington do anything about this pontoon which has been abandoned?

Any suggestion you have will be appreciated, as will an early reply to this inquiry.

Thank you,

Vasant K. Prabhu

Cc: Arlington Parks & Recreation, City of Arlington
Department of Code Enforcement, City of Arlington



A

B

Appendix B – Email from Becky Fuentes, Received 9/18/10

To All,
I enjoyed hearing the great news concerning the Master Plan for Lake Arlington. The improvement to the Lake area will not only help the lake residents but also provide beautification to the area and will benefit all of Arlington. I think the plan is wonderful, not only the Arlington side but the Ft. Worth side will benefit as well. Since I live on the south end of the lake most of my comments are directed to that area. Please see below:

1. Beautification: The roads are my major concern. The roads off Bowman Springs were built so long ago before the increase traffic. In order to beautify the lake, I believe the entrance to and from the Lake would help the appearance of the whole area. Bowman Springs is a very dangerous road. I know there have been plans on the books for many years to straighten out the road, widen it and cover the culverts. The road still looks like a FM road, not a road for the city limits, it need curbs and perhaps monument wall as you enter from I 20 to show everyone they are entering the Lake area. I have seen children riding bikes on the road at the curve, walking on the street, and jogging. There are no sidewalks for most of the road on the south end. I would suggest in order to have biking and jogging trails, this area would need a lot of well deserved attention. I know they are planning to resurface the street, but that is just not enough, it needs widening and straightening. The road could be connected to Pleasant Ridge and save a lot of time traveling back and forth to Little Road. Polywebb and Shorewood, also need widening as well. There are so many joggers and walkers in this area, I am concerned for their safety.
2. Shoreline Development: This is a great idea and I welcome the improvement to the Lake. I am concerned about the south end of the lake that flows under the service road on I20. There is so much debris and trash in that area. That all seems to flow into the lake. That is a concern for the water supply. This would probably need to be dredged.
3. Ft. Worth Area: I think that anything that can be done to improve the west side of the lake is extremely important. Hwy 820 is such a run down area. Although it is not in Arlington, as you said at the meeting Ft. Worth thinks anything east of 820 is Arlington. Same is true for some of 360, anything east of 360 is Grand Prairie. When in fact, we all know that is not true. I would welcome everything on the Master plan for that area. Mixed use development, Marina and Commercial. As long as there are planning and zoning restrictions concerning the types of businesses. I am not sure what can be done with the Mobile Home park, but it would be nice if it could be relocated to another area in Ft. Worth.
4. Lastly, in order to truly help the beautification of Arlington, is to bury the electrical/ telephone lines. The telephone poles in Arlington are so bad. When I visit other cities, this is just not a problem like Arlington. When the city was designed, Arlington should have stricter regulation concerning this. Even now, we are still allowing new businesses to be built and not requiring them the bury the telephone poles, I really don't understand why Arlington cannot enforce the burying of the poles. Perhaps, go street by street and start to improve the appearance and beautification of Arlington.

Thank you for all of your hard work and efforts in getting this Master Plan accomplished. Hopefully, in a few years we will reap the benefits of this plan.

Regards,
Becky Fuentes
972-839-9979
bafuentes@sbcglobal.net

Appendix C – Email from Pat Hollabaugh, Received 9/19/10

From: Pat and Sharon Hollabaugh <hollabaugh@earthlink.net>
Date: Sun, 19 Sep 2010 08:58:23 -0500
To: <LakeArlington@arlingtontx.gov>
Resent-From: <LakeArlington@arlingtontx.gov>

Please look into the use of Decorative Sheet piling, as used on the very nice homes along the San Marcos and Comal Rivers here in Texas, as you explore materials for construction use in our lake. This material is both attractive, and yet a permanent solution to to the short vertical walls needed to secure the shores along our lake, especially in areas that have a vertical rise to the shoreline.. This site shows some of the homes and seawalls constructed using this method and material
http://www.cmiwaterfront.com/homeowners.aspx. This is not a plug for this company and I have no affiliation with this firm.
Pat Hollabaugh
Commodore
Arlington Yacht Club

Appendix D – Email from Valery Jean-Bart to Demetrica Williams, Sent 9/20/10

From: Valery Jean-Bart <Valery.Jean-Bart@arlingtontx.gov>
Date: Mon, 20 Sep 2010 15:30:36 -0500
To: "'Demetrica.williams@sbcglobal.net'" <Demetrica.williams@sbcglobal.net>
Cc: Julie Hunt <Julie.Hunt@arlingtontx.gov>, Kurt Beilharz <Kurt.Beilharz@arlingtontx.gov>, Pete Jamieson <Pete.Jamieson@arlingtontx.gov>, Shuronda Robinson <srobinson@makingthingsclear.com>, "'Blumberg, Fred'" <FBlumberg@PIRNIE.com>, Brad Franklin <Brad.Franklin@arlingtontx.gov>, Terry Benton <Terry.Benton@arlingtontx.gov>
Subject: Barrier Free Playground

Ms. Williams,

The "barrier free" playground will be located at Randol Mill Park in north Arlington. The construction contract has been awarded and construction should start in about a month. It will probably be a six month construction process.

Parks will be master planning the new barrier-free playground in Randol Mill Park for possible future expansion. The expansion would occur directly adjacent to the north of the portion that will be constructed in this first phase, and nowhere else in Randol Mill Park. Following are some features the playground will offer:

• **Swings with high backs and straps to support a paralyzed child –** We will have a swing that accommodates a child in a wheel chair.

• **Sandboxes that will be at wheelchair height –** We will not have a sand box in this playground for this first phase. They are difficult to keep clean and the sand frequently gets put into the drinking fountain. It's something we can consider for phase II.

• **Paths that will be wide with safe surfaces** – During the design process, Parks met with a number of people in the Arlington community who work with persons with disabilities and this is one of the issues they wanted us to address. We did, and the walkways leading to the playground and around the playground will be 8' wide to allow for the passage of two wheelchairs. Also, the ramps on the playground equipment will be double wide as well.

• **Interactive equipment to encourage socialization –** Yes, some of the play equipment in this first phase will be interactive. We are also working on purchasing additional pieces of specialized interactive equipment that will be installed near the entrance to the playground. Fundraising activities have gone underway and attached you will find a brochure detailing this endeavor:

- **Transfer station for wheelchair accessibility –** Yes, there will be at least one transfer station, but because most of our play equipment will be accessed at the deck height via ramps, transfer stations will not be used much or really needed.

- **Many other fun features,** Yes.

Your comment regarding providing access and playground facilities for children with disabilities around the Lake has been forwarded to Parks and will be taken into consideration in our future planning efforts.

Please feel free to contact me for any further detail.

Thanks

Val

Valery Jean-Bart, P.E.
Civil Engineer
City of Arlington
Water Utilities Department
101 W. Abram Street
P.O. Box 90231, MS 01-0200
Arlington, TX 76004-3231
P: 817.459.6610 | Fax: 817.459.6626

Appendix E – Email from Solonya McKinney, Photo of Duck Boat

Appendix F – Email from Mindy Carmichael to Jerry Duck, 9/16/10

Mr Duck;

I received your email regarding the status of road projects around the Lake Arlington area. I will try to provide you with information relative to Shorewood, Bowman Springs, and the extension of Pleasant Ridge. However, to provide more information relative the neighborhood streets, I will need specific street names to research.

Bowman Springs Road –From IH20 to Shorewood – A resurfacing project is planned for this year. For more information on this project, please contact Bill Bateman at 817-459-5435.

Shorewood Drive – From Saddle Ridge to Beachview – A resurfacing project is planned for this year. For more information on this project, please contact Bill Bateman at 817-459-5435.

Extension of Pleasant Ridge Road – The extension of Pleasant Ridge Road is on the city's Thoroughfare Development Plan. However, there is no authorized funding to proceed with the extension any time soon.

Should you require additional information, please contact me at 817-459-6552.

Mindy Carmichael, P.E.

Engineering Operations Manager

City of Arlington

Department of Public Works

817-459-6552

Appendix G – Email from Mr. and Mrs. Emmons, 9/30/10

From: s emmons <saemmons03@yahoo.com>
Date: September 30, 2010 9:01:33 AM CDT
To: Pete Jamieson <Pete.Jamieson@arlingtontx.gov>, Kathryn Wilemon <Kathryn.Wilemon@arlingtontx.gov>, Julie Hunt <Julie.Hunt@arlingtontx.gov>, Robert Cluck <Robert.Cluck@arlingtontx.gov>, Michael Debrecht <Michael.Debrecht@arlingtontx.gov>
Cc: jemmons <jemmons@gecscales.com>
Subject: FYI: Lake Arlington Master Plan

To all parties concerned:

We do NOT want:
- a marina (of any size)
-a gas station on the water
- commercial business(es) of any kind
- retail business(es) of any kind, including restaurants, bait shops, etc.

onthe Arlington side of Lake Arlington.

Any one of these will drastically devastate the value of the residential properties, not to mention the lifestyle and tranquilityof thehomeownersin Waterwood Estates & Lakehurst Estates.

I am requesting a reply acknowledging that you did receive this email. Thank you.

Very sincerely,
James & Susan Emmons
6005 Lakehurst Dr, 76016, Waterwood Estates

Appendix H – Email to and from Mike Williams and Julie Hunt, 9/30/10

From: Julie Hunt
Sent: Friday, October 01, 2010 4:23 PM
To: 'Mike Williams'; Kathryn Wilemon
Cc: Kathy Fitzgerald; Terry Benton; Michael Debrecht; Pete Jamieson; Patrick Embry
Subject: RE: Waterwood Estates Association meeting

Mr. Williams,
I appreciate your interest in the Lake Arlington Master Plan. I hope you have been able to participate in our public meetings on this project. All project materials are located at http://www.arlingtontx.gov/water/lakearlingtonmasterplan.html.

Tuesday is National Night Out so Councilperson Wilemon and I already have previous commitments. Mrs. Wilemon will be on a rotation to many National Night Out events and may be able to stop by Richard Simpson Lake office briefly, depending on the schedule of her other meetings.

I have arranged for Michael Debrecht (Parks Lake office) and Terry Benton (Assistant Director/Water Utilities) to attend your meeting for a few minutes beginning at 6pm. They can answer questions related to the project's progress to date.

Have a great potluck,
Julie

Julia J. Hunt, P.E.
Director of Water Utilities
Arlington Water Utilities
817.459.6600

From: Mike Williams [mailto:MWilliams@pursol.com]
Sent: Thursday, September 30, 2010 1:16 PM
To: Kathryn Wilemon; Julie Hunt
Cc: Kathy Fitzgerald
Subject: Waterwood Estates Association meeting

Councilperson Wilemon and Ms. Hunt:

Next Tuesday, October 5th, our neighborhood association is holding a pot luck dinner at the Richard Simpson lake offices. As one of the biggest issues facing our neighborhood is the Lake Arlington Master Plan, we would greatly appreciate the attendance of both or at least one of you at our meeting. As the overall plan will have a great impact on Waterwood Estates due to our neighborhood's frontage to the lake and Arkansas Lane, many of our residents are concerned about the potential changes that may take place near our area of the lake. There are many questions that our residents have which either or both of you would be more educated to answer and discuss with us.

We have planned to hold the pot luck dinner and discussions beginning at 6:00 p.m. at the Richard Simpson lake office and would appreciate your brief attendance and answering of our residents' questions during this event. Also, I would like to ask that you provide us with a PDF formatted version of the latest information that has been distributed regarding the Master Plan so that we can give them out to all of the attendees.

Thank you in advance for your consideration and attendance. Please do not hesitate to contact me by phone or email with any questions, comments or if you require any additional information. I look forward to hearing from you very soon.

Thank you,

J. Mike Williams
Waterwood Estates Neighborhood Association
2316 Woodsong Trail
Arlington, TX 76016
***mwilliams@pursol.com <mailto:*mwilliams@pursol.com>**
((817) 862-8774 (office)
((817) 496-8303 (home)
((817) 312-6453 (cell)
3(817) 862-9774

Give Us Your Feedback!

The City of Arlington wants to know your thoughts on the Master Plan for Lake Arlington.
Please use this page to provide any additional comments, opinions, or ideas for Lake Arlington.

Additional Comments:

Some sort of signs need to be posted, in our area of the Lake, to slow jetskiis + boats down in the paddle boat + canoe area.

James Kincannon
817-988-4717

10 SEP 29 PM 3:44
RECEIVED AWU

PM3

Give Us Your Feedback!

The City of Arlington wants to know your thoughts on information from the stations at this public meeting.

Please comment on the following:

Please comment on the Draft Vision:

What are your thoughts about the opportunities and constraints?

Are there specific issues or concerns you have about the opportunities and constraints?

What do you think the top priority should be for the City of Arlington?

I would Like to rebuild my old Dock or you should Let Ross Calhoun build our marina, of boat slips only, You say that our area may be too narrow for a dock. If it is a paddling area it should be fine to build a dock. If the boats and Jet Skis would stay out or slow down. They ride extremely fast, close to our retaining wall. That is also a safety hazard.

PM3

Val- please add
to Lake Arlington
info.
Thank you,
Julie

Rec'd 9-9-10

Aug. 9, 2010

Dear Friends,

I love the openness of Waterwood Estates to Richard Simpson Park.

I was glad to hear that the first priority of the Lake Arlington Master Plan Committee is the purity of our drinking water and the environment.

The beauty of the wind-powered sailboats gliding from the Arlington Yacht Club contribute to the aesthetic enjoyment and tax value of homes along Lake Arlington.

The park offers grassy and treed areas which improve our breathing and absorb water in heavy rains, lessening the chances of flooding in our neighborhood.

Thank you for preserving these amenities at Richard Simpson Park.

Sincerely,
Carole Underwood
2107 Englishoak Dr.

Appendix K – Email from Chris Stinson, 10.18.10

From: Chris Stinson
Sent: Monday, October 18, 2010 7:42 PM
To: Michael Debrecht; Joe Gildersleeve
Subject: Fish Habitat on Lake Arlington

Michael and Joe,

In planning for the off-season and 2011, I have been thinking about some of the issues at hand. I would like to run them by you two, and would ask for some feedback please from your prospective departments.

I would like to propose a citizen volunteer cleanup event this fall. Articulating the details would be extremely time consuming, so I would like to see if this is a possibility before spending too much time on it. This event would address: Cleaning up trash, adding fish habitat to the lake, increasing interest in the lake, attracting new people to the lake and increasing revenue generated by the city.

A common complaint with local anglers is that there is not enough structure on the bottom of the lake to boost our lake's fish population and health. I will be riding out with TPWD biologist in the next couple weeks to discuss this with him as well.
Of course, officially, citizens are prohibited from adding structures, such as brush piles to the lake. It is not at all uncommon to find governmental agencies adding structures to promote fish habitat and increase revenue and interest in the lake.

There is even a national fish habitat organization. http://www.reservoirpartnership.org/index.html
Example of structure being added: http://www.reservoirpartnership.org/Projects/Eufaula_Lake_Oklahoma_Habitat_Restoration_Proposal.pdf
I would like to have a citizen group formed of local fisherman serve as a labor force. This group could remove trash from the lake with the intent of using some of it as fish habitat. This is where the details come in. The materials, location, depth, construction, etc, would all be subject to approval. There are hundreds of tires that are currently in the water. I would like to remove them from the shoreline when the lake level is low, bundle them together, and sink a series of tire reefs in the lake. I fear that tires pose a threat to the water supply and doubt this idea will be granted. Of course, these tires ARE already in the water and there is no effort to remove them.

Another idea would be to remove large trash items on the shoreline, salvaging things like plastic barrels, buckets, PVC and driftwood. These things can be permanently formed together to serve as sustainable fish habitat for years to come. For example, several pieces of driftwood could be placed in a plastic bucket and concreted in place. This example would present no water quality issues that I can think of. It would have to be sunk deep enough as to not be a hazard, even when the lake reaches low levels.

A third idea involves discarded Christmas Trees, and does not include removing trash from the lake. After the holidays, the City could hold the tree collection site at Richard Simpson Park. There, I could get lots of volunteers to bundle trees together and sink them. This is what was done in that example on Lake Eufala.

These fish habitat locations could be mapped at the main office.   The Parks Dept could organize and sponsor tournaments with all this added interest, generating more revenue for the city.

Essentially, if done correct, these structures would be deep enough to never be seen or be a hazard. They would not cause any water quality issues, and would not interfere with any Master Plan goals.

I would like to know what you guys think as far as obtaining permission to sink fish habitat into the waters of Lake Arlington. That would be the first step. If the idea is humored, I would be more than happy to write up all the details on water depths, locations, etc.

Thanks
Chris

Appendix L – Email and Photos from Dick Kahle, 11.08.10

From: Dick Kahle <dick@kahle.org>
Subject: The Lake
To: "Lynn Healy" <lynnjhealy@yahoo.com>
Date: Monday, November 8, 2010, 7:52 AM Lynn

As we have talked, if the city is really serious about improving the Lake Arlington, they MUST treat it like a park, and have maintenance funds to keep it clean. By the way that would also improve the water quality. As a homeowner that is on the lake, I am very proud as to how the shore line looks. But to that end I spend too many hours cleaning up after each rain. My theory is "if the lake give it, the lake can take it back". There are so many dead trees that go up and down the lake after each storm, I am starting to name them since I have seen them before. The first priority of the city is not codes on sea walls, but a plan to clean the lake and then how to keep it clean. Attached are just a couple of pictures I from the rain in Oct. This is little compared to this past spring.

Let me know how I can help

Dick

Appendix M – Email from J. T. Evans, 01.11.11

From: Evans [charandtom@sbcglobal.net]
Sent: Tuesday, January 11, 2011 3:18 PM
To: Robert Cluck; Sheri Capehart; Julie Hunt
Cc: 'Charlie Anderson'; Terry Benton; Joe Gildersleeve
Subject: Trash in Lake Arlington

Mayor Robert Cluck, Sheri Capehart, Julie Hunt and others January 11, 2011

On April 08, 2009 I was fishing at Lake Arlington and decided to go into Panther Creek. It had been a long time since I had fished this area. This creek runs into Lake Arlington from Fort Worth in the vicinity of the electric power plant. (See first graphic picture page number 2 for Panther Creek location) This creek heads up in a housing area and drains under Loop 820 and then through an industrial area before entering Lake Arlington. I entered this creek by going through the cut that was called the hot water outlet. This is where the hot water was pumped from the generator plant into the lake as a cooling stream when the plant was operating. To my surprise I discovered this area was polluted with all types of bottles, paper, plastic and all sorts of trash. (See page number 3 for pictures) My first impression of this was, **O-My-Gosh,** this is in my drinking water since I live in Arlington. It's hard to tell what may be in this trash site. No-telling what type of **toxic/ or carcinogenic material** that might have accumulated there since I could not identify anything. I hope it is just bottles and plastic. At this time, the lake was six to seven feet low. In some places trash is ten to fifteen feet up the banks and is completely covered in some areas. This amount of dumping/or pollution indicated to me that it had accumulated or washed into the lake over a number of years.

I didn't know if it was the responsibility of Fort Worth or Arlington since it's on the Fort Worth side. After I got home I sent emails to my city council reposenatives to find out who I should notify. Some of the feed back I received had copied Mayor Cluck and several leaders of Arlington. I was given the address of the person in charge of the water in Arlington. I sent an email to this person with my pictures attached. I was told this had been a problem for a long time and they were working with Fort Worth. They asked me to volunteer to help clean up this area. I didn't volunteer because I am a 72 years old retired Manufacturing Engineer who has had many classes on the danger of chemicals to the human population which can also be adsorbed through your skin. I also told them in an email I thought an environmental company needs to clean this area up because they had the equipment to protect there workers. A friend of mine which is an Arlington policeman said several police officers had volunteered to help clean up. I thought it had been taken care of by what he said.

I went fishing at Lake Arlington again 01-08-2011 before our major cold front hit and decided to see if anything had been done to clean this trash up. **Not-a-thing** has been done to clean up our lake we use for drinking water. I just sat there looking at it and my thoughts were Arlington and Tarrant county tax payers have maybe ∏ a trillion in Cowboy Stadium, interest, and new road work, bridges and now the super bowl but doesn't have the money to hire an environmental company to clean this pollution up from our lake. The sad thing is the city has asked for voluntary labor to clean an area up that may be contaminated. When it's cleaned up what can be done so it won't **happen** again?

If you don't know where or how to get to this area I will show you where this area is.

J.T. Evans (Tom)
5827 Terra Dr.
Arlington, TX 76017

Email from Joe Gildersleeve, City of Austin

From: Joe Gildersleeve
Sent: Tuesday, January 11, 2011 5:56 PM
To: Evans
Cc: Michael Buettner; Sheri Capehart; Julie Hunt; Robert Cluck
Subject: RE: Trash in Lake Arlington

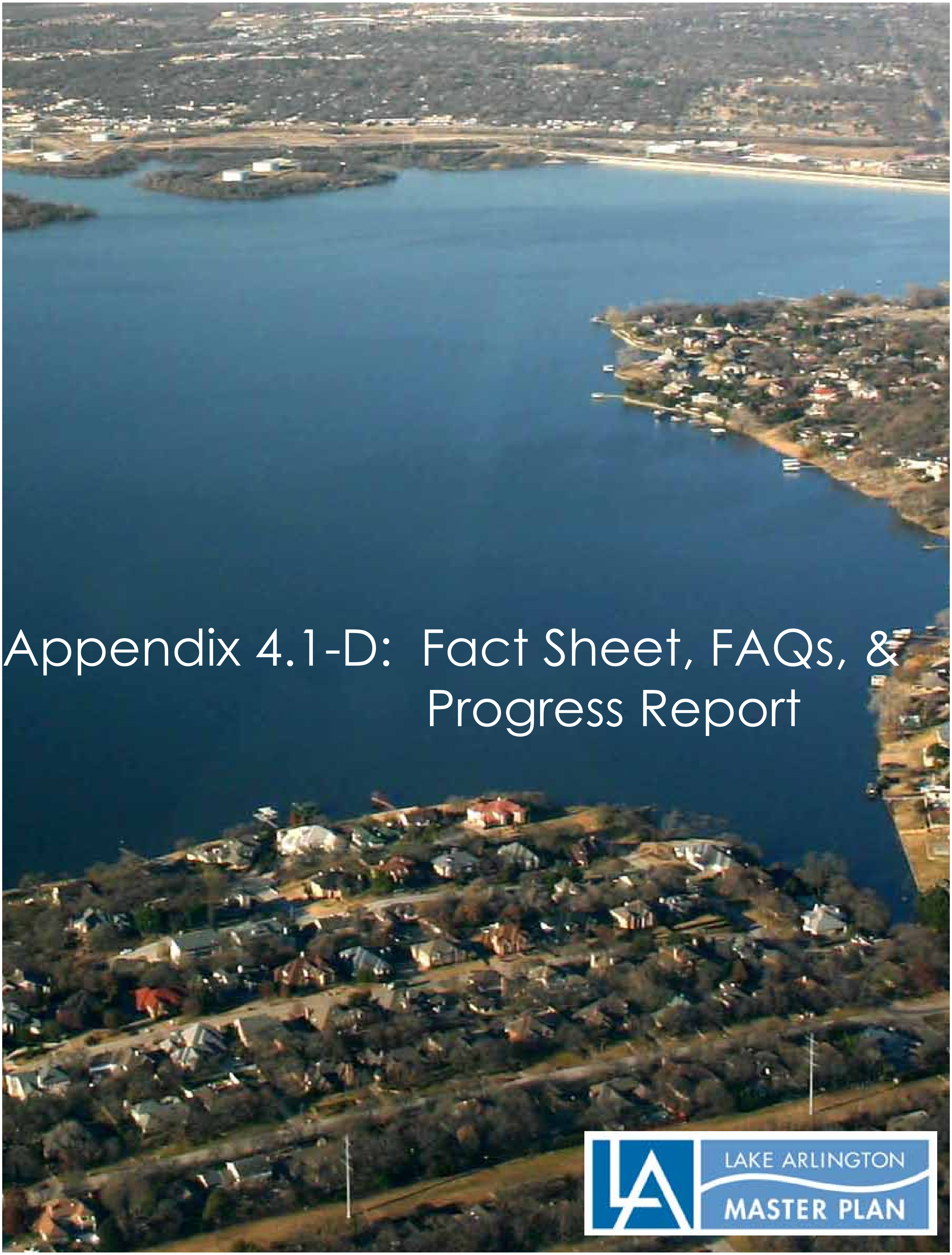
Dear Mr. Evans,

Wildcat Branch continues to be a venue for floatable debris to accumulate. When we have long dry periods with little rainfall the litter continues to accumulate in the feeding streams of the lake. Then a rain event, similar to this past weekend, is large enough to push the accumulated trash into the lake. The trash then lines the island and mouth of the tributary. Arlington is not unique in its struggle to handle floatable trash. Public campaigns such as TXDOTs "Don't Mess with Texas" are a continued effort to try and educate the public on litter prevention. Arlington and Fort Worth also produce similar educational outreach material and activities like the Lake Arlington Cleanup to try and reduce trash in our environments. We are aware of your concern and have incorporated this issue into the current Lake Arlington Master Plan development. Fort Worth is also aware and is past the design phase for trash collectors on a future newly constructed bridge on Wildcat Branch. This bridge has the potential to be an outstanding preventive measure to reducing trash in Lake Arlington. We are excited and look forward to the development of the Fort Worth bridge. I continue to appreciate your passion in this matter and can assure you that our drinking water quality is of upmost importance to the City of Arlington Water Utilities. We continue to meet and exceed all state water quality requirements. Please feel free to contact me with any other issues or ideas that should be considered in our Lake Arlington Master Plan. To view the details of the Lake Arlington Master Plan or submit comments please visit http://www.arlingtontx.gov/water/lakearlingtonmasterplan_getinvolved.html <http://www.arlingtontx.gov/water/lakearlingtonmasterplan_getinvolved.html> .

Sincerely,

Joe Gildersleeve
City of Arlington
Water Resource Services Manager
817-459-5892

Appendix 4.1-D: Fact Sheet, FAQs, & Progress Report



LAKE ARLINGTON MASTER PLAN

quick facts

For More Information
Attend a public meeting or
Visit our website at:
www.arlingtontx.gov/water/lakearlingtonmasterplan.html

Give us your comments online
Send a letter to the contacts shown on the website
Call us at 817.877.9978 ext 1

LAKE ARLINGTON MASTER PLAN

Pour yourself into its future.

About the Master Plan

The City of Arlington is developing a Master Plan for Lake Arlington. The City of Arlington will use the Master Plan as a short and long-term planning tool to:

- Protect the City's water quality
- Protect the City's water supply
- Optimize recreational opportunities
- Identify impacts of future development

The final plan will include a vision for Lake Arlington, a set of guidelines and standards for protection of water quality, beautification, recreation and open space opportunities and recommendations on how to implement the vision.

The project includes modeling water quality and identifies how the various forms of development may impact water supply and quality. Best Management Practices for protecting water quality will be prioritized based on the results of the water quality modeling.

About Lake Arlington

Lake Arlington was built in 1957 at the end of the 1950s drought. The lake covers about 2,000 surface acres (three square miles). It is located on Village Creek, a tributary of the West Fork Trinity River. Lake Arlington is on the western border of Arlington just north of Interstate 20. Water flows into Lake Arlington from a watershed area that is 143 square miles and includes 13 cities and two counties. The primary purpose of the lake is to store water to be treated for drinking. Lake Arlington is owned and operated by the City of Arlington.

The lake is also used for power plant cooling, recreational purposes, and is home to the first lake paddling trail in the Dallas-Fort Worth Metroplex. Additionally, Lake Arlington is home to several species of game fish including the Florida largemouth bass, white bass, white crappie, and the channel and flathead catfish.

The Master Plan Project Team

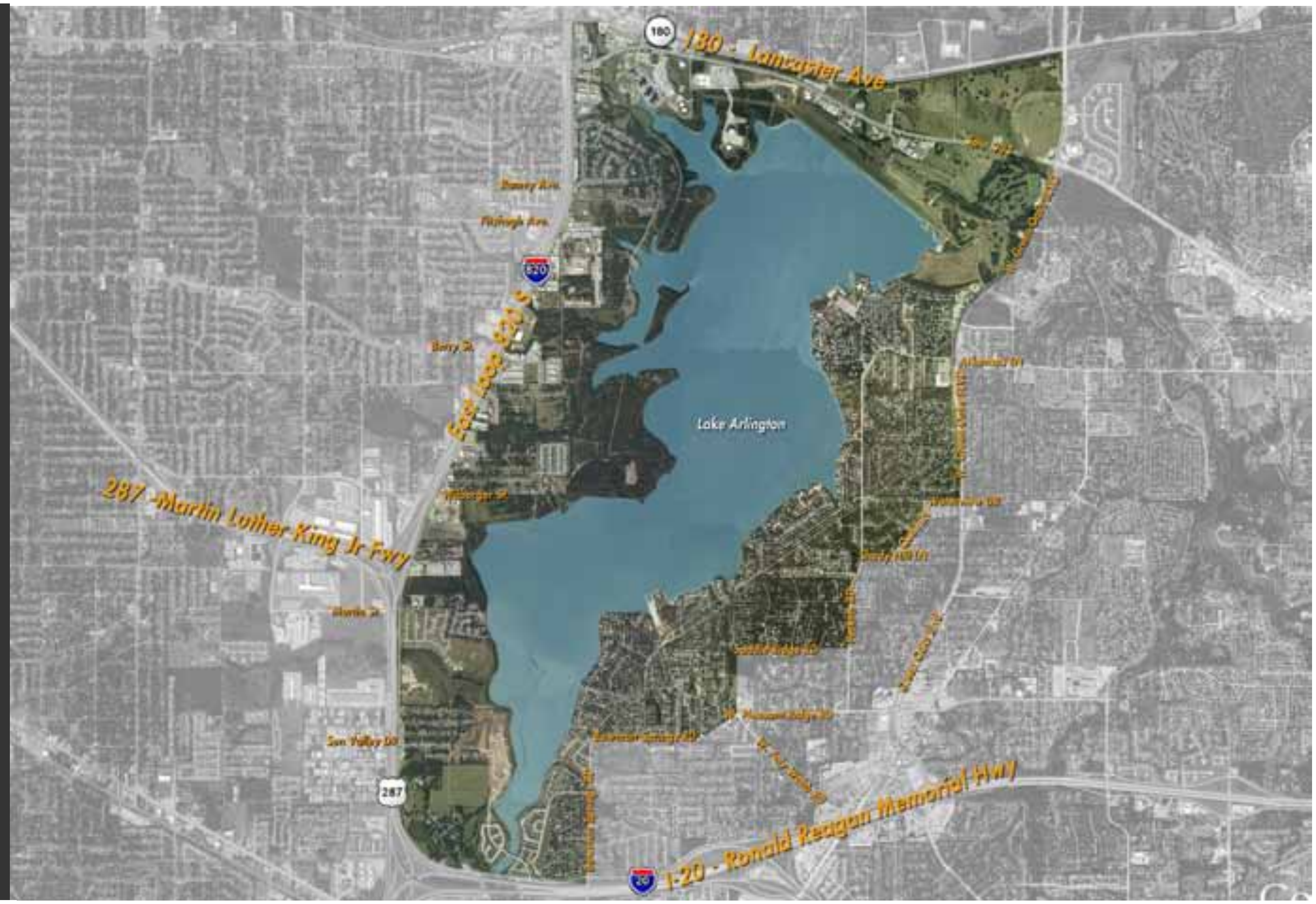
The City of Arlington Water Utilities Department is leading the Master Plan effort with participation from Parks and Recreation, Community Development & Planning, and Public Works/Storm Water Management. City staff are working collaboratively with municipalities within the watershed and other stakeholders.

Project Timeline

The Master Plan process began in December 2009 and will last for about 15 months. A final document is expected to be completed spring 2011.

CITIES IN THE WATERSHED:
ARLINGTON • BRIAR OAKS • BURLESON • CROSS TIMBER • CROWLEY • EDGECLIFF VILLAGE • EVERMAN• FOREST HILL • FORT WORTH • JOSHUA • KENNEDALE • MANSFIELD • RENDON CDP•
COUNTIES IN THE WATERSHED:
JOHNSON COUNTY • TARRANT COUNTY

study area



LAKE ARLINGTON MASTER PLAN

PROJECT TIMELINE

frequently asked questions

LAKE ARLINGTON MASTER PLAN

Pour yourself into its future.

Here are some of the most Frequently Asked Questions about the Lake Arlington Master Plan:

1) What is the Master Plan and what is its purpose?

The City of Arlington is developing a Master Plan for Lake Arlington. The Master Plan will be used by the City of Arlington as a short and long-term planning tool to:

- Protect the City's water quality
- Protect the City's water supply
- Optimize recreational opportunities
- Identify impacts of future development

The Master Plan is also a tool for policy makers and citizens to plan appropriately for the potential impacts of development and growth in and around this important water resource.

2) What is the timeline for the Master Plan?

The Master Plan process began December 2009 and will last for about 15 months. A final document is expected to be completed in spring 2011.

3) Why is the City of Arlington developing a Master Plan?

It is a priority for the City of Arlington to protect the quality of the city's water supply. Arlington and other communities receive their drinking water supply from Lake Arlington. The Trinity River Authority's Tarrant County Water Supply Project Water Treatment Plant provides water to five other cities. Completing the Master Plan will allow the establishment of Best Management Practices that are beneficial in protecting the watershed. Communication with cities in the watershed upstream from Lake Arlington will be included. The Master Plan process will explore recreation, open space ideas and land development enhancements. This will benefit all users of Lake Arlington.

4) Who is leading the Master Plan?

The City of Arlington Water Utilities Department is leading the Master Plan effort. The City has also formed a team of city departments including Parks and Recreation, Community Development & Planning, and Storm Water/Public Works. City staff is working collaboratively with municipalities within the watershed and other stakeholders. An engineering consultant, Malcolm Pirnie, was hired in December 2009 to provide engineering, planning and public involvement services for the Master Plan project.

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5) What is the expected outcome of the Master Plan?

The final plan will include a vision for Lake Arlington, a set of guidelines and standards for protection of water quality, impact of future development, beautification, recreation and open space opportunities and recommendations on how to implement the vision. The Arlington City Council will make the final decision to adopt the guidelines and recommendations of the Master Plan.

6) Will Lake Arlington be available for recreational use during the planning process?

Yes. Boating, fishing, and other recreational activities on and around the lake will remain available.

7) How is the Master Plan being funded and what are the costs?

The total cost of the current project is approximately $542,000. It is initially being paid for by the City of Arlington; however, the city is pursuing grant funding alternatives and working relationships with potential partners.

8) Which local entities will be involved in the Master Plan process?

The City of Arlington Water Utilities Department is responsible for maintaining the drinking water quality from Lake Arlington for more than a half million people who receive their treated drinking water from the lake. The planning process will include collection of data from the 13 municipalities and two counties in the watershed.

They include:

- Arlington
- Briar Oaks
- Burleson
- Cross Timber
- Crowley
- Edgecliff Village
- Everman
- Forest Hill
- Fort Worth
- Johnson County
- Joshua
- Kennedale
- Mansfield
- Rendon CDP
- Tarrant County

9) Why are Fort Worth and other cities involved in the Master Plan?

The water that flows into Lake Arlington drains from a 143 square mile area surrounding the lake. A large portion of this area is south of Arlington. The 13 cities and two counties within the drainage area are being asked to participate in the Lake Arlington Master Plan because their policies and planning decisions could affect the water quality in Lake Arlington.

10) What does the Master Plan include?

Developing the Master Plan involves evaluating existing water quality data, assessing current standards, methodologies and processes, gathering input from stakeholders, and developing new standards and best management practices.

Specifically, the Master Plan team will:

- Collect and review relevant policies, ordinances and master plans from the cities and towns in the watershed
- Collect and analyze water quality and other environmental data
- Collect and analyze physical data – e.g. open spaces, wetlands and roads
- Evaluate likely pollutant sources
- Review current Best Management Practices
- Perform watershed modeling
- Develop appropriate standards, guidelines and best management practices
- Identify open space and recreational improvement opportunities
- Identify development opportunities
- Develop construction standards for development on and adjacent to the lake
- Perform a boating capacity study for Lake Arlington
- Conduct a pro-active public involvement process

11) Will water quality be negatively impacted because of the Master Plan process?

No. The Master Plan will actually provide recommendations on additional Best Management Practices for maintaining or enhancing the water quality of Lake Arlington.

12) What does the temporary suspension of all new construction permits around Lake Arlington mean and why has it been implemented?

The temporary suspension of new construction permits applies to all structures and earthwork in Lake Arlington or in the lake's adjacent flowage easement (such as docks, pools and retaining walls). The temporary suspension will enable the Arlington City Council to make informed decisions concerning the future improvements that should be allowed in the flowage easement based on the input received during the master planning process. However, during the suspension period, necessary repairs to legal, existing structures and earthwork will be allowed with the approval of the city. Any repairs to existing structures will follow the standard permitting process.

13) How can I contribute to the Master Plan process?

Your input is welcomed and encouraged. The City of Arlington is seeking opinions and ideas from everyone in the watershed and from users of the lake. Here's how you can learn more, provide input to the Master Plan team, and get involved:

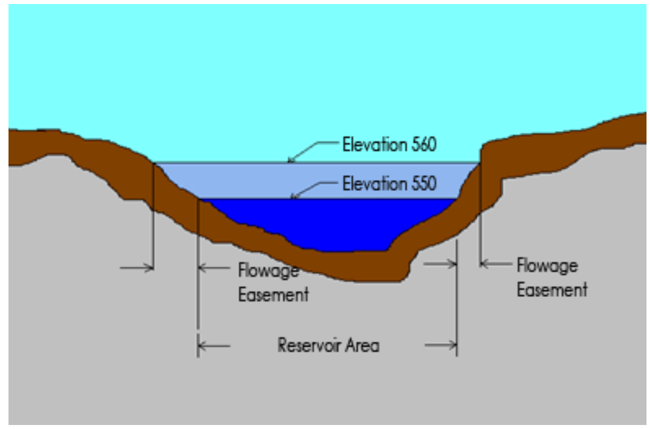
- Attend a public meeting
- Provide us with your comments online
- Send a letter to the contacts shown on the website

We encourage your opinions and ideas on the following:

- Recreation on and around the lake
- Open space opportunities and uses
- Beautification opportunities
- Shoreline development and protection
- Environmental protection
- Types of development – residential, commercial, mixed use
- Other issues that are important to you and your family and friends

14) What is the flowage easement and how do I find out if my property is within the flowage easement?

A flowage easement is the land adjacent to Lake Arlington that is reserved to handle high water levels that occur when floodwater enters



the lake from upstream. For Lake Arlington, the flowage easement is located between elevation 550 feet and elevation 560. In order to find out if any portion of your property is located within the flowage easement, you would need to have a surveyor conduct a topographic survey.

15) I live in Fort Worth and want to know who to contact to build a dock, pier or retaining wall.

Since Lake Arlington is owned and operated by the City of Arlington, all development that occurs within the Lake Arlington reservoir and flowage easement requires approval and issuance of a permit by the City of Arlington. This includes all construction activity that occurs at or below the 560 foot elevation. Fort Worth residents should also contact the City of Fort Worth for any requirements. Residents can contact the City of Arlington's Community Development & Planning Department at 817.459.6502.

16) How will the standards for docks, piers and retaining walls be administered on the Fort Worth side of the lake?

The City of Fort Worth is forwarding any permit and building requests within the Lake Arlington flowage easement to the City of Arlington, since the lake is owned and operated by the City of Arlington. This process will ensure uniform standard compliance for any docks, piers and retaining walls on the Fort Worth side of the lake.

17) Can I do work on my property that is located within the flowage easement?

The Arlington City Council has temporarily suspended the processing of all applications for site plan review for earthwork and permits for structures on and around Lake Arlington. This temporary suspension will remain in effect until the Arlington City Council has acted on the Master Plan, which is estimated to be completed in March 2011.

18) Once the standards for docks, piers and retaining walls are adopted by Arlington's City Council, who pays for any new construction and/or any necessary modifications?

Private property owners are responsible for any new construction costs or improvements. Any new construction or improvements on public land would be the responsibility of the public land owner (i.e. for parks and public shoreline).

19) How do I get a permit for repairs to existing structures during the temporary suspension?

Necessary repairs to existing permitted structures will be allowed if there is an imminent threat to public health or safety as determined by the City of Arlington Administrator, or as necessary due to an imminent threat to public health or safety as determined by the Arlington City Council. Applications for such repairs will be reviewed on a case-by-case basis. Any repairs to existing structures will follow the standard permitting process. Both Arlington and Fort Worth residents should contact the City of Arlington's Community Development & Planning Department at 817.459.6502, and ask for the Engineer of the day. Each request will be evaluated on a case-by-case basis. It will be determined if the request is a matter of life safety and will be processed accordingly.

20) I am concerned about increased street traffic and lake crowding due to any new development that might occur. How is the plan addressing congestion and safety?

This is a high level vision plan designed to provide guidance for how the community would like to see development occur. When the City and others decide to move forward with specific projects, each project developed within the study area will have to meet the current City of Arlington development standards for traffic and safety.

21) What can be done to make Arlington parks safer and to reduce the noise and rowdy behavior, especially at night?

The Master Plan will document the concerns of residents related to park safety. The Parks and Recreation Department is working with the Police Department to limit vehicle access to Richard Simpson Park in the evening hours. In addition, the Parks and Recreation Department is taking public comments on changing the operating hours of Richard Simpson Park.

22) Why does the water level of the lake fluctuate?

There are a number of reasons why the lake level fluctuates, including:

- Evaporation
- The operations of the lake within the Tarrant Regional Water District (TRWD) reservoir system; and
- Actual water use.

Water is pumped into Lake Arlington during low use periods and held for storage. When customer water usage increases during hotter, drier weather more water is pumped from Lake Arlington to the water treatment facilities to meet these demands.

Lake Arlington is part of a system of seven reservoirs managed by the TRWD. The TRWD operates Lake Arlington by pumping water from Cedar Creek and Richland Chambers for use within its reservoir system. The TRWD operates the system as efficiently as possible in order to minimize costs and maintain a reliable supply of water for all four wholesale customers: Arlington, Fort Worth, Mansfield and the Trinity River Authority.

23) Who is responsible for implementing the Master Plan?

While the Arlington and Fort Worth City Councils will ultimately approve the Master Plan and use it as a guidance document for future development along the shoreline, many players will have a role in carrying out the vision.

The Arlington Water Utilities Department is interested in implementing parts of the Master Plan that have to do with protecting water quality. Many other City departments will also be involved in carrying out the Master Plan vision and associated plans, policies, procedures and ordinances.

Cities and counties within the watershed will have an opportunity to address how they can reduce potential sources of pollution and manage stormwater.

Developers who propose a specific plan and funding to develop vacant land or new projects as part of the overall vision would follow the City's normal review and permitting processes.

24) How much will it cost to implement the Master Plan and who will pay for it?

The Master Plan will include a range of costs for the ideas and projects described in the plan. The ideas and projects envisioned by the Master Plan are not currently funded and any costs described in the Master Plan are preliminary.

As specific parts of the Master Plan are implemented the City of Arlington, private developers and other parties will develop the detailed cost estimates required for implementation of a specific project.

In addition the City of Arlington is pursuing grant funds to implement some of the ideas and projects related to water quality impacts, as well as engaging potential partners.

25) Where can I get more information?

Please visit our website at
www.arlingtontx.gov/water/lakearlingtonmasterplan.html

or call us at
817.877.9978 ext 1

LAKE ARLINGTON MASTER PLAN

Pour yourself into its future.

frequently asked questions

ARLINGTON

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Lake Arlington Master Plan

LAKE ARLINGTON MASTER PLAN

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ARLINGTON

PROJECT UPDATE
FALL 2010

Lake Arlington: A Vision for the Future

Creating a Sustainable Way to Protect Water Quality

Years from now the City of Arlington and the City's Water Utilities Department will recognize that they made a significant impact on protecting the water quality of one of its main water supplies, Lake Arlington. Currently, the City of Arlington is proceeding with a comprehensive master planning effort for Lake Arlington. The Plan addresses the following goals:

- ✓ Protect the city's water quality
- ✓ Protect the city's water supply
- ✓ Optimize recreational opportunities
- ✓ Identify impacts and opportunities for future development

"We really want to understand how land uses upstream of and around the lake, and recreational uses on the lake, need to be planned for and managed," says Julia J. Hunt, P.E., Director of the Water Utilities Department. This master plan will give us a short-term and long-term planning vision, as well as tools by which our

see Vision, page 2

Key Elements

- Best management practices for water quality protection
- Standards for docks, piers and retaining walls
- Ideas for new trails and open spaces
- Boating Capacity Study
- Development opportunities
- Enhancements to existing parks

Vision for Lake Arlington

The vision for Lake Arlington is to provide a safe drinking water supply and to protect the Lake and its surroundings by identifying and promoting sustainable uses and watershed management practices that enhance the beauty and the value of Lake Arlington to the community.

Vision continued...

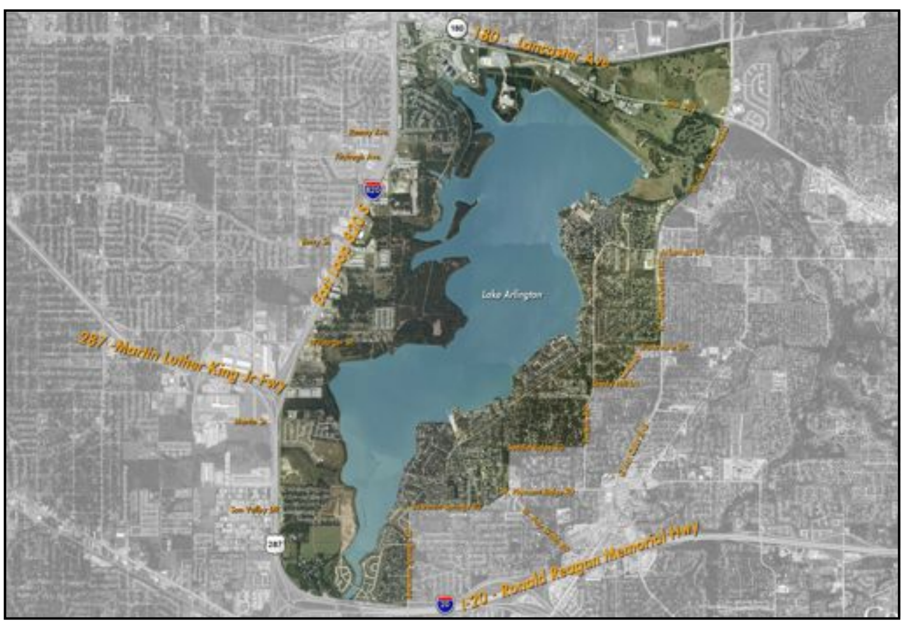
policy makers can guide the future decisions affecting the lake."

Arlington is taking a collaborative approach to the Master Plan by working very closely with the City of Fort Worth, the North Central Texas Council of Governments and communities within the watershed that drains into Lake Arlington. "Water flows to Lake Arlington from a 143 square mile watershed. So the decisions and actions of thousands of people impact our water supply. It is integral for us to engage our neighbors in these planning discussions," adds Hunt.

The Master Plan also includes developing a set of best management practices that the two counties and 12 cities in the watershed can use as a baseline for storm water quality protection standards. The Lake Arlington Master Plan will evaluate the present land use plans and ordinances, and impacts of current and planned development on the lake. This process will allow the city to prioritize which best management practices will be most effective in addressing the Lake Arlington watershed challenges.

"We are also proactively engaging citizens on the east and west sides of Lake Arlington in the Master Plan process. We know they love to live around the lake and use it as a recreational amenity," says Hunt.

To date, three public meetings have been held. Additional public meetings will be held on the Master Plan in spring 2011. For more information please visit the website, www.arlingtontx.gov/water/lakearlingtonmasterplan.html.



The immediate study area (shown above as the highlighted areas) for the Master Plan includes the neighborhoods directly adjacent to Lake Arlington. There are 13 cities and two counties that are included in the planning efforts: Arlington, Briar Oaks, Burleson, Cross Timber, Crowley, Edgecliff Village, Everman, Forest Hill, Fort Worth, Johnson County, Joshua, Kennedale, Mansfield, Rendon CDP, and Tarrant County.

Shaping Water Quality Protection

It is no accident that the City of Arlington enjoys a "superior" water quality rating by the Texas Commission on Environmental Quality. But to ensure the quality and safety of drinking water for more than half a million citizens in North Central Texas takes planning and guidelines.

That is where "best management practices" (BMPs) come into play. BMPs describe policies and procedures for governments, businesses and individuals to take to keep pollution out of the water.

> *A Best Management Practice (BMP) is...*
> *a set of standards and guidelines to address the best ways to protect water quality.*

Through the Master Plan, the City is drafting a watershed management strategy which include BMPs to share with all of the cities found within the watershed - which covers more than 143 square miles. These BMPs will include ideas and guidelines such as:

- Ordinances for storm water management in areas of development and significant redevelopment
- Illicit discharge detection and elimination ordinance and program
- Trash collection programs
- Recommended practices for oil and gas well drilling and exploration near Lake Arlington and Village Creek
- Construction management practices for road construction in and near Lake Arlington and Village Creek
- Public involvement and outreach
- Pollution prevention and good housekeeping for municipal

To date, hundreds of Arlington and Fort Worth citizens have participated in discussion on the Lake Arlington Master Plan during three public meetings. The final round of public meetings will be held in spring 2011 in both Arlington and Fort Worth.

Public Input Integral to Planning Process

When you attend a Lake Arlington Master Plan public meeting expect to be greeted warmly and to have the opportunity to speak directly with planning team leaders about your thoughts on the Master Plan.

"We are listening to our customers and the stakeholders affected by the Master Plan. We are incorporating their feedback into the plan as feasible," says Valery Jean-Bart, project manager. "Our meetings are designed to accommodate one-on-one conversations and direct interaction with attendees. We believe it is a better way to learn from each other."

At each of the public meetings held in Arlington and Forth Worth, attendees have provided input on the Master Plan. During the first round of public meetings, attendees learned about the Master Plan and gave their input on the Master Plan process and what results they would like to see.

Erich Dohrer, lead planner for the project knows the value of talking with stakeholders about their desires, dislikes and ideas. "After each meeting, we always come away having learned something new. When we are back in our offices putting the ideas together, we are able to use the input from the conversations and comment cards during the meetings," adds Dohrer.

At the Sept. 13, 2010 public meeting, the Planning Team collected input on the vision statement and stakeholder reactions to the development opportunities presented that evening.

All of the materials and information presented during the public meetings are posted on the project website. The public is also welcome to provide comments and feedback through the website at: www.arlingtontx.gov/water/lakearlingtonmasterplan.html.

Questions and Answers

Here are a few frequently asked questions and answers about the Lake Arlington Master Plan. For more Q&A, please visit the project website.

1. I am concerned about increased street traffic and lake crowding due to any new development that might occur. How is the plan addressing congestion and safety?
This is a high level vision plan designed to provide guidance for how the community would like to see development occur. When the City and others decide to move forward with specific projects, each project developed within the Study Area will have to meet the current City of Arlington development standards for traffic and safety.

2. Once the standards for docks, piers and retaining walls are adopted by Arlington's city Council, who pays for the improvements?
Private property owners are responsible for any new construction costs or improvements. Any new construction or improvements on public land would be the responsibility of the public land owner (i.e. for parks and public shoreline).

3. What can be done to make the parks safer and to reduce the noise and rowdy behavior, especially at night?
The Master Plan will document the concerns of residents related to park safety. The Parks and Recreation Department is working with the Police Department to limit vehicle access to Richard Simpson Park in the evening hours. Barricades will be placed so that drivers will have limited access and thoroughfare to the park. In addition, the Parks Dept. is taking public comment on changing the operating hours of Richard Simpson Park.

4. Why does the water level of the lake fluctuate?
There are a number of reasons why the lake level fluctuates including evaporation, the operations of the lake for water use within the reservoir system and actual water use. Water is pumped into Lake Arlington during low use periods and held for storage. Customer usage increases during hotter, drier weather and more water is pumped from Lake Arlington to the water treatment facilities to meet these demands.

What's Next?

While the City of Arlington Council will ultimately approve the Master Plan, many players will have a role in carrying out the vision.

The Water Utilities Department is interested in implementing parts of the Master Plan that have to do with protecting water quality. Many other City departments will also be involved carrying out Vision and associated plans, policies, procedures and ordinances. .

Cities and counties within the watershed will have an opportunity to address how they can reduce potential sources of pollution and manage storm water.

Developers can put together a more specific plan and funding to develop vacant land or new projects as part of the overall vision. These projects would follow the City's normal review and permitting processes.

Fall 2010

Data Collection and Watershed Modeling Continues

Public Meeting

A public meeting was held in September that focused on gathering input on the development opportunities and the draft vision.

Vision Planning

Copies of the ideas and the Vision for Lake Arlington can be found on the project website.

Winter 2010

Boating Capacity Study Finalized

This study tells us how the lake is currently being used and highlight safety concerns for current and potential uses.

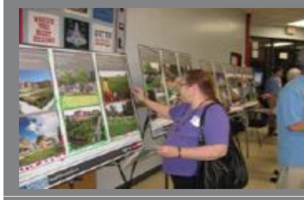
Regional Coordination Continues

With the cities and counties within the 143 mile watershed on best management practices for watershed protections

Spring 2011

How to Reach Us

Phone: 817.877.9978, ext. 1
Email: LakeArlington@arlingtontx.gov



Public Meetings

The final round of public meetings will be held in Arlington and Fort Worth.

Council Approval

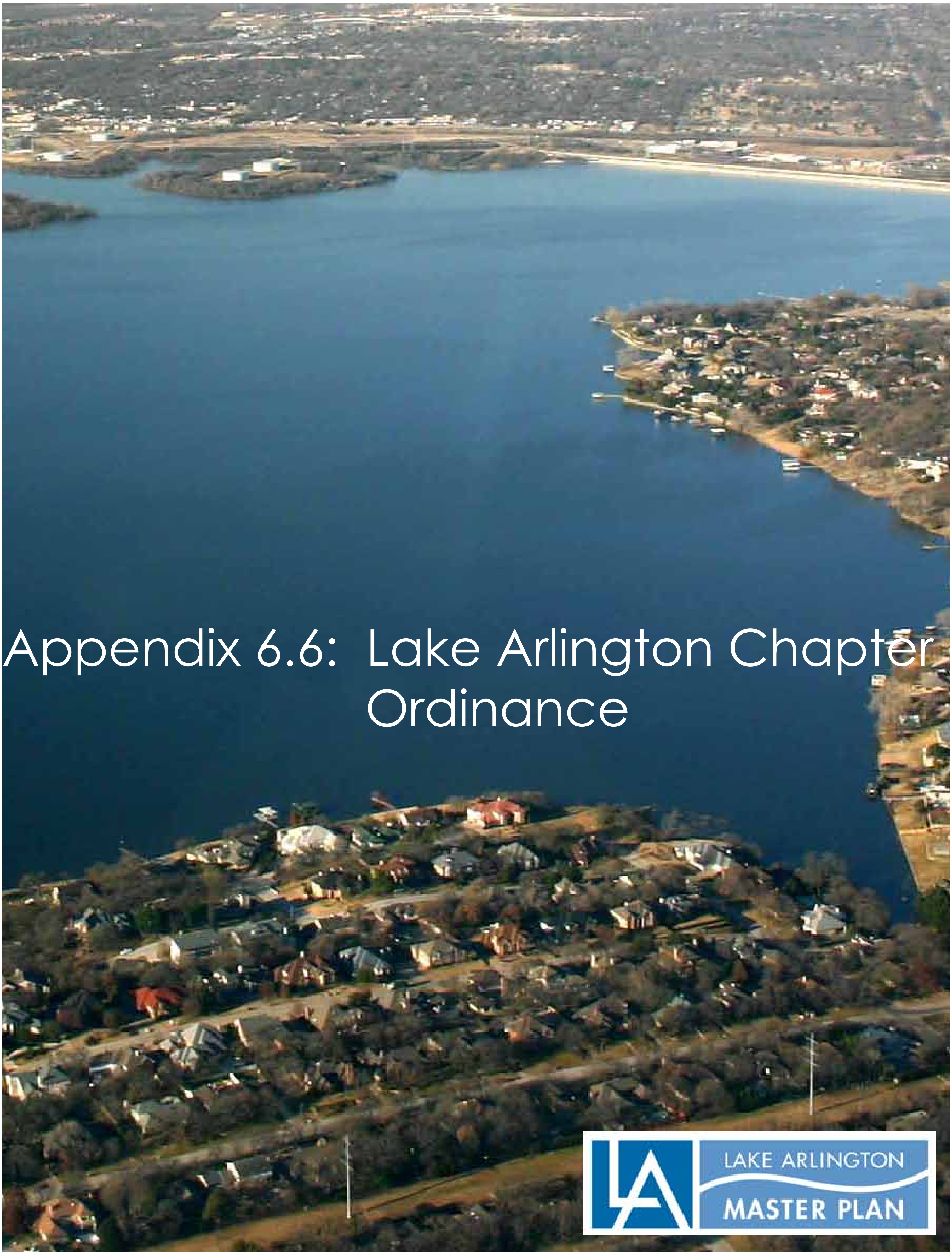
Arlington's City Council approves the Master Plan. Any development or redevelopment projects will follow the normal permitting and approval process.

LAKE ARLINGTON MASTER PLAN

Pour yourself into its future.

City of Arlington
Water Utilities Department
P.O. Box 90231, MS 01-0200
Arlington, TX 76004-3231

Appendix 6.6: Lake Arlington Chapter Ordinance



Ordinance No. __________

An ordinance amending the "Lake Arlington" Chapter of the Code of the City of Arlington, Texas, 1987, through the repeal of the existing chapter and the adoption of a new "Lake Arlington" chapter, relative to new requirements and clarification and updating of the ordinance; and providing for a fine of up to $500 for each offense in violation of the ordinance; providing this ordinance be cumulative; providing for severability; providing for governmental immunity; providing for injunctions; providing for publication and becoming effective ten days after first publication

BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF ARLINGTON, TEXAS:

1.

That the "Lake Arlington" Chapter of the Code of the City of Arlington, Texas, 1987, is hereby amended to read as follows:

ARTICLE I

GENERAL PROVISIONS

Section 1.01 Definitions

"Boat" means all devices used or capable of being used for transportation on water, regardless of the means of propulsion or locomotion.

"Boathouse" means any covered structure or attached appurtenance which is used for the temporary or permanent storage of watercraft or personal property on or over the water.

"City" means the City of Arlington, Tarrant County, Texas.

"City Code" means the Code of Ordinances of the City of Arlington, Texas, 1987, as amended.

"Competition Type Motorboat" means any detachable propulsion system boat which exceeds U.S. Coast Guard maximum horsepower limitations or any non-detachable propulsion system boat which does not meet limitations specified in this Chapter.

"Earthwork" means the disturbance of soils associated with filling, clearing, and grading or excavation activity.

"Facilities" mean any building, boathouse, pier or other structure or any combination of structures.

"Gunwales" mean the upper edge of a vessel or boat.

"Hearing Authority" means the City's Municipal Court, a board or commission listed in the Administration Chapter of the City Code, or a person assigned the responsibility of conducting a hearing under this Chapter by the Ordinance Administrator.

"Lake Arlington" means all of the waters within the Lake Arlington reservoir area that are located within the corporate limits of the City of Arlington.

"Lake Arlington Flowage Easement or Flowage Easement" means that area adjacent to the Reservoir Area which is bounded by the contour line of elevation five hundred sixty feet (560') above mean sea level, lying between said contour line and the Lake Arlington Reservoir Area.

"Lake Arlington Reservoir Area or Reservoir Area" means the area bounded by the Lake Arlington Dam and the contour line of elevation five hundred fifty feet (550') above mean sea level.

"Launch Area" means the geographic area operated or designed for the purposes of launching and recovering watercraft including the water covered areas from the shore to the center thread of the waterway and bounded by the property lines extended to said center thread.

"License" means that license required for any boathouse, pier or other structure or any combination of structures.

"Motorboat" means any watercraft propelled or designed to be propelled by machinery, whether or not the machinery is permanently or temporarily affixed, or is the principal source of propulsion.

"Operate" means to navigate or otherwise use a watercraft.

"Ordinance Administrator or Director" means the City Manager appointed Department Ordinance Administrator or their designees charged with the administration and enforcement of this Chapter.

The word "Owner", applied to a building, land, personal property, or structure shall include any part owner, joint owner, tenant in common, tenant in partnership, joint tenant by the entirety, of the whole or of a part of such building or land or personal property or structure.

"Peace Officer" means any person so designated by the Texas Code of Criminal Procedure.

"Person" means any natural person, association of persons, partnership, corporation, agent or officer, or other entity.

"Personal watercraft" means any type of watercraft which is specifically designed to be operated by a person or persons sitting, standing, or kneeling on the surface of the watercraft such as a jet ski or surfboard, rather than in the conventional manner of sitting or standing inside the vessel, such as a motorboat or sailboat.

"Pier" means any pier, wharf, boat dock, gangway, or other platform or structure in or adjoining the water to which vessels may be moored, by which they may be boarded, or on which persons may walk or sit.

"Raft" means a collection of logs or timber fastened together or any non-motorized rubber, canvas or plastic vessel not approved for use on Lake Arlington by the Ordinance Administrator.

"Waste Disposal Site" means a bin, can or other container placed and designated for the disposal of solid waste, litter, or recyclable materials.

"Watercraft" means any and all kinds or types of flotation vessels designated for use on the water whether or not motorized including, but not limited to, boats, canoes, kayaks, jet skis, skidoos, pedal craft, pontoon boats, rafts, inflatable craft, tubes, or wind propelled surfboards.

Section 1.02 Inspection

The Ordinance Administrator shall inspect all boats and other watercraft before they are permitted on Lake Arlington. The Ordinance Administrator or any peace officer may exclude any person or watercraft from Lake Arlington when such person or watercraft is in violation of the terms and provisions of this Chapter including watercraft that is unsafe or dangerous to life or property.

Section 1.03 Liability

The City shall in no event be liable to any person on account of the loss or damage to any property that may be placed in or upon Lake Arlington, nor shall the City be liable in any event to any person or persons whomsoever on account of personal injuries or loss of life that may be sustained by any person or persons in or upon Lake Arlington; and persons entering in or upon Lake Arlington shall do so at their sole risk and shall not be privileged to enter or remain in or upon Lake Arlington save and except under the terms and provisions of this Chapter and any other applicable law.

Section 1.04 Waiver

The City Council may upon owner application and consideration waive for a specified length of time such of the terms, provisions and conditions of this Chapter as may be deemed appropriate for the accommodation of water carnivals, shows, boat races, swimming meets, educational purposes, exhibitions and other special events as may be permitted from time to time and subject to such safety measures as the City Council may require.

Section 1.05 Purpose

The provisions in this chapter are cumulative of all City ordinances. The purpose of this chapter is to protect the health, safety and general welfare of Arlington citizens and visitors; to minimize property damages or losses; and to prevent erosion at or near Lake Arlington, Lake Arlington Flowage Easement or Lake Arlington Reservoir Area. The provisions of this Chapter are also designed to:

1. Regulate or prohibit activities or buildings or structures which are dangerous to health, safety or property or may cause increased flood heights or velocities.

2. Minimize damage to public facilities and utilities such as water, gas, electric, telephone, storm drainage, sanitary sewer, streets and bridges located in Lake Arlington.

3. Conserve in perpetuity the waterways throughout the City as a natural protection against the hazards and losses connected with flooding.

4. Regulate the construction and disposal of Lake Arlington hazards or flood barriers which will unnaturally divert waters or which may increase flood hazards to other lands or citizens or visitors in the Lake Arlington area, Lake Arlington Flowage Easement or Lake Arlington Reservoir Area.

Section 1.06 Permits and Licenses

Any permits or licenses issued under any provision of this chapter are not transferable.

ARTICLE II

WATERCRAFT

Section 2.01 Recreation Permit

A. No person shall place, operate or keep any watercraft on Lake Arlington without first having obtained a Recreation Permit. The Recreation Permit shall be issued for a one year period by the Ordinance Administrator upon the approval of the watercraft as being safe, seaworthy and in compliance with all provisions of this Chapter, and upon payment of the applicable Recreation Permit fee. The fee shall be as set by resolution of the City Council. A Recreation Permit may be revoked if the watercraft is occupied on Lake Arlington by an intoxicated person who does not leave said Lake pursuant to an order to do so by an Ordinance Administrator or a peace officer. In such case, a new permit must be obtained, or the revocation overturned pursuant to this Chapter before the watercraft may be returned to Lake Arlington.

B. All annual Recreation Permits, regardless of their dates of issuance, shall expire at 12:00 o'clock midnight on December 31st of the year of issuance.

C. Upon payment of the Recreation Permit fee, a decal evidencing the issuance of such Recreation Permit shall be affixed securely to the transom of the watercraft. Any watercraft without a decal may be denied admittance to Lake Arlington. The Ordinance Administrator may remove from the waters of Lake Arlington any boat or watercraft for which a Recreation Permit has not been obtained or on which a Recreation Permit has not been affixed.

D. Application for a Recreation Permit and its issuance shall constitute consent by the permittee and probable cause for any Ordinance Administrator and any peace officer to stop, board and inspect the permitted watercraft. Failure to comply with this Chapter shall constitute grounds to exclude such watercraft from Lake Arlington, regardless of whether a permit has been issued. No person shall place, operate or keep any watercraft on Lake Arlington in contravention of an order by the Ordinance Administrator. The Ordinance Administrator may remove the boat under this section. A watercraft shall not be returned to the waters of Lake Arlington until there is full compliance with the provisions of this Chapter.

Section 2.02 Launching of Watercraft

A. No person shall launch a boat or other watercraft on Lake Arlington except at points designated and authorized by the Ordinance Administrator.

B. No vehicle, watercraft or trailer shall be placed, parked or left unattended in such a position and manner as to limit access to any designated launch area.

Section 2.03 Minimum Age of Operators

No person under the age of 14 years shall operate a watercraft on Lake Arlington without a person aged 21 years or older in such watercraft giving immediate and direct supervision to such minor.

Section 2.04 Traffic Rules

The following traffic rules shall be observed by watercraft operating on Lake Arlington:

A. Passing: When two (2) boats or other watercraft are approaching each other "head-on" or nearly so (so as to involve risk of collision), it shall be the duty of each boat to bear to the right and pass the other boat on its left side.

B. Crossing: When boats or other watercraft approach each other obliquely or at right angles, the boat or other watercraft approaching on the right side has the right-of-way.

C. Overtaking: One (1) boat or other watercraft may overtake another on either side, but must grant right-of-way to the overtaken boat or other watercraft.

D. Speed Limit: No person shall operate any boat or other watercraft on Lake Arlington at a rate of speed greater than thirty (30) miles per hour.

E. No person operating a personal watercraft above headway speed may come closer than one-hundred fifty (150) feet from another vessel, except another personal watercraft.

F. No person operating a personal watercraft shall jump the wake of another watercraft towing a person for any type of water skiing activity.

G. No person shall operate a personal watercraft between the hours of sunset to sunrise.

H. No person may operate a boat above headway speed in any area marked/designated as a "No Wake" zone.

I. No person may operate a boat above headway speed within fifty (50) feet of another boat, platform, person, object or shore.

J. A boat when not at dock must have and exhibit at least one bright light from sunset to sunrise.

K. A boat underway between sunset and sunrise must have and exhibit the lights prescribed by the Water Safety Act, Chapter 31, of the Parks and Wildlife Code, V.T.C.A.

Section 2.05 Personal Flotation Devices

The following rules regarding personal flotation devices shall be observed by all watercraft operating on Lake Arlington:

A. A watercraft must have at least one Coast Guard approved life preserver aboard for each person on the boat.

B. All passengers under 13 years of age on a watercraft must wear a Coast Guard approved life preserver any time the watercraft is underway.

C. All persons operating or riding upon a personal watercraft shall wear a U.S. Coast Guard approved Type I, II, III or V personal flotation device.

Section 2.06 Riding on Decks and Gunwales

No person operating a motorized watercraft on Lake Arlington shall allow any person to ride or sit on the gunwales thereof or on the decking over the bow of said motorized watercraft while the same is underway, nor shall any person operating an open motorized watercraft allows any person to stand in said motorized watercraft while the same is underway. Nothing in this section shall be construed to mean that passengers or other persons aboard a motorized watercraft cannot stand on the decking over the bow of said motorized watercraft to moor the same or to cast off, or for any other necessary purpose when said motorized watercraft is not underway.

Section 2.07 Obstruction of Traffic Lanes Prohibited

No person shall anchor a watercraft for fishing or other purpose on Lake Arlington in such a position as to obstruct a passageway ordinarily used by other watercraft.

Section 2.08 Hanging On to Buoys

No person shall at any time hang on with a watercraft to any buoy, beacon or sign placed on Lake Arlington by the City.

Section 2.09 Anchoring

No person shall leave a watercraft on Lake Arlington without having the same dependably fastened to an anchorage, either in the water or upon the land. Any such watercraft not so fastened must be removed from the water a sufficient distance to assure that it will not be caused to float away from its station because of rising waters.

Section 2.10 Accidents

The operator of any watercraft involved in an accident resulting in injury or death to any person, or resulting in damage to property, shall report such accident immediately to an Ordinance Administrator.

Section 2.11 Fishing

A. No person shall be in possession of any game fish which is under the statewide legal size limit for that species as defined by the Texas Parks and Wildlife Department.

B. No person may possess more game fish of any species than is allowed by the Texas Parks and Wildlife Department.

C. No person may fish in Lake Arlington without a current Texas Fishing License.

Section 2.12 Skiing, Surfing and Water Sports

The activities of skiing, surfing, pulling another person upon any buoyant device or material behind or beside a watercraft, or other comparable water sports shall be governed as follows:

1. All persons directly engaged in any activities under this section shall wear life preservers at all times.

2. No watercraft or person engaged in any activities under this section shall approach closer than 100 feet to docks, swimming areas, any shoreline or other watercraft.

3. No person shall engage in activities under this section south of Bowman Springs Park.

4. No boat or other watercraft shall follow closer than 200 feet behind a person engaged in any activity under this section.

5. No person shall tow another person by any method into a "No Ski" area, regardless of whether the towed person is using a ski or skis or is on any other buoyant device or material.

Section 2.13 Capacity of Watercraft

No person owning or operating a watercraft on Lake Arlington shall permit watercraft to be occupied by more persons than the rated capacity of such watercraft, nor shall any person owning or operating a watercraft on Lake Arlington permit same to be loaded with passengers or cargo beyond its safe capacity, taking into consideration weather and other operating conditions.

Section 2.14 Intoxication

Any person operating or occupying a watercraft on Lake Arlington, or engaged in any activity in or upon the water of Lake Arlington, who is found to be or appears to be intoxicated and a danger to himself or herself or others may be ejected from Lake Arlington by an Ordinance Administrator or any peace officer. Failure to leave Lake Arlington when ordered to do so under this section shall constitute grounds for the revocation of the Recreation Permit issued to any watercraft involved in a violation of this section.

Section 2.15 Certain Types of Watercraft Prohibited

A. No person shall place, operate or keep any watercraft commonly referred to as a competition type motorboat, houseboat, air boat or raft on Lake Arlington without first obtaining written permission from the Ordinance Administrator. The ordinance Administrator may grant, for a period not to exceed 30 days, a permit to use these types of watercraft on Lake Arlington under specific written guidelines.

B. No detachable propulsion system watercraft shall be operated on Lake Arlington with an engine horsepower exceeding that listed on its permanently attached U.S. Coast Guard capacity plate. In the event that the watercraft has no capacity plate attached, the maximum safe horsepower for such watercraft shall be determined by using the Code of Waters, Chapter 1, Coast Guard, Department of Transportation, Part 183, Subpart D - Safe Powering, and the engine horsepower of the watercraft shall not exceed that maximum safe horsepower. Non-detachable propulsion system boats shall be exempt from a horsepower limitation.

C. All motorized watercraft shall meet the following conditions:

1. The engine shall be exhausted below the water line.

2. The watercraft shall be in a safe condition and may be utilized only for recreational purposes.

Section 2.16 <u>Use for Commercial Fishing Prohibited</u>

No person shall use or operate a watercraft on Lake Arlington for the purpose of catching and taking fish or game for market or sale, except for the removal of rough fish as authorized by the Ordinance Administrator.

Section 2.17 <u>Severe Weather Warning</u>

When in the opinion of an Ordinance Administrator, severe weather is forecast, or when weather conditions on Lake Arlington are such as to render boating, fishing, swimming and other activities hazardous, he shall have the authority to order all persons and all watercraft ashore, under such terms and conditions as in his sole judgment are deemed necessary for the protection of people and property. No person shall knowingly or intentionally remain in or upon the waters of Lake Arlington in violation of a severe weather warning issued under this section.

Section 2.18 <u>Removal of Watercraft from Lake</u>

A. An Ordinance Administrator may require the removal of any watercraft from Lake Arlington if such watercraft is in an unsafe operating condition or is in violation of any of the applicable provisions of this Chapter.

B. Any peace officer may require the removal of any watercraft from Lake Arlington if such watercraft is in an unsafe operating condition or is in violation of any of the applicable provisions of this Chapter or the Texas Parks and Wildlife Code.

C. Any person refusing to remove any watercraft under the provisions of this section shall be deemed guilty of a misdemeanor.

Section 2.19 Abandoned Watercraft, Boathouses or other Structures

A. Any watercraft, boathouses, or other structures found abandoned or adrift on Lake Arlington, not in use and not anchored or grounded in compliance with this Chapter, shall be deemed to be abandoned and shall be taken up by an Ordinance Administrator; and the City shall have a lien thereon for the expenses of taking, towing and keeping the same, which shall be done at the owner's risk and without any liability whatsoever on the part of the City. Processing of the abandoned watercraft shall be in accordance with the Nuisance Chapter of the Code of the City of Arlington.

B. The abandonment of any property on the land and waters covered by this article is prohibited. Property shall not be left unattended upon such land or waters.

Section 2.20 Inspection of Watercraft

A. In order to enforce the provisions of this Chapter or the Texas Parks and Wildlife Code, any peace officer may stop and board any watercraft subject to this Chapter and may inspect the same to determine compliance with applicable provisions. In order to enforce the provisions of this Chapter, an Ordinance Administrator may board and inspect a watercraft when the same is at dock or anchored at a shoreline only.

B. Failure by the owner or operator of a watercraft on Lake Arlington to comply with an inspection under this Chapter shall be a misdemeanor and may constitute grounds for ejection from said Lake and the revocation of the Recreation Permit issued for such watercraft.

Section 2.21 Revocation of Recreation Permit

A. The Ordinance Administrator may revoke a Recreation Permit if an authorized representative of the City or a peace officer provides the Ordinance Administrator with written notice that a person operating or occupying a watercraft on Lake Arlington for which the Recreation Permit was issued was found to be in violation of any provision of this Chapter.

B. Written notice of the revocation shall be sent by the Ordinance Administrator to the person in whose name the permit was obtained by certified mail or shall be given to such individual personally. The notice shall contain the date of the notice, the effective date of the revocation and shall state the grounds therefore.

C. A person that has had his Recreation Permit revoked may, within ten calendar days after the date of the notice of revocation, submit to the Ordinance Administrator a written request to appear before the Ordinance Administrator in order to show cause why the permit should not be revoked. Such request for a hearing shall not stay the revocation, and the watercraft affected thereby shall not be allowed on Lake Arlington unless and until the revocation is overturned. If no hearing is requested, the Ordinance Administrator's decision shall be final.

D. Following the show cause hearing, the Ordinance Administrator may either uphold or overturn the revocation. The Ordinance Administrator's decision shall be in writing and delivered to the permit holder in person or by certified mail.

E. A decision, after a show cause hearing, to revoke a permit may be appealed to the Appeal Officer by written request to the Appeal Officer within five business days of the date of the decision of the Ordinance Administrator rendered pursuant to Subsection (D) above. The Appeal Officer shall set a date for the appeal hearing no later than five business days following receipt of the notice of appeal, and after such hearing, shall uphold or overturn the revocation. If no such appeal is taken, the decision of the Ordinance Administrator rendered pursuant to Subsection (D) above shall be final.

F. No person whose permit has been revoked twice within a 12 month period shall be eligible for a new permit until 12 months have expired from the date of the second revocation. Otherwise, an application for a new permit following a revocation shall be processed pursuant to this Chapter.

ARTICLE III

SWIMMING AND BATHING

Section 3.01 <u>Swimming</u>

No person shall swim, wade, bathe or otherwise immerse himself or herself in whole or in part in the waters of Lake Arlington except in specified areas designated by the Ordinance Administrator.

ARTICLE IV

FISHING

Section 4.01 <u>Trotlines and Juglines</u>

No person shall place a trotline or jugline in open water between the Bowman Springs Park buoy line and the Lake Arlington Dam.

Section 4.02 Fishing from Bridges Prohibited

No person shall fish from any bridge that crosses any part of the waters of Lake Arlington.

ARTICLE V

BUILDINGS AND STRUCTURES

Section 5.01 Annual License Required

No person shall keep, maintain, erect, construct, enlarge, alter or move any building, boathouse, pier or other structure or any combination of structures on the Reservoir Area or Flowage Easement, nor shall any person cause any of said acts to be done without first making application and obtaining a license and complying with all other applicable City ordinances.

Section 5.02 Permit Required

No person shall keep, maintain, erect, construct, enlarge, alter or move any building, boathouse, pier or other structure or any combination of structures on the Reservoir Area or Flowage Easement, nor shall any person cause any of said acts to be done without first making application and obtaining a permit and complying with all other applicable City ordinances.

Section 5.03 Site Plan Approval Required

No person shall perform any earthwork in the Reservoir Area or Flowage Easement, nor shall any person cause any of said acts to be done without first making application and obtaining the Ordinance Administrator's approval of the site plan or the earthwork and complying with all other applicable City ordinances.

Section 5.04 License, Permit and Site Plan Application

Each application for a license, permit or approval of a site plan, together with the required fee, shall be filed with the Ordinance Administrator on a form prescribed by the Ordinance Administrator.

Section 5.05 Consideration of Application and Issuance of Permit, License or Approval

The Ordinance Administrator shall examine and consider each application for a license, permit or approval of a site plan and shall ascertain whether the structure or earthwork complies with the requirements of the City Code. If the structure complies with such requirements and is determined to be a safe and proper use of the Reservoir Area consistent with the public interest, having due regard for the recreational and water storage and conservation purposes of said Reservoir Area, the Ordinance Administrator shall issue a permit, license or approval of the site plan. Otherwise, he or she shall deny the application. The license herein required shall be in addition to such permits or approvals as may be required by other provisions of this Chapter and other Chapters of the City Code. Such license shall be issued for the calendar year or the unexpired portion thereof. The fee required, however, shall not be prorated to cover a portion of a calendar year, but in all instances shall be collected as if the license covered the full calendar year.

The Department responsible for building permits and site plan review shall require compliance with the Flood Hazards Chapter for structures, buildings and earthwork in the Reservoir Area and Flowage Easement.

Section 5.06 <u>Duration of Annual License</u>

A license issued under this Article is valid for the calendar year or the unexpired portion thereof unless such license is revoked under the authority of this Chapter.

Prior to expiration of an issued license, a license for the following calendar year shall be applied for by submission of an application for a license together with the required fee to the Ordinance Administrator on a form prescribed by the Ordinance Administrator.

Section 5.07 <u>Fees</u>

License, permit and approval of site plan fees for a boathouse, pier or other structure, any combination of structures or earthwork shall be as established by resolution of the City Council. An applicant shall pay the fee in effect at the time of the application. The fees shall be reviewed on an annual basis and, if necessary, shall be revised by resolution of the City Council.

Section 5.08 <u>Revocation of License and Unlicensed Facilities</u>

After written notice of the Ordinance Administrator, licenses under this Ordinance may be revoked in the event the facilities are not properly maintained by the owner or licensee and unlicensed facilities may be removed at the property owner's expense in accordance with this Chapter. The written notice by the Ordinance Administrator shall be addressed to the last licensee, if such facility has been previously licensed, and to the owner of the property to which such facility is appurtenant as the ownership appears in the Tarrant Appraisal District records. Such notice shall be mailed by certified United States mail, postage prepaid and properly addressed to the licensee, if any, and owner. The Ordinance Administrator shall issue written notice as follows:

1. In the event a licensed facility is found to be improperly maintained or otherwise in disrepair, the Ordinance Administrator shall issue written notice ordering said licensee and owner to make required improvements to the facility licensee within 30 days from the date of the written notice. If the required improvements are not made by the licensee or owner within the specified time and the written notice was not appealed in accordance with this Chapter, the license for the facility shall be revoked and the facility shall be removed at the property owner's expense, in accordance with this Chapter.

2. In the event a facility is found to be unlicensed and improperly maintained or otherwise in disrepair, the Ordinance Administrator shall issue written notice ordering said owner to obtain a license and to make required improvements to the facility within 30 days from the date of the written notice. If the license for the facility is obtained but the required improvements are not made within the specified time and the written notice was not appealed in accordance with this Chapter, the license for the facility shall be revoked and the facility shall be removed at the property owner's expense, in accordance with this Chapter. If the license is not obtained within the specified time, irregardless to whether the required improvements are or are not made, and the written notice was not appealed in accordance with this Chapter, the City may remove, or cause to be removed, all or any part of same at the owner's expense. The City may proceed with all legal remedies available to collect such expense and no further license shall be issued for such facilities appurtenant to the property which was served by such removed facility until said City has been reimbursed for such removal expense.

3. In the event a facility is found to be unlicensed, the Ordinance Administrator shall issue written notice ordering said owner to obtain a license within 30 days from the date of the written notice. If the license for the facility is not obtained and the written notice was not appealed in accordance with this Chapter, the City may remove, or cause to be removed, all or any part of same at the owner's expense. The City may proceed with all legal remedies available to collect such expense and no further license shall be issued for such facilities appurtenant to the property which was served by such removed facility until said City has been reimbursed for such removal expense.

Section 5.09 <u>Certain Structures Prohibited</u>

A. Except as otherwise specifically provided in this Chapter and except for any permitted structure in existence at the time of the effective date of this ordinance amendment, it shall be unlawful for any person to construct, place or locate within, over or on Lake Arlington or on the City's lands or easements abutting Lake Arlington, any structure of any nature whatsoever, including but not limited to buildings, boat slips, pilings, trailers, houses, cabins, shacks, outhouses, toilets, privies, septic tanks, cesspools, canals, ditches, fills, causeways, channels, jetties, bridges, islands and roads (excluding from this provision, however, boats of any nature). It shall be unlawful to construct any canals, channels, ditches, boat slips or other excavation connection to Lake Arlington or any of its connecting waters.

B. It shall be unlawful for any person to erect, place or permit to stand any duck or goose blind upon Lake Arlington Reservoir, its draining streams or tributaries.

C. Boathouses shall be used for the housing of boats and equipment only, and human habitation therein shall not be permitted.

D. The City expressly reserves the right to exercise and pursue any and all legal procedures and remedies available to it to protect its property rights, including but not limited to requiring the removal of any existing structures, fill or excavation constructed or encroaching into or upon Lake Arlington or any of the City's lands or easements. This express reservation of this right to the City shall be in addition to any other rights, remedies and penalties provided for in this Chapter.

Section 5.10 <u>Earthwork within Reservoir Area or Flowage Easement</u>

A. Prior to performing any earthwork within the Lake Arlington Reservoir Area or Flowage Easement, the owner must submit a site plan for approval by the Ordinance Administrator. The owner may be required to abandon the Flowage Easement and dedicate additional Flowage Easement area if the work proposed will result in an adjustment of the 560 feet mean sea level contour line. Permanent structures proposed with the site plan, such as retaining walls, docks or piers, require a construction permit in accordance with the Construction Chapter of the City Code.

B. The following items shall be included with the site plan submittal:

1. Description of the work.

2. Map.

3. Plan prepared by a licensed Professional Engineer or registered Landscape Architect showing existing and proposed grades (topography), easements and structures where applicable. Existing topography shall be verified by a Registered Public Land Surveyor.

4. Cross-section(s) of any proposed excavation or fill.

5. Earthwork calculations demonstrating zero net loss of lake volume within the Flowage Easement.

6. Copy of letter from the U.S. Army Corps of Engineers verifying that the work proposed is permitted.

7. Copy of executed easement abandonment documents and new Flowage Easement dedication, if applicable.

8. As-Built plans within 30 days of project completion.

C. Plans which show that the work has been completed as originally intended on the approved site plan (Record Drawings) must be provided and accepted upon completion of earthwork activities. The record drawing must include a verification statement or seal prepared by a Registered Public Land Surveyor.

Section 5.11 Construction Chapter Applicable to Piers and Boathouses

Piers and boathouses are structures, as that term is used in the Construction Chapter of the Code of the City of Arlington, and persons desiring to construct them shall comply in all respects with the Construction Chapter.

Section 5.12 Design and Construction of Piers and Boathouses

A. Width and Length Requirements: The minimum width of any pier constructed in the Lake Arlington Reservoir Area shall be four feet (4'). The maximum length that any pier constructed in such area may extend beyond the back property line and onto public property shall in no case exceed one hundred feet (100').

B. Loadings and Structural Requirements: All plans submitted for permit shall be signed and sealed by a Texas licensed, professional engineer.

C. Addresses: Each pier, dock or boathouse shall have the street address of the property clearly marked and legible from the lake side of the structure.

Section 5.13 Enforcement Authority

Enforcement and inspections under this Chapter shall be made by the Ordinance Administrator or any peace officer.

Section 5.14 Requiring Repair, Removal, or Demolition of Building

If the Ordinance Administrator has reason to believe that a building is a dangerous building as defined in the Construction Chapter of the City Code or other relevant ordinances, the Ordinance Administrator shall proceed in accordance with the Construction Chapter or other relevant law:

1. to determine whether the building is a dangerous building and, if so, whether it shall be vacated, secured, repaired, removed, and/or demolished, or any occupants relocated; and,

2. to recover expenses incurred for any work that is done to repair, remove, secure, vacate, or demolish.

Section 5.15 Requiring Repair, Removal, or Demolition of Structure

A. If the Ordinance Administrator has reason to believe that a bulkhead or other method of shoreline protection, fence, shed, awning, or other structure, or part of a structure, hereinafter referred to as "structure", is likely to endanger persons or property, the Ordinance Administrator shall schedule a public hearing before the Hearing Authority for a determination of whether the structure is likely to endanger persons or property and for the issuing of a proposed order on the determination of whether the structure is likely to endanger persons or property and on the repair, removal or demolition of the structure.

B. Hearing Authority Hearing

   1. Scheduling a Hearing. The Ordinance Administrator shall schedule a public hearing when the Ordinance Administrator has inspected any structure and has determined that such structure is likely to endanger persons or property.

   2. Issuance of Notice.

      a. The Ordinance Administrator shall issue a notice of hearing to each owner of the structure, owner of the property on which the structure is located, mortgagee, and lienholder, as known by the City and as shown by search of the following records:

         (1) Official Public Records of Real Property in Tarrant County, specifically in the Tarrant County Clerk's Office;

         (2) Appraisal district records for the appraisal district in which the structure is located;

         (3) Records of the Texas Secretary of State;

(4) Assumed name records for Tarrant County;

(6) Tax records of the City of Arlington; and

(7) Utility records for the City of Arlington.

b. The Ordinance Administrator shall issue notice of hearing to all unknown owners, if any, by posting a copy of the notice on the front door of each improvement situated on the affected property or as close to the front door as practicable.

3. <u>Contents of Notice</u>. The notice shall contain:

a. The street address or legal description of the structure;

b. A statement that the Ordinance Administrator has found that the structure is likely to endanger persons or property, and a brief description of the conditions found to render such likely to endanger persons or property;

c. A statement specifying the date, time and place of the hearing; and

d. A statement that the owner of the structure, owner of the property on which the structure is located, mortgagee, and lienholder will be afforded an opportunity to comment at the hearing and will be required to submit at the hearing proof of the scope of any work that may be required to abate the condition likely to endanger persons or property and the time it will take to reasonably perform the work.

4. <u>Service of Notice</u>.

a. Notice of the hearing shall be given by certified mail, return receipt requested, or by personal service. If the address of any person entitled to notice cannot be ascertained, or if service cannot be made by mail or in person after a reasonable attempt, and for all unknown owners, service shall be made by posting a copy of the notice on the front door of each improvement situated on the affected property or as close to the front door as practicable.

b. The notice shall be mailed and/or posted before the tenth (10th) day before the date of the hearing. Service by certified mail shall be effective on the date of mailing.

c. Proof of personal service shall be certified at the time of service by a written declaration executed by the person effecting service, declaring the date, time and manner in which service was made. The declaration, together with any receipt card returned in acknowledgment of receipt by certified mail shall be affixed to the copy of the notice retained by the Ordinance Administrator.

d. Notice of the hearing may be filed in the Official Public Records of Real Property in Tarrant County, specifically in the Tarrant County Clerk's Office. The notice shall contain:

(1) the name and address of the owner of the affected property if that information can be determined;

(2) a legal description of the affected property; and

(3) a description of the hearing.

The filing of the notice is binding on subsequent grantees, lienholders, or other transferees of an interest in the property who acquire such interest after filing of the notice, and constitutes notice of the hearing on any subsequent recipient of any interest in the property who acquires such interest after the filing of the notice.

5. Conduct of Hearing.

a. Failure to Appear. If the owner fails to appear at the hearing after being duly served, the Hearing Authority shall conduct the hearing as if the owner personally appeared.

b. Subpoena Power. Witnesses may be subpoenaed in accordance with the procedures set forth in Article XI of the "Administration" Chapter.

c. Procedure. The Hearing Authority shall be authorized to establish rules and regulations for the conduct of hearings, if such are consistent with this Chapter, other local ordinances and state law.

6. Findings and Orders.

a. After all evidence has been presented, the Hearing Authority shall determine whether the structure is likely to endanger persons or property.

b. The Hearing Authority shall enter an order as set forth below:

(1) If the structure is believed by the Hearing Authority to likely endanger persons or property, the Hearing Authority may issue an order that:

(a) finds that the structure is likely to endanger persons or property;

(b) orders the owner of the structure or owner of the property on which the structure is located, at his option, to repair, remove, or demolish the structure, or the part of the structure within a specified time;

(c) orders an additional specified period of time for all mortgagees or lienholders to comply with the order should the owner of the structure or the owner of the property on which the structure is located fail to comply with the order within the time provided for action; and

(d) orders that if the owner of the structure or the owner of the property on which the structure is located fails to comply with any part of the order by the specified dates and if any of the mortgagees or lienholders fail to comply with the order in the owner's stead by the specified dates, the City is hereby authorized at its discretion to repair, remove or demolish, at the expense of the City, on behalf of the owner of the structure or the owner of the property on which the structure is located, and assess the repair, removal or demolition expenses on the property on which the structure was located.

(2) If the structure is not believed by the Hearing Authority to likely endanger persons or property, the Hearing Authority may issue an order that finds that the structure is not likely to endanger persons or property.

7. <u>Proposed Order.</u>

a. The proposed order issued by the Hearing Authority shall be in writing and shall set forth the decisions of the Hearing Authority made pursuant to this Chapter.

b. An order to repair, remove or demolish shall set forth those items that need to be repaired, removed, or demolished.

c. The proposed order shall be signed and dated by the Municipal Court Judge or one or more persons assigned the responsibility of conducting a hearing under this Chapter.

d. After the hearing, the Hearing Authority shall promptly send a copy of the proposed order, a record of the hearing and any evidence to the Ordinance Administrator.

e. The Ordinance Administrator shall promptly send a copy of the Hearing Authority's proposed order by certified mail, return receipt requested, to the owner of the structure, owner of the property on which the structure is located, mortgagee, and lienholder. If a notice is mailed according to this subsection and the United States Postal Service returns the notice as "refused" or "unclaimed", the validity of the notice is not affected, and the notice shall be deemed as delivered.

f. The Ordinance Administrator may schedule on the City Council agenda the proposed order for final resolution by City Council. The Ordinance Administrator shall issue notice of the City Council agenda date, time and place for final resolution pursuant to the issuance, contents and service of notice for the Hearing Authority's hearing in this Chapter.

C. <u>City Council Resolution</u>

1. City Council may adopt, in whole or part, by City Council Resolution the Hearing Authority's order as its finding and order.

2. City Council may amend, modify or reject the Hearing Authority's order. If City Council amends, modifies or rejects the Hearing Authority's order, the City Council by City Council Resolution shall issue its finding and order. City Council's finding and order shall be issued in accordance with the Hearing Authority's procedures for Findings and Decisions set forth in this Chapter.

3. A copy of the City Council Resolution shall be sent promptly by the Ordinance Administrator by certified mail, return receipt requested, to the owner of the structure, owner of the property on which the structure is located, mortgagee, and lienholder. If such City Council Resolution is mailed according to this subsection and the United States Postal Service returns the order as "refused" or "unclaimed", the validity of notice of the order is not affected, and the order shall be deemed as delivered.

4. Within ten (10) days after the date of passage of the City Council Resolution:

   a. a copy of the City Council Resolution containing its finding and order regarding the structure shall be filed in the Office of the City Secretary; and

   b. a notice shall be published in a newspaper of general circulation in the City, said notice containing:

      (1) the street address or legal description of the property;

      (2) the date of consideration of the City Council Resolution;

      (3) a brief statement indicating the results of the City Council Resolution; and

      (4) instructions stating where a complete copy of the City Council Resolution may be obtained.

      (5) If the owner of structure or the owner of the property on which the structure is located fails to comply with an order in the City Council Resolution within the allotted time, the Ordinance Administrator shall cause a copy of the City Council Resolution to be sent by certified mail return receipt requested to each lienholder and mortgagee as was determined pursuant to this Chapter. This shall constitute notice to the lienholders and mortgagees that the owner has failed to comply with the order.

5. When any work to repair, remove, or demolish is done pursuant to this Chapter, the Ordinance Administrator shall cause the work to be accomplished by City personnel or by private contract under the direction of the Ordinance Administrator, or he may employ such architectural, engineering, or other specialized assistance on a contract basis as reasonably necessary.

6. Any expenses for work to repair, remove or demolish shall be assessed pursuant to Article XVIII of the Construction Chapter except as to the following:

   The Ordinance Administrator shall also provide notice of the assessment to the owner of structure and the owner of the property on which the structure was located by mailing by certified mail, postage prepaid a copy of the Hearing Authority's order assessing cost.

ARTICLE VI

SANITATION

Section 6.01 Sewage Systems Required

All habitations located within thirteen hundred feet (1,300') of the emergency spillway level (elevation five hundred sixty feet [560'] above mean sea level) in Lake Arlington shall be connected to a municipal sanitary sewer system.

Section 6.02 Livestock

No animals or livestock shall be permitted nearer to Lake Arlington than the emergency spillway level (elevation five hundred sixty feet [560'] above mean sea level). No animal pens, corrals or barns shall be constructed within three hundred feet (300') (measured horizontally) of said emergency spillway elevation, nor shall they be constructed at any point from which drainage may run into Lake Arlington or into any stream which lies within the Lake Arlington watershed.

ARTICLE VII

MISCELLANEOUS OFFENSES

Section 7.01 Restricted Areas

No person shall engage in wading, bathing, swimming or floating, fishing, boating, skiing or otherwise being towed, surfing, jet skiing or any other activity in or upon Lake Arlington in any areas designated as restricted areas and marked with buoys, signs or in any other manner. Nor shall any person, other than City employees in the performance of their duties, in any manner go upon any part of the Lake Arlington Dam or emergency spillway for any purpose whatever.

Section 7.02 No Motor Vehicles Permitted on Dam or Emergency Spillway

No person, other than City employees in the performance of their duties, shall operate or park any motor vehicle on the Lake Arlington Dam or emergency spillway.

Section 7.03 Parachute or Kite Flying

No person shall engage in parachute flying or kite flying on or over Lake

Arlington unless authorized to do so in writing by the Ordinance Administrator.

Section 7.04 Camping

No camping shall be permitted within thirteen hundred feet (1,300') of the emergency spillway level (elevation five hundred sixty feet [560'] above mean sea level) of Lake Arlington, save and except in certain designated areas authorized by the Ordinance Administrator.

Section 7.05 Children to be Accompanied by Adults

No child under the age of twelve (12) years shall be permitted to enter or remain in or upon Lake Arlington unless accompanied by and under the immediate supervision at all times of an adult person aged 21 or older.

Section 7.06 Prohibited Hours

No person shall engage in any activity, with the exception of fishing, on a twenty-four (24) hour basis at the Arkansas Lane Park, on Lake Arlington or on any City property adjacent to Lake Arlington daily between the hours of 12:00 midnight and 5:00 a.m.

Section 7.07 Unmanned Boats

No person shall leave a watercraft on Lake Arlington overnight unmanned, unless he has written permission to do so from the Ordinance Administrator.

Section 7.08 Landing Airplanes

No person shall land an airplane on Lake Arlington, except in case of emergency or as allowed by law.

Section 7.09 Vehicles in Water

No person shall intentionally drive a motor vehicle into the waters of Lake Arlington or on the lake bed at times when the water level has receded below elevation five hundred fifty feet (550'), unless while engaged in the act of launching or retrieving a watercraft.

Section 7.10 Weapons on Lake

No person, while engaged in any activity upon, on, in or at Lake Arlington, shall carry on or about his person any firearm, as that term is defined in Texas Penal Code, Section 46.01(3); provided, however, that this section shall not apply to conduct addressed in Chapter 46, entitled “Weapons”, of the Texas Penal Code.

Section 7.11 Littering

A person commits an offense if the person disposes or allows or permits the disposal of litter or other solid waste under fifteen (15) pounds or with a volume of thirteen (13) gallons or less into Lake Arlington or onto its surrounding shorelines. It is an exception to the above offense that the litter or solid waste was disposed of into an approved waste disposal or recycling site.

Section 7.12 Storage of Fuel or Oil

No person shall store within the Reservoir Area or Flowage Easement any gasoline, oil, or other flammable or combustible liquid without written approval of the Ordinance Administrator.

ARTICLE VIII

ENFORCEMENT

Section 8.01 Violations and Penalties

Any person who violates or fails to comply with any section or provision of this Chapter or the order, rule, regulation, license or permit issued hereunder shall be guilty of a misdemeanor, and each day the violation continues shall be a separate offense. Upon conviction each offense shall be punishable by a fine not to exceed Five Hundred Dollars ($500.00). This penalty shall be in addition to and supplemental to any other remedies available to the City to suppress and abate the acts and conditions prohibited under the provisions hereof.

ARTICLE IX

APPEAL

Section 9.01 Appeal

Any person aggrieved by a decision of the Ordinance Administrator in accordance with this Chapter may appeal said decision or action to the Appeal Officer by making a written request within seven business days of the adverse decision or action. Appeal Officer means the City Manager designee that presides over appeals of the Ordinance Administrator actions or decisions. The appeal hearing shall be conducted no later than seven business days following receipt of the notice of appeal unless the parties agree to a later date. The appeal shall be conducted by the Appeal Officer. The decision of the Appeal Officer shall be final.

2.

Any person, firm, corporation, agent or employee thereof who violates any of the provisions of this ordinance shall be guilty of a misdemeanor and upon conviction thereof shall be fined an amount not to exceed Five Hundred and No/100 Dollars ($500) for each offense. Each day that a violation is permitted to exist shall constitute a separate offense.

3.

This ordinance shall be and is hereby declared to be cumulative of all other ordinances of the City of Arlington, and this ordinance shall not operate to repeal or affect any of such other ordinances except insofar as the provisions thereof might be inconsistent or in conflict with the provisions of this ordinance, in which event such conflicting provisions, if any, in such other ordinance or ordinances are hereby repealed.

4.

If any section, subsection, sentence, clause or phrase of this ordinance is for any reason held to be unconstitutional, such holding shall not affect the validity of the remaining portions of this ordinance.

5.

All of the regulations provided in this ordinance are hereby declared to be governmental and for the health, safety and welfare of the general public. Any member of the City Council or any City official or employee charged with the enforcement of this ordinance, acting for the City of Arlington in the discharge of his/her duties, shall not thereby render himself/herself personally liable; and he/she is hereby relieved from all personal liability for any damage that might accrue to persons or property as a result of any act required or permitted in the discharge of his/her said duties.

6.

Any violation of this ordinance can be enjoined by a suit filed in the name of the City of Arlington in a court of competent jurisdiction, and this remedy shall be in addition to any penal provision in this ordinance or in the Code of the City of Arlington.

7.

The caption and penalty clause of this ordinance shall be published in a newspaper of general circulation in the City of Arlington, in compliance with the provisions of Article VII, Section 15, of the City Charter. Further, this ordinance may be published in pamphlet form and shall be admissible in such form in any court, as provided by law.

8.

This ordinance shall become effective ten (10) days after first publication as described above.

PRESENTED AND GIVEN FIRST READING on the ______ day of ____________________, 2009, at a regular meeting of the City Council of the City of Arlington, Texas; and GIVEN SECOND READING, passed and approved on the ______ day of ____________________, 2009, by a vote of ______ ayes and ______ nays at a regular meeting of the City Council of the City of Arlington, Texas.

____
ROBERT N. CLUCK, Mayor

ATTEST:

____
KAREN BARLAR, City Secretary

APPROVED AS TO FORM:
JAY DOEGEY, City Attorney

BY____________________________

Reference Sheet

City of Arlington Staff Review of

Subdivision Ordinances and Deed Restrictions

As of April 18, 2011

1. **Bay Club**
   A. There is 1 reference to Docks/Piers. The entry is as follows:
      "The construction plans, specifications and plot plans showing the location of the structure shall include any dock structures or water front walkways proposed for Lots 1 through 7 of Block __ of The Bay Club."
   B. There are 3 references to Flowage Easements in the plat diagrams.
   C. There are 3 references to a Seawall as follows:
      Article VI, Section 1, (b)
      "Maintenance of grounds lying outside of the property line along designated streets, the seawall, and beaches accessible to the Association."

      Article XI
      "No building, structure or improvement of any nature shall be erected, placed or altered including but not limited to the seawall, on any lot until the construction plans and specifications and plot plan showing the location of such building, structure or improvement have been submitted to and approved in writing by the Committee as to: (i) quality of workmanship and materials, (ii) conformity and harmony of external design, color and texture, with existing structures, (iii) location with respect to topography and finished grade elevation, (iv) conformity to requirements of and agreements with the City of Arlington, such as sidewalks, etc., and (v) the other standards set forth within this instrument. The Committee is authorized to request the submission of samples of proposed construction materials or colors of proposed exterior surfaces."

      Article XI
      "The Committee shall establish standards for the repair, replacement and maintenance of the seawall."

2. **Waterwood Estates- no mention of deed restrictions or subdivision ordinances**

3. **Lakehurst Estates- no mention**

4. **J.A. Creary**

A. There are 4 references to Flood Easements in the plat diagrams

5. Arlington Shores

A. There are 6 references to Flowage Easements in the plat diagrams

6. Tiffany Park

A. There are 2 references to Flowage Easements in the plat diagrams

B. There are 2 references to Flood Easements in the plat diagrams

7. Shorewood- no mention

8. Shorewood Estates

A. There is 1 reference to a Dock/Pier. The entry is as follows:

Architectural Standards

"Patios, piers and docks on Lot 24, Block 2 and Lots 26 through 38, Block 2 located on the shore of Lake Arlington shall protrude not more than 10 feet into the lake at elevation 550 above sea level."

B. There is reference to a channel. The entries are as follows:

"The lot owners of Lots 4 through 8 and Lots 10 through 23 in Block 2 are placed upon notice that the channel and water course upon the rear and side of such lots leading into Lake Arlington was created to conform with the natural topography affecting such lots and that it shall be the responsibility and obligation of subsequent lot owners thereof to dredge, clean, maintain and keep open such channel for the purpose of beautification and to maintain an open channel way for the free flow of surface and rain waters into Lake Arlington."

"The lot owners of Lots 24, 26, 27, 28 and 29, Block 2 are placed upon notice that the channel and water course upon the rear and side of such lots leading into Lake Arlington was created to conform with the natural topography affecting such lots and that it shall be the responsibility and obligation of subsequent lot owners thereof to dredge, clean, maintain and keep open such channel for the purpose of beautification and to maintain an open channel way for the free flow of surface and rain waters into Lake Arlington."

9. Enchanted Lakes

A. There are 3 references to a Dock/Pier. The entries are as follows:

Architectural Control

"No structures, whether residence, accessory building, tennis court, swimming pool, fence, wall, lot drainage works, boat dock, boat house, exterior area lighting or other improvements shall be constructed or maintained upon any Lot, and no alteration to the exterior of a structure shall be undertaken unless complete plans, specifications and plot plans therefor showing the exterior design, height, building material and color scheme thereof, the location of the structure plotted horizontally and vertically, the location of driveways and fencing shall have been submitted to and approved in writing by the Architectural Committee and a copy of such plans, specifications and plot plans as finally approved deposited with the Architectural Committee."

"No structure whatever shall be erected, placed or permitted to remain on any Lot except one detached single family residence, together with;
A boat dock of a design approved by the Architectural Committee."

"Boat Docks. All boat docks built on any Lot in Enchanted Lake Estates shall be of a uniform nature and shall be approved prior to construction by the Architectural Committee."

B. There is 1 reference to a Boat House. The entry is as follows:

"No structure whatever shall be erected, placed or permitted to remain on any Lot except one detached single family residence, together with an attached or detached boat house of a design approved by the Architectural Committee."

C. There are 2 references to Flowage Easements in the plat diagrams

10. Enchanted Oaks- no mention

11. The Waterfront at Enchanted Bay – no mention

12. The Island at Enchanted Bay – no mention

Appendix 7.3-A: Technical Memorandum

LAKE ARLINGTON
MASTER PLAN

Technical Memorandum

Date: November 29, 2010

To: City of Arlington

From: Caroline Russell, Brian Ruggs, and Fred Blumberg

Re: Review of Lake Arlington Water Quality

Project No.: 3498011

Lake Arlington is foremost a water supply reservoir, providing a source of drinking water to approximately 500,000 people in the City of Arlington, and other communities. Lake Arlington is within the Village Creek watershed and receives water from Tarrant Regional Water District's (TRWD) Richland-Chambers and Cedar Creek Reservoirs through 72-inch and 90-inch pipelines. The Lake is also used as a source of cooling water for an electric generating plant and for public recreation. The Handley Generating Station is owned and operated by Exelon Power, a business unit of Exelon Generation. It is a 5-unit, 1,441 megawatt (MW) natural gas-fired power plant. It provides electricity to customers in the Electric Reliability Council of Texas (ERCOT) when needed.

Water from Lake Arlington supplies the Pierce-Burch Water Treatment Plant (WTP), owned and operated by the City of Arlington, and the Tarrant County Water Supply Project (TCWSP) WTP, owned and operated by the Trinity River Authority (TRA). The Pierce-Burch and TCWSP WTPs intakes are at the northeast end of the Lake, as illustrated in Figure 1. At the Pierce-Burch WTP, up to 75 million gallons of water per day (mgd) of raw water is treated at the south plant by primary disinfection using ozone, coagulation and sedimentation (using aluminum sulfate and a cationic polymer as coagulants), filtration through granular activated carbon (GAC), and secondary disinfection with chloramines (a combination of chlorine and ammonia) prior to distribution for potable use. Land is available at the Pierce-Burch WTP site to expand to 109 mgd capacity when needed to meet future demands. The TCWSP WTP treats up to 72 mgd of raw water from Lake Arlington through coagulation, flocculation, and filtration. Ozone is used as a primary disinfectant with chloramines applied post-filtration to achieve a disinfectant residual in the distribution system. TRA has planned expansions to 100 mgd.

The Arlington Water System has been rated "Superior" by the Texas Commission on Environmental Quality (TCEQ).

The Lake Arlington Master Plan is important because development around the lake and within the watershed can impact water quality and the ability to meet drinking water standards using the current water treatment processes. This memorandum presents:

- A general overview of watershed activities that could impact water quality and required treatment processes; and

- Current water quality conditions, providing a baseline for establishing water quality goals as part of the Master Plan.

The goals will then be used to evaluate the impact of various development scenarios on lake water quality and to develop best management practices (BMPs) that would be needed to maintain the target water quality.

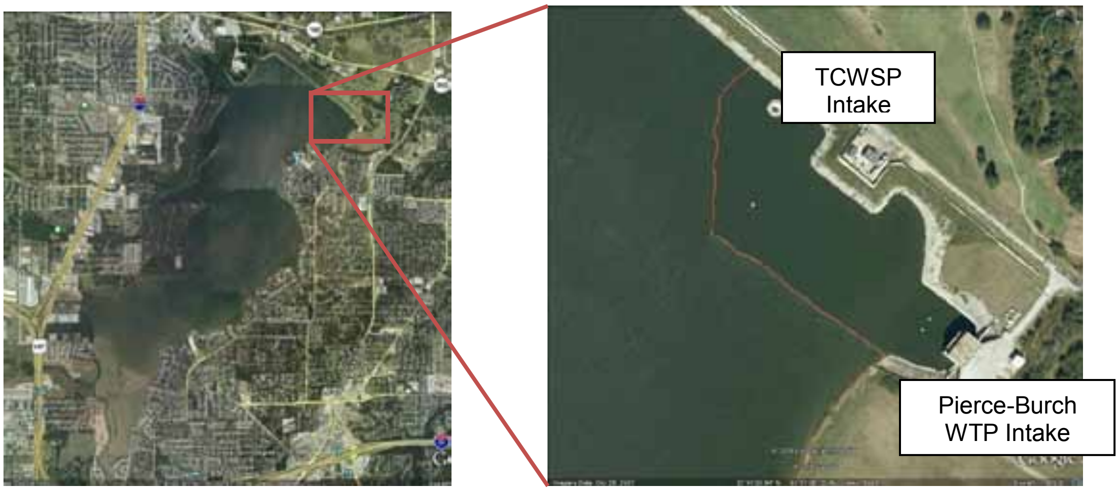


Figure 1. Water Treatment Plant Raw Water Intakes from Lake Arlington

1. Potential Watershed Activities Impacting Water Quality

Watershed characteristics (e.g., soil type, terrain) and land use patterns impact water quality and provide an indication of potential contaminants that could be a concern for a given area. For example, animal and human activities can impact microbial water quality, contribute chemical contaminants to the water, and can impact disinfection by-product precursor concentrations, affecting water quality issues resulting from treatment and distribution. Lake Arlington covers approximately 2,000 acres and is located at the end (northeast portion) of the Village Creek Watershed. Current land use activities in the Village Creek Watershed include a mix of urban and rural with some pastureland. A brief review of the Village Creek Watershed and the area surrounding Lake Arlington was conducted to gain a basic understanding of current and future water quality concerns.

Figure 2 shows known point source (TPDES-permitted) discharges in the Village Creek Watershed. Five municipal wastewater treatment plants (WWTPs) currently discharge treated effluent into Village Creek or its tributaries in the headwaters of the watershed. Treated wastewater from a motel/restaurant and from a Texas Department of Transportation (TXDOT) rest area is also discharged within the watershed. While treated to meet strict discharge standards, wastewater effluent can contain pathogens, nutrients, trace pharmaceuticals and personal care products (PPCPs), and organic precursors that are either unregulated or present at concentrations below the permit limits. **Attachment 1** lists the name, status, permit number, and discharge limits (e.g., flow, nutrient concentrations, etc.) for the permitted sites.

The industrial footprint in the Village Creek Watershed, in terms of land use, is relatively limited. Nevertheless, a variety of industrial activities are conducted within the watershed, with the potential to impact water quality. The Handley Generating Station, located on the northwest shore of Lake Arlington, has a TPDES permit (WQ0000552000) allowing discharge of treated wastes directly into the reservoir. The permit specifies discharge limitations associated with temperature, total and free chlorine concentrations, total suspended solids, and oil and grease at two outfall locations (Outfall 001 and 201). Table 1 summarizes the discharge limitations for each outfall. The 2002 Texas Water Quality Inventory lists a July 25, 1997 historical fish kill near the Handley Plant hot pond, with approximately 50 fish killed. The suspected cause of the kill was temperature. Based on the report, exceedances were reported for temperature, ammonia nitrogen, nitrite+nitrate nitrogen, and orthophosphorus in samples collected from the lake between 1996 and 2001.

Table 1. Summary of TPDES Permit Requirements for the Exelon Handley Generating Station

	Daily Average	Daily Maximum
Outfall 001		
Flow (MGD)	1,280	1,280
Temperature (°F)	111	116
Free Chlorine (mg/L)	0.2	0.5
Total Chlorine (mg/L)	N/A	0.2
No discharge of floating solids, visible foam, no discharge of visible oil		
Outfall 201		
Total Suspended Solids	30	100
Oil and Grease	15	20
pH	Not less than 6 and no greater than 9	
No discharge of floating solids, visible foam, no discharge of visible oil		

Over 95 natural gas wells have recently been constructed in the watershed (Figure 3). As the development of the Barnett Shale natural gas field continues, plans for additional gas drilling sites and pipelines are anticipated. EPA published a report in 2004 evaluating the impacts of hydraulic fracturing on underground sources of drinking water. The study concluded that the process was safe; however, it did identify data gaps regarding the potential for migration of fracturing fluid through the subsurface. EPA has initiated a new study on hydraulic fracturing to further assess any relationships between the process and contamination of drinking water. The report is due to be released in 2012. The Railroad Commission of Texas (TRRC) oversees installation and operation of gas wells in Texas.

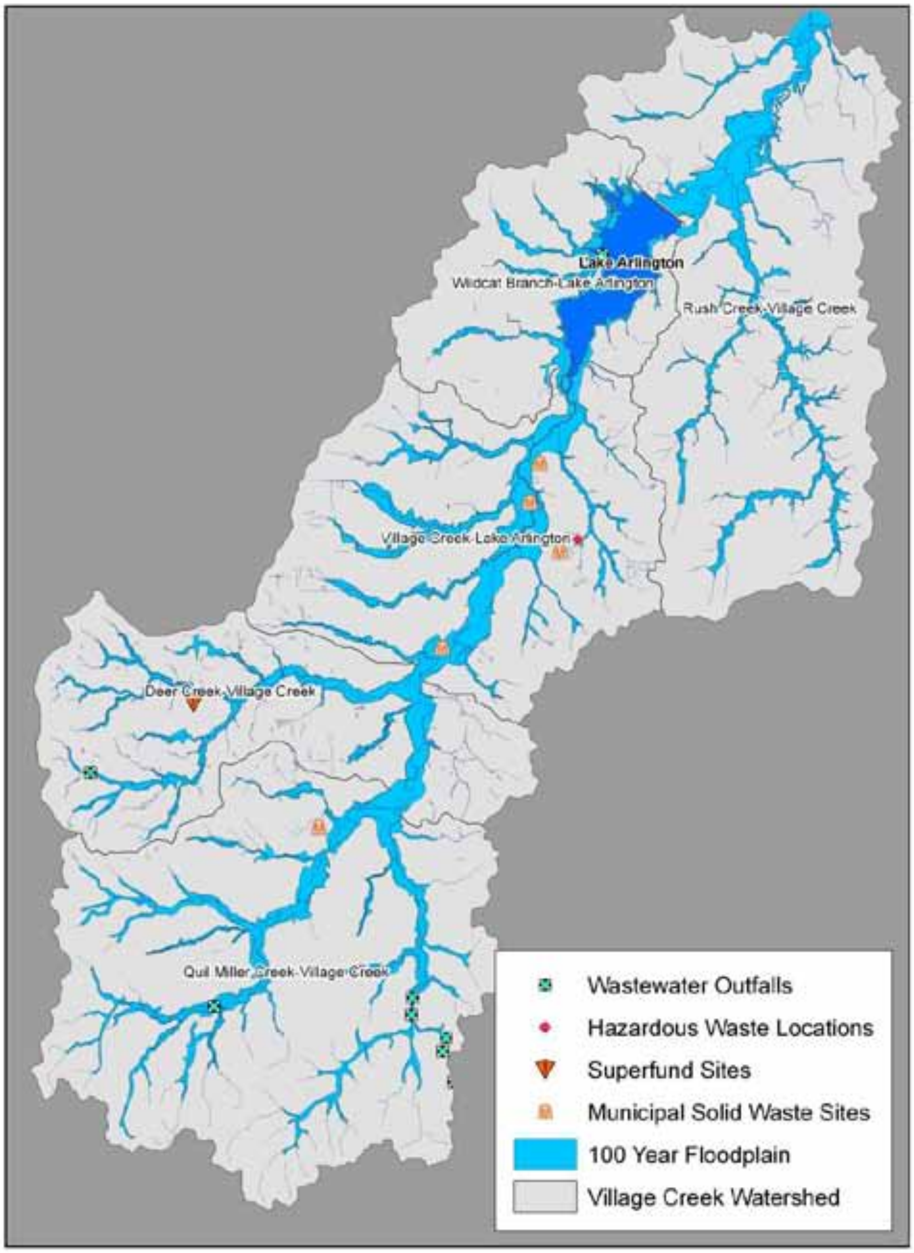


Figure 2. Map of TCEQ Permitted Sites in the Village Creek Watershed
(see Attachment 1 for specifications on permitted sites)

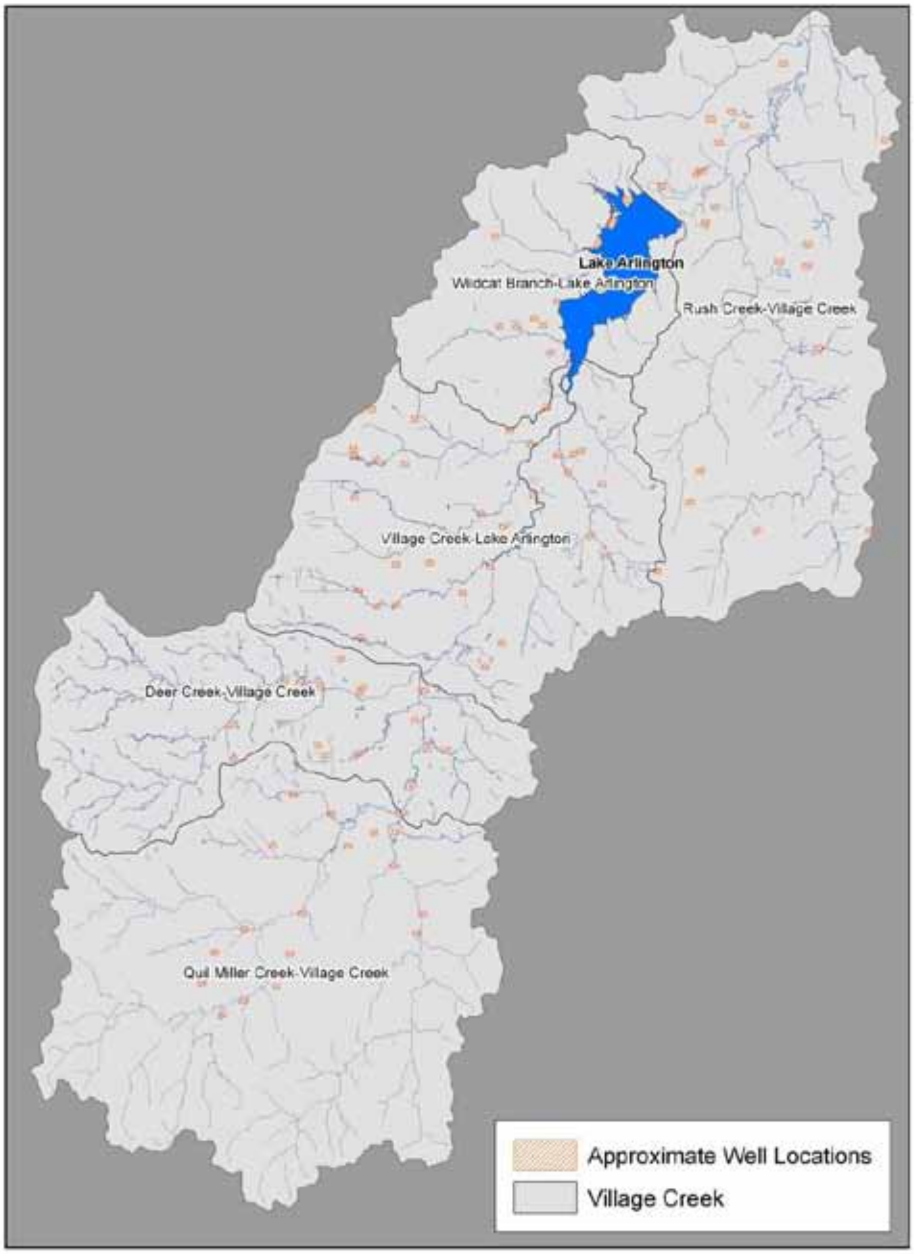


Figure 3. Map of Gas Wells in the Village Creek Watershed

Non-point source pollution from agricultural activities can contribute nutrients from fertilizers, pesticides (e.g., atrazine), animal pathogens, and growth hormones (e.g., endocrine disrupting compounds) to the watershed. Agricultural activities in the Village Creek Watershed are limited, occurring primarily near the watershed headwaters, and are not expected to have a significant impact on lake water quality. In fact, over time, agricultural activities can be expected to decrease with urbanization.

Urban runoff during storm events can be a source of polyaromatic hydrocarbons (PAHs, from roads), pathogens (e.g., from pet excrements), and other synthetic organic compounds (SOCs) used for basic human activities (i.e., cleaning products, etc.). Figure 4 shows turbidity levels before and after a September 10, 2010 rain event. The data illustrate the influence of stormwater runoff on particle loading in the source water to the Pierce-Burch WTP. Land use changes associated with development around Lake Arlington and their impacts on surface runoff and lake water quality are being assessed as part of the Master Planning process.

Recreational lake activities also have the potential to impact water quality. For example, the marina fueling station could be a source of polyaromatic hydrocarbons (PAHs) if spills occur during refueling. A 2003 EPA Handbook for Marina Operators and Recreational Boaters[1] lists boat maintenance, discharge of sewage from boats, and fuel release during refueling or recreational boating as the primary sources of pollution from boating.

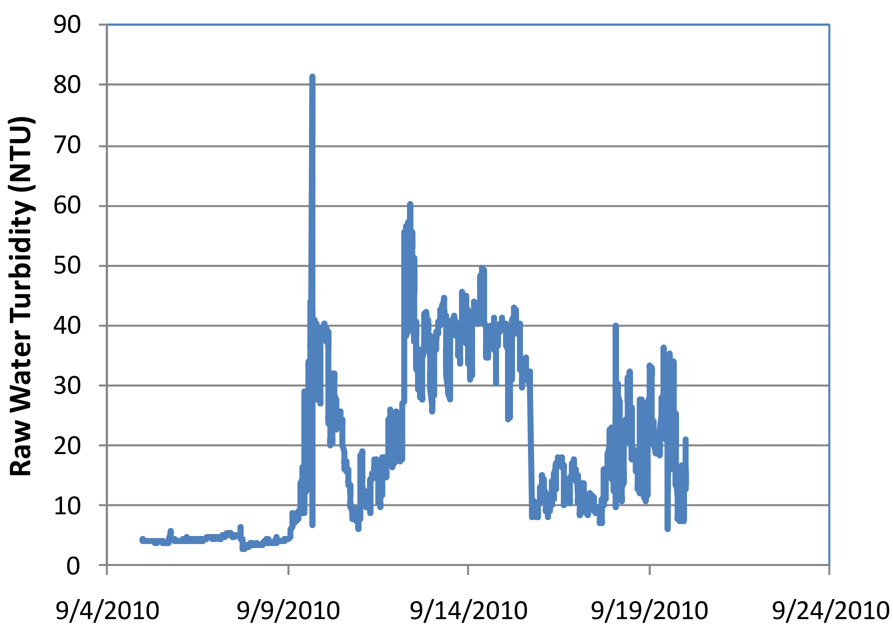


Figure 4. Turbidity in Lake Arlington (Pierce-Burch WTP Raw Water) Surrounding a September 10, 2010 Rain Event

[1] EPA (2003) Shipshape Shores and Waters: A Handbook for Marina Operators and Recreational Boaters, EPA-841-B-03-001

2. Overview of Existing Water Quality

Data were obtained from the sources listed in Table 2 to review current water quality in Lake Arlington and identify potential water quality considerations for assessment in the Lake Arlington Master Plan. Data were reviewed for both temporal trends (e.g., increase/decrease in nutrient concentrations over time) and spatial trends through the watershed (e.g., higher/lower concentrations at WTP intake relative to southern portion of Lake Arlington).

Table 2. Data Sources Reviewed

ID #	Data Source	Description of Data	Time Period Evaluated
1	City of Arlington Annual Reports	Finished water quality from Pierce-Burch WTP	2001 to 2009
2	City of Arlington	Raw water quality at intake for the Pierce-Burch WTP	2007 to 2009
3	TCEQ Website	SWQMIS data – raw water data from samples collected at specific locations in the Village Creek Watershed	August 2005 to November 2008
4	Exelon Cooling Station	Water quality in water discharged at the power plant outfalls into the lake	February 2006 to March 2008
5	Trinity River Authority	Water quality at Tarrant County Water Supply Project (TCWSP) raw water intake	April to September 2008
6	U.S. Geological Survey (USGS)	Sampling information provided through SWQMIS database	August 2005 to November 2008

Lake Arlington is foremost a source of drinking water. Thus, the following review of lake water quality data addresses parameters of importance for water treatment plant operations and for compliance with U.S. Environmental Protection Agency (USEPA) and TCEQ primary drinking water standards. **Attachment 2** provides a list of national primary drinking water standards for reference. TCEQ standards are provided under Subchapter F of 30 Texas Administrative Code (TAC) §290.[2]

Table 3 lists measured concentrations for various general physical, chemical, and microbial parameters in the lake.[3] Maximum contaminant levels (MCLs) and secondary MCL are provided for reference. Note, however that the listed average, minimum, and maximum concentrations are for raw water samples; treatment is applied at the City of Arlington Pierce-Burch WTP and the TRA TCWSP WTP to meet the MCL requirements in finished water.

[2] http://info.sos.state.tx.us/pls/pub/readtac$ext.ViewTAC?tac_view=5&ti=30&pt=1&ch=290&sch=F&rl=Y
[3] Data presented in the table were downloaded from the TCEQ Surface Water Quality Monitoring Information System (SWQMIS), which includes data for more than 270 different parameters. Data are compiled from USGS and other monitoring stations.

Table 3. Lake Arlington Raw Water Quality at the Pierce-Burch WTP Intake(1)

Parameter	MCL(2)	SMCL (2)	Detection Frequency	Average	Minimum	Maximum
pH, S.U	NR	> 7	135 samples	8.0	6.9	8.7
Temperature, deg. Celcius	NR	-	105 samples(3)	23	5	39
Total Alkalinity, mg/L as $CaCO_3$	NR	-	42 samples	94	76	114
Hardness, mg/L as $CaCO_3$	NR	-	14 samples(4)	109	91	150
Calcium, mg/L	NR	-	70 samples(4)	38	28	48
Magnesium, mg/L	NR	-	78 samples(4)	4.4	3.4	6.6
Total Dissolved Solids, mg/L	-	1,000	14 samples(4)	168	140	243
Specific Conductivity (µS/cm)	NR	-	135 samples	315	274	462
Chloride, mg/L	-	300(2)	42 samples	17.9	13.2	23.2
Sodium, mg/L	NR	-	78 samples(4)	18.3	5.7	27.4
Sulfate, mg/L	-	300(2)	39 samples	34.6	23.6	54.0
Total Organic Carbon, mg/L	35% removal(5)	-	20 samples	5.7	4.3	7.5
Dissolved Organic Carbon, mg/L	NR	-	34 samples	4.8	3.5	6.1
Microbial Characteristics						
Chlorophyll a, µg/L	NR	-	40 of 41 samples	37.5	5.0	91.4
E.coli, MPN/100mL	absence	-	32 of 41 samples	14.8	1.0	100.0
Fecal coliform, colonies/100 mL	absence	-	14 of 15 samples(4)	25	1	68
Cryptosporidium, #/10 L	(6)	-				
Nutrients						
Total Ammonia-N, mg/L	NR	-	83 samples(4)	0.08	0.02	1.10
Nitrate, mg/L	10	-	4 samples(4)	0.28	0.03	0.37
Phosphorus (total), mg/L	NR	-	83 samples(4)	0.07	0.03	0.25
Inorganic Compounds						
Iron, mg/L	-	0.3(2)	39 samples	0.35	0.14	1.27
Manganese, mg/L	-	0.05(2)	39 samples	0.09	0.04	0.81
Arsenic (µg/L)	10	-	14 of 39 samples	4.2	1.4	6.0

NR – Not regulated

Note: The water quality data listed are for source water samples. The MCL and SMCL values only apply to treated water and are listed for reference only.

(1) TCEQ SWQMIS data collected from USGS Site AC, ID 324304097113601. Average, minimum, and maximum values are for samples collected between August 10, 2005 and November 12, 2008.

(2) The water testing results listed are source water levels and only apply to treated drinking water. They are listed for reference only as source water areas of potential water quality concern.

(3) Data collected from USGS Site Mid Lake. Average, minimum, and maximum values are for samples collected between July 8, 1982 and September 8, 1986.

(4) Average, minimum, and maximum values are for samples collected from USGS Site AC, ID 324304097113601 between December 30, 1992 and May 12, 2005.

(5) Under the Disinfectant/Disinfectant By-Product Rule (D/DBPR), an average percent removal of TOC that would be required is 35% based on the average raw water alkalinity between 60 and 120 mg/L as $CaCO_3$ and the average TOC concentration between 4 and 8 mg/L.

(6) *Cryptosporidium* are regulated under the Long-Term 2 Enhanced Surface Water Treatment Rule with log removal requirements based on the number of oocysts detected during

Raw water from Lake Arlington is characterized by moderate alkalinity, hardness, and pH. Average concentrations of salts in Lake Arlington water are low, with total dissolved solids (TDS) and chloride concentrations significantly below the secondary maximum contaminant level (SMCLs). At an average of 5.7 milligrams per liter (mg/L), total organic carbon (TOC) concentrations in Lake Arlington are fairly typical for surface water. Based on the average raw water alkalinity and TOC concentrations, the City of Arlington and Trinity River Authority are required to remove 35% of the TOC to meet Step 1 TOC removal requirements under the Disinfectant/Disinfection By-Product Rule (D/DBPR).[4] Microbial characteristics of the raw water and concentrations of other parameters are discussed in the following paragraphs.

Microbiological Characteristics

E. coli and fecal coliform concentrations are also listed in Table 3. While *E. coli* and fecal coliform do not present a direct public health risk, their occurrence in water samples is an indication of animal or human fecal contamination and the potential presence of pathogenic microorganisms that do exert a health concern (e.g., *Giardia*, *Cryptosporidium*). The average *E. coli* and fecal coliform concentrations in Lake Arlington samples are within range of expected values for surface water with upstream discharges from wastewater treatment plants and nonpoint sources of pollution (e.g., stormwater runoff, etc.). Cryptosporidium samples collected at the Pierce-Burch WTP raw water intake between January 2009 and November 2011 were non-detect and the Pierce-Burch WTP has been classified as Bin 1 under the LT2ESWTR based on data previously reported to TCEQ. The Pierce-Burch and TCWSP WTPs are designed to meet 4-log virus removal (i.e., 99.99% removal) and 3-log *Giardia* removal (i.e., 99.9% removal) to prevent exposure to any pathogens that may be present in the source water.

In addition to pathogens, the presence of other microorganisms, such as algae, can also be a concern. Acceptable algal concentrations in drinking water are not explicitly specified in water quality standards. Algae are considered indirectly through non-specific parameters such as turbidity, color, or TOC. However, it is possible that finished water that meets regulatory standards may still contain a relatively high algal load.

Chlorophyll a is a pigment found in algae; chlorophyll a concentrations above 10 micrograms per liter (μg/L) can be used as a guideline for algal activity in water. The average chlorophyll a concentration in samples collected from USGS Site AC (see Figure

[4] The TOC removal requirement is driven by the objective of minimizing formation of unknown and unregulated disinfection by-products (DBPs). Since the City uses ozone as a primary disinfectant, followed by chloramines, DBP formation is expected to be generally low.

10) between April 2005 and November 2008 (37.5 μg/L, see Table 3), indicates significant algal activity in the lake. Complications associated with algae include:

- Presence of algal by-products, such as geosmin and methylisoborneol (MIB), impacting the taste and odor of WTP finished water.
- Lake eutrophication, leading to anoxic conditions and the potential release of dissolved iron and manganese from lake sediments.
- Increased chlorine demand with potential implications on drinking water treatment efficiency and operations, including clogging of intake screens, flow disruption and shortened filter run times.
- Presence of certain algal toxins (e.g., cyanobacterial secretions) that have been linked to fish kills, poisoning of shellfish, and illness in humans.
- Biological growth in the distribution system if algae pass through the filters.
- Increased DBP precursors concentrations leading to the formation of trihalomethanes, haloacetonitriles, and other halogenated by-products that may have adverse health effects.

Taste and odor concerns associated with the release of geosmin, and iron and manganese during anoxic conditions are likely the most pressing concerns related to algal growth for Lake Arlington. Geosmin is a metabolite of blue-green algae that imparts a characteristic earthy/beet odor to water. The odor threshold concentration (OTC) for geosmin is 10 nanograms per liter (ng/L); at concentrations above the OTC, sensitive portions of the population can usually detect the characteristic odor in water.

Figure 5 shows geosmin concentrations in samples collected from the Lake Arlington intake. As expected based on the relatively high chlorophyll a concentrations in Lake Arlington, geosmin concentrations above the OTC were routinely detected in samples collected between November 2007 and March 2008. Ozone addition at the Pierce-Burch and TCWSP WTPs helps control taste and odor in the finished water.

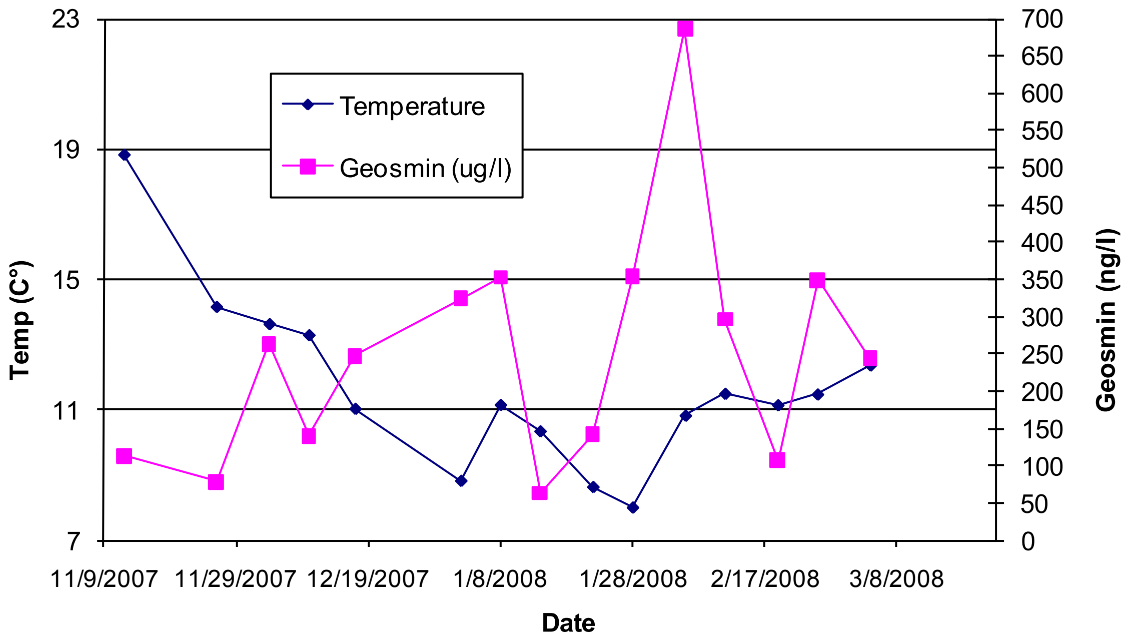


Figure 5. Temperature and Geosmin Concentrations (Source: samples collected at the Lake Arlington intake between November 2007 and March 2008)

Nutrients

Table 3 lists total ammonia, nitrate, and phosphorus concentrations in samples collected at the Pierce-Burch WTP intake. Ammonia, nitrate, and phosphorus concentrations would be expected to be high in surface water heavily impacted by agricultural activities. As indicated by the low average ammonia concentrations, nitrate concentrations well below the 10 mg/L MCL, and low phosphorus concentrations, nutrient loading (e.g., from urban landscaping or rural agricultural activities) does not currently present a significant concern with regard to lake water quality.

Temporal trends in nitrate concentrations were also assessed. Figure 6 shows nitrate concentrations in finished water from the Pierce-Burch WTP between April 2007 and December 2009. Nitrate concentrations in the finished water are expected to be fairly representative of raw water concentrations since the Pierce-Burch WTP does not include treatment designed for nitrate removal, nor are chemicals added that would be expected to change nitrate concentrations. As shown in Figure 6, nitrate concentrations are consistently low with no apparent seasonal variation nor trend in concentrations over time. Seasonal variations would be expected if non-point sources were major contributors to pollution. Based on the relatively low nitrate concentrations, no major source of nitrate contamination is apparent, from point or non-point sources.

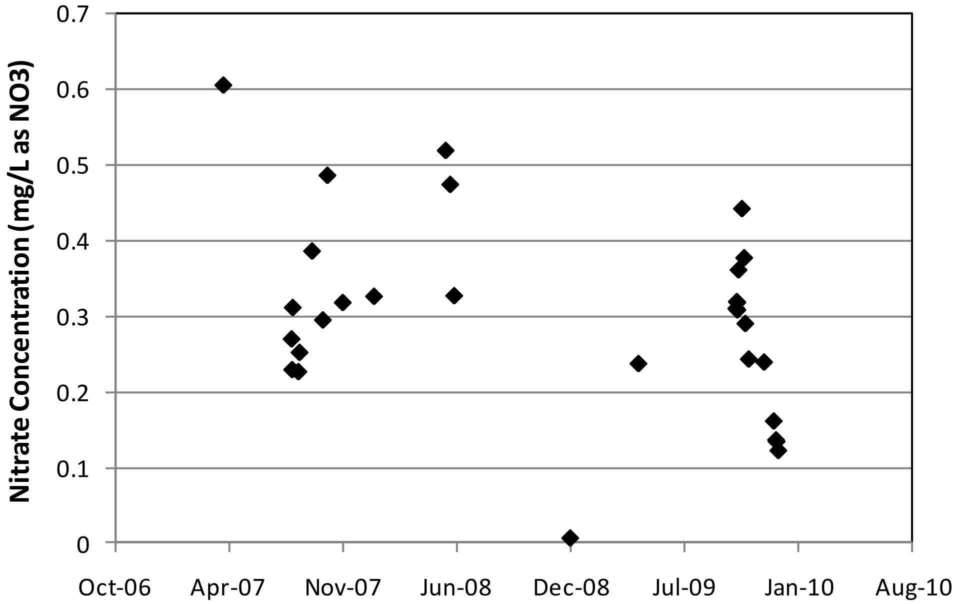


Figure 6. Nitrate Concentrations in Finished Water from the Pierce-Burch WTP

Nitrate and phosphorus are important nutrients for microorganisms, including algae. Thus, in addition to the health concern associated with nitrate at concentrations above the 10 mg/L MCL, the presence of nitrate and phosphorus in surface waters is of interest due to the impact on potential for algal growth and issues associated with algal activity. Draft criteria for total phosphorus, 0.039 mg/L, were established for Lake Arlington by the TCEQ Water Quality Standards Workgroup on September 6, 2007 (see **Attachment 3**) to minimize algal growth and the potential for eutrophication and associated deterioration in water quality.

Inorganic Contaminants

As indicated in Table 3, average iron and manganese concentrations in the lake exceed the SMCLs, leading to potential aesthetic concerns if the metals are not removed through the WTPs. Elevated manganese concentrations are a well-studied water quality issue for both the City of Arlington and TRA. While iron and manganese do not present a health risk at concentrations found in drinking water, elevated concentrations of both metals can lead to colored water complaints due to a reddish appearance associated with iron precipitation and black particles associated with manganese precipitation.

Iron and manganese are naturally-occurring metals. Village Creek flows through the iron-rich sandy soils of the Eastern Cross Timbers Region and is likely picking up both metals which then may accumulate in the sediments in Lake Arlington. As the water column becomes anoxic in summer months, iron and manganese are released from the sediments, leading to elevated concentrations at the TRA and City of Arlington raw water intakes (Figure 7).

Figures 8 and 9 show manganese and dissolved oxygen concentrations in water samples collected near the TRA intake structure. The data signals summer stratification, with anoxic conditions in the hypolimnium leading to elevated manganese concentrations. The raw water intake for the Pierce-Burch WTP is designed with intake gates at multiple levels. The shallow gate draws water from elevations 527 to 535 feet above mean sea level (water surface elevation is typically maintained between 540 and 550 feet) and is most often used by the City. The deep gate draws water from elevations 516 to 524 feet above mean sea level. The City of Arlington can adjust the intake elevation to higher elevations to minimize withdrawal of water with high manganese concentrations during the summer month. Manganese oxidation, followed by sedimentation and filtration aids in manganese removal through the TCWSP and Pierce-Burch WTPs.

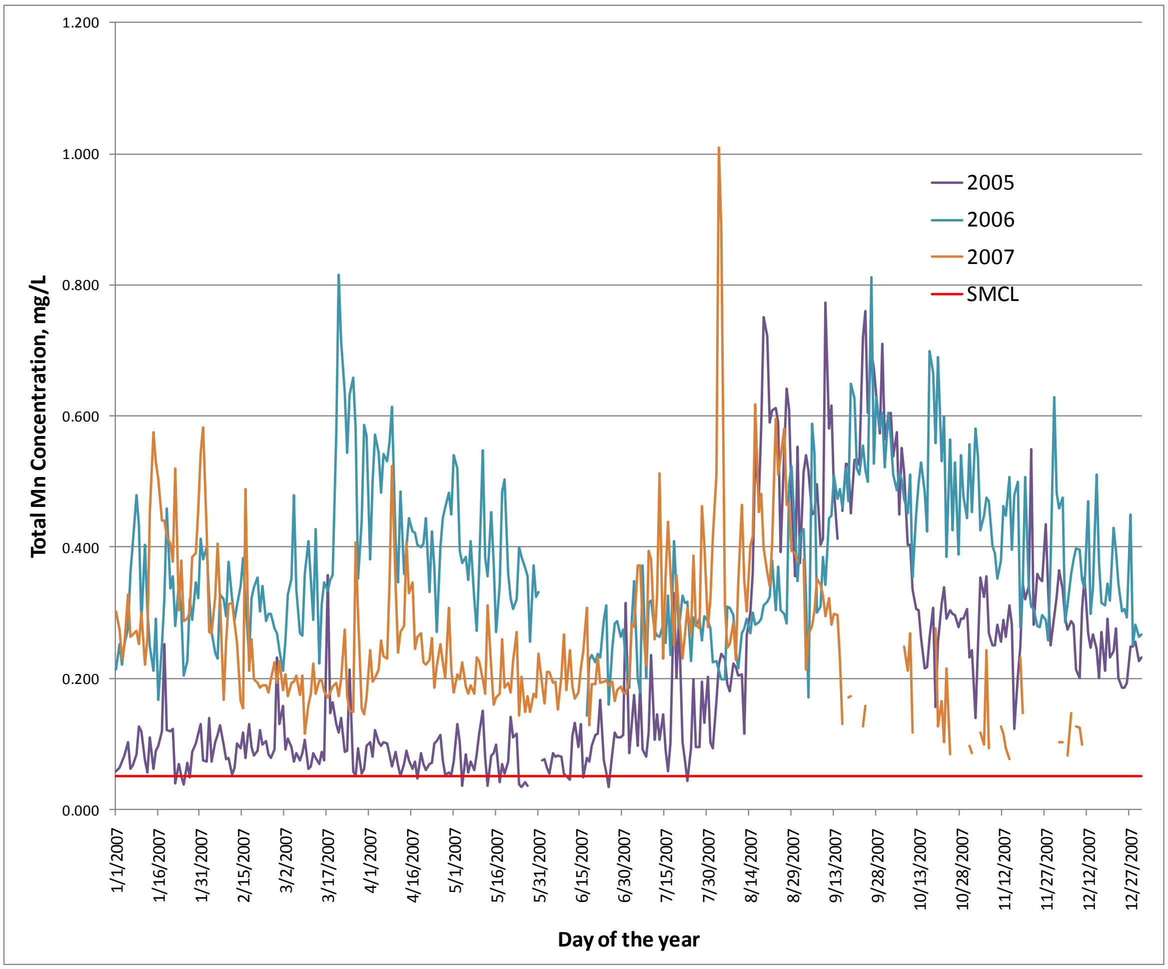


Figure 7. Total Manganese Concentrations in Lake Arlington Water

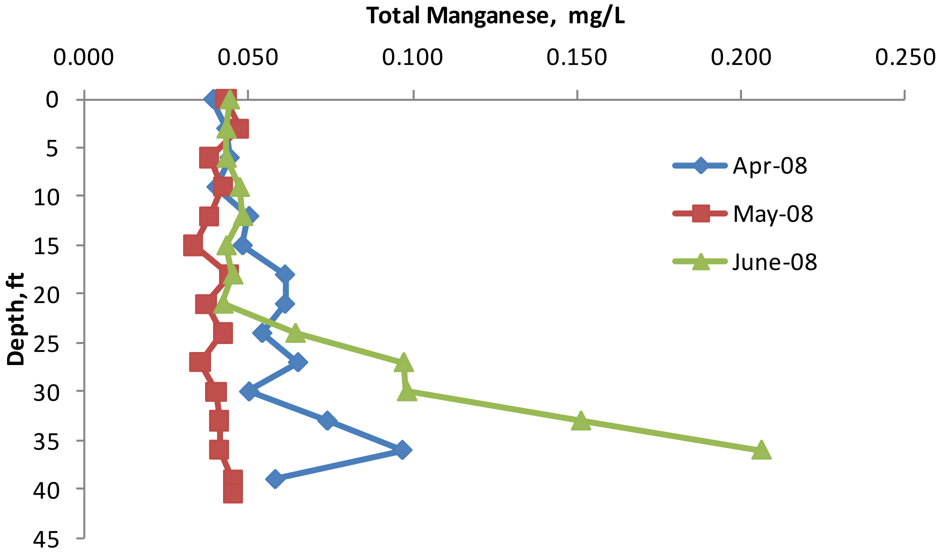


Figure 8. Total Manganese Profile in Samples Collected Near the TCWSP West Intake in April, May, and June 2008

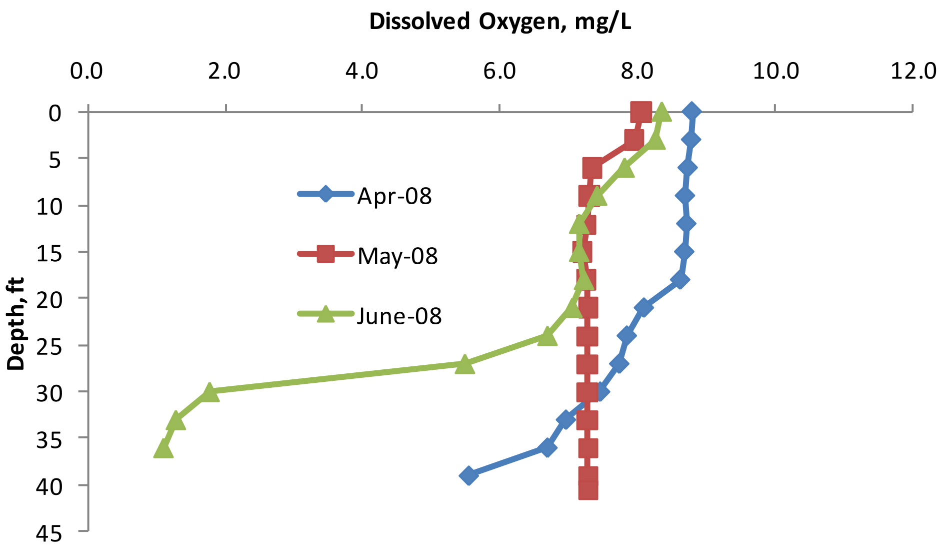


Figure 9. Dissolved Oxygen Profile in Samples Collected Near the TCWSP West Intake in April, May, and June 2008

Table 3 also lists average and maximum arsenic concentrations in lake samples collected from USGS Site AC between April 2005 and November 2008. Concentrations were below the 10 μg/L MCL. However, arsenic concentrations in samples collected from other parts of the lake were above the MCL (Table 5). Arsenic is a naturally-occurring metal and elevated concentrations in Lake Arlington water are likely attributed to the mineralogy of the watershed. Although there is some arsenic removal achieved at the Pierce-Burch and TCWSP WTPs, concentrations above the MCL are a concern since the plants are not specifically designed to remove arsenic.

Organic Contaminants

In addition to naturally-occurring organic matter (NOM), organic chemicals derived from human activities may enter the watershed either via direct point sources or from street runoff (e.g., polyaromatic hydrocarbons from vehicular traffic), agricultural runoff (e.g., herbicides/pesticides), or other contaminant routes. Organic chemicals can generally be defined within one or more of the following categories:

- Volatile organic compounds (VOCs),
- Other synthetic organic compounds (SOCs), or
- Pharmaceuticals and personal care products (PPCPs)

In 1986, USGS monitored for several organic compounds at the sites shown on Figure 10. Specifically, monitoring data for the following compounds were available through the TCEQ SWQMIS website: 2,4-D, endrin, lindane, methoxychlor, silvex, and toxaphene. All six compounds are used either as a pesticide, insecticide, or herbicide. Several are currently regulated (or banned) herbicides that likely entered the watershed before the regulations were enacted. Concentrations of 2,4-D and silvex exceeding the MCL were detected. Concentrations of the other four listed compounds were below the detection limit.

The TCEQ SWQMIS website only provided data on herbicides/pesticides that would likely enter the watershed via agricultural runoff. Data from a Handley Power Plant were also reviewed for potential point source contribution of organic compounds. Attachment 4 lists concentrations for the parameters investigated. Compliance data for all of the organic compounds showed concentrations below the maximum acceptable level (MAL) established by TCEQ for the discharge location. In fact, all of the organic compounds monitored in the effluent were below the detection limit.

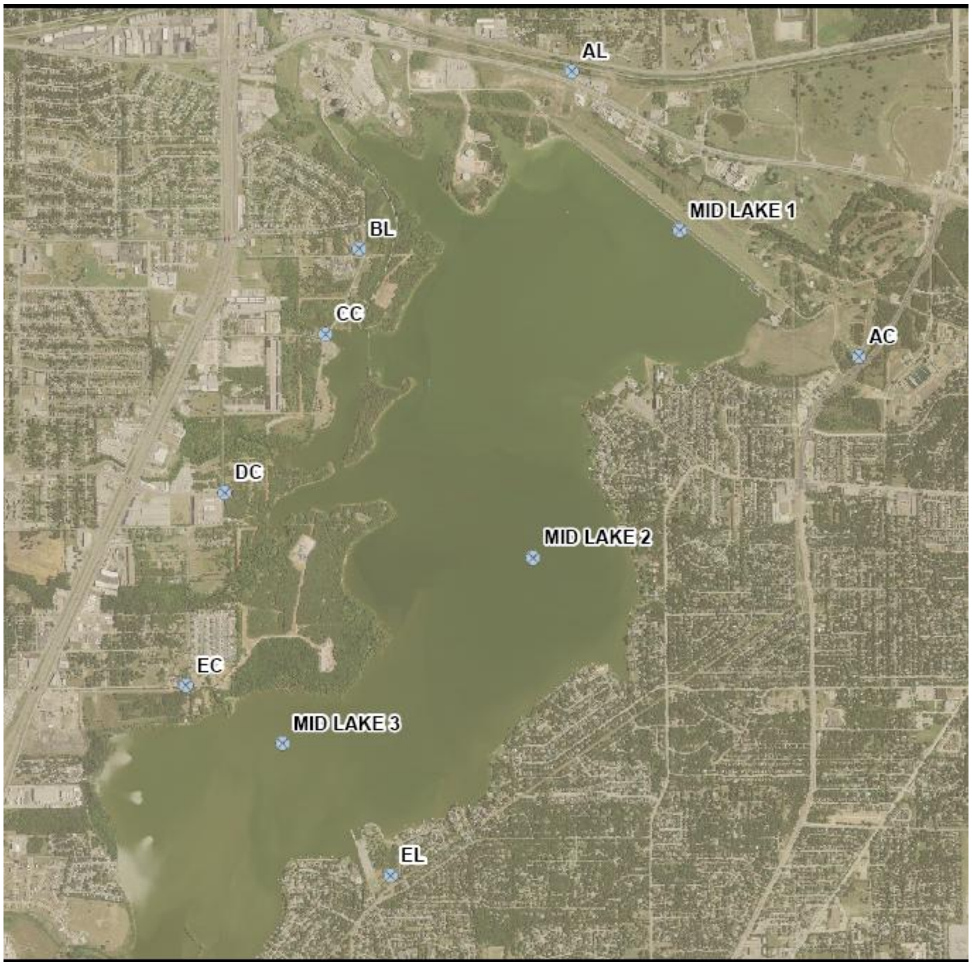


Figure 10. Lake Arlington SWQMIS Monitoring Sites

Table 4 lists minimum, average, and maximum concentrations of regulated organic compounds measured in finished water samples collected at the Pierce-Burch WTP in 2009. For all of the listed organic compounds, measured concentrations were below the MCL. The use of ozone could reduce concentrations of some organic compounds if present in the raw water; however, if the lake became contaminated with synthetic or volatile organic compounds, additional treatment would likely be required for regulatory compliance.

Table 4. Finished Water Organic Compounds[(1)]

Compound	MCL (μg/L)	Detection Frequency	Finished Water		
			Minimum (μg/L)	Average (μg/L)	Maximum (μg/L)
1,2,4-Trichlorobenzene	70	15 of 17 samples	0	0.06	0.23
Atrazine	3	12 of 12 samples	0.15	0.31	0.61
Di(2-ethylhexyl) adipate	400	11 of 12 samples	0.03	0.05	0.1
Di(2-ethylhexyl)phthalate	6	12 of 12 samples	0.09	0.59	1.26
Bromodichloromethane*	80*	12 of 17 samples	0	2.87	6.01
Bromoform*	80*	12 of 17 samples	0	0.95	1.38
Carbon Tetrachloride	5	3 of 17 samples	0	0.07	0.25
Chlorodibromomethane*	80*	12 of 17 samples	0	2.86	4.57
Chloroform*	80*	12 of 17 samples	0	1.79	5.49
Dichloromethane	5	3 of 17 samples	0	0.41	1.94
Methoxychlor	40	1 of 12 samples	0.01	0.01	0.01
Metolachlor	NR	2 of 12 samples	0.01	0.01	0.02
Simazine	4	4 of 12 samples	0	0.06	0.15
Styrene	10	1 of 17 samples	0	0.02	0.09
Toluene	1,000	4 of 17 samples	0	0.10	0.25
Vinyl Chloride	2	3 of 17 samples	0	0.06	0.14
Xylenes (Total)	10,000	1 of 17 samples	0	0.08	0.39

NR – Not regulated
* Bromodichloromethane, bromoform, chlorodibromomethane, and chloroform are regulated by an MCL of 80 μg/L for the sum of the concentrations of the four trihalomethanes.
(1) Tap water samples collected in 2007-2009 at the Pierce-Burch WTP.
(2) These compounds belong to the group of Total Trihalomethanes (TTHMs). The combined MCL for the TTHM is 80 mg/L. There is no collective MCLG for this contaminant group, there are individual MCLGs for some of the individual contaminants: bromodichloromethane (zero); bromoform (zero); dibromochloromethane (60 mg/L); chloroform (70 mg/L)

Spatial Variations in Water Quality

USGS collects samples from various locations throughout Lake Arlington (Figure 10). Water quality data for samples collected in the northern, middle, and southern portions of the lake were reviewed for any spatial trends in water quality. Table 5 lists the average concentrations of select parameters for samples collected from each location between April 2005 and November 2008. Several potential trends are worth noting:

- Turbidity is higher and transparency is lower in the southern portion of the lake, indicating particle settling across the length of the reservoir. While particle sedimentation improves influent water quality to the water treatment plant, the settled particles lead to gradual accumulation of sediments in the lake and reduced lake storage capacity.
- The average pH is lower at the dam (northern portion) where both of the WTP intakes are located. The pH is affected by various chemical and biological processes in the lake.

Table 5. Average Water Quality in the Middle of Lake Arlington at the South, Central, and Northern Portions of the Reservoir

Parameter	Northern Portion (Mid Lake 1)[1]	Central Portion (Mid Lake 2)	Southern Portion (Mid Lake 3)
Transparency, Secchi Disc (inches)	32	22	24
Transparency, Secchi Disc (meters)	0.84	0.78	0.60
Turbidity, NTU	7.8	8.8	10.8
Temperature	22.6	21.5	22.9
pH	7.9	8.0	8.3
Hardness	110	113	102
Chloride, mg/L	22	18	NS
Sulfate, mg/L	28.1	29.3	23.5
Specific Conductivity, µS/cm (Field)	337	313	283
Specific Conductance (Lab)	319	315	294
Total Organic Carbon, mg/L	6.6	5.6	NS
Dissolved Organic Carbon, mg/L	NS	5.0	NS
E.coli, MPN/100mL	NS	39	NS
Total Coliform	83	NS	NS
Fecal coliform	36	39	48
Chlorophyll-A, µg/L	11.9	32.4	NS
Total Ammonia-N, mg/L	0.12	0.03	2.55
Nitrate, mg/L	0.08	0.08	0.15
Phosphorus (total), mg/L	0.048	0.062	NS
Arsenic, µg/L	2.9	5.3	4.9
Iron, µg/L	443	494	554
Manganese, µg/L	57	37	75
2,4-D, µg/L	0.24	0.37	0.57
Endrin, µg/L	BDL	NS	BDL
Lindane, µg/L	BDL	NS	BDL
Methoxychlor, µg/L	BDL	NS	BDL
Silvex, µg/L	0.11	0.04	0.06

NS- Not sampled; BDL – below detection limit
(1) See Figure 10.

- The conductivity is slightly higher at the dam (northern portion). However, conductivity, which is an indirect measure of total dissolved solids concentrations, is relatively low throughout the lake.
- Fecal coliform concentrations are lower at the dam (northern portion), potentially due to particle settling, microbial inactivation from UV exposure, and/or dilution.
- Chlorophyll-A concentrations are lower at the dam (northern portion) than in other portions of the lake (Table 5). In contrast, the 2004 Village Creek Assessment report similarly showed chlorophyll a concentrations increasing through the reservoir.[5] Further assessment is required to confirm spatial trends in algal growth through the lake. Generally, chlorophyll a concentrations are high and the TCEQ draft chlorophyll *a* criteria (Attachment 3) for Lake Arlington are exceeded.
- Iron concentrations appear to be slightly higher in the southern portions of the lake.
- Average concentrations of 2,4-D, a regulated herbicide were highest in the southern portion of the lake, whereas concentrations of silvex (a banned herbicide) were highest at the dam. Agricultural activities are limited to the southern (upstream) portion of the watershed. The presence of the two herbicides in the lake is likely attributable to contamination from agricultural activities conducted prior to the regulation of or ban on those two chemicals. Accumulation of the herbicides in the lake sediments could also be contributing to release into the raw water.

3. Water Quality Goals

Water quality goals depend on the desired use. This technical memorandum focuses on goals related to drinking water quality and treatability. The City of Arlington currently meets all drinking water quality standards in finished water from the Pierce-Burch and John F. Kubala WTPs (Table 6). The chemical and physical treatment processes at the plants are designed to remove targeted constituents to meet the water quality standards and data presented in the annual reports illustrate the ability to meet those goals. However, changes to raw water quality could impact operations at the WTPs (e.g., coagulant and disinfectant doses, etc.) and the continued ability to meet drinking water standards without the addition of new or additional treatment processes. As part of the Lake Arlington Master Planning process, future development scenarios will be assessed and best management practices recommended to continue achieving water quality goals (without requiring significant additional treatment expense).

[5] 2004 Water Quality Assessment Results for Individual Water Bodies (Segment 828 Lake Arlington).

Table 6. Finished Water Quality from City of Arlington Annual Reports

Parameter	Average	Minimum	Maximum	MCL
pH, S.U	8.2			6.5 - 8.5
Turbidity, NTU	0.13	0.2	0.7	95% of the samples < 0.3 NTU
Total Alkalinity, mg/L as $CaCO_3$	94	77	109	Not Regulated
Total Hardness, mg/L as $CaCO_3$	108	96	117	Not Regulated
Calcium, mg/L	37	34	40	Not Regulated
Sodium, mg/L	22	16	25	Not Regulated
Chloride, mg/L	19	13	23	MCLG: 250
Sulfate, mg/L	37	34	42	MCLG: 250
Barium, mg/L	0.046	0.045	0.049	2
Fluoride, mg/L	0.73	0.60	0.90	4
Nitrate-N, mg/L	0.52	0.26	1.02	10
Nitrite-N, mg/L	0.02	0.01	0.07	1
Lead, µg/L	1.83	0.06	3.00	Action Level: 15 µg/L
Copper, mg/L	0.25	0.13	0.55	Action Level: 1.3 mg/L
Chloramines, mg/L	3.43	3.4	3.5	MRDL: 4 mg/L
Total Trihalomethanes, µg/L	9.1	5.1	26	80
Haloacetic Acids, µg/L	6.2	3.7	10.8	60
TOC Removal Ratio, %	1.31	1.1	1.6	Percent of TOC removed by the treatment process divided by the percent of TOC required by TCEQ to be removed, should be greater than 1.0
Radium 228, pCi/L	< 1	< 1	< 1	5
Beta/Photon Emitters, pCi/L	< 4	< 4	< 4	50
Gross Alpha Particle Activity, pCi/L	< 2	< 2	< 2	15

4. Summary of Lake Water Quality

Water quality in Lake Arlington is generally of good quality, with only a few specific issues of concern:

- Temperature. TCEQ's 303(d) report issued in 2002 lists high temperatures for Lake Arlington at several locations.[6] TCEQ's 2004 Assessment Report states that "additional data are needed to determine whether natural conditions alone can cause elevated temperatures in the lake or whether the Handley Power Plant is a significant contributing factor."
- Manganese. Manganese concentrations increase during the late summer months due to anoxic conditions in the lake hypolimnium. The City of Arlington has the ability to vary intake levels to withdraw source water with lower manganese concentrations for the Pierce-Burch WTP. Oxidation followed by sedimentation and filtration reduces manganese concentrations in the finished water. However, if manganese concentrations increase and/or anoxic conditions occur at shallower depths, management of Mn in the WTP source water and at the WTP may become more challenging.
- Algae. The Village Creek screening level for chlorophyll a is exceeded[7] and concentrations in the reservoir indicate significant algal activity. Geosmin concentrations close to two orders of magnitude above the 10 ng/L odor threshold concentration were measured in samples collected at the Lake Arlington intake in 2008. Ozone addition at the Pierce-Burch WTP helps control taste and odor in the finished water.

The Pierce-Burch WTP currently meets all microbial and chemical drinking water standards; however, any future drinking water regulations (e.g., Long-Term 2 Enhanced Surface Water Treatment Rule) should be closely monitored within the context of development plans for the lake. A round of monitoring for 2,4-D and silvex could be conducted to assess current concentrations since the 1986 USGS data showed detectable levels of both herbicides. Other lake water quality issues that were not considered as part of this memorandum include trash collection in the southern portion of the lake and sediment loading. The Lake Arlington Master Plan will consider both of those water quality considerations in addition to the water quality issues presented in this memorandum.

[6] 2002 Water Quality Assessments for Individual Water Bodies, http://www.tceq.state.tx.us/compliance/monitoring/water/quality/data/02twqi/02_305b.html
[7] 2004 Water Quality Assessment Results for Individual Water Bodies (Segment 828 Lake Arlington).

Attachment 1. Permitted Sites in Lake Arlington Watershed

Permitted Site Name	County	Status	Permit I
Hazardous Waste			
Everett Kates, Incorporated	Tarrant	Inactive	N
Municipal Solid Waste			
City of Fort Worth Southeast Landfill	Tarrant	Active	
Duncan Thomas C Landfill	Tarrant	Inactive	N
City of Burleson Transfer Station Facility	Johnson	Not Constructed	Per Witho
City of Burleson Transfer Station Facility	Johnson	Active	
Clyde and Joe E Reese Landfill	Tarrant	Inactive	N
IESI Fort Worth C and D Landfill	Tarrant	Active	
Superfund Site			
Tricon America, Incorporated	Tarrant	Listed	TXD117
Industrial Wastewater Outfall			
Handley Power Plant	Tarrant	C	0055
JoCo Holding Corporation (motel/restaurant complex)	Johnson	C	0273
Texas Department of Transportation (rest area wastewater treatment facility)	Johnson	C	1479
Municipal Wastewater Outfall			
Oak Ridge Square MHP WWTP	Johnson	C	1337
Johnson County FWSD 1	Johnson	C	1435
Mayfair WWTP	Tarrant	C	1351
Briarhaven Wastewater Treatment Facility	Johnson	C	1468
South Fort Worth RV Ranch, LLC	Johnson	C	1468

[1]EPA ID Number
NA - Not applicable

Attachment 1 (cont'd)

TPDES Permitted Site	Parameter	Units	Average[1]	Maximum[2]
Handley Steam Electric Station ID #00552000	Flow - *Location 1*	MGD	219	1014
	Flow - *Location J*	MGD	4.0	13
	Oil and Grease - *Location J*	mg/L	0.01	15
	pH[4] - *Location J*	S.U.	8.1	8.7
	Temperature - *Location 1*	mg/L	73	103
	Total residual chlorine[5] - *Location 1*	mg/L	ND	ND
	Total suspended solids - *Location J*	mg/L	13	60
Johnson County WWTP ID #1435001	Ammonia Nitrogen	mg/L	1.6	25
	BOD	mg/L	4.1	25
	Dissolved Oxygen[3]	mg/L	6.77	
	Fecal Coliform	MPN/g	NODI	NODI
	Flow	MGD	0.39	1.4
	pH[4]	S.U.	6.7	9.0
	Salmonella	MPN/g	NODI	NODI
	Total residual chlorine[5]	mg/L	2.5	4.0
	Total suspended solids	mg/L	7.6	48
Mayfair WWTP ID #13518001	Ammonia Nitrogen	mg/L	6.4	51
	BOD	mg/L	5.4	21
	Dissolved Oxygen[3]	mg/L	5.1	
	Fecal Coliform	MPN/g	NODI	NODI
	Flow	MGD	0.04	1.0
	pH[4]	S.U.	7.6	8.0
	Salmonella	MPN/g	NODI	NODI
	Total residual chlorine[5]	mg/L	2.0	3.9
	Total suspended solids	mg/L	8.6	38
Oak Ridge Square MHP WWTP ID #13376001	BOD	mg/L	20	230
	Dissolved Oxygen[3]	mg/L	3.0	
	Fecal Coliform	MPN/g	NODI	NODI
	Flow	MGD	0.0076	0.056
	pH[4]	S.U.	7.2	8.2
	Salmonella	MPN/g	NODI	NODI
	Total residual chlorine[5]	mg/L	1.3	4.0
	Total suspended solids	mg/L	29	270
RV Ranch	BOD	mg/L	16	36

WWTP ID #14680001	Dissolved Oxygen[3]	mg/L	4.3	
	Fecal Coliform	MPN/g	NODI	NODI
	Flow	MGD	0.0076	0.061
	pH[4]	S.U.	7.5	8.3
	Salmonella	MPN/g	NODI	NODI
	Total residual chlorine[5]	mg/L	1.4	3.5
	Total suspended solids	mg/L	31	130
Briarhaven WWTP ID #0014681001	BOD	mg/L	≤ 46	
	Dissolved Oxygen	mg/L	≥ 2.1	
	Flow	MGD	≤ 0.046	
	pH	S.U.	6.0 - 9.1	
	Total residual chlorine	mg/L	1.0 - 4.1	
	Total suspended solids	mg/L	≤ 46	
JOCO Holding Corporation #02730000	BOD	mg/L	30	
	Flow	MGD	1.030	
	pH	S.U.	6.0 - 9.0	
TXDOT Johnson County Rest Area #14790-002	BOD	mg/L	30	45
	Dissolved Oxyen	mg/L	≥ 2.0	
	Flow[6]	MGD	0.006	0.026
	pH	S.U.	6.0 - 9.0	
	Total suspended solids	mg/L	30	45

NODI - No Discharge/No Data Indicator

[1]Average of daily sample averages

[2]Maximum of daily sample maximums

[3]Dissolved oxygen reports only daily minimum; average is of daily minimum

[4]pH reports daily minimum and maximum; average is of daily average of minimum and maximum

[5]Total residual chlorine reports daily minimum and maximum; average is of daily average of minimum and maximum

[6]Average discharge during any two-hour period must not exceed 18 gpm

National Primary Drinking Water Regulation

	Contaminant	MCL or TT[1] (mg/L)[2]	Potential health effects from long-term[3] exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)[2]
OC	Acrylamide	TT[4]	Nervous system or blood problems; increased risk of cancer	Added to water during sewage/ wastewater treatment	zero
OC	Alachlor	0.002	Eye, liver, kidney or spleen problems; anemia; increased risk of cancer	Runoff from herbicide used on row crops	zero
R	Alpha/photon emitters	15 picocuries per Liter (pCi/L)	Increased risk of cancer	Erosion of natural deposits of certain minerals that are radioactive and may emit a form of radiation known as alpha radiation	zero
IOC	Antimony	0.006	Increase in blood cholesterol; decrease in blood sugar	Discharge from petroleum refineries; fire retardants; ceramics; electronics; solder	0.006
IOC	Arsenic	0.010	Skin damage or problems with circulatory systems, and may have increased risk of getting cancer	Erosion of natural deposits; runoff from orchards; runoff from glass & electronics production wastes	0
IOC	Asbestos (fibers >10 micrometers)	7 million fibers per Liter (MFL)	Increased risk of developing benign intestinal polyps	Decay of asbestos cement in water mains; erosion of natural deposits	7 MFL
OC	Atrazine	0.003	Cardiovascular system or reproductive problems	Runoff from herbicide used on row crops	0.003
IOC	Barium	2	Increase in blood pressure	Discharge of drilling wastes; discharge from metal refineries; erosion of natural deposits	2
OC	Benzene	0.005	Anemia; decrease in blood platelets; increased risk of cancer	Discharge from factories; leaching from gas storage tanks and landfills	zero
OC	Benzo(a)pyrene (PAHs)	0.0002	Reproductive difficulties; increased risk of cancer	Leaching from linings of water storage tanks and distribution lines	zero
IOC	Beryllium	0.004	Intestinal lesions	Discharge from metal refineries and coal-burning factories; discharge from electrical, aerospace, and defense industries	0.004
R	Beta photon emitters	4 millirems per year	Increased risk of cancer	Decay of natural and man-made deposits of certain minerals that are radioactive and may emit forms of radiation known as photons and beta radiation	zero
DBP	Bromate	0.010	Increased risk of cancer	Byproduct of drinking water disinfection	zero
IOC	Cadmium	0.005	Kidney damage	Corrosion of galvanized pipes; erosion of natural deposits; discharge from metal refineries; runoff from waste batteries and paints	0.005
OC	Carbofuran	0.04	Problems with blood, nervous system, or reproductive system	Leaching of soil fumigant used on rice and alfalfa	0.04
OC	Carbon tetrachloride	0.005	Liver problems; increased risk of cancer	Discharge from chemical plants and other industrial activities	zero
D	Chloramines (as Cl_2)	MRDL=4.0[1]	Eye/nose irritation; stomach discomfort; anemia	Water additive used to control microbes	MRDLG=4[1]
OC	Chlordane	0.002	Liver or nervous system problems; increased risk of cancer	Residue of banned termiticide	zero
D	Chlorine (as Cl_2)	MRDL=4.0[1]	Eye/nose irritation; stomach discomfort	Water additive used to control microbes	MRDLG=4[1]
D	Chlorine dioxide (as ClO_2)	MRDL=0.8[1]	Anemia; infants, young children, and fetuses of pregnant women: nervous system effects	Water additive used to control microbes	MRDLG=0.8[1]
DBP	Chlorite	1.0	Anemia; infants, young children, and fetuses of pregnant women: nervous system effects	Byproduct of drinking water disinfection	0.8
OC	Chlorobenzene	0.1	Liver or kidney problems	Discharge from chemical and agricultural chemical factories	0.1
IOC	Chromium (total)	0.1	Allergic dermatitis	Discharge from steel and pulp mills; erosion of natural deposits	0.1
IOC	Copper	TT[5]; Action Level = 1.3	Short-term exposure: Gastrointestinal distress. Long-term exposure: Liver or kidney damage. People with Wilson's Disease should consult their personal doctor if the amount of copper in their	Corrosion of household plumbing systems; erosion of natural deposits	1.3

Contaminant		MCL or TT[1] (mg/L)[2]	Potential health effects from long-term[3] exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)[2]
IOC	Cyanide (as free cyanide)	0.2	Nerve damage or thyroid problems	Discharge from steel/metal factories; discharge from plastic and fertilizer factories	0.2
OC	2,4-D	0.07	Kidney, liver, or adrenal gland problems	Runoff from herbicide used on row crops	0.07
OC	Dalapon	0.2	Minor kidney changes	Runoff from herbicide used on rights of way	0.2
OC	1,2-Dibromo-3-chloropropane (DBCP)	0.0002	Reproductive difficulties; increased risk of cancer	Runoff/leaching from soil fumigant used on soybeans, cotton, pineapples, and orchards	zero
OC	o-Dichlorobenzene	0.6	Liver, kidney, or circulatory system problems	Discharge from industrial chemical factories	0.6
OC	p-Dichlorobenzene	0.075	Anemia; liver, kidney or spleen damage; changes in blood	Discharge from industrial chemical factories	0.075
OC	1,2-Dichloroethane	0.005	Increased risk of cancer	Discharge from industrial chemical factories	zero
OC	1,1-Dichloroethylene	0.007	Liver problems	Discharge from industrial chemical factories	0.007
OC	cis-1,2-Dichloroethylene	0.07	Liver problems	Discharge from industrial chemical factories	0.07
OC	trans-1,2-Dichloroethylene	0.1	Liver problems	Discharge from industrial chemical factories	0.1
OC	Dichloromethane	0.005	Liver problems; increased risk of cancer	Discharge from drug and chemical factories	zero
OC	1,2-Dichloropropane	0.005	Increased risk of cancer	Discharge from industrial chemical factories	zero
OC	Di(2-ethylhexyl) adipate	0.4	Weight loss, liver problems, or possible reproductive difficulties	Discharge from chemical factories	0.4
OC	Di(2-ethylhexyl) phthalate	0.006	Reproductive difficulties; liver problems; increased risk of cancer	Discharge from rubber and chemical factories	zero
OC	Dinoseb	0.007	Reproductive difficulties	Runoff from herbicide used on soybeans and vegetables	0.007
OC	Dioxin (2,3,7,8-TCDD)	0.00000003	Reproductive difficulties; increased risk of cancer	Emissions from waste incineration and other combustion; discharge from chemical factories	zero
OC	Diquat	0.02	Cataracts	Runoff from herbicide use	0.02
OC	Endothall	0.1	Stomach and intestinal problems	Runoff from herbicide use	0.1
OC	Endrin	0.002	Liver problems	Residue of banned insecticide	0.002
OC	Epichlorohydrin	TT[4]	Increased cancer risk; stomach problems	Discharge from industrial chemical factories; an impurity of some water treatment chemicals	zero
OC	Ethylbenzene	0.7	Liver or kidney problems	Discharge from petroleum refineries	0.7
OC	Ethylene dibromide	0.00005	Problems with liver, stomach, reproductive system, or kidneys; increased risk of cancer	Discharge from petroleum refineries	zero
M	Fecal coliform and *E. coli*	MCL[6]	Fecal coliforms and *E. coli* are bacteria whose presence indicates that the water may be contaminated with human or animal wastes. Microbes in these wastes may cause short term effects, such as diarrhea, cramps, nausea, headaches, or other symptoms. They may pose a special health risk for infants, young children, and people with severely compromised immune systems.	Human and animal fecal waste	zero[6]
IOC	Fluoride	4.0	Bone disease (pain and tenderness of the bones); children may get mottled teeth	Water additive which promotes strong teeth; erosion of natural deposits; discharge from fertilizer and aluminum factories	4.0
M	*Giardia lamblia*	TT[7]	Short-term exposure: Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste	zero
OC	Glyphosate	0.7	Kidney problems; reproductive difficulties	Runoff from herbicide use	0.7
DBP	Haloacetic acids (HAA5)	0.060	Increased risk of cancer	Byproduct of drinking water disinfection	n/a[9]
OC	Heptachlor	0.0004	Liver damage; increased risk of cancer	Residue of banned termiticide	zero
OC	Heptachlor epoxide	0.0002	Liver damage; increased risk of cancer	Breakdown of heptachlor	zero
M	Heterotrophic plate	TT[7]	HPC has no health effects; it is an	HPC measures a range of bacteria	n/a

	Contaminant	MCL or TT[1] (mg/L)[2]	Potential health effects from long-term[3] exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)[2]
OC	Hexachlorobenzene	0.001	Liver or kidney problems; reproductive difficulties; increased risk of cancer	Discharge from metal refineries and agricultural chemical factories	zero
OC	Hexachlorocyclopentadiene	0.05	Kidney or stomach problems	Discharge from chemical factories	0.05
IOC	Lead	TT5; Action Level=0.015	Infants and children: Delays in physical or or mental development; children could show slight deficits in attention span and learning abilities; Adults: Kidney problems; high blood pressure	Corrosion of household plumbing systems; erosion of natural deposits	zero
M	*Legionella*	TT7	Legionnaire's Disease, a type of pneumonia	Found naturally in water; multiplies in heating systems	zero
OC	Lindane	0.0002	Liver or kidney problems	Runoff/leaching from insecticide used on cattle, lumber, gardens	0.0002
IOC	Mercury (inorganic)	0.002	Kidney damage	Erosion of natural deposits; discharge from refineries and factories; runoff from landfills and croplands	0.002
OC	Methoxychlor	0.04	Reproductive difficulties	Runoff/leaching from insecticide used on fruits, vegetables, alfalfa, livestock	0.04
IOC	Nitrate (measured as Nitrogen)	10	Infants below the age of six months who drink water containing nitrate in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits	10
IOC	Nitrite (measured as Nitrogen)	1	Infants below the age of six months who drink water containing nitrite in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits	1
OC	Oxamyl (Vydate)	0.2	Slight nervous system effects	Runoff/leaching from insecticide used on apples, potatoes, and tomatoes	0.2
OC	Pentachlorophenol	0.001	Liver or kidney problems; increased cancer risk	Discharge from wood-preserving factories	zero
OC	Picloram	0.5	Liver problems	Herbicide runoff	0.5
OC	Polychlorinated biphenyls (PCBs)	0.0005	Skin changes; thymus gland problems; immune deficiencies; reproductive or nervous system difficulties; increased risk of cancer	Runoff from landfills; discharge of waste chemicals	zero
R	Radium 226 and Radium 228 (combined)	5 pCi/L	Increased risk of cancer	Erosion of natural deposits	zero
IOC	Selenium	0.05	Hair or fingernail loss; numbness in fingers or toes; circulatory problems	Discharge from petroleum and metal refineries; erosion of natural deposits; discharge from mines	0.05
OC	Simazine	0.004	Problems with blood	Herbicide runoff	0.004
OC	Styrene	0.1	Liver, kidney, or circulatory system problems	Discharge from rubber and plastic factories; leaching from landfills	0.1
OC	Tetrachloroethylene	0.005	Liver problems; increased risk of cancer	Discharge from factories and dry cleaners	zero
IOC	Thallium	0.002	Hair loss; changes in blood; kidney, intestine, or liver problems	Leaching from ore-processing sites; discharge from electronics, glass, and drug factories	0.0005
OC	Toluene	1	Nervous system, kidney, or liver problems	Discharge from petroleum factories	1
M	Total Coliforms	5.0 percent[8]	Coliforms are bacteria that indicate that other, potentially harmful bacteria may be present. See fecal coliforms and *E. coli*	Naturally present in the environment	zero
DBP	Total Trihalomethanes (TTHMs)	0.080	Liver, kidney or central nervous system problems; increased risk of cancer	Byproduct of drinking water disinfection	n/a[9]
OC	Toxaphene	0.003	Kidney, liver, or thyroid problems; increased risk of cancer	Runoff/leaching from insecticide used on cotton and cattle	zero
OC	2,4,5-TP (Silvex)	0.05	Liver problems	Residue of banned herbicide	0.05
OC	1,2,4-Trichlorobenzene	0.07	Changes in adrenal glands	Discharge from textile finishing factories	0.07
OC	1,1,1-Trichloroethane	0.2	Liver, nervous system, or circulatory problems	Discharge from metal degreasing sites and other factories	0.2
OC	1,1,2-Trichloroethane	0.005	Liver, kidney, or immune system problems	Discharge from industrial chemical factories	0.003
OC	Trichloroethylene	0.005	Liver problems; increased risk of cancer	Discharge from metal degreasing	zero

Contaminant		MCL or TT[1] (mg/L)[2]	Potential health effects from long-term[3] exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)[2]
M	Turbidity	TT[7]	Turbidity is a measure of the cloudiness of water. It is used to indicate water quality and filtration effectiveness (e.g., whether disease-causing organisms are present). Higher turbidity levels are often associated with higher levels of disease-causing microorganisms such as viruses, parasites and some bacteria. These organisms can cause short term symptoms such as nausea, cramps, diarrhea, and associated headaches.	Soil runoff	n/a
R	Uranium	30µg/L	Increased risk of cancer, kidney toxicity	Erosion of natural deposits	zero
OC	Vinyl chloride	0.002	Increased risk of cancer	Leaching from PVC pipes; discharge from plastic factories	zero
M	Viruses (enteric)	TT[7]	Short-term exposure: Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste	zero
OC	Xylenes (total)	10	Nervous system damage	Discharge from petroleum factories; discharge from chemical factories	10

NOTES

1 Definitions

- Maximum Contaminant Level Goal (MCLG)—The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety and are non-enforceable public health goals.
- Maximum Contaminant Level (MCL)—The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to MCLGs as feasible using the best available treatment technology and taking cost into consideration. MCLs are enforceable standards.
- Maximum Residual Disinfectant Level Goal (MRDLG)—The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contaminants.
- Maximum Residual Disinfectant Level (MRDL)—The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.
- Treatment Technique (TT)—A required process intended to reduce the level of a contaminant in drinking water.

2 Units are in milligrams per liter (mg/L) unless otherwise noted. Milligrams per liter are equivalent to parts per million (ppm).

3 Health effects are from long-term exposure unless specified as short-term exposure.

4 Each water system must certify annually, in writing, to the state (using third-party or manufacturers certification) that when it uses acrylamide and/or epichlorohydrin to treat water, the combination (or product) of dose and monomer level does not exceed the levels specified, as follows: Acrylamide = 0.05 percent dosed at 1 mg/L (or equivalent); Epichlorohydrin = 0.01 percent dosed at 20 mg/L (or equivalent).

5 Lead and copper are regulated by a Treatment Technique that requires systems to control the corrosiveness of their water. If more than 10 percent of tap water samples exceed the action level, water systems must take additional steps. For copper, the action level is 1.3 mg/L, and for lead is 0.015 mg/L.

6 A routine sample that is fecal coliform-positive or *E. coli*-positive triggers repeat samples--if any repeat sample is total coliform-positive, the system has an acute MCL violation. A routine sample that is total coliform-positive and fecal coliform-negative or *E. coli*-negative triggers repeat samples--if any repeat sample is fecal coliform-positive or *E. coli*-positive, the system has an acute MCL violation. See also Total Coliforms.

7 EPA's surface water treatment rules require systems using surface water or ground water under the direct influence of surface water to (1) disinfect their water, and (2) filter their water or meet criteria for avoiding filtration so that the following contaminants are controlled at the following levels:

- *Cryptosporidium*: 99 percent removal for systems that filter. Unfiltered systems are required to include Cryptosporidium in their existing watershed control provisions.
- Giardia lamblia: 99.9 percent removal/inactivation
- Viruses: 99.99 percent removal/inactivation
- *Legionella*: No limit, but EPA believes that if *Giardia* and viruses are removed/inactivated accordi to the treatment techniques in the surface water treatment rule, *Legionella* will also be controlle
- Turbidity: For systems that use conventional or direct filtration, at no time can turbidity (cloudiness c water) go higher than 1 nephelolometric turbidity unit (NTU), and samples for turbidity must be less than or equal to 0.3 NTU in at least 95 percent of the samples in any month. Systems that us filtration other than conventional or direct filtration must follow state limits, which must include turbi at no time exceeding 5 NTU.
- HPC: No more than 500 bacterial colonies per milliliter
- Long Term 1 Enhanced Surface Water Treatment; Surface water systems or ground water system under the direct influence of surface water serving fewer than 10,000 people must comply with t applicable Long Term 1 Enhanced Surface Water Treatment Rule provisions (e.g. turbidity standar individual filter monitoring, *Cryptosporidium* removal requirements, updated watershed control requirements for unfiltered systems).
- Long Term 2 Enhanced Surface Water Treatment; This rule applies to all surface water syste or ground water systems under the direct influence of surface water. The rule targets addition *Cryptosporidium* treatment requirements for higher risk systems and includes provisions to reduce risks from uncovered finished water storages facilities and to ensure that the systems maintain micro protection as they take steps to reduce the formation of disinfection byproducts. (Monitoring start dates are staggered by system size. The largest systems (serving at least 100,000 people) will begin monitoring in October 2006 and the smallest systems (serving fewer than 10,000 people) will not begin monitoring until October 2008. After completing monitoring and determining their treatment bin, systems generally have three years to comply with any addition treatment requirements.)
- Filter Backwash Recycling: The Filter Backwash Recycling Rule requires systems that recycle return specific recycle flows through all processes of the system's existing conventional or dir filtration system or at an alternate location approved by the state.

8 No more than 5.0 percent samples total coliform-positive in a month. (For water systems that coll fewer than 40 routine samples per month, no more than one sample can be total coliform-positi per month.) Every sample that has total coliform must be analyzed for either fecal coliforms or *E. coli*. If two consecutive TC-positive samples, and one is also positive for *E. coli* or fecal coliform system has an acute MCL violation.

9 Although there is no collective MCLG for this contaminant group, there are individual MCLGs fo some of the individual contaminants:

- Haloacetic acids: dichloroacetic acid (zero); trichloroacetic acid (0.3 mg/L)
- Trihalomethanes: bromodichloromethane (zero); bromoform (zero); dibromochloromethane (0.06 mg

National Secondary Drinking Water Regulation

National Secondary Drinking Water Regulations are non-enforceable guidelines regarding contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. EPA recommends secondary standards to water systems but does not require systems to comply. However, some states may choose to adopt them as enforceable standards.

Contaminant	Secondary Maximum Contaminant Level
Aluminum	0.05 to 0.2 mg/L
Chloride	250 mg/L
Color	15 (color units)
Copper	1.0 mg/L
Corrosivity	noncorrosive
Fluoride	2.0 mg/L
Foaming Agents	0.5 mg/L
Iron	0.3 mg/L
Manganese	0.05 mg/L
Odor	3 threshold odor number
pH	6.5-8.5
Silver	0.10 mg/L
Sulfate	250 mg/L
Total Dissolved Solids	500 mg/L
Zinc	5 mg/L

For More Information

EPA's Safe Drinking Water Web site:
http://www.epa.gov/safewater/

EPA's Safe Drinking Water Hotline:
(800) 426-4791

To order additional posters or other ground water and drinking water publications, please contact the National Service Center for Environmental Publications at :
(800) 490-9198, or
email: nscep@bps-lmit.com.

Nutrient Criteria for Reservoirs

Water Quality Standards Workgroup – September 6, 2007
TCEQ Staff DRAFT

The Basics:

What nutrient regulations or controls are currently in place in Texas?

- Narrative nutrient criteria in the Surface Water Quality Standards §307.4(e).
- There are 8 "watershed rules" that typically specify nutrient controls or other restrictions on wastewater discharges.
- There are well over 30 permits have effluent limits for phosphorus.
- In the 2006 Water Quality Inventory, many water bodies are listed with nutrient related concerns.
- The North Bosque River is the only listing for nutrient impairment in the 303(d) list.

How did this all start, and what has been happening?

- In 2001 EPA mandated that states demonstrate progress in developing numerical nutrient standards by 2004.
- EPA required that states submit a development plan. (See the following link for the latest plan from TCEQ: http://www.tceq.state.tx.us/permitting/water_quality/stakeholders/nutrient_criteria_group.html#plans.)
- The state of Texas and EPA now have a plan that they have both agreed upon.
- Texas is developing reservoir criteria first.
- The TCEQ worked with USGS in developing a data base, calculating criteria, and performing data analyses for reservoirs and streams and rivers.
- Other approaches have been presented and considered.
- A nutrient criteria development workgroup was formed and has provided input into the process. This group has been incorporated into the Water Quality Standards Advisory Workgroup.
- The Nutrient workgroup requested that numeric criteria be developed for all reservoirs with "sufficient data."
- An ACCESS relational data base with values for a variety of constituents exists for reservoirs and streams and rivers.
- Data was taken from TCEQ's TRACS and USGS's NWIS data bases. Data base creation and data manipulation can be found in handout titles "Nutrient Data Base Development"
- This data base has been QA'd.
- Criteria/screening values for chlorophyll a, total phosphorus (TP), and total nitrogen have been calculated for all reservoirs with sufficient data.

- The criteria have been compared against the historical data using "what-if" scenarios as if the data was being assessed for the 305(b)/303(d) report. The results of these comparisons with means, medians, criteria at 99th, 95th, and 90th confidence intervals, and TPWD's criteria (least impacted only), for most reservoirs are posted on the website. How this was accomplished is found in handout "5 Year Assessment" dated May 16, 2007."
- The final deliverables of data analysis done by USGS which includes trends analysis was received in May 2007 and have been reviewed. Other analyses have yet to be examined in detail.

Criteria:

How is TCEQ proposing to set numerical nutrient criteria?

- The TCEQ is proposing that chlorophyll a be the primary numerical criteria.
- A methodology similar to that used for total dissolved solids has primary consideration,
  - pooled 2 sample t-test. For the formula see the handout "Development of Nutrient Criteria in the Texas Surface Water Quality Standards"
  - historical data
- Based on comments from the Nutrient Criteria Development Advisory Workgroup, TCEQ is proposing chlorophyll *a* criteria for all reservoirs that are assessed for trophic status in the TCEQ Water Quality Inventory, except for those with insufficient data points.
- Use the same station as the reservoir trophic state assessment.
- Include criteria/screening values for total phosphorus and total nitrogen. See Appendix A.

How many data points are "sufficient" for setting criteria?

When USGS originally calculated criteria using EPA's methodology, there had to be at least 6 data points over three years before the reservoir was included. When USGS calculated criteria using the pooled 2 sample t-test there had to be at least 15 data points over the period of record (1970-2003).

1. Set a cut off for the minimum number of data points required before criteria are assigned.
   - 30
   - 35
2. Based on current assessment procedures, some reservoirs with less than 35 data points would not be assessed for standards compliance.
   - Current assessment procedures require that at least half of the samples (five) must be collected within the last five years even though the number of samples required for assessment can include up to ten years ago. Based on this procedure, a number of reservoirs using data from the Reservoir data base, which extends up to 2003, would not be assessed. See the table

below and Appendix B for a comparison of less than 35 data points vs. less than 5 data points from 1999 to 2003.

Issue:

- Some reservoirs at the main pool site near the dam have few data points. Those with less than 30, which is the typical sample size required for site-specific criteria, are listed below. It may be appropriate to raise the required number to 35, where there is a small break in the frequency distribution when total numbers of data points are plotted.
- There are 25 reservoirs with less than 30 data points at the dam location. (36 with 35 and less).

Options:

- Propose criteria for all reservoirs irregardless of the number of data points.
- Not propose criteria for reservoirs with less than x number of data points.
- Look for and, if present, add other open water stations.
- Look for and, if present, add any data that exists that was not included in TRACS or NWIS.
- Change the station against which the criteria is developed or the assessment is conducted.

Reservoirs with less than 35 data points

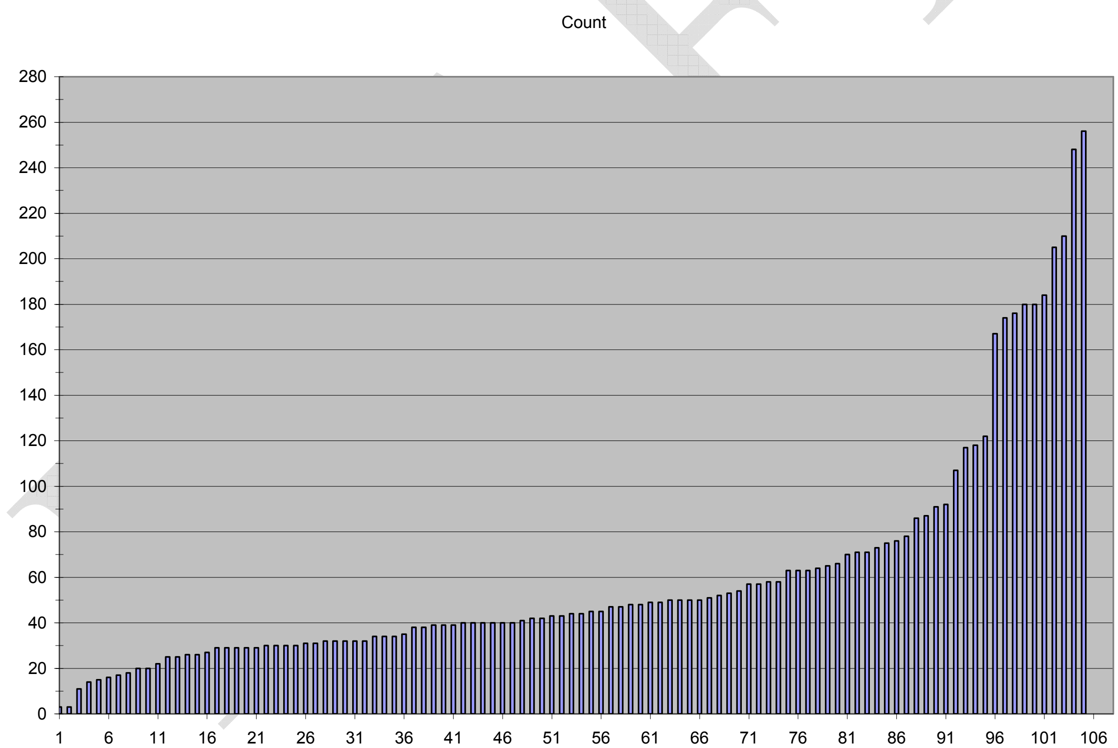
Reservoir	No. of data points
B. A. Steinhagen Reservoir	26
Brady Creek Reservoir	29
Cox Lake	22
Ellison Creek Reservoir	11
Fin Feather Lake	16
Granger Lake	29
Grapevine Lake	3
Hubbard Creek Reservoir	30
Joe Pool Lake	14
Lake Amon G. Carter	30
Lake Bob Sandlin	20
Lake Georgetown	30
Lake Graham	29
Lake Limestone	25
Lake Mexia	26
Lake Palo Pinto	30
Lake Tanglewood	29
Lake Texana	15
Lake Theo	3
Lake Wichita	18
O.H. Ivie Reservoir	17
Oak Creek Reservoir	29
Palo Duro Reservoir	20

Pat Cleburne Reservoir	27
Sam Rayburn Reservoir*	25

Reservoirs with 30-35 data points

Aquilla Reservoir	34
Choke Canyon Reservoir	32
Diversion Lake	34
Lake Cherokee	31
Lake Cisco	35
Lake Crook	32
Lake Cypress Springs	32
Lake Granbury	34
Lake Kickapoo	32
Possum Kingdom Reservoir*	31
White Rock Lake	32

Frequency distribution of data points



Reservoirs that would not be assessed	
Brady Creek	
Buffalo Springs	

Ellison Creek Reservoir	
Falcon Lake	
Fort Phantom Hill	data to 1998
Grapevine	
Joe Pool Lake	
Lake Arlington	data to 1994
Lake Cherokee	data to 1994
Lake Colorado	
Lake Conroe	
Lake Crook	
Lake Kickapoo	
Lake Lavon	data to 1995
Lake Limestone	
Lake Sweetwater	
Lake Texana	
Lake Texoma	data to 1994
Lake Whitney	
Lake Wichita	
Millers Creek	
Pat Cleburne	
Pat Mayse	
Possum Kingdom	
White Rock Lake	data to 1994

Should there be a minimum value for reservoir criteria?

A minimum limit to reservoir criteria appears to be appropriate to minimize sampling quantification problems. 5 µg/L is an appropriate cutoff, since (1) this is a typical Ambient Water Reporting Limit (AWRL) for chlorophyll *a*, and (2) this concentration is relatively low for Texas reservoirs (15th percentile of the reservoir criteria).

The following reservoir criteria are below 5.00 µg/L:

Reservoir Name	Chlorophyll *a* criteria
Amistad	3.02
Belton Reservoir	4.27
Canyon Lake	3.10
Greenbelt Reservoir	3.78
Joe Pool Lake	3.38
Lake Austin	4.05
Lake Brownwood	4.94
Lake Cisco	2.90
Lake Jacksonville	4.60
Lake Mackenzie	4.85
Lake Meredith	3.56
Lake Texana	4.78

Lake Travis	4.10
Medina Lake	4.00
Sam Rayburn Reservoir	4.32
White River Lake	3.93

Should secondary criteria be established to augment procedures for (1) evaluating wastewater discharge permits and (2) for assessing standards compliance?

- Consider a secondary set of criteria for each reservoir for total phosphorus (TP), calculated from historical data using the same procedures as for chlorophyll *a* (Appendix A). As discussed below, TP criteria would facilitate (1) weight-of-evidence approaches for assessing monitoring data, and (2) assessing the impacts of nutrient loading.

- Consider a similar secondary set of criteria for each reservoir for nitrate, as a partial surrogate for total nitrogen, since inadequate data exists for total nitrogen for the majority of reservoirs.

Trends:

USGS conducted statistical trend analyses on individual reservoirs using Statistica. Chlorophyll a, total phosphorus, and total nitrogen data were log transformed before the analyses were conducted. Some reservoirs showed an increasing trend that was statistically significant. At least eight reservoirs showed decreasing trends in either chlorophyll *a* or total phosphorus. See the tables below.

USGS also plotted the historical data over time for each reservoir and included linear fit lines. R^2 values were included.

The exercise of comparing the criteria to 5 year blocks of data in a “what-if” scenario to mimic the 305(b)/303(d) assessment, revealed that at least six reservoirs had means and medians that were increasing over time. This scenario also shows the assessment periods that the means and averages would exceed the criteria for a number of reservoirs. See the handout “Reservoir Trends and Exceedances.”

Trends in chlorophyll *a* – Statistical
USGS statistical analysis of correlations of date vs. chl a.
▪ Buffalo Springs – because of high chlorophyll *a* values, the criteria is the highest in the state using available data.
▪ Lake Colorado City
▪ Lake Worth
▪ Lake Lyndon B. Johnson. Though the trend is statistically

significant, there were very few data points in early years. Most of the data points are later and are all higher than the earlier data points.
▪ Lake Marble Falls – see LBJ
▪ Granger Lake – decreasing trend
▪ Lake Brownwood – decreasing trend
▪ Lake Buchanan – decreasing trend
▪ Lake Stamford – decreasing trend
Increasing trends in chlorophyll *a* – Assessment scenario
Based on increasing variability, increasing means and medians over time, and increasing linear trend lines.
▪ Inks Lake
▪ Eagle Mountain
▪ Lake Tawakoni
▪ Toledo Bend
▪ Town Lake
▪ Cedar Creek Reservoir

Trends in TP – Statistical
From USGS statistical analysis of correlations of date vs. TP.
▪ Lake Austin
▪ Falcon
▪ Lake Colorado City
▪ Lake Conroe
▪ Lake Corpus Christi
▪ Lake Crook
▪ Lake Fort Phantom Hill
▪ Lake Palestine
▪ Lake Waco
▪ Lake Whitney
▪ OC Fisher Reservoir
▪ Richland Chambers
▪ Sam Rayburn, not sure which station was used
▪ Somerville Lake
▪ Town Lake
▪ Twin Buttes
▪ White River Lake
▪ Fin Feather – decreasing trend
▪ Lake Kickapoo – decreasing trend
▪ Lake Lavon – decreasing trend
▪ Lake Livingston – decreasing trend
▪ Lake Tanglewood – not enough data points in early years to really tell if increasing

Increasing trends in TP – Assessment scenario
▪ Canyon Lake – data collected in the 70's is lower as a group than data collected since the early 90's
▪ Cedar Creek Reservoir slight increase and linear trend upward r^2=.0835
▪ Falcon – fewer data points after 1990 and most of them are higher than those collected in the 70's and 80's
▪ Inks
▪ Lake Arrowhead
▪ Lake Austin
▪ Lake Colorado City
▪ Lake Livingston – downward trend
▪ Lake Travis
▪ Lake Waco
▪ Lake Whitney
▪ OC Fisher Reservoir
▪ Somerville Lake
▪ Toledo Bend
▪ Twin Buttes

Other trends
▪ Proctor Lake
o TP going up
o Chl a going down

Options to Assess Compliance with Nutrient Criteria:

- Measure compliance in the main pool of the reservoir, at the reference station used to set criteria, with flexibility to switch to comparable areas and pool stations where appropriate.

- Base compliance on long-term average of monitoring data (5-years) compared to the chlorophyll *a* criterion.

- Define a water body as impaired for nutrients only if an exceedance of the chlorophyll *a* criterion is also confirmed by an exceedance of a secondary criterion (TP).

- Compare the criteria with the median of monitoring data, rather than with the mean, as a measure of "average" concentration. Use of the median reduces the impact of outlier data, but it can also fail to address temporary elevations caused by real algal blooms.

- Require additional statistical confirmation that exceedances are different from the historical conditions in the reservoir. One approach is to compare the data over the 5-year period of record against historical data using a pooled-t test.

- Increase the averaging time for assessment. For examples, (1) require that a reservoir exceed criteria for two consecutive assessment periods before listing it as impaired for nutrients; or (2) increase the assessment period to 10 years (instead of 5).

Options to Implement Nutrient Criteria in Wastewater Permitting:

For numerical criteria in the main pool of a reservoir:

- Estimate the permitted contribution of a wastewater discharge to the concentration of TP in the main pool of the reservoir, using a simple steady-state, and completely mixed "model."

- Compare the estimated concentration of TP with the secondary criterion for TP.

- Or, estimate the effects of increases in TP and TN on chlorophyll *a* using empirical relationships derived from historical data for large groups of reservoirs (regression equations).

- For the antidegradation review of proposed permitted increases in nutrient loading, check to see if the increase in load could utilize a significant (non-negligible) portion of the remaining assimilative capacity for TP. [One expression of assimilative capacity is TP criterion minus historically average (median) TP in the main pool.]

- Examples of additional factors to consider for antidegradation review:

  Magnitude of proposed increase in discharge loading.
  Distance of the proposed increase from the reservoir.
  Existence of reported water quality problems in the area of the discharge.
  Cumulative impacts of other sources of nutrient loading.

To evaluate localized impacts under the narrative nutrient criterion:

- For typical discharges to coves and backwater areas with restricted circulation, evaluate the anticipated increase in local TP with a completely mixed, steady state model of the restricted area, using a maximum area of [10 acres].

- For narrow transition zones that are subject to evaluation by QUAL-TX, evaluate the relative contribution of effluent TP linearly along the discharge route.

- For the antidegradation review of proposed increases in nutrient loading, weigh the following factors to determine the potential need for an effluent limit for TP:

Relative contribution of effluent to TP in the affected area, or at a specified distance [200 feet] into the reservoir from the wastewater source.

Amount of the proposed increase in discharge.

Existence of reported, observed, or measured nutrient impacts in the area of the discharge.

Distance of the discharge from the edge of the reservoir.

Cumulative impacts of additional permitted sources of nutrients.

- Develop more explicit examples of potential degradation from nutrient increase in the Standards Implementation Procedures. [For example, a projected increase in phosphorus concentration greater than __(x)__ at a distance of __(y)__ into a reservoir.]

- Evaluate available data from reservoir peripheries to (1) establish screening criteria as concentrations of nutrients/chlorophyll *a* for transition zones, coves; (2) improve application/calibration of models to predict localized impacts.

Additional watershed protection? :

- TCEQ currently has watershed rules for 15 reservoirs (in 30 TAC 311) that apply various additional protective measures in wastewater permits.

- Should TCEQ consider additional watershed rules (30 TAC 311) that require effluent limits for TP for discharges to reservoirs that have concerns such as the following?

Recent or projected increases in wastewater discharges and population growth in the watershed.

Trend of increasing concentration of nutrients and/or chlorophyll *a*.

Observations of nutrient-related water quality problems.

Evidence of sensitivity to nutrient additions.

Other local concerns.

Appendix A:

Nutrient Criteria

Chlorophyll *a,* Total Phosphorus, Total Nitrogen

May 16/Sept 6, 2007

Water Quality Standards Workgroup – September 6, 2007
TCEQ Staff DRAFT

Lake Name	Site ID	Segment No.	Chl criteria		TP criteria		TN criteria (mg/L)
			(µg/L)	Count	(mg/L)	Count	
Amistad Reservoir	13211	2305	3.02	118	0.036	165	
Aquilla Reservoir	12127	1254	9.52	34	0.058	36	
B. A. Steinhagen Reservoir	10582	0602	9.3	26	0.094	29	
Bardwell Reservoir	10979	0815	16.07	43	0.054	41	
Belton Reservoir	11921	1220	4.27	42	0.024	44	
Benbrook Lake	15151& 11046	0830	21.19	71	0.062	63	
Brady Creek Reservoir	12179	1416	19.60	29	0.039	26	
Buffalo Springs Lake	11529		83.77	58	0.330	58	
Caddo Lake	10283	0401	15.6	77	0.065	71	0.764
Canyon Lake	12598	1805	3.1	111	0.054	190	0.841
Cedar Creek Reservoir	10982	0818	23.47	63	0.068	64	0.995
Choke Canyon Reservoir	13019	2116	12.0	32	0.064	35	
Country Club Lake	11792	1209			0.977	17	
Cox Lake	12514	2454	14.77	22	0.462	23	
Diversion Lake	10157	0215	10.3	35	0.043	33	
E.V. Spence Reservoir	12359	1411	9.94	44	0.025	48	
Eagle Mountain Reservoir	10945	0809	14.83	122	0.067	126	
Ellison Creek Reservoir	14473	0404	5.77	11	0.032	11	
Falcon Lake	13189	2303	11.23	50	0.046	60	
Farmers Creek Reservoir	10139	0210	6.1	42	0.037	34	
Fin Feather Lake	11798	1209	16.83	16	0.750	20	
Granger Lake	12095	1247	7.53	29	0.051	31	
Grapevine Lake	16113	0826	11.91	3		89	
Greenbelt Reservoir	10173	0223	3.78	86	0.025	50	
Houston County Lake	10973	0813	10.2	52	0.033	26	
Hubbard Creek Reservoir	12002	1233	5.5	30	0.091	28	0.719
Inks Lake	12336	1407	11.7	182	0.033	205	0.699
Joe Pool Lake	11073	0838	3.38	14	0.026	18	
Lake Amon G. Carter	11063	0834	9.7	32	0.072	32	
Lake Arlington	11040	0828	15.00	40	0.039	100	
Lake Arrowhead	10142	0212	10.19	40	0.146	41	
Lake Austin	12294	1403	4.05	256	0.029	258	
Lake Bob Sandlin	10329	0408	8.0	20	0.034	20	
Lake Bridgeport	10970	0811	6.3	87	0.044	88	0.468
Lake Brownwood	12395	1418	4.94	47	0.021	49	

Lake Name	Site ID	Segment No.	Chl criteria		TP criteria		TN criteria (mg/L)
			(µg/L)	Count	(mg/L)	Count	
Lake Buchanan	12344	1408	7.5	182	0.043	213	0.637
Lake Cherokee	10445	0510	8.23	31	0.057	29	
Lake Cisco	12005	1234	2.9	37	0.019	36	
Lake Coleman	12398	1419	6.08	44	0.019	43	
Lake Colorado City	12167	1412	15.71	52	0.046	54	
Lake Conroe	11342	1012	18.77	43	0.052	102	
Lake Corpus Christi	12967	2103	14.6	80	0.190	85	
Lake Crook	10137	0208	6.80	32	0.246	32	
Lake Cypress Springs	10312	0405	11.5	33	0.040	33	
Lake Fork Reservoir	10458	0512	13.63	118	0.039	103	
Lake Fort Phantom Hill	12010	1236	8.48	50	0.066	53	
Lake Georgetown	12111	1249	5.1	31	0.032	35	0.788
Lake Graham	11979	1231	5.41	29	0.083	29	
Lake Granbury	11860	1205	11.60	34	0.035	37	
Lake Houston	11204	1002	8.85	49	0.208	81	
Lake Jacksonville	10639	0614	4.6	58	0.019	56	
Lake Kemp	10159	0217	8.37	50	0.043	50	
Lake Kickapoo	10143	0213	6.06	32	0.089	32	
Lake Lavon	11020	0821	10.31	51	0.075	53	
Lake Limestone	12123	1252	18.5	26	0.044	23	0.958
Lake Livingston	10899	0803	24.95	210	0.178	378	
Lake Lyndon B. Johnson	12324	1406	8.02	205	0.053	209	0.769
Lake Mackenzie	10188	0228	4.85	73	0.027	76	
Lake Marble Falls	12319	1405	8.6	177	0.036	207	0.592
Lake Meredith	10036	0102	3.56	92	0.050	94	
Lake Mexia	14238	1210	26.38	26	0.221	24	
Lake Murvaul	10444	0509	33.	54	0.073	49	
Lake Nasworthy	12418	1422	18.07	76	0.051	75	
Lake O'The Pines	10296	0403	11.21	91	0.079	91	
Lake Palestine	16159	0605	15.57	70	0.031	130	
Lake Palo Pinto	11977	1230	5.1	31	0.080	29	
Lake Ray Roberts	11075	0840				61	0.929
Lake Stamford	12006	1235	15.65	63	0.068	40	
Lake Sweetwater	12021	1237	18.11	40	0.040	31	
Lake Tanglewood	10192	0229	30.38	29	1.468	167	
Lake Tawakoni	10434	0507	17.89	176	0.058	17	
Lake Texana	12529	1604	4.78	15	0.227	37	1.259
Lake Texoma	10128	0203	10.01	39	0.065	202	
Lake Theo	10079		2.00	3		43	
Lake Travis	12302	1404	4.1	186	0.048	54	0.426
Lake Tyler	10637	0613	7.9	58	0.035	54	
Lake Tyler Midlake east	10638	0613			0.040	63	
Lake Waco	11942	1225	9.85	64	0.094	135	
Lake Waxahachie	10980	0816	6.06	40	0.053	41	
Lake Weatherford	11061	0832	10.93	38	0.059	36	

Lake Name	Site ID	Segment No.	Chl criteria (µg/L)	Count	TP criteria (mg/L)	Count	TN criteria (mg/L)
Lake Whitney	11851	1203	7.20	49	0.021	51	
Lake Wichita	10163	0219	42.50	18	0.182	21	
Lake Worth	10942	0807	17.20	45	0.050	43	
Leon Reservoir	11939	1224	9.06	45	0.034	47	
Lewisville Lake	11027	0823	17.11	39	0.079	53	
Medina Lake	12826	1904	4.0	67	0.027	71	0.320
Millers Creek Reservoir	11679		18.48	38	0.175	40	
Navarro Mills Reservoir	10981	0817	12.25	42	0.065	41	
O.C. Fisher Reservoir	12429	1425	27.2	48	0.089	48	
O.H. Ivie Reservoir	12511	1433	8.87	17	0.035	16	
Oak Creek Reservoir	12180		6.11	29	0.033	31	
Palo Duro Reservoir	10005	0199	17.51	20	0.266	20	
Pat Cleburne Reservoir	11974	1228	12.65	27	0.149	28	
Pat Mayse Reservoir	10138	0209	13.36	40	0.055	40	
Possum Kingdom Reservoir	11865	1207	6.35	31	0.059	33	
Proctor Lake	11935	1222	29.58	54	0.063	55	
Red Bluff Reservoir	13267	2312	20.3	71	0.044	72	
Richland-Chambers Reservoir	15168	0836	15.03	63	0.037	63	
Sam Rayburn Reservoir	14906	0610	4.32	25	0.097	128	
Somerville Lake	11881	1212	30.10	47	0.061	50	
Stillhouse Hollow Lake	11894	1216	1.9	42	0.018	44	0.595
Toledo Bend Reservoir	10402	0504	9.51	167	0.040	162	
Town Lake	12476	1429	6.86	248	0.049	253	
Twin Buttes Reservoir	12422		12.92	48	0.051	53	
White River Lake	12027	1240	3.93	58	0.031	63	
White Rock Lake	11038	0827	31.78	32	0.103	32	
Wright Patman Lake	10213	0302	21.4	44	0.103	40	1.384

*Nutrient criteria were calculated for reservoirs using the formula in Moore & McCabe, Pooled two-sample *t* procedures. pp 542-549. *In* Introduction to the practice of statistics. W. H. Freeman and Company, New York. Degrees of freedom are (n_1+n_2-2). n_1 is the count of the baseline data, n_2 is always 10.

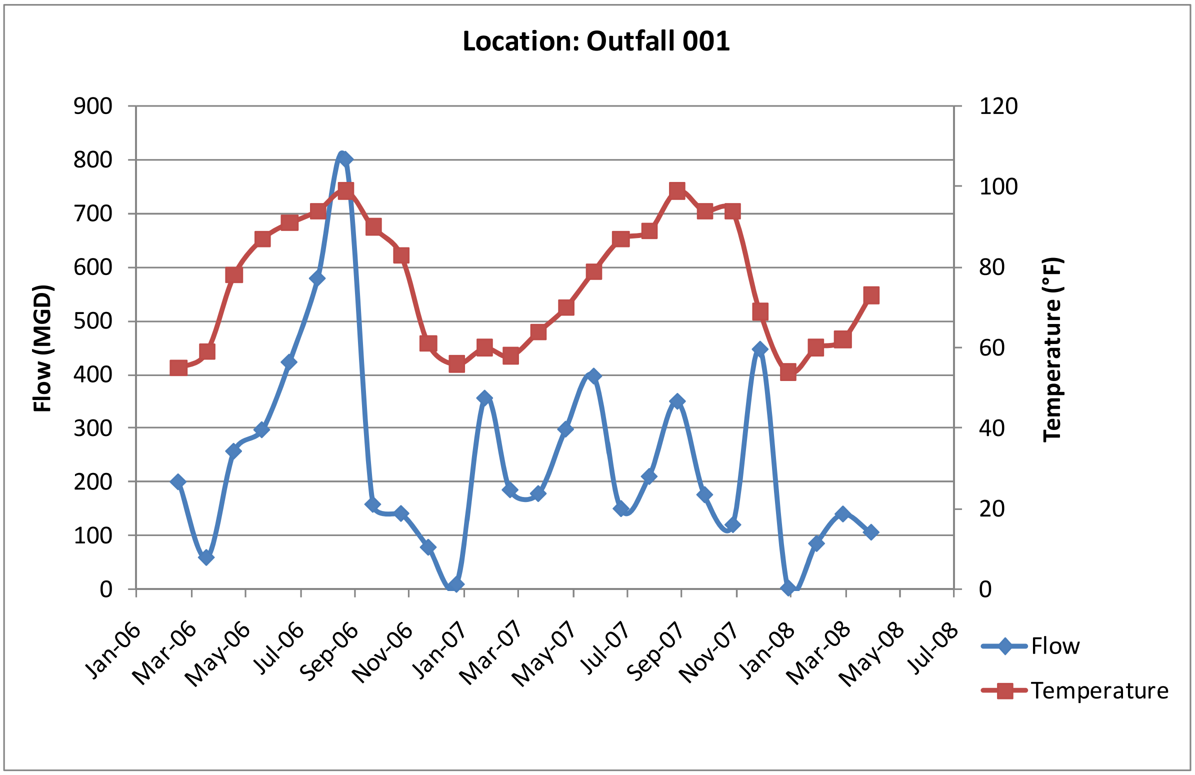
Appendix B. Reservoirs that would be excluded because of few data points for criteria development and would not be assessed because of fewer than 5 data points in the last 5 years of sampling. Shaded reservoirs meet both conditions.

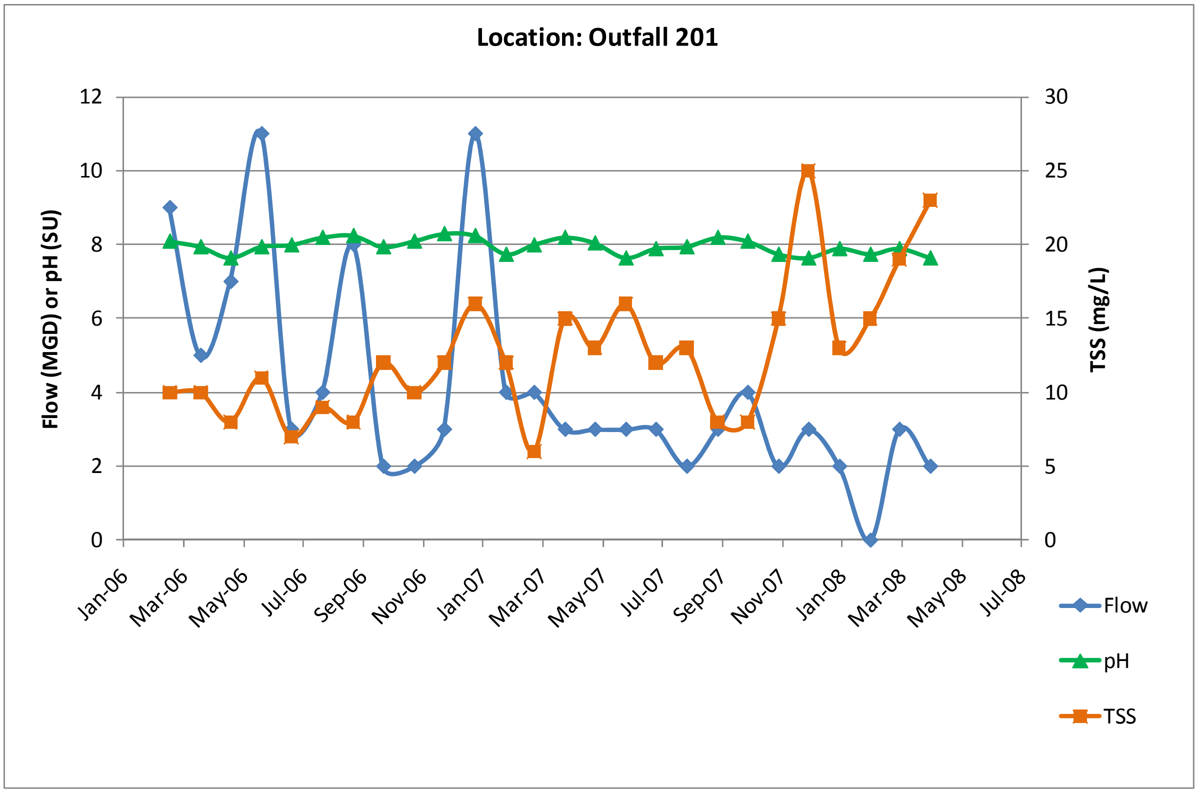
Reservoir	No. of data points	Less than 5 data points
Aquilla Reservoir	34	
B. A. Steinhagen Reservoir	26	
Brady Creek Reservoir	29	Brady Creek Reservoir
Choke Canyon Reservoir	32	Buffalo Springs
Cox Lake	22	
Diversion Lake	34	
Ellison Creek Reservoir	11	Ellison Creek Reservoir
Fin Feather Lake	16	Falcon Lake
Granger Lake	29	Fort Phantom Hill
Grapevine Lake	3	Grapevine Lake
Hubbard Creek Reservoir	30	
Joe Pool Lake	14	Joe Pool Lake
Lake Amon G. Carter	30	Lake Arlington
Lake Bob Sandlin	20	
Lake Cherokee	31	Lake Cherokee
Lake Cisco	35	Lake Colorado
		Lake Conroe
Lake Crook	32	Lake Crook
Lake Cypress Springs	32	Lake Kickapoo
Lake Georgetown	30	Lake Lavon
Lake Graham	29	
Lake Granbury	34	
Lake Kickapoo	32	
Lake Limestone	25	Lake Limestone
Lake Mexia	26	Lake Sweetwater
Lake Palo Pinto	30	
Lake Tanglewood	29	
Lake Texana	15	Lake Texana
Lake Theo	3	Lake Texoma
		Lake Whitney
Lake Wichita	18	Lake Wichita
O.H. Ivie Reservoir	17	Millers Creek
Oak Creek Reservoir	29	
Palo Duro Reservoir	20	
Pat Cleburne Reservoir	27	Pat Cleburne Reservoir
		Pat Mayse
Possum Kingdom Reservoir*	31	Possum Kingdom Reservoir
Sam Rayburn Reservoir*	25	
White Rock Lake	32	White Rock Lake

Attachment 4: Handley Power Plant Data

Summary Water Quality -Regional Discharge Compliance Monitoring Report

Parameter	Outfall 001			Outfall 201		
	Minimum	Average	Maximum	Minimum	Average	Maximum
Flow, MGD	10.6	235.2	601.1	2.8	4.1	5.9
Temperature, °F	72.8	75.9	80. 7	82	86	94
pH, SU	N.A.	N.A.	N.A.	7.7	7.9	8.2
TSS, mg/L	N.A.	N.A.	N.A.	4	12.4	20.1




Location: Outfall 201
Flow (MGD) or pH (SU)
TSS (mg/L)
12
10
8
6
4
2
0
30
25
20
15
10
5
0
Jan-06
Mar-06
May-06
Jul-06
Sep-06
Nov-06
Jan-07
Mar-07
May-07
Jul-07
Sep-07
Nov-07
Jan-08
Mar-08
May-08
Jul-08
Flow
pH
TSS

Compliance Data for Discharge Location Outfall 001

Pollutants	Units	Average	MAL
BOD (5-day)	mg/L	2.5	
CBOD (5-day)	mg/L	1.4	
Chemical Oxygen Demand	mg/L	< 25	
Total Organic Carbon	mg/L	6.3	
Dissolved Oxygen	mg/L	7.67	
Ammonia Nitrogen	mg/L	0.32	
Total Suspended Solids	mg/L	9.5	
Nitrate Nitrogen	mg/L	0.24	
Total Organic Nitrogen	mg/L	0.96	
Total Phosphorus	mg/L	< 0.25	
Oil and Grease	mg/L	< 6.0	
Total Residual Chlorine	mg/L	0	
Total Dissolved Solids	mg/L	188	
Sulfate	mg/L	36.8	
Chloride	mg/L	22.75	
Fluoride	mg/L	0.3	
Temperature	°F	54.3	
pH (min/max)	Standard Units	8.39/6.41	
Total Aluminum	µg/L	222	30
Total Antimony	µg/L	< 10	60
Total Arsenic	µg/L	< 10	10
Total Barium	µg/L	59	10
Total Beryllium	µg/L	< 5	5
Total Cadmium	µg/L	< 1	1
Total Chromium	µg/L	< 1	10
Trivalent Chromium	µg/L	< 10	NA
Hexavalent Chromium	µg/L	< 10	10
Total Copper	µg/L	< 5	19
Cyanide	µg/L	< 20	20
Total Lead	µg/L	< 5	5
Total Mercury	µg/L	< 0.2	0.2
Total Nickel	µg/L	< 5.0	10
Total Selenium	µg/L	< 10	10
Total Silver	µg/L	< 2.0	2
Total Thallium	µg/L	< 10	10
Total Zinc	µg/L	4	5
Fluoride	µg/L	0.3	500
Bromide	µg/L	Absent	

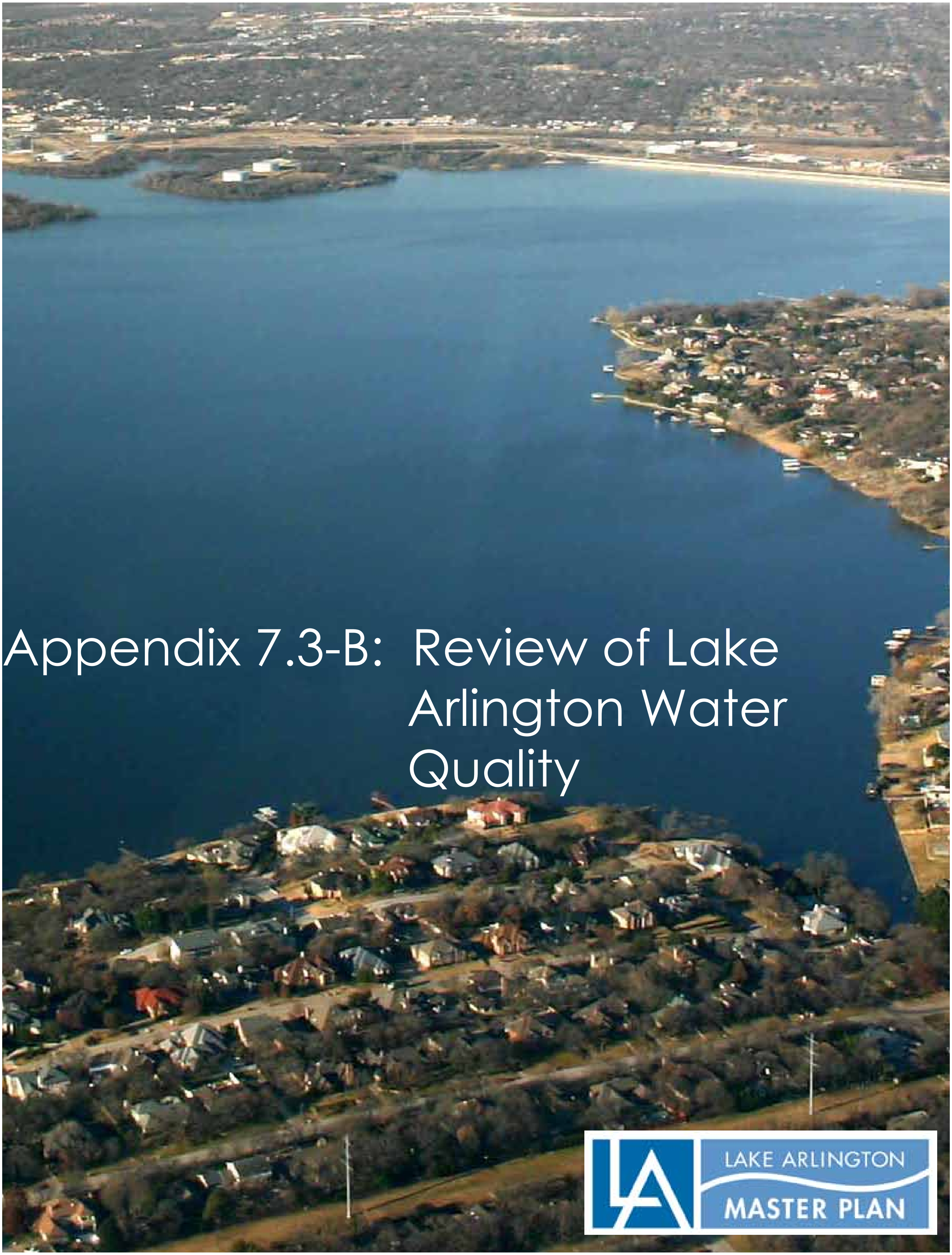
Pollutants	Units	Average	MAL
Color	CPU	Absent	
Nitrate-Nitrite(as N)	mg/L	Absent	
Sulfide(as S)	mg/L	Absent	
Sulfite(as SO3)	mg/L	Absent	
Surfactants	mg/L	Absent	
Total Antimony	mg/L	Absent	
Total Beryllium	mg/L	Absent	
Total Boron	mg/L	Absent	
Total Cobalt	mg/L	Absent	
Total Iron	mg/L	0.36	
Total Magnesium	mg/L	4.9	
Total Molybdenum	mg/L	Absent	
Total Manganese	mg/L	0.96	
Total Thallium	mg/L	Absent	
Total Tin	mg/L	Absent	
Total Titanium	mg/L	Absent	
Organic Pollutants			
Benzene	µg/L	< 2	10
Benzidine	µg/L	< 10	50
Benzo(a)anthracene	µg/L	< 10	10
Benzo(a)pyrene	µg/L	< 10	10
Carbon Tetrachloride	µg/L	< 2	10
Chlorobenzene	µg/L	< 2	10
Chloroform	µg/L	< 2	10
Chrysene	µg/L	< 10	10
Cresols (*2)	µg/L	< 10	
Dibromochloromethane	µg/L	< 2	10
1,2-Dibromoethane	µg/L	< 2	2
1,4-Dichlorobenzene	µg/L	< 10	10
1,2-Dichloroethane	µg/L	< 2	10
1,1-Dichloroethylene	µg/L	< 2	10
Hexachlorobenzene	µg/L	< 10	10
Hexachlorobutadiene	µg/L	< 10	10
Hexachloroethane	µg/L	< 10	20
Methyl Ethyl Ketone	µg/L	< 10	50
Nitrobenzene	µg/L	< 10	10
n-Nitrosodiethylamine	µg/L	< 10	20
n-Nitroso-di-n-Butylamine	µg/L	< 10	20
PCB’s, Total (*3)	µg/L	< 0.25	1
Pentachlorobenzene	µg/L	< 10	20

Pollutants	Units	Average	MAL
Pentachlorophenol	µg/L	< 1.9	50
Phenanthrene	µg/L	< 10	10
Pyridine	µg/L	< 10	20
1,2,4,5-Tetrachlorobenzene	µg/L	< 10	20
Tetrachloroethylene	µg/L	< 2	10
Trichloroethylene	µg/L	< 2	10
1,1,1-Trichloroethane	µg/L	< 2	10
2,4,5-Trichlorophenol	µg/L	< 10	50
TTHM (Total Trihalmethanes)	µg/L	< 10	10
Vinyl Chloride	µg/L	< 2	10
Tributyltin			0.01
VOLATILE COMPOUNDS			
Acrolein	µg/L	< 5	50
Acrylonitrile	µg/L	< 2	50
Benzene	µg/L	< 2	10
Bromoform	µg/L	< 2	10
Carbon Tetrachloride	µg/L	< 2	10
Chlorobenzene	µg/L	< 2	10
Chlorodibromomethane	µg/L	< 2	10
Chloroethane	µg/L	< 2	50
2-Chloroethylvinyl Ether	µg/L	< 2	10
Chloroform	µg/L	< 2	10
Dichlorobromomethane	µg/L	< 5	10
1,1-Dichloroethane	µg/L	< 2	10
1,2-Dichloroethane	µg/L	< 2	10
1,1-Dichloroethylene	µg/L	< 2	10
1,2-Dichloropropane	µg/L	< 2	10
1,3-Dichloropropylene	µg/L	< 2	10
Ethylbenzene	µg/L	< 2	10
Methyl Bromide	µg/L	< 2	50
Methyl Chloride	µg/L	< 2	50
Methylene Chloride	µg/L	< 2	20
1,1,2,2-Tetrachloroethane	µg/L	< 2	10
Tetrachloroethylene	µg/L	< 2	10
Toluene	µg/L	< 2	10
1,2-Trans-Dichloroethylene	µg/L	< 2	10
1,1,1-Trichloroethane	µg/L	< 2	10
1,1,2-Trichloroethane	µg/L	< 2	10
Trichloroethylene	µg/L	< 2	10
Vinyl Chloride	µg/L	< 2	10

Pollutants	Units	Average	MAL
ACID COMPOUNDS			
2-Chlorophenol	µg/L	< 1.8	10
2,4-Dichlorophenol	µg/L	< 2.2	10
2,4-Dimethylphenol	µg/L	< 1.8	10
4,6-Dinitro-o-Cresol	µg/L	< 2.2	50
2,4-Dinitrophenol	µg/L	< 1.2	50
2-Nitrophenol	µg/L	< 2.1	20
4-Nitrophenol	µg/L	< 1.4	50
P-Chloro-m-Cresol	µg/L	< 1.8	10
Pentalchlorophenol	µg/L	< 1.9	50
Phenol	µg/L	< 0.95	10
2,4,6-Trichlorophenol	µg/L	< 2.2	10
BASE/NEUTRAL COMPOUNDS			
Benzidine	µg/L	< 10	50
Chrysene	µg/L	< 10	10
1,4-Dichlorobenzene	µg/L	< 10	10
Hexachlorobenzene	µg/L	< 10	10
Hexachlorobutadiene	µg/L	< 10	10
Hexachloroethane	µg/L	< 10	20
Nitrobenzene	µg/L	< 10	10
Phenanthrene	µg/L	< 10	10
PESTICIDES			
Aldrin	µg/L	Absent	0.05
alpha-BHC	µg/L	Absent	0.05
beta-BHC	µg/L	Absent	0.05
gamma-BHC	µg/L	Absent	0.05
delta-BHC	µg/L	Absent	0.05
Chlordane	µg/L	Absent	0.15
4,4-DDT	µg/L	Absent	0.1
4,4-DDE	µg/L	Absent	0.1
Dieldrin	µg/L	Absent	0.1
alpha-Endosulfan	µg/L	Absent	0.1
beta-Endosulfan	µg/L	Absent	0.1
Endosulfan Sulfate	µg/L	Absent	0.1
Endrin	µg/L	Absent	0.1
Endrin Aldehyde	µg/L	Absent	0.1
Heptachlor	µg/L	Absent	0.05
Heptachlor Epoxide	µg/L	Absent	
PCB-1254	µg/L	Absent	1
PCB-1221	µg/L	Absent	1

Pollutants	Units	Average	MAL
PCB-1242	µg/L	Absent	
PCB-1232	µg/L	Absent	1
PCB-1248	µg/L	Absent	1
PCB-1260	µg/L	Absent	1
PCB-1016	µg/L	Absent	1
Toxaphene	µg/L	Absent	5

Appendix 7.3-B: Review of Lake Arlington Water Quality



LAKE ARLINGTON
MASTER PLAN

Table CG-1: Lake Arlington Raw Water Quality at the Pierce-Bush WTP Intake[5]

Parameter	MCL(2)	SMCL (2)	Detection Frequency	Average	Minimum	Maximum
pH, S.U	NR	> 7	135 samples	8.0	6.9	8.7
Temperature, deg. Celcius	NR	-	105 samples(3)	23	5	39
Total Alkalinity, mg/L as $CaCO_3$	NR	-	42 samples	94	76	114
Hardness, mg/L as $CaCO_3$	NR	-	14 samples(4)	109	91	150
Calcium, mg/L	NR	-	70 samples(4)	38	28	48
Magnesium, mg/L	NR	-	78 samples(4)	4.4	3.4	6.6
Total Dissolved Solids, mg/L	-	1,000	14 samples(4)	168	140	243
Specific Conductivity (µS/cm)	NR	-	135 samples	315	274	462
Chloride, mg/L	-	300(2)	42 samples	17.9	13.2	23.2
Sodium, mg/L	NR	-	78 samples(4)	18.3	5.7	27.4
Sulfate, mg/L	-	300(2)	39 samples	34.6	23.6	54.0
Total Organic Carbon, mg/L	35% removal(5)	-	20 samples	5.7	4.3	7.5
Dissolved Organic Carbon, mg/L	NR	-	34 samples	4.8	3.5	6.1
Microbial Characteristics						
Chlorophyll a, µg/L	NR	-	40 of 41 samples	37.5	5.0	91.4
E.coli, MPN/100mL	absence	-	32 of 41 samples	14.8	1.0	100.0
Fecal coliform, colonies/100 mL	absence	-	14 of 15 samples(4)	25	1	68
Cryptosporidium, #/10 L	(6)	-	23 of 23 samples(7)	ND	ND	ND
Nutrients						
Total Ammonia-N, mg/L	NR	-	83 samples(4)	0.08	0.02	1.10
Nitrate, mg/L	10	-	4 samples(4)	0.28	0.03	0.37
Phosphorus (total), mg/L	NR	-	83 samples(4)	0.07	0.03	0.25
Inorganic Compounds						
Iron, mg/L	-	0.3(2)	39 samples	0.35	0.14	1.27
Manganese, mg/L	-	0.05(2)	39 samples	0.09	0.04	0.81
Arsenic (µg/L)	10	-	14 of 39 samples	4.2	1.4	6.0

NR – Not regulated; ND - Non-detect

Note: The water quality data listed are for source water samples. The MCL and SMCL values only apply to finished water and are listed for reference only.

(1) TCEQ SWQMIS data collected from USGS Site AC, ID 324304097113601. Average, minimum, and maximum values are for samples collected between August 10, 2005 and November 12, 2008.

(2) The water testing results listed are source water levels and only apply to treated water. They are listed for reference only as

source water areas of potential water quality concern.

(3) Data collected from USGS Site Mid Lake. Average, minimum, and maximum values are for samples collected between July 8, 1982 and September 8, 1986.

(4) Average, minimum, and maximum values are for samples collected from USGS Site AC, ID 324304097113601 between December 30, 1992 and May 12, 2005.

(5) Under the Disinfectant/Disinfectant By-Product Rule (D/DBPR), an average percent removal of TOC that would be required is 35% based on the average raw water alkalinity between 60 and 120 mg/L as CaCO¬3 and the average TOC concentration between 4 and 8 mg/L.

(6) *Cryptosporidium* are regulated under the Long-Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) with log removal requirements based on the number of oocysts detected during LT2ESWTR compliance monitoring.

(7) Samples collected at Lake Arlington intake between January 6, 2009 and November 1, 2010.

Table CG-2: Finished Water Organic Compounds[5]

Compound	MCL (μg/L)	Detection Frequency	Finished Water		
			Minimum (μg/L)	Average (μg/L)	Maximum (μg/L)
1,2,4-Trichlorobenzene	70	15 of 17 samples	0	0.06	0.23
Atrazine	3	12 of 12 samples	0.15	0.31	0.61
Di(2-ethylhexyl) adipate	400	11 of 12 samples	0.03	0.05	0.1
Di(2-ethylhexyl)phthalate	6	12 of 12 samples	0.09	0.59	1.26
Bromodichloromethane	80(2)	12 of 17 samples	0	2.87	6.01
Bromoform	80(2)	12 of 17 samples	0	0.95	1.38
Carbon Tetrachloride	5	3 of 17 samples	0	0.07	0.25
Chlorodibromomethane	80(2)	12 of 17 samples	0	2.86	4.57
Chloroform	80(2)	12 of 17 samples	0	1.79	5.49
Dichloromethane	5	3 of 17 samples	0	0.41	1.94
Methoxychlor	40	1 of 12 samples	0.01	0.01	0.01
Metolachlor	NR	2 of 12 samples	0.01	0.01	0.02
Simazine	4	4 of 12 samples	0	0.06	0.15
Styrene	10	1 of 17 samples	0	0.02	0.09
Toluene	1,000	4 of 17 samples	0	0.10	0.25
Vinyl Chloride	2	3 of 17 samples	0	0.06	0.14
Xylenes (Total)	10,000	1 of 17 samples	0	0.08	0.39

NR – Not regulated

(1) Tap water samples collected in 2007-2009 at the Pierce-Burch WTP.

(2) These compounds belong to the group of Total Trihalomethanes (TTHMs). The combined MCL for the TTHM is 80 ug/L.

Table CG-3: Average Water Quality in the Middle of Lake Arlington at the South, Central, and Northern Portions of the Reservoir

Parameter	Mid Lake 1[(2)] (Northern Portion)	Mid Lake 2[(2)] (Central Portion)	Mid Lake 3[(2)] (Southern Portion)
Transparency, Secchi Disc (inches)	32	22	24
Transparency, Secchi Disc (meters)	0.84	0.78	0.60
Turbidity, NTU	7.8	8.8	10.8
Temperature	22.6	21.5	22.9
pH	7.9	8.0	8.3
Hardness	110	113	102
Chloride, mg/L	22	18	NS
Sulfate, mg/L	28.1	29.3	23.5
Specific Conductivity, µS/cm (Field)	337	313	283
Specific Conductance (Lab)	319	315	294
Total Organic Carbon, mg/L	6.6	5.6	NS
Dissolved Organic Carbon, mg/L	NS	5.0	NS
E.coli, MPN/100mL	NS	39	NS
Total Coliform	83	NS	NS
Fecal coliform	36	39	48
Chlorophyll-A, µg/L	11.9	32.4	NS
Total Ammonia-N, mg/L	0.12	0.03	2.55
Nitrate, mg/L	0.08	0.08	0.15
Phosphorus (total), mg/L	0.048	0.062	NS
Arsenic, µg/L	2.9	5.3	4.9
Iron, µg/L	443	494	554
Manganese, µg/L	57	37	75
2,4-D, µg/L	0.24	0.37	0.57
Endrin, µg/L	BDL	NS	BDL
Lindane, µg/L	BDL	NS	BDL
Methoxychlor, µg/L	BDL	NS	BDL
Silvex, µg/L	0.11	0.04	0.06

NS- Not sampled; BDL – below detection limit

(1) Number of samples varies for the different parameters. TCEQ SWQMIS data reviewed for this table includes samples collected from 1971 to 2008.

(2) See Figure CG-1.

Figure CG-1: Lake Arlington SWQMIS Monitoring Sites

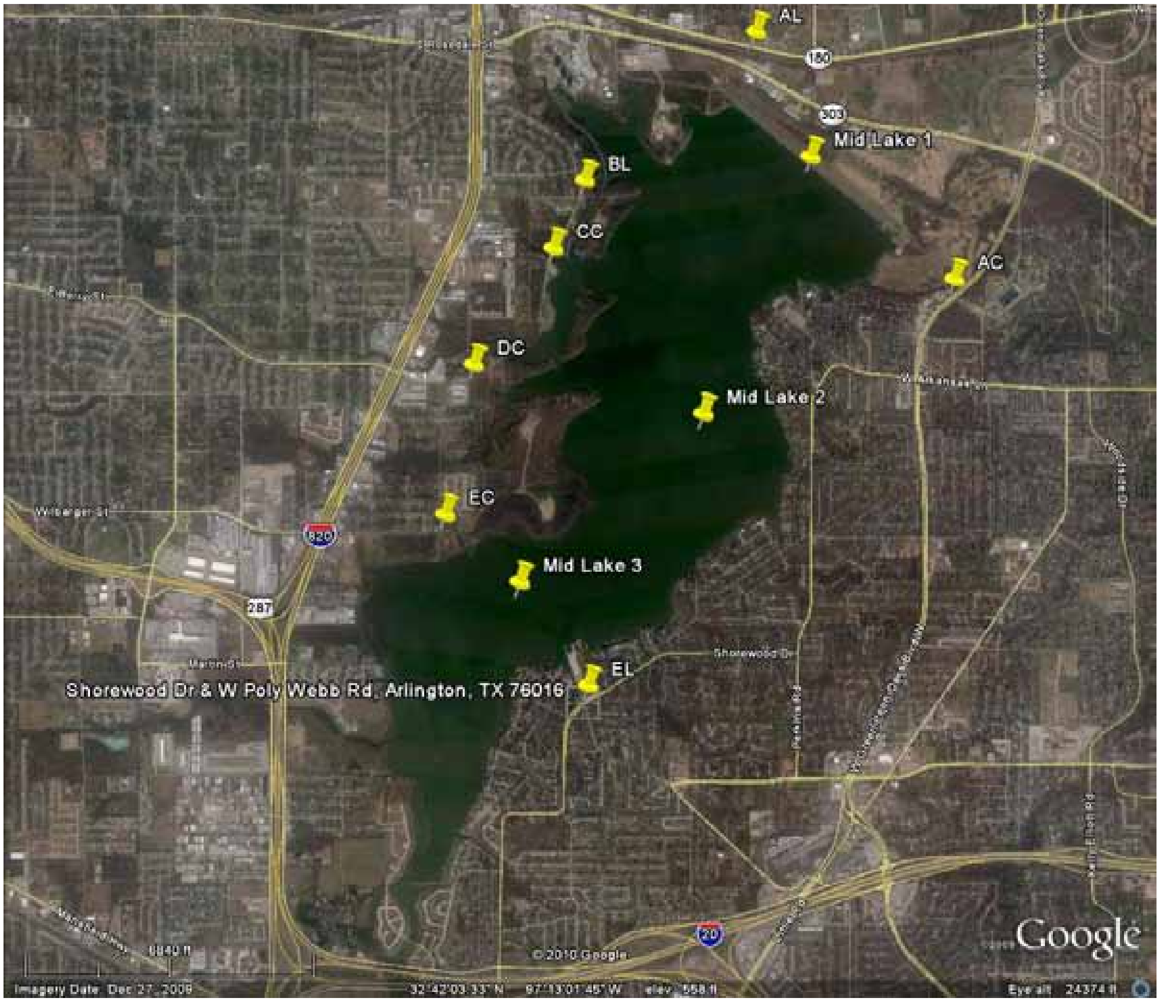


Figure CG-2: Temperature and Geosmin Concentrations (Source: samples collected at the Lake Arlington intake between November 2007 and March 2008)

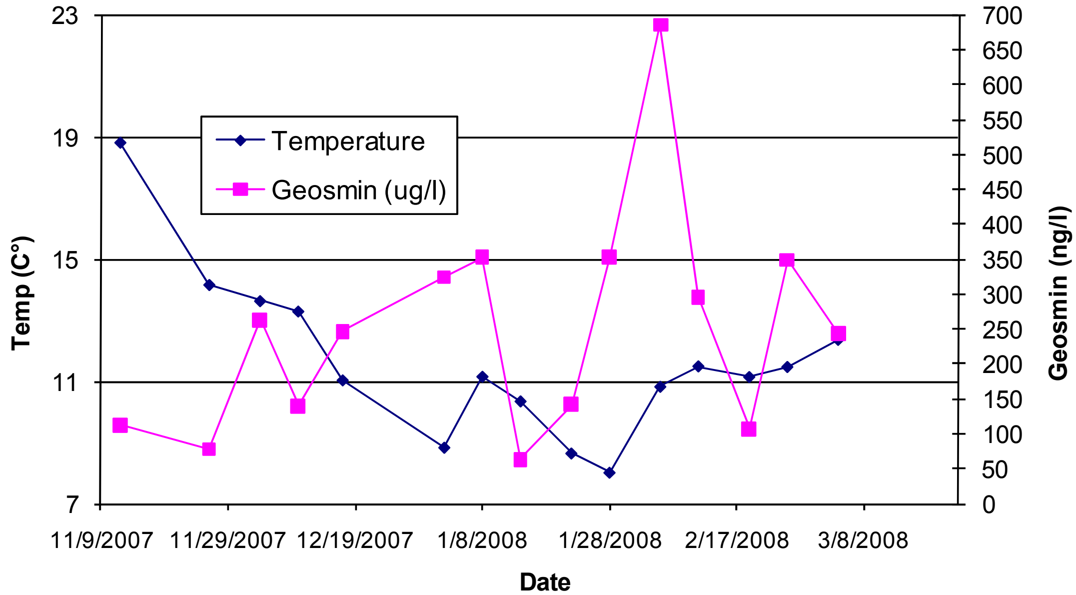
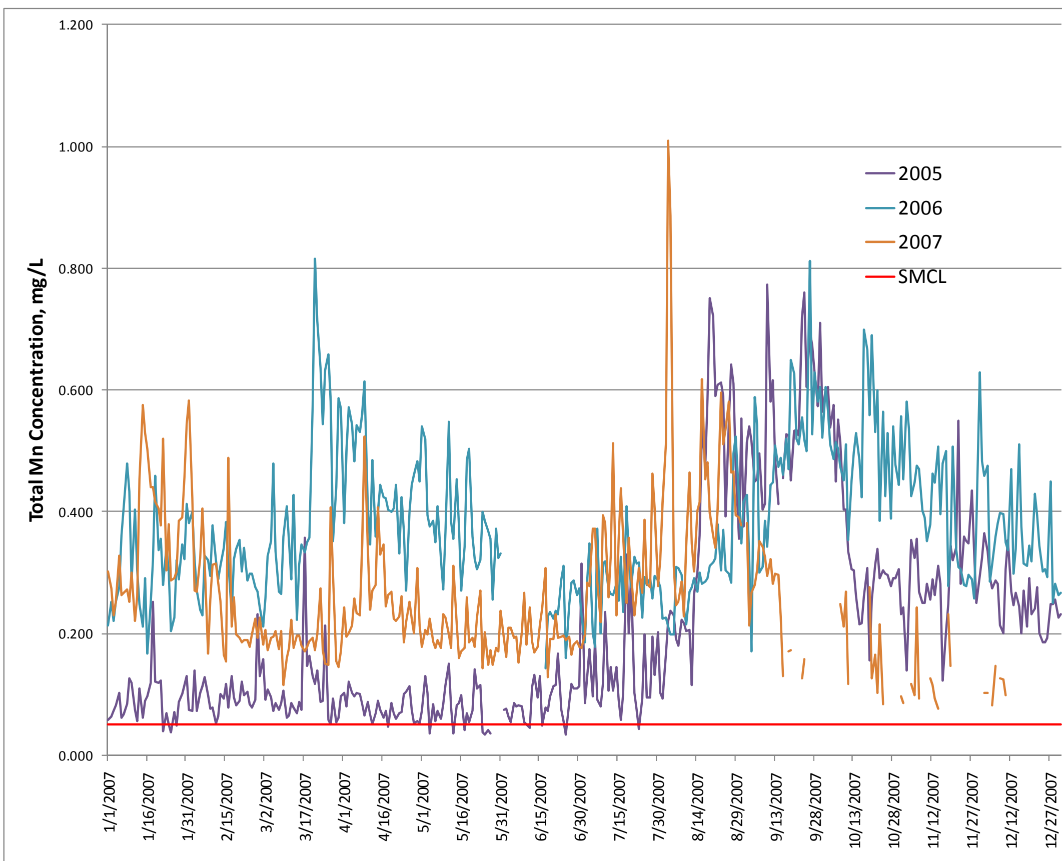
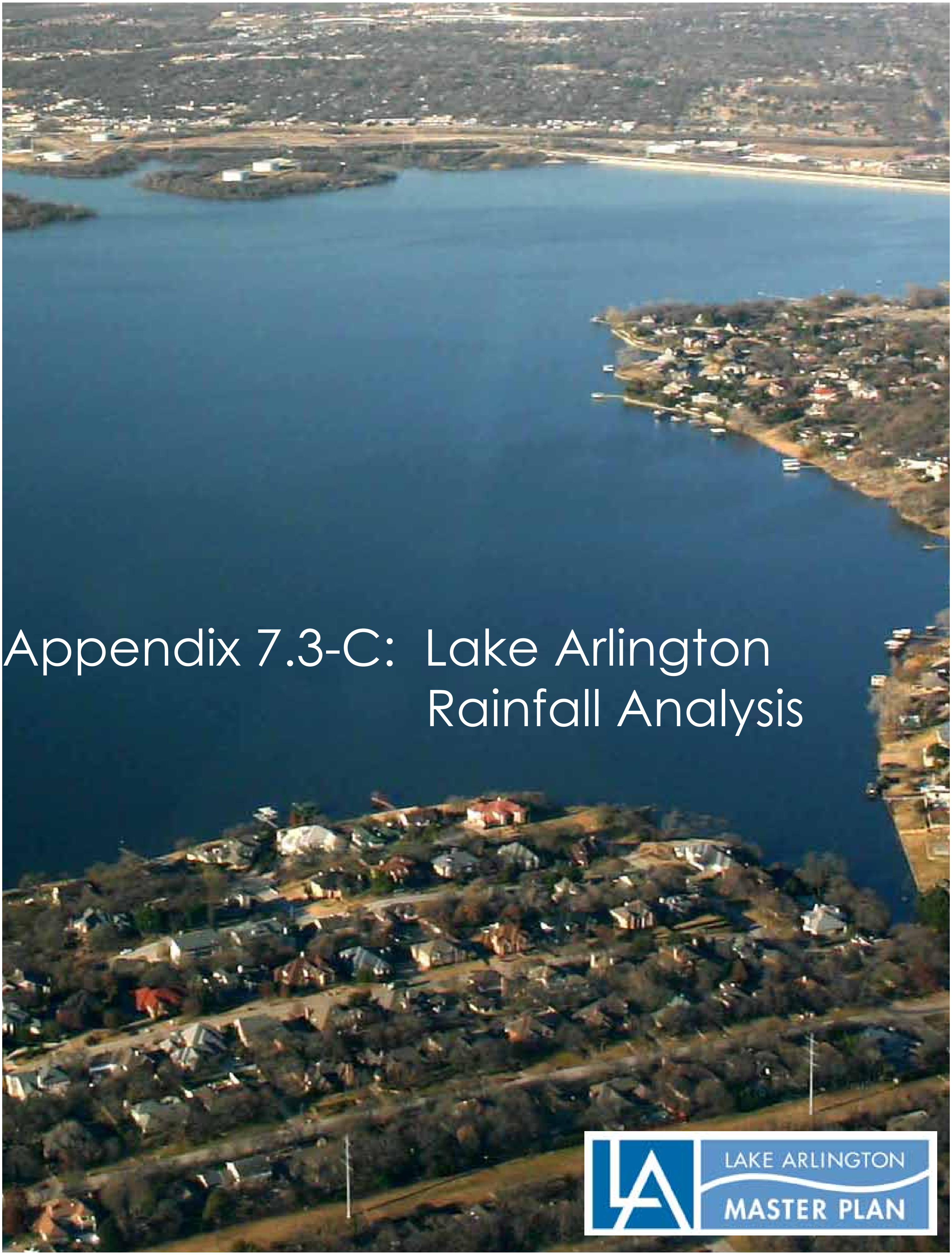


Figure CG-3: Total Manganese Concentrations in Lake Arlington Water





Appendix 7.3-C: Lake Arlington Rainfall Analysis

Date:	September 13, 2010
To:	Fred Blumberg (AUS)
From:	Brian Ruggs, P.E., (BIR)
Re:	Lake Arlington Rainfall Analysis
Project No:	3498011

Introduction

As part of the Master Plan development for Lake Arlington, the sensitivity of the receiving streams and Lake Arlington to future development and associated pollutant loads is tested using a screening level model. The screening level evaluation tool chosen for this project is the PLOAD model. One of the input parameters required for the PLOAD model is annual rainfall depth for the watershed to be modeled. Use of local rainfall data is required because local rainfall patterns influence the runoff water quantity and quality, as well as the design of water treatment facilities. In absence of local data, it is common practice to depend on data from the region of interest. A typical approach would be to assess long-term data from the project site's region to predict rainfall patterns for the site.

For this project, 34 years of rainfall data were assessed for temporal trends and average annual rainfall depth. Although daily rainfall data are not used as an input into this master planning-level model (PLOAD), such data are evaluated subjectively as part of the sensitivity analysis and the quality control/quality assurance process.

This technical memorandum summarizes the local rainfall data analysis and estimation of rainfall depths used for developing the PLOAD model for the Lake Arlington watershed.

Rain Gage Information

To achieve the goals of the analysis, it was desired that the selected precipitation gauge data be located near the study area to ensure that long-term rainfall records closely resemble the anticipated rainfall patterns for the watershed. The National Weather Service (NWS) weather station at the Dallas-Fort Worth International Airport is in the proximity of the Lake Arlington watershed and data from this gauge are expected to represent the rainfall patterns near Lake Arlington.

At the present time the Lake Arlington watershed is characterized by both urban and rural land uses, and the watershed is located in a metropolitan area. The Dallas-Fort Worth Airport is located approximately 22 miles northeast of the study area and is centrally located in the metropolitan area. While land use patterns such as urban versus rural lands may affect the meteorological conditions of an area, the magnitude of this effect is typically significant only if the meteorological condition is measured at a considerably long distance from the watershed being modeled. Also, the difference in meteorological patterns will be more significant when comparing an urban area with high rise buildings versus open lands or forest lands that are a long distance from the urban area. That is not the case in this modeling effort.

The Dallas-Fort Worth Metroplex is located in North Central Texas, approximately 250 miles north of the Gulf of Mexico. This station has been in operation at the location from August 1974 to present. Table 1 summarizes pertinent information for this gage. Hourly rainfall data for this station was obtained from the National Oceanic and Atmospheric Administration (NOAA). Data are available online at http://www.ncdc.noaa.gov/oa/climate/climatedata.html, for the years 1975 to 2010. Complete annual data are available for the years 1976 to 2009.

Table 1. Dallas-Fort Worth International Airport Precipitation Gage Information

Date Began	Date Ended	Lat/Lon	Elevation meters/feet	COOP ID	WBAN	Call Sign	WMO ID	Type
1-Dec-95	Present	32°54'N / 97°01'W	170.7m / 560'	412242	3927	DFW	72259	LAND SURFACE COOP AB ASOS ASOS-NWS
1-Jul-91	1-Dec-95	32°54'N / 97°02'W	167.6m / 550'	412242	3927	DFW	72259	LAND SURFACE COOP AB WSCMO
1-Jan-90	1-Jul-91	32°54'N / 97°02'W	167.9m / 551'	412242	3927	DFW	72259	LAND SURFACE COOP WSCMO
1-Jan-82	1-Jan-90	32°54'N / 97°02'W	167.9m / 551'	412242	3927	DFW	72259	LAND SURFACE COOP WSMO
6-Mar-75	1-Jan-82	32°54'N / 97°02'W	167.9m / 551'	412242	3927	DFW	72259	LAND SURFACE COOP WSMO
14-Aug-74	6-Mar-75	32°54'N / 97°02'W	167.9m / 551'	.	3927	DFW	72259	LAND SURFACE WSMO

Monitored Data Analysis

This section describes the procedures used to analyze the rainfall records and the resulting rainfall statistics. The period of record to be used in this modeling effort included the years 1976 through 2009. Recorded data after 1996 has a data qualifier flag (T-trace amount"), and this flag is included if no rainfall values other than a trace amount occurred during the 24 hour period (NCDC, 1999). Rain that occurred in a day was considered an event for data analysis purposes. For the period of record, there were 3,128 rain events, including 466 events qualified as “T” with no measurable rainfall. For the purposes of validating the annual average rainfall data to be used in the PLOAD model, rainfall depths less than 0.1 inches were subtracted from the total. Such events usually do not produce any measurable runoff, unless they occur over a very short period of time. Reliable data over short intervals (for example, every 15 minutes) are not readily available and are not used in the model. After subtracting rainfall depths less than 0.1 inches, there were 1,757 rainfall events remaining in the 34-year record.

The percentage of occurrences (frequency) of rainfall events in specific depth ranges are shown in the Table 2, and this analysis includes trace amount ”T” data. As indicated by long term monitored data, 56% of the total rain events over a period of time will be producing runoff from the watershed. Figure 1 presents the cumulative frequency of the precipitation daily depths for the period of record. As expected, the smaller volume rainfall events are more frequent (smaller return period) and the larger storms are more infrequent (smaller number) and have a larger return period. Approximately 90% of the daily rainfall values for the period were equal to or less than 1.1 inches, and 44% of total daily rainfall events were below the minimum depth of 0.1 inches required to produce runoff.

Table 2. Percent of Daily Events for the Period by Precipitation Depth

Rain Depth (in)	Percent of Events
<0.1	44
0.10 - 0.29	20
0.30 - 0.59	14
0.60 -0.89	9
0.90 - 1.19	5
1.20 - 1.49	3
1.50 -1.79	2
1.80 - 2.09	1
2.10 - 2.5	1
> 2.5	1
Total	100

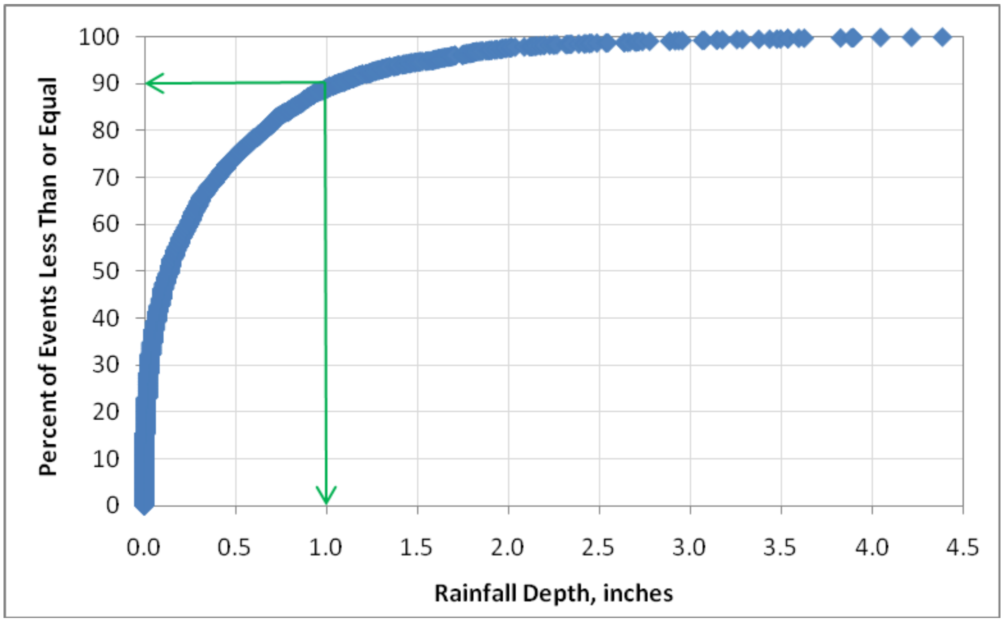


Figure 1. Cumulative Distribution of Daily Rainfall Events for the Data Period

Table 3 presents a summary of daily statistics for the period of record. The annual precipitation depths for the period calculated by Malcolm Pirnie were compared with the annual averages published on the NOAA website at http://www.srh.noaa.gov/fwd/?n=dmoprecip. For most of the years, the calculated annual precipitation depths matched the published data. For a few years the calculated annual rainfall differed by less than 1.0 inch. For the years 1996 and 1998 the calculated annual rainfall and the published data differed by more than 1.0 inch of rainfall. No specific reasons were identified for the difference, but the published data may have been subject to change in the NOAA review process. As a quality control method for this technical memorandum, recorded data for the years 1996 and 1998 were excluded in calculating the average annual precipitation depth for the Lake Arlington watershed.

The year 1980 had the lowest number of rainy days with 56, whereas 2007 had the highest number of rainy days with 142. For the period of analysis, the maximum recorded daily rainfall depth of 4.4 inches occurred in 2002. On average, there were 93 average days with recorded rainfall per year. The maximum annual rainfall of 52 inches occurred in 1991, and the lowest total annual rainfall of 19.0 inches occurred in 2005. The average annual rainfall for the period was calculated to be 35.2 inches. Figure 2 displays the annual total rainfall depths for the period of record.

Table 3. Summary Statistics of Long-Term Rainfall Data

Year	No. of Rainy Days	Max. Daily Rainfall (in)	Total Rainfall (in)	% of Events Producing Runoff	Average Dry Days Between Rain Events
1976	85	4.05	35.63	66	4
1977	67	3.89	27.19	63	5
1978	68	3.54	24.37	57	5
1979	85	1.99	32.42	65	4
1980	56	3.29	22.08	57	7
1981	82	3.63	44.60	70	4
1982	90	2.55	40.75	61	4
1983	73	2.89	31.07	73	5
1984	76	2.13	33.89	59	5
1985	69	1.77	30.68	70	5
1986	85	1.98	32.45	60	4
1987	89	2.92	26.78	57	4
1988	69	1.65	24.88	65	5
1989	74	3.38	39.95	59	5
1990	89	3.15	45.27	71	4
1991	92	4.22	53.45	78	4
1992	92	2.34	42.19	74	4
1993	84	2.15	32.83	63	4
1994	91	3.90	44.10	74	4
1995	73	3.50	35.39	70	5
1996	93	2.74	28.47	48	4
1997	123	3.26	44.84	46	3
1998	113	3.54	32.42	44	3

Year	No. of Rainy Days	Max. Daily Rainfall (in)	Total Rainfall (in)	% of Events Producing Runoff	Average Dry Days Between Rain Events
1999	91	1.59	23.60	45	4
2000	113	2.13	35.63	49	3
2001	120	3.83	38.14	53	3
2002	129	4.39	44.21	46	3
2003	105	2.67	24.53	43	3
2004	132	2.64	47.49	46	3
2005	97	1.60	18.97	35	4
2006	84	3.44	29.75	44	4
2007	142	3.90	50.05	48	3
2008	94	2.35	27.10	46	4
2009	125	3.60	40.89	43	3
Average	93	4.39	35.16*	57	4

* Data for the years 1996 and 1998 excluded in annual average rainfall calculations as part of data QA/QC

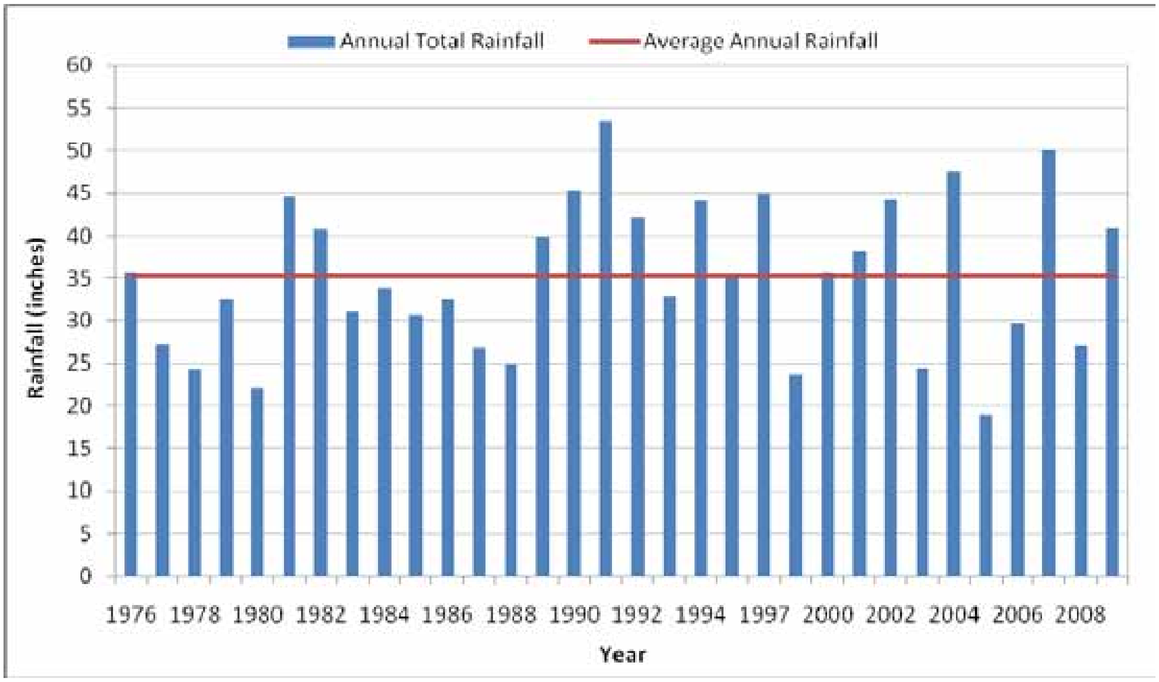


Figure 2. Annual Rainfall Depths Patterns for the Period of Data

90% Rain Events Capture

It is common practice to design water quality structures to treat runoff from small and medium-sized storms, but not attempt to fully treat larger, more infrequent storm events. "Percent capture" is defined as the percentage of the rainfall events fully treated by a stormwater best management practice (BMP). A recent regulatory trend is to base stormwater control requirements on the total volume of stormwater runoff from a site, rather than on runoff rates or a specific pollutant removal rate. This trend is based on a growing body of research that concludes that volume-based controls attain the concurrent benefits of pollutant reduction, peak flow reduction, and base flow protection.

Land cover change is generally expected to be from pervious to impervious for a development or re-development site. For the Lake Arlington watershed, one of the scenarios that will be analyzed in this master planning process is the requirement that new development and redevelopment maintain pre-development runoff volumes for rainfall depths equal to 90% of expected rainfall events. While such a limitation is being initiated in other parts of the country, it is not currently a regulatory requirement in Texas. However, the Malcolm Pirnie Team believes it is appropriate to evaluate this requirement in order to determine the potential benefits to Lake Arlington. Under this scenario, for example, the excess runoff caused by changes in the land cover for a rainfall event with depth corresponding to 90% of expected rainfall events needs to be captured by the BMPs on the site. If such a requirement were to be implemented, additional guidance would be needed.

For the purpose of PLOAD modeling, the runoff depths would be calculated by subtracting the rainfall depth corresponding to 90% of rainfall event depths from the rain depth of individual events. Smaller events (events less than the 90% of rainfall event depth) would be assumed to not produce any excess runoff from the developed sites.

Figure 3 is a rainfall cumulative frequency analysis of 34 years of available rainfall data. The rainfall depth associated with 90% events was calculated to be 1.46 inches. As discussed above, for this analysis, all precipitation depths of 0.1 inches or less were discarded based on the assumption that many of these events will not produce a measurable amount of runoff, and reliable data to determine the frequency of high-intensity rain events were not readily available. These data were excluded to prevent underestimation of the 90th percentile runoff-producing rainfall depth.

Smaller volume rain events with high intensity rains may produce runoff from a site if the site is highly impervious. Such events have a high runoff coefficient with little to no opportunity for infiltration. Open rural land or more pervious areas will have a higher capacity for holding rain water before it can produce downstream runoff . The assumption that rain events of less than 0.1 inches generally will not produce runoff will be valid for the Lake Arlington watershed because most parts of the watershed are currently rural or suburban with a high percent of pervious areas. Where future developments are expected, there is high potential for runoff reduction of initial and small rainfall.

Under this scenario, the total allowable runoff for post development conditions of the site would be the sum of: (i) the expected runoff for pre-development conditions, plus (ii) the additional runoff produced by a change in land use for rainfall events of more than 90% rainfall events depth.

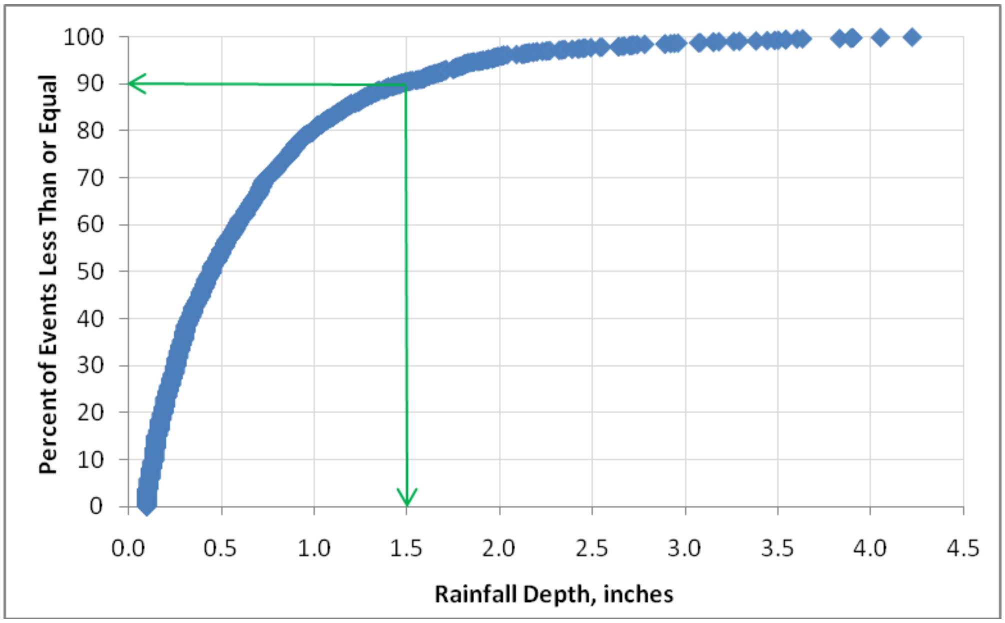
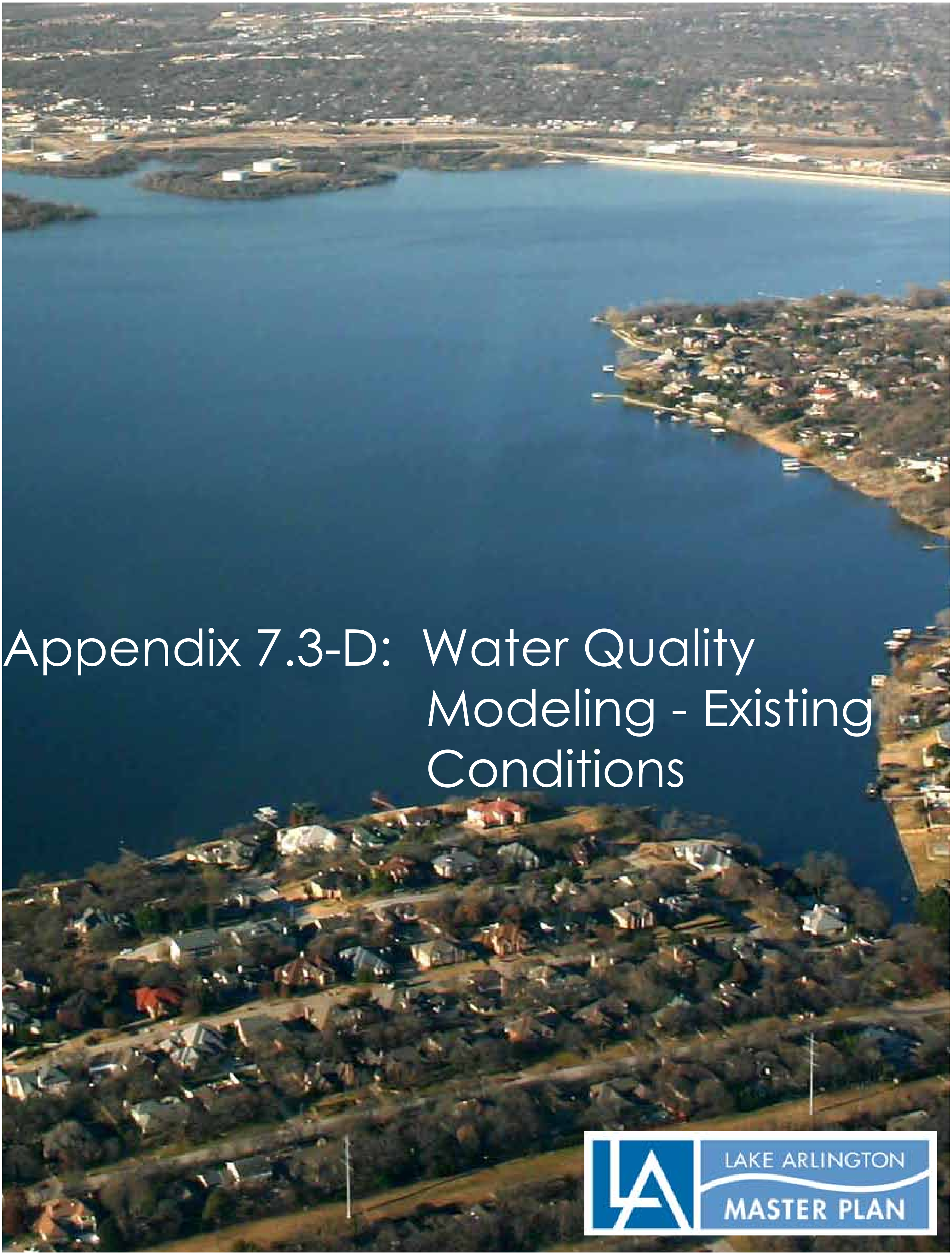


Figure 3. Cumulative Analysis Graph of Rainfall Depths for the Period of Data

Appendix 7.3-D: Water Quality Modeling - Existing Conditions



Lake Arlington Master Plan - City of Arlington, Texas

Water Quality Modeling Report – Existing Conditions

December 2010

Table of Contents

Table of Tables

Table of Figures

1 Introduction

Lake Arlington covers approximately 2,000 surface acres (three square miles), which is located on Village Creek, a tributary of the West Fork Trinity River. Lake Arlington is on the western border of Arlington just north of Interstate 20. The primary purpose of the Lake is to store water to be treated for drinking. Lake Arlington serves the City of Arlington and some surrounding communities (through the Trinity River Authority), and it is owned and operated by the City of Arlington.

Task 2 of the overall project scope of Lake Arlington Master Plan (LAMP or the "Master Plan") project is to develop a screening level model to test the sensitivity of the receiving streams and Lake Arlington to future development and associated pollutant loads. This report describes the Lake Arlington watershed existing condition hydrologic calculations and pollutant load estimation for support of the LAMP development. It supports the LAMP development process and includes a generalized analysis of existing conditions related to stormwater management with existing strategies for the watershed as it develops. Modeling the existing conditions will: (i) aid in tuning the models; (ii) provide an understanding of the impact of existing regulatory enforcement actions on protecting the watershed water quality; and (iii) form the basis for modeling future development conditions of the watershed.

2 Watershed Modeling

Watershed and water quality models are essential planning tools for evaluating potential future conditions and the impact of management alternatives in a watershed. Watershed loading models can range from planning level, uncalibrated models (*e.g.*, PLOAD) to complex, dynamic models that require very significant amounts of data for set-up and calibration (*e.g.*, HSPF). The evaluation tool chosen for LAMP is the PLOAD model. PLOAD is an extension of the Better Assessment Science Integrating Point and Non-point Sources (BASINS) model. It was developed by U.S. Environmental Protection Agency (U.S. EPA). BASINS is a decision support system for multipurpose environmental analysis used by regional, state, and local agencies for watershed and water quality based studies. PLOAD is a GIS-based model that can be used to derive planning-level estimates of non-point source pollutant loads generated within a watershed. PLOAD estimates non-point constituent loads on an annual average basis, for any user-specified pollutant, relying on land-cover-specific runoff coefficients and pollutant concentrations. This tool allows an evaluation of the relative magnitude of change in pollutant loading associated with various future scenarios. In addition, results can be used to target management measures to those areas with the highest existing and/or future pollutant loading.

2.1 Model Description

The PLOAD tool is capable of to analyzing the watershed for pollutant loads using one of two methods, the Exponent Coefficient Method and the Simple Method. For modeling the Lake Arlington watershed, the Simple Method was used. Under this method, pollutant loads are calculated using the following equation:

$L_P = \sum_u (P * P_J * R_{VU} * C_U * A_U * 2.72 / 12)$

Where: L_P = Pollutant load, lbs

P = Precipitation, inches/year

P_J = Ratio of storms producing runoff (default = 0.9)

R_{VU} = Runoff Coefficient for land use type u, $\text{inches}_{run}/\text{inches}_{rain}$

C_U = Event Mean Concentration for land use type u, milligrams/liter

A_U = Area of land use type u, acres

Consistent with the purpose of LAMP modeling, the purpose of PLOAD model is to provide a general planning estimate of the likely increase in pollutant loads from the watershed for various future land use scenarios when compared to the existing conditions of the watershed. The PLOAD model is appropriate for comparing the changes in relative storm flow pollutant loads from various land use scenarios with proposed regulations. PLOAD estimates are considered more accurate when modeled for long periods rather than short periods. As a screening level tool, PLOAD may not be calibrated against observed data but attempts are made to adjust the model input parameters to better represent the monitored data. The pollutant contributions caused by base-flows are estimated by the separation technique.

The following sections describe how the non-point source loading model was developed to simulate existing and future conditions.

2.2 Model Setup

The tributary watershed area upstream of Lake Arlington is approximately 140 square miles. Since the Simple Method was developed to predict the pollutant loads for smaller watersheds, the Lake Arlington watershed area was sub-divided to create 55 smaller sub-basins. The sub-basins in the project watershed were numbered from 1 to 55. A shape file provided by North Central Texas Council of Governments (NCTCOG) of the watershed boundary was used as a reference to delineate the watershed into sub-watersheds. The delineation was performed using manual delineation techniques in ESRI's ArcMap software, version 9.1. Figure 1 shows the watershed boundary with delineated sub-watersheds.

In the model, the average annual precipitation based on rain gauge data from Dallas Fort Worth International Airport for 34 years of record was used. Point source discharges were included in the model, and information about inventory, location and type of point source was obtained from the cities in the watershed. Additional parameters and input data developed include land use, impervious cover factors, event mean concentrations (EMC), and contributions from septic systems. Regulatory requirements and best management practice (BMP) effectiveness for pollution control were considered in the modeling. The following sections describe the development of all input parameter data.

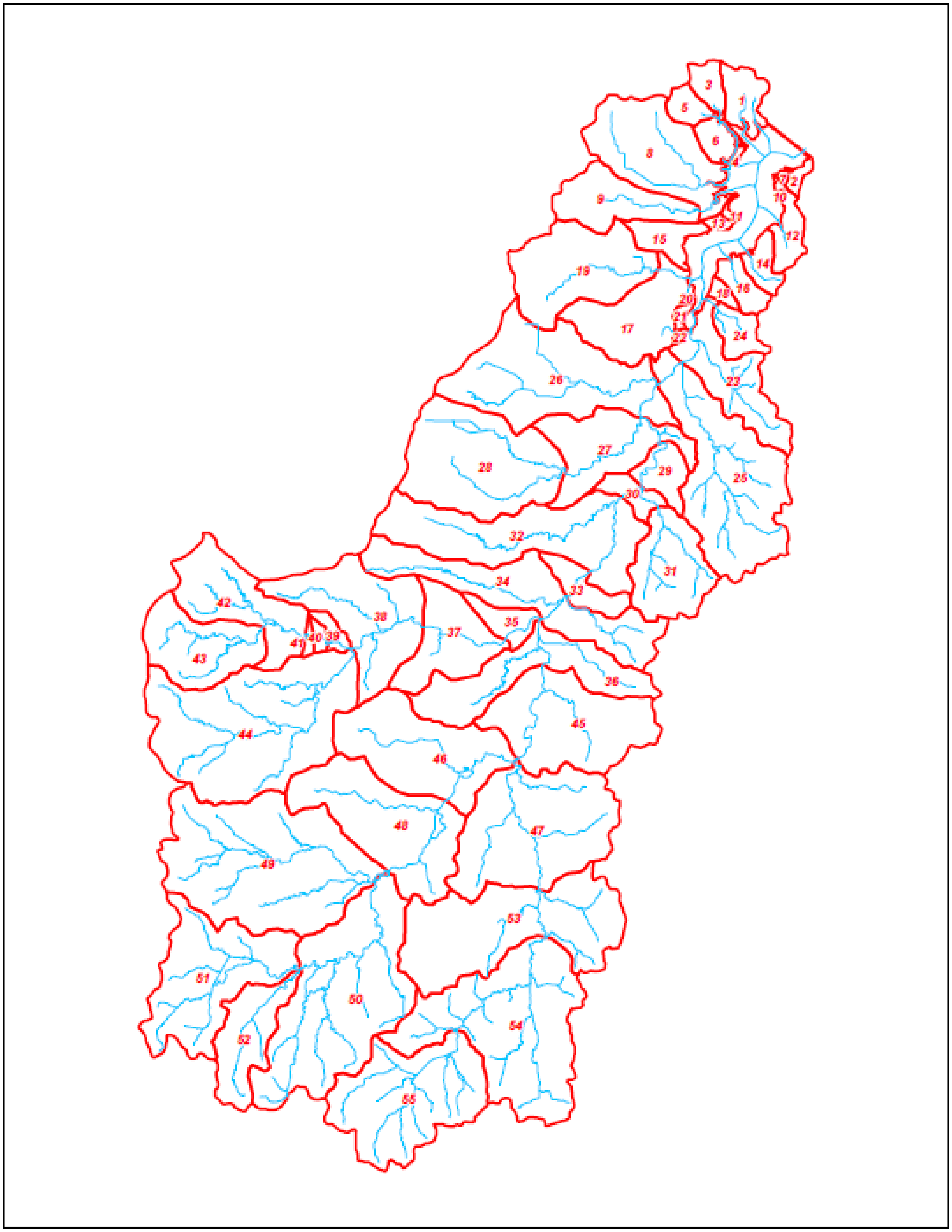


Figure 1: Modeled Sub-Basins of Lake Arlington Watershed

2.3 Existing Land Use

The existing land uses in the watershed were based on the land use shape file provided by NCTCOG, which also defined the land use codes for the each land use type. Based on the shape file, there are 69 land uses in the study area, some of which have the same land use code. For example, residential town homes, residential condominiums, residential triplexes have the same land use code. All land uses identified in the watershed area have been verified by aerial photographs.

2.4 Model Input Parameters

2.4.1 Impervious Cover Factors

PLOAD requires input of impervious cover percentages based on land uses within a study area to calculate associated runoff coefficients.

$R_{VU} = 0.05 + (0.009 * I_U)$

Where: I_U = Impervious percentage

Since site-specific impervious factors were not readily available for the Lake Arlington watershed, literature-based estimates were adapted to the watershed. Table 1 shows the literature values for percent imperviousness by land use. These values were derived from field observations of Natural Resource Conservation Service (NRCS).

Table 1: Percent Impervious Cover by Land Use (SCS, 1986)

Land Use	Description	Percent Imperviousness
Low Density Residential	Single Family:1/2 - 2 units per acre; average 1 unit per acre	25
Medium Density Residential	Single Family:2 - 3 1/2 units per acre; average 3 units per acre	41
High Density Residential	Single family: greater than 3 1/2 units per acre; average 4 units per acre	47
Multifamily Residential	Row houses, apartments, townhouses, etc	70
Mobile Home Parks	Single family: 5 - 8 units per acre	20
Central Business Districts	Intensive, high-density commercial	95
Strip Commercial	Low-density commercial; average 3 units per acre	90
Shopping Centers	Grocery stores, drug stores, malls, etc	95
Institutional	Schools, churches, hospitals, etc.	40
Industrial	Industrial centers and parks; light and heavy industry	90

Land Use	Description	Percent Imperviousness
Transportation	Major highways, railroads	35
Communication	Microwave towers, etc	35
Public Utilities	Electrical substations, transmission line rights-of-way, sewage treatment facilities, water towers, and water treatment facilities	60
Strip Settlement	Densities less than 1/2 -2 units per acre; average 1 unit per 3 - 5 acres	10
Parks and Developed Open Spaces	Parks, cemeteries, etc.	6
Developing Cropland	Land currently being developed	15
Grassland	Pasture, short grasses	0
Woodlands, Forest		0
Water Bodies	Lakes, large ponds	100
Barren Land	Bare exposed rock, strip mines, gravel pits	0

2.4.2 Precipitation

The Dallas-Fort Worth Metroplex is located in North Central Texas, approximately 250 miles north of the Gulf of Mexico. The National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) weather station at the Dallas-Fort Worth International Airport is in the proximity of the Lake Arlington watershed, and data from this gauge will represent the rainfall patterns near Lake Arlington. The period of record included the years 1976 through 2009, a total of thirty-four years. These rainfall data were assessed for temporal trends and average annual rainfall depth. The recorded daily rainfall data were obtained from the NOAA website for the period, which includes all rain events which occurred during the period of record. Although daily rainfall data are not used as an input into this master planning-level model, such data are evaluated subjectively as part of the sensitivity analysis and the quality control/quality assurance process. The rainfall data analysis details can be found in **Attachment A**, Lake Arlington Rainfall Analysis (Malcolm Pirnie, August 2010) technical memorandum.

The year 1980 had the lowest number of days with rain (56), whereas 2007 had the highest number of rainy days (142). The maximum recorded daily rainfall depth of 4.4 inches occurred in 2002 for the period of record. On average, there were 93 average days with recorded rainfall per year. The maximum annual rainfall of 52 inches occurred in 1991 and the lowest annual total rainfall of 19.0 inches occurred in 2005. The average annual rainfall for the period was calculated to be 35.2 inches. Figure 2 displays the annual total rainfall depths for the period of record.

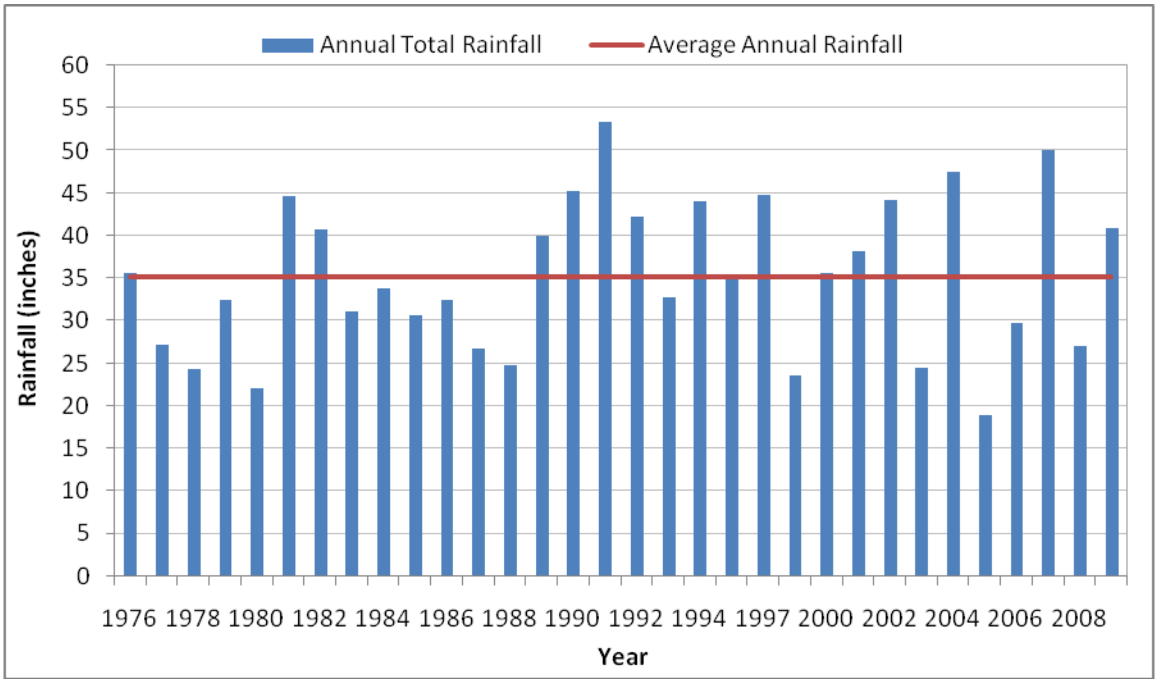


Figure 2: Annual Rainfall Depth Pattern for the Period of Data

2.4.3 Selection of Pollutants EMC Values

The PLOAD model calculates annual pollutant loads based on runoff and pollutant event mean concentrations (EMCs) for each land use. EMCs represent the average concentration of a pollutant in stormwater runoff and are usually reported in mass per unit volume (mg/L). Many factors can affect EMC values including land use, annual rainfall, percent impervious cover, season, sample collection method, watershed size, and storm event magnitude. Appropriate selection of EMC values is an important step in development of the model application.

A review of available literature related to EMC data was performed to develop reasonable EMC values for the various land uses represented in the PLOAD model. Studies presenting data specific to the region were targeted. Since regional data was not available for open space and roads, national and other related references were used in estimating the EMCs for these land uses. Land use descriptions in the NCTCOG dataset were typically more detailed than those associated with the EMC values identified in applicable literature sources. Therefore, similar land use categories were grouped under one recommended EMC value.

Studies were reviewed for EMC values for one or more of the following constituents: fecal coliform; biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), total nitrogen (TN) and total phosphorus (TP). The EMC values selected for the LAMP project are average median values presented in the Table 2.

Table 2: Literature Review of Parameter EMCs

Land Use	Reference	Location	TSS (mg/L)	TN (mg/L)	TP (mg/L)	COD (mg/L)	BOD (mg/L)	Fecal Coliform (cfu/100ml)
Residential	Pitt et al. (2005)	EPA Rain Zone 3	41	1.6	0.18	37	6.5	2,800
	NSQD v3 (2008)	Arlington, TX	54		0.39	45.4	8.2	17,000
	Pitt et al. (2005)	EPA Rain Zone 2	43	1.97	0.31	60	11	1,600
	Baird et al. (1996)	TX	41	1.82	0.57			2,000
	NSQD v3 (2008)	Dallas, TX	90		0.3	54	7.5	14,500
	Selected Value		**54**	**1.8**	**0.35**	**49**	**8.3**	**7,580**
Industrial	Pitt et al. (2005)	EPA Rain Zone 3	66	1.24	0.16	35	7.2	2,000
	NSQD v3 (2008)	Arlington, TX	84		0.22	89	8.3	4,200
	Pitt et al. (2005)	EPA Rain Zone 2	37	1.95	0.23		8	1,377
	Baird et al. (1996)	TX	61	1.26	0.28	54		9,700
	NSQD v3 (2008)	Dallas, TX	85		0.17	33	5.25	9,850
	Selected Value		**67**	**1.5**	**0.21**	**53**	**7.2**	**5,425**
Open Space	Pitt et al. (2005)	EPA Rain Zone 3	49					
	NSQD v3 (2008)	Arlington, TX						

Land Use	Reference	Location	TSS (mg/L)	TN (mg/L)	TP (mg/L)	COD (mg/L)	BOD (mg/L)	Fecal Coliform (cfu/100ml)
	Pitt et al. (2005)	EPA Rain Zone 2		2.19	0.15			
	Baird et al. (1996)	TX	70					2,500
	NURP	National			0.121	40		
	Pitt et al (2005)	National			0.22	25	4	
	Selected Value		**60**	**2.2**	**0.16**	**32**	**4.0**	**2,500**
Commercial	Pitt et al. (2005)	EPA Rain Zone 3	36	1.55	0.11	69	21.5	2,000
	NSQD v3 (2008)	Arlington, TX	34		0.10	41	7.3	8,700
	Pitt et al. (2005)	EPA Rain Zone 2	39	2.18	0.22	54		2,400
	Baird et al. (1996)	TX	56	1.34	0.32		13	6,900
	NSQD v3 (2008)	Dallas, TX	34.5		0.12	49	7.2	7,400
	Selected Value		**40**	**1.7**	**0.17**	**53**	**12.3**	**5,480**
Roads	Baird et al. (1996)	TX	74	1.86	0.22	59	6.4	
	EPA (2001)	GA						1,400
	Tetra Tech (2005)	NC						1,540
	Selected Value		**74**	**1.9**	**0.22**	**59**	**6.4**	**1,470**

2.4.4 Consideration of Potential Point Sources of Pollution

2.4.4.1 Natural Gas Wells

Natural gas wells are considered potential point sources in the model. Construction of the drilling pad, which is similar to constructing a residential or commercial building, is the major activity at the natural gas well site which contributes TSS to runoff during rain events. The drilling pad construction may disturb an area of about 3 acres at the site. Once the construction phase of developing a natural gas well is finished, most of the disturbed area will be reclaimed to near natural condition. After construction of the drilling pad, other major pollutant contributors at the site may include any oils and greases which may leak from the machinery operating at the site, illegal dumping of the material, wastes from the gas well, etc. Data containing the locations and categories of active natural gas and oil well sites were obtained from the NCTCOG. Dry holes, horizontal drain holes, permitted locations, plugged oil wells, service wells, shut-in wells (oil) and sidetrack wells present in the watershed were considered in estimating gas well point sources for PLOAD modeling. According to the data, approximately 1,150 wells constructed over an assumed 5 year period.

The City of Denton, Texas and EPA (2007) monitored the stormwater runoff from three natural gas sites in North Central Texas. The monitoring results indicated high concentrations of TSS and are in the typical order expected for construction sites. The observed TSS concentrations ranged from 394 mg/L to 9,898 mg/L with average median concentrations from three sites of 2,745 mg/L. The monitored concentration for manganese ranged from below detection limit to 1.31 mg/L, with an average median concentration of 0.29 mg/L. Additionally most of the metals monitored at the site had higher concentrations than expected from natural undisturbed sites. Construction vehicles, oil and grease leaks at the site and waste from the gas well are expected to contribute to the stormwater runoff from the natural gas well sites. However, the monitored runoff quality in the North Central Texas study found total petroleum hydrocarbons (TPH) below detection limits for all collected samples, indicating that TPH contribution from site activities were negligible.

It was assumed for this modeling task that active land disturbance occurs for an average of four months. Rainfall for four months, used to estimate runoff from the natural gas well sites, was calculated as average annual rainfall depth over four months. A runoff coefficient of 0.9 for the pad construction site was used in estimating runoff volume by using the rational method. The median concentration value from City of Denton study, described above, in combination with the estimated runoff volume from the gas well drilling site for active land disturbance period was used to calculate the TSS load for a gas well point source of potential pollution. Table 3 shows the calculated annual TSS load used in PLOAD for modeling a natural gas well drilling site.

Table 3: Natural Gas Wells Point Source Parameters Load

Parameter	Concentration (mg/L)	Load (lb)
TSS (mg/L)	2,745	19,684

Because of the factors discussed above, gas well sites were considered as one time contributors of pollutants. As gas well sites in the watershed were mostly developed in last ten years, and considering they are one time pollutant contributors, the number of gas well point sources in a sub-basin were determined as the average number of gas wells in the sub-basin over last five years. For an example, if a sub-basin in the watershed currently has 21 gas wells, as it was assumed that these wells were developed in last five years; therefore, an average of two wells were developed per annum in that sub-basin and two gas well point sources were modeled in PLOAD for that sub-basin (in determining pollutant loading on an average annual basis). Table 4 presents the number of gas well point sources by sub-basin in the watershed for a given year. If calculations yielded less than an average of one gas well point source in a sub-basin, one gas well point source was modeled in PLOAD in those sub-basins that had natural gas well exploration over the past ten years. For those sub-basins that had experienced no historic natural gas well exploration, no gas well point sources were modeled.

Table 4: Gas Well Point Sources by Sub-Basin in the Watershed

Sub-Basin	No. Point Sources	Sub-Basin	No. Point Sources	Sub-Basin	No. Point Sources
1	4	29	1	45	7
4	2	30	1	46	8
8	6	31	4	47	12
13	2	32	10	48	8
15	3	33	1	49	15
17	4	34	6	50	13
19	3	36	8	51	9
23	1	37	3	52	4
25	8	38	6	53	11
26	6	42	7	54	10
27	6	43	3	55	9
28	14	44	17		

2.4.4.2 Richland-Chambers Lake and Cedar Creek Lake

The natural water supply yield of Lake Arlington is supplemented with flows from both Cedar Creek Lake and Richland-Chambers Lake. As demand exceeds the Lake supply during dry periods, Lake Arlington receives imported water from Richland-Chambers and Cedar Creek under operations by the Tarrant Regional Water District (TRWD). The water from these two East Texas reservoirs is co-mingled in a pipeline prior to discharge into Village Creek, upstream of Lake Arlington. The water quality of Lake Arlington is therefore influenced by land use in its watershed along with the imported water from Richland- Chambers and Cedar Creek reservoirs.

Flows and any potential pollutant loads added to Lake Arlington from the East Texas reservoirs were modeled as a point source in the PLOAD model. The monitored flow obtained from TRWD for the years January 1, 2005 thru December 31, 2009 were analyzed to estimate average annual flows. Figure 3 illustrates the total deliveries by month and the estimated average annual flow. It was estimated that an average of approximately 14,183 MG of water is discharged from these two reservoirs into Village Creek annually.

Total nitrogen (TN) and total phosphorus (TP) concentrations in the discharges of Cedar Creek and Richland-Chambers reservoirs to Village Creek were calculated as the average of TCEQ-monitored data from 1993 – 2004, as measured in the reservoirs. Conservative concentration values of 30 mg/L for TSS and 500 cfu/100mL for fecal coliform were assumed in the discharges to Village Creek. Estimated pollutant loads of the discharges from these two reservoirs to Village Creek are presented in the Table 5.

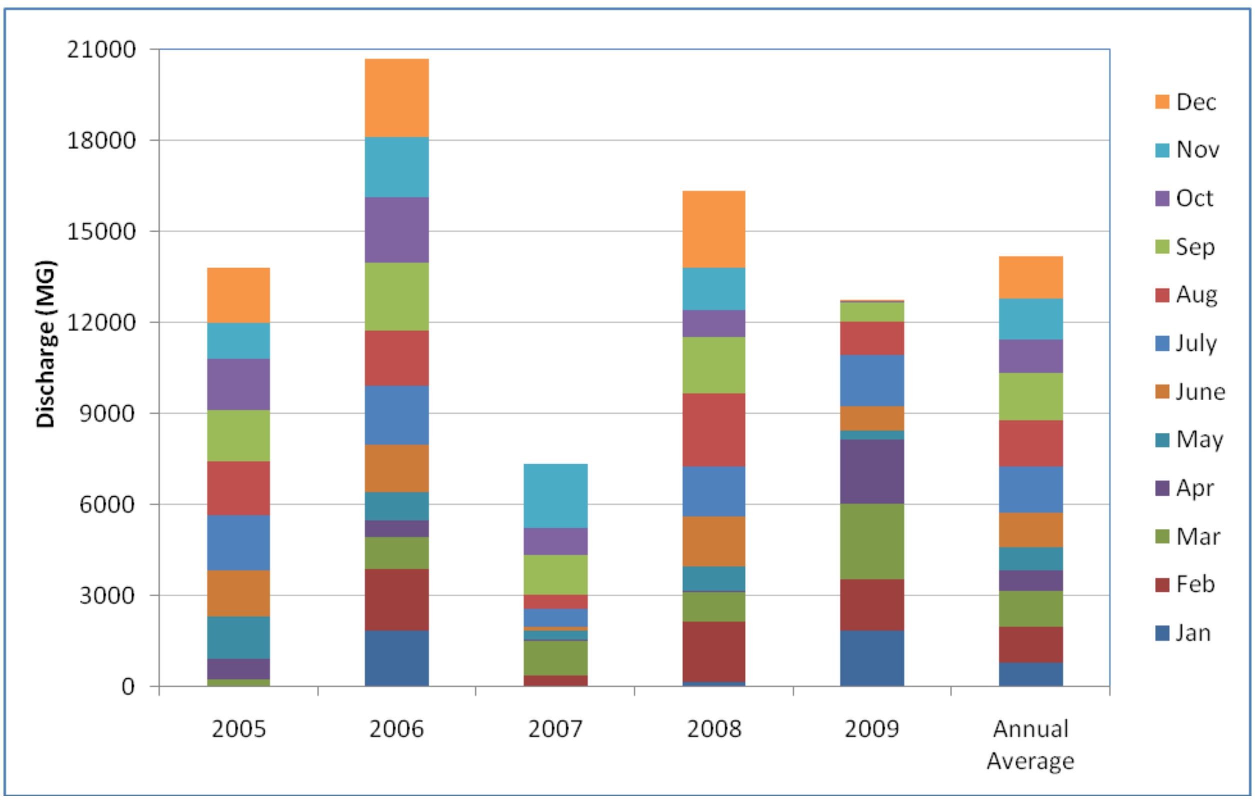


Figure 3: Monitored Discharges from Cedar Creek and Richland Chambers Reservoirs to Village Creek

Table 5: Pollutant Loads in the Cedar Creek and Richland Chambers Reservoirs (Aaverage of TCEQ data, 1993-2004)

Pollutant	Concentration (mg/L)	Annual Load (lb)
TN	0.398	47,003
TP	0.0875	10,334
TSS	30	3,542,945
Fecal Coliform	500 (cfu/100 mL)	2.7E+14 (cfu)

2.4.4.3 Wastewater Treatment Plants

The Lake Arlington watershed currently has five wastewater treatment plants (WWTPs) discharging to Village Creek or its tributaries. Locations of the WWTPs in the watershed are illustrated in Figure 4. Discharge monitoring report (DMR) data and the TPDES permits were obtained from the municipalities and NCTCOG to quantify the effluent flow and loads from these plants. Current conditions were characterized as the average daily flows and concentrations for the most recent years of monitoring data (Table 6). Whenever discharge monitoring data were not available, the permitted daily average values were used for quantifying discharge loads. Similarly, when discharge monitoring data and permit numerical standards were not available, then the average of discharge concentrations of available monitored data from other WWTPs in the watershed were used for estimating the average concentration of pollutants.

Annual average pollutant loads from the WWTPs are presented in Table 7.

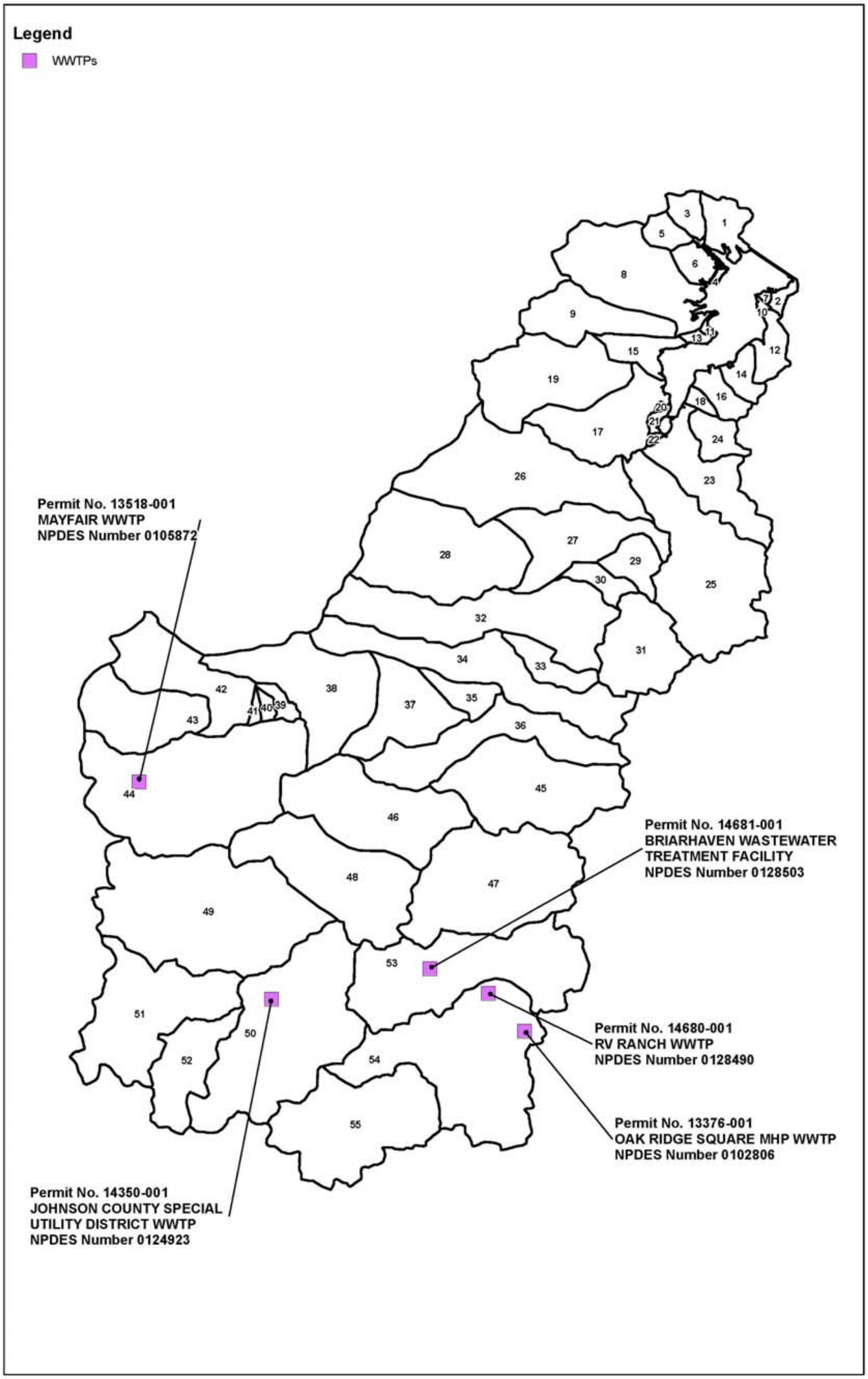
Table 6: Wastewater Treatment Plant Discharge Data

TPDES ID	EPA ID	Location or Permittee	Data Period	Flow (MGD)	Daily Average Concentration (mg/L)			
					BOD5	Phosphorus, Total[2]	Nitrogen, ammonia total (as N)	TSS
143500 01	TX012 4923	JOHNSON COUNTY SPECIAL UTILITY DISTRICT WWTP	Jan'06 - Apr'10	0.39	4.05	1	1.61	7.6
135180 01	TX010 5872	MAYFAIR WWTP	Jan'06 - Apr'10	0.04	5.44	1	6.37	8.6
133760 01	TX010 2806	OAK RIDGE SQUARE MHP WWTP	Jan'06 - Apr'10	0.0076	20.23	1	3.99[3]	29.1
146800 01	TX012 8490	RV RANCH WWTP	Sep'07- Apr'10	0.0079	16.19	1	3.99[3]	31.1
146810 01	TX012 8503	Briarhaven Wastewater Treatment Facility	Permit	0.0225[2]	20	1	3.99[3]	20.0

[1] Since WWTPs DMR data or Permits did not include pollutants concentration of their discharge, corresponding. Concentrations were estimated as average of monitored or permit data from other WWTPs in the list.
[2] Value was not reported in DMRs or Permits. Value was assumed based on experience.
[3]Corresponds to maximum discharge allowed.

Table 7: Wastewater Treatment Plant Discharge Pollutant Loads at End-Of-Pipe

Location or Permittee	EPA ID	BOD_5 (lb)	Nitrogen, ammonia total (as N) (lb)	Phosphorus, Total (lb)	TSS (lb)
Johnson County Special Utility District WWTP	TX0124923	4.36E+03	1.80E+04	1.08E+03	3.40E+04
Mayfair WWTP	TX0105872	6.01E+02	7.04E+02	1.11E+02	9.52E+02
Oak Ridge Square MHP WWTP	TX0102806	4.25E+02	8.38E+01	2.10E+01	6.11E+02
RV Ranch WWTP	TX0128490	3.53E+02	8.71E+01	2.18E+01	6.80E+02
Briarhaven Wastewater Treatment Facility	TX0128503	1.24E+03	2.48E+02	6.22E+01	1.24E+03



Legend
WWTPs
Permit No. 13518-001
MAYFAIR WWTP
NPDES Number 0105872
Permit No. 14681-001
BRIARHAVEN WASTEWATER
TREATMENT FACILITY
NPDES Number 0128503
Permit No. 14680-001
RV RANCH WWTP
NPDES Number 0128490
Permit No. 13376-001
OAK RIDGE SQUARE MHP WWTP
NPDES Number 0102806
Permit No. 14350-001
JOHNSON COUNTY SPECIAL
UTILITY DISTRICT WWTP
NPDES Number 0124923

These plants may not be discharging all of the calculated loads into Lake Arlington because they are a considerable distance from the Lake. For an example, most of the BOD_5 load will have decayed prior to reaching the Lake. Similarly, loads of nitrogen and phosphorus will be partially attenuated by settling and biological uptake in Village Creek and its tributaries, and then partially remobilized during higher flows or algal sloughing events. The delivery ratios for nutrients cannot be precisely quantified with information available for this type of planning effort. However, the majority of the point source nutrient loads would be expected to eventually reach Lake Arlington. It was conservatively assumed that 90 percent of the end-of-pipe nutrient loads from the WWTP reach Lake Arlington on an annual basis. Similarly, it was conservatively assumed that 80 percent of TSS and 50 percent of BOD (of the end-of-pipe load from the plants) reach Lake Arlington. WWTPs pollutant loads to Lake Arlington are presented in the Table 8. Since monitored COD concentrations were not available in the WWTP discharge monitoring reports (DMR), COD loads from WWTPs are not modeled.

Table 8: Wastewater Treatment Plant Discharge Pollutant Loads to the Lake

Location or Permittee	EPA ID	Annual Loads (lb) to Lake			
		BOD5	**Nitrogen, ammonia total (as N)**	**Phosphorus, Total**	**TSS**
Johnson County Special Utility District WWTP	TX0124923	2.18E+03	1.62E+04	9.70E+02	2.72E+04
Mayfair WWTP	TX0105872	3.01E+02	6.34E+02	9.95E+01	7.61E+02
Oak Ridge Square MHP WWTP	TX0102806	2.12E+02	7.54E+01	1.89E+01	4.89E+02
RV Ranch WWTP	TX0128490	1.77E+02	7.84E+01	1.96E+01	5.44E+02
Briarhaven Wastewater Treatment Facility	TX0128503	6.22E+02	2.23E+02	5.60E+01	9.95E+02

2.4.4.4 Septic Systems

The number and flow of septic systems in the Lake Arlington watershed cannot be precisely determined. However, the contribution of septic systems can be estimated by determining the potential wastewater flow in the watershed, and subtracting the flow that is treated at WWTPs. The 2008 population of Tarrant and Johnson Counties, which cover the Lake Arlington watershed area, is estimated to be approximately 1.9 million, based on the U.S. Census Bureau's Population Estimates Program (PEP). Using a typical per capita wastewater generation rate of 70 gallons per day, the present population in the two counties would generate approximately 133 MGD. The WWTPs in the counties have capacity to treat an average of 0.5 MGD. Therefore, it was assumed that the wastewater in the watershed is primarily treated by septic systems (approximately 132.5 MGD, due to limited availability of wastewater treatment. All of Arlington and Kennedale are presumed to have accessible organized wastewater service, but not all the septic waste in the service area is currently is being treated by the wastewater treatment plants. Where the City might have an official certificated area that gives them the "authority" to provide wastewater treatment service, but it doesn't necessarily mean that service within that area is not via individual septic systems. The integrity of that assumption would break down if one were trying to drill down and determine which areas have septic systems and which are served by the Arlington wastewater collection system.

Properly designed and functioning septic systems would be negligible sources of BOD_5, TSS, and TP to surface waters. However, poorly designed or maintained subsurface disposal systems can fail, resulting in exfiltration (*i.e.*, surface breakout) of septic tank effluent. It was assumed that, at any given time, 2 percent of the septic tank loads of these BOD_5, TSS, TP and fecal coliform from septic systems were delivered to Lake Arlington. Most nitrogen from subsurface disposal systems is nitrified in the soil and continues to be mobile in the environment, even if the system is working properly. It was assumed that 25 percent of the nitrogen from septic systems ultimately reaches Lake Arlington; this may be conservatively low value. When septic effluent is drained to drainfield (trench), the water slowly infiltrates into the underlying soil and evaporates in some instants. The amount of the septic effluent reaching surface water depends on different factors including soil type, proximity to surface waters, groundwater direction. Though no such information for the watershed is available for this modeling task, some time the effluents from drainfield are directed nearest stream through pipe. For this modeling purpose half of the effluent was assumed to reach the Lake Arlington. The septic system loads were distributed among the watershed model sub-basins, excluding the sub-basins with WWTP services, based on the proportion of the residential, commercial and industrial land uses together in a sub-basin of their total land use in the watershed.

Table 9. Estimate of Septic System Watershed Loads to the Lake Arlington [based on total flow to septic systems of 132.5 MGD]

CONSTITUENT	CONCENTRATION (mg/L)	DELIVERY FACTOR	LOAD (lb/yr)
Total suspended solids	70	0.02	5.65E+05
5-day biological oxygen demand	170	0.02	1.37E+06
Total nitrogen	40	0.25	4.03E+06
Total phosphorus	8	0.02	6.46E+04
Fecal Coliform	10000 (counts/100ml)	0.02	8.06E+08

2.4.4.5 Industrial Discharges

The Handley Generating Station is owned and operated by Exelon Power, a business unit of Exelon Generation, and is the major industrial point source in the watershed. It is a 5-unit, 1,441 megawatt (MW) natural gas-fired power plant. It provides electricity to customers in the Electric Reliability Council of Texas (ERCOT) when needed. The Handley Generating Station, located on the northwest shore of Lake Arlington, has a TPDES permit allowing discharge of treated wastes into the reservoir. The permit specifies discharge limitations associated with temperature, total and free chlorine concentrations, total suspended solids, and oil and grease at two outfall locations (Outfall 001 and 201). The discharge monitored data from the facility was reviewed and average concentrations for TSS are presented in the Table 10.

Table 10: Industrial Discharge Pollutant Loads to the Lake

TPDES ID	EPA ID	Location or Permittee	Data Period	Daily Average		Annual Average	
				Flow (MGD)	TSS (mg/L)	Flow (MGY)	TSS (lb/y)
00552 000	TX00 01198	HANDLEY STEAM ELECTRIC STATION	Jan'06 - Apr'10	223.08[1] 3.95[2]	13.5[3]	82866	8.46E+06

[1&2] Corresponds to Outfalls 001A &101A.
[3] Based on the measurable observed data at the Outfall 001A

2.4.5 Consideration of Water Quality Regulations and BMPs

The NPDES (National Pollutant Discharge Elimination System) was established as part of the Clean Water Act amendments of 1972. It was intended to control and regulate point source water pollution throughout the US, with the eventual objective of ensuring all US receiving waters were "fishable" and "swimmable."

These initial regulations affected municipal wastewater treatment plants (or "publicly owned treatment works," or POTWs) and industrial discharges. Stormwater was initially considered an exempt point source and was not included in the initial regulations. The EPA then established separate regulations for stormwater in 1987. The original Phase I regulations for stormwater (implemented in 1990) applied to large municipalities (generally >250,000 population) and certain industries. Medium-sized municipalities (100,000 to 250,000 in population, plus other industries) were regulated several years later. The recently implemented Phase II regulations are intended to be applied to urban areas in the US. The Phase I regulations included construction activity as an industry and were applied to all construction sites greater than five acres. The Phase II regulations will generally apply to all construction sites larger than one acre.

In the State of Texas, TCEQ is the permitting agency for municipal “separate storm sewer system” (MS4) permits. In the Lake Arlington watershed, the City of Arlington and the City of Fort Worth are permitted under Phase I permits, and all other cities in the watershed are permitted under Phase II permit. Per TCEQ’s Phase II general permit from USEPA, municipalities operating under MS4 Phase II permits must develop a storm water management program (SWMP) that includes at least these six control measures:

- Public education and outreach
- Public involvement or participation
- Detection and elimination of illicit discharges
- Controls for storm water runoff from construction sites
- Post-construction storm water management in areas of new development and redevelopment
- Pollution prevention and “good housekeeping” measures for municipal operations

These measures must be developed by identifying and applying best management practices (BMPs). Phase I municipalities have additional minimum measures including monitoring receiving water quality.

For pollutant load modeling on the scale of the Lake Arlington watershed, the effectiveness of current non-point source pollution control programs (Phase I and II permits) is difficult to formulate and simulate, and indeed there is very little precedent for such activity at this scale. Following the intent of USEPA’s Phase II Stormwater program to reduce non-point source pollution in the form of stormwater to receiving waters, it was assumed that the BMPs commonly promoted and implemented by municipalities in the watershed could, on average, reduce pollutant levels in runoff by approximately 20%. The value is assumed in the form of a target that is more hypothetical than scientific. A 20% reduction throughout the watershed was thus selected as the benchmark associated with the management strategy for non-point source pollution. This exercise in no way implies that diffuse loads are so evenly distributed, or that each community or county would implement the same level of controls. It simply represents an idealized method of developing a planning-level model of the watershed, which does not intuitively overestimate nor underestimate the effectiveness of USEPA’s Phase II Stormwater program.

2.4.6 USGS Streamflow Analyses

The Lake Arlington watershed has three U.S. Geological Survey (USGS) stream flow monitoring stations in the watershed. In order to determine the contribution from overland flow to the streams in the watershed, it is necessary to separate the base flow from stream gage data. A FORTRAN program called Base Flow Index (BFI) was developed using the Institute of Hydrology procedures developed in 1980 (Wahl and

Wahl, 1995). The base-flow index is the total volume of base flow divided by the total volume of runoff for a period (Wahl and Wahl, 1995). The base-flow index can be compared from year to year to obtain an understanding of overall base flow for the area of interest.

The program output data includes the base-flow index, total base flow for the year in acre-feet (ac-ft), the total runoff for the year in ac-ft, and other statistical data. The program cannot compute base-flow index for a year that has missing data. Along with the USGS daily stream flow data, the program requires two other parameters, which are "N" (number of days) and "F" (turning point factor). N refers to the number of days over which a minimum flow is determined. It is the connection of these minimum points that determines the base flow. Although the procedure developed by the Institute of Hydrology uses 5-day minimums, after three days, BFI usually is not expected to vary much. The value of F is insensitive, so the default value of 0.9 used for this analysis.

Since the available data for USGS station 08049000 is not very recent, it may not represent the current flow conditions of Village Creek. USGS station 08048970 has more recent and long term data than the other two stations in the Village Creek watershed. Therefore, monitored flows at station 08048970 are ideal for comparing and adjusting the Lake Arlington watershed PLOAD model. Table 9 shows the information and flows estimated using BFI for USGS gauging station 08048970.

Table 11: Summary of the Annual Baseflow Estimations

USGS Station No	Location	Years of Complete Data	Mean Baseflow (Deviation) (ac-ft)	Mean Total Flow (Deviation) (ac-ft)	BFI	Expected Mean Flow from Overland Runoff (ac-ft)
08048970	Village Creek at Everman	1992 – 2009	2,735 (1,895)	26,323 (18,064)	0.12	23,588

```
Input file = c:\docume~1\bathi\desktop\lamp
File format = Web/rdb (NWIS-W)
Base-flow output file = c:\docume~1\bathi\desktop\lamp
Turning point output file =
Daily base flow and total flow output file = c:\docume~1\bathi\desktop\lamp

Program Version = BFI 4.14

 AVAILABLE SEPARATION METHODS:
 * 1 = STANDARD Institute of Hydrology method
```

(N-day avg. recession test; uses "N" and "f")
2 = MODIFIED method
(1-day recession constant adjusted for number of days
between points; uses "N" and "K")

BASE-FLOW SEPARATION PARAMETERS
METHOD = 1
N = 3
f = .900000

==

Base-Flow Index for gage 08048970

agency 08048970 sample data

Calendar Year	Base-Flow Index	Base Flow (acre-ft)	Total Runoff (acre-ft)	Day of Turning Point [First]	[Last]
1992	.204	6142.	30060.	12	366
1993	.079	2546.	32137.	1	365
1994	.287	3608.	12589.	1	365
1995	.109	3288.	30027.	1	365
1996	.149	596.	4014.	1	366
1997	.186	4597.	24758.	1	365
1998	.098	2240.	22923.	1	365
1999	.211	891.	4225.	1	365
2000	.030	642.	21500.	1	366
2001	.054	899.	16613.	1	365
2002	.080	3180.	39832.	1	365
2003	.092	1060.	11539.	1	365
2004	.102	6430.	62759.	1	366
2005	.170	1979.	11611.	1	365
2006	.016	357.	21808.	1	365
2007	.063	4286.	68302.	1	365
2008	.134	1993.	14877.	1	366
2009	.102	4490.	44238.	1	355

2010 Incomplete year. Base flow cannot be determined.

Statistics for 18 Calendar years at gage 08048970

	MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIATION
BASE FLOW (AC-FT)	2734.7	1895.2	.693
TOTAL RUNOFF (AC-FT)	26322.9	18064.1	.686
BASE-FLOW INDEX	.120	.070	.580

Figure 5: BFI Program Output for USGS Station Number 08048970

2.5 In-Stream Phosphorus Reduction

As discussed above, physical, chemical and biological processes during pollutant transport will change the actual pollutant loads reaching the Lake. For an example, phosphorus uptake by plants and particulate phosphorus settling to stream beds will reduce the phosphorus load at the Lake. Based on professional experience, attenuation of non-point source phosphorus within the Lake Arlington watershed was estimated using a conservative reduction rate of 2.55E-6% for every foot traveled, to represent settling and uptake of phosphorus in the stream channels. This reduction rate was applied to the sub-basin phosphorus load for those sub-basins having a discharge more than 3,500 feet from Lake Arlington. The distance traveled was calculated as the distance from the point where flow leaves a sub-basin to the point where that flow enters the reservoir. All sub-basins with outlets less than 3,500 feet from Lake Arlington were assigned a reduction rate of zero. Because the reservoir model is primarily sensitive to phosphorus in predicting anticipated eutrophication, no reduction rates were developed for other modeled constituents. Therefore, the prediction of other constituent levels reaching Lake Arlington is much more conservative.

2.6 Existing Conditions Model Results

2.6.1 Model Validation

The PLOAD model used for estimating the stormwater runoff and pollutant load from the watershed's overland flow is a non-calibrated model. For the purposes of the Master Plan modeling effort and to have confidence in the model's results, the project team compared the estimated flow values to the monitored flow data at USGS gauge station 08048970 (Village Creek at Everman). As described in the earlier sections, the total flow measured at the gauge station was separated into baseflow and runoff flow using BFI modeling. The mean runoff volume (measured total volume – baseflow volume at the station) was calculated to be 7,686 million gallons (MG) per year.

The USGS gauging station is located on Village Creek at the downstream end of sub-basin 33 in the modeled watershed. Therefore, the estimated runoff flows from sub-basin 33 and other upstream sub-basins (up to sub-basin 55) are totaled and compared with the runoff flow measured at the USGS gauge. The estimated annual flow at the USGS gauge station location was 8,140 MG, which is comparable to the flow actually measured at the gauge. Figure 6 illustrates the measured mean flow and flow range with observed standard deviation. The flow near the USGS gauging station estimated by the model was well within the displayed range and very close to the measured mean runoff value. This comparison clearly indicated the estimated flows are reasonable and will represent the actual flows of the watershed. The assumptions made in the modeling effort are validated.

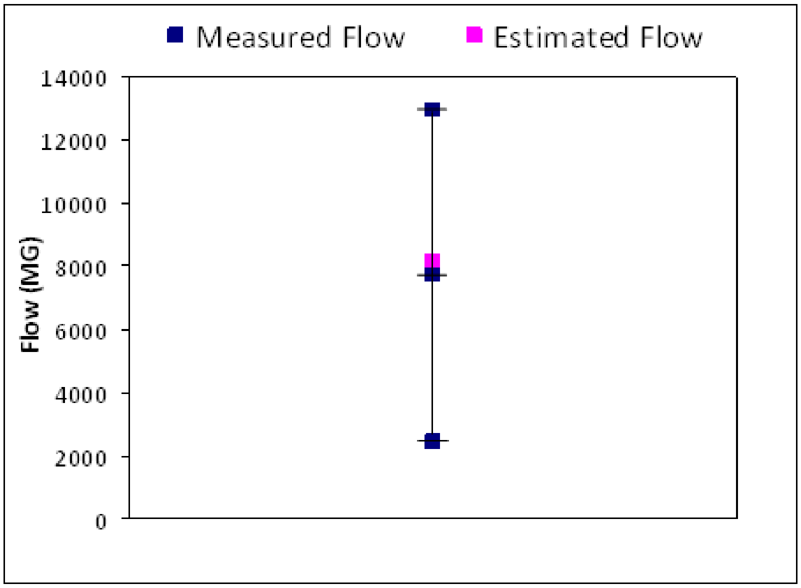


Figure 6: Measured and Estimated Flows Comparison

2.6.2 Model Results

PLOAD annual runoff volume and pollutant load estimates for each of the 55 sub-basins (for the existing conditions of the watershed) including point sources are shown in the Table 12. The high estimated flows in sub-basin 8 are caused by the Handley Steam Electric Station wastewater discharges (TX0001198) to the sub-basin. The high estimated flows in sub-basin 27 are caused by the eastern reservoirs discharges into the sub-basin.

The pollutant loads expected to be generated from the individual sub-basins will not all reach the Lake. Physical, chemical and biological processes during the pollutant transport from the sub-basin to the lake will change the actual pollutant loads reaching the Lake. The assumption that all generated pollutants will reach the lake is extremely conservative. However, for this master planning level effort, such an assumption was used for all pollutants except phosphorus.

Because the reservoir model is primarily sensitive to phosphorus in predicting anticipated eutrophication, the load reduction was applied to PLOAD sub-basin phosphorus loads. The approach used for reducing the sub-basin generated phosphorus loads is presented in the following section.

Table 12: PLOAD Estimated Annual Pollutants Load

Sub-basin	TSS (lb)	TN (lb)	TP (lb)	COD (lb)	BOD (lb)	FC (counts)	Flow (MG)
1	1.46E+05	4.72E+04	1.01E+03	5.32E+04	2.45E+04	2.96E+13	4.35E+02

Sub-basin	TSS (lb)	TN (lb)	TP (lb)	COD (lb)	BOD (lb)	FC (counts)	Flow (MG)
2	9.34E+03	9.15E+03	1.80E+02	5.96E+03	3.93E+03	3.40E+12	7.30E+01
3	3.44E+04	2.50E+04	5.21E+02	2.87E+04	1.30E+04	1.31E+13	2.27E+02
4	4.80E+04	2.63E+03	6.67E+01	7.63E+03	2.18E+03	3.45E+12	3.72E+01
5	3.56E+04	2.64E+04	5.52E+02	2.61E+04	1.26E+04	1.40E+13	2.32E+02
6	3.50E+04	2.23E+04	4.75E+02	2.55E+04	1.13E+04	1.25E+13	2.06E+02
7	2.24E+03	1.77E+03	3.56E+01	1.37E+03	7.80E+02	7.28E+11	1.49E+01
8	8.78E+06	1.69E+05	3.86E+03	1.37E+05	8.24E+04	7.12E+13	8.43E+04
9	1.13E+05	1.13E+05	2.22E+03	7.92E+04	4.98E+04	4.35E+13	9.03E+02
10	2.73E+03	6.00E+03	1.07E+02	1.68E+03	2.30E+03	1.14E+12	4.08E+01
11	1.20E+03	4.30E+01	3.21E+00	6.37E+02	7.85E+01	2.23E+11	2.40E+00
12	3.77E+04	4.88E+04	9.57E+02	2.78E+04	2.09E+04	1.88E+13	3.72E+02
13	4.18E+04	1.05E+03	2.31E+01	1.46E+03	5.14E+02	5.68E+11	1.12E+01
14	3.18E+04	4.19E+04	8.18E+02	2.37E+04	1.81E+04	1.60E+13	3.18E+02
15	1.20E+05	2.80E+04	6.21E+02	4.43E+04	1.56E+04	1.79E+13	2.94E+02
16	3.37E+04	4.13E+04	8.12E+02	2.43E+04	1.78E+04	1.61E+13	3.18E+02
17	2.79E+05	1.42E+05	2.95E+03	1.41E+05	6.78E+04	6.88E+13	1.25E+03
18	9.78E+03	1.16E+04	2.26E+02	6.74E+03	4.94E+03	4.31E+12	8.90E+01
19	3.08E+05	2.08E+05	4.23E+03	1.73E+05	9.57E+04	9.52E+13	1.75E+03
20	1.21E+03	8.34E+02	1.67E+01	6.81E+02	3.67E+02	3.31E+11	7.13E+00
21	6.00E+03	3.75E+03	7.74E+01	3.57E+03	1.71E+03	1.69E+12	3.36E+01
22	4.95E+03	1.93E+03	4.34E+01	3.71E+03	1.06E+03	9.11E+11	2.08E+01
23	1.67E+05	1.29E+05	2.59E+03	9.84E+04	5.76E+04	5.40E+13	1.06E+03
24	4.07E+04	3.47E+04	7.08E+02	2.86E+04	1.57E+04	1.43E+13	2.88E+02
25	5.88E+05	2.95E+05	6.15E+03	3.01E+05	1.43E+05	1.57E+14	2.68E+03
26	5.01E+05	2.37E+05	4.90E+03	2.57E+05	1.17E+05	1.19E+14	2.19E+03
27	3.79E+06	1.22E+05	1.19E+04	8.00E+04	3.76E+04	3.07E+14	1.49E+04
28	6.74E+05	1.97E+05	4.18E+03	2.52E+05	9.81E+04	1.09E+14	1.93E+03
29	1.05E+05	4.06E+04	8.74E+02	5.46E+04	2.05E+04	2.43E+13	4.06E+02
30	3.77E+04	5.93E+03	1.37E+02	9.98E+03	3.15E+03	3.97E+12	6.80E+01
31	1.96E+05	1.19E+05	2.27E+03	6.87E+04	5.11E+04	3.73E+13	9.29E+02
32	3.89E+05	8.33E+04	1.78E+03	1.07E+05	4.05E+04	4.26E+13	8.41E+02
33	6.07E+04	3.51E+04	6.88E+02	2.50E+04	1.52E+04	1.30E+13	2.87E+02
34	3.01E+05	1.48E+05	2.91E+03	1.10E+05	6.44E+04	5.36E+13	1.23E+03
35	1.17E+05	2.93E+04	5.98E+02	2.53E+04	1.36E+04	1.36E+13	2.52E+02
36	3.44E+05	1.18E+05	2.42E+03	1.14E+05	5.47E+04	5.33E+13	1.06E+03
37	1.68E+05	6.12E+04	1.27E+03	6.99E+04	2.99E+04	2.91E+13	5.93E+02
38	2.90E+05	8.20E+04	1.75E+03	1.01E+05	4.00E+04	4.27E+13	8.07E+02

Sub-basin	TSS (lb)	TN (lb)	TP (lb)	COD (lb)	BOD (lb)	FC (counts)	Flow (MG)
39	2.40E+04	1.47E+04	3.14E+02	1.68E+04	7.38E+03	8.79E+12	1.38E+02
40	7.26E+03	4.21E+03	8.73E+01	4.30E+03	1.95E+03	1.99E+12	3.88E+01
41	9.38E+03	5.10E+03	1.10E+02	6.27E+03	2.54E+03	3.11E+12	4.88E+01
42	2.90E+05	8.82E+04	1.85E+03	9.55E+04	4.22E+04	4.42E+13	8.26E+02
43	1.48E+05	6.45E+04	1.25E+03	4.78E+04	2.76E+04	2.16E+13	5.38E+02
44	6.47E+05	1.20E+04	1.28E+03	2.09E+05	1.98E+04	9.99E+13	7.30E+02
45	3.49E+05	2.24E+05	4.29E+03	1.30E+05	9.37E+04	7.20E+13	1.74E+03
46	4.23E+05	1.83E+05	3.74E+03	1.76E+05	8.61E+04	8.57E+13	1.65E+03
47	4.90E+05	2.33E+05	4.47E+03	1.47E+05	9.81E+04	7.41E+13	1.85E+03
48	4.31E+05	2.36E+05	4.66E+03	1.81E+05	1.06E+05	9.42E+13	1.95E+03
49	5.60E+05	1.65E+05	3.29E+03	1.47E+05	7.32E+04	6.25E+13	1.46E+03
50	5.48E+05	2.55E+04	1.97E+03	1.71E+05	2.98E+04	8.45E+13	7.35E+02
51	3.45E+05	1.22E+05	2.38E+03	9.21E+04	5.25E+04	4.19E+13	1.02E+03
52	2.03E+05	9.93E+04	1.99E+03	8.04E+04	4.48E+04	4.22E+13	8.42E+02
53	4.63E+05	8.80E+03	1.15E+03	1.77E+05	3.19E+04	9.78E+13	5.93E+02
54	4.08E+05	7.83E+03	8.09E+02	1.36E+05	2.12E+04	6.18E+13	4.79E+02
55	3.56E+05	1.27E+05	2.49E+03	9.85E+04	5.49E+04	4.47E+13	1.08E+03

2.7 Baseflow Pollutants Load

The PLOAD model does not incorporate the pollution load associated with the creek's baseflow. The baseflow pollutant load to the Lake was calculated as the product of the baseflow volume multiplied by the observed mean concentration of each pollutant in Village Creek and in its tributaries. Except for TSS, COD, and TN, the monitored ambient water quality data were obtained from the TCEQ database. Additional water quality data for Village Creek and its tributaries were reported by various other agencies. The monitored data ranged from 1972 to 2008 and the data reporting agencies include: the City of Arlington, USGS, TCEQ Regional Office, Senate Bill 835 program and Trinity River Authority. For TSS, COD and TN, conservative numbers were assumed for calculation purposes. [Only TP and TN are required for the BATHTUB reservoir model and is described in the following sections of this report.]

The calculated baseflow at USGS station 08048970 was 2,735 ac-ft per year, and the total area draining to this station is about 57,722 acres. Therefore, the estimated annual baseflow rate is 0.0474 ac-ft/acre of drainage area at this station. This calculated baseflow rate was used to estimate the base flows of all streams and tributaries entering Lake Arlington.

Table 13 summarizes the mean concentrations of the pollutants used for baseflow load estimation. These estimated baseflow pollutant loads were added to the pollutant loads estimated by the PLOAD model and the total of these two loads was determined to be the total pollutant load delivered to Lake Arlington from the watershed.

Table 13: Baseflow pollutant average concentration

Parameter	TSS*	TP	TN*	COD*	BOD	Fecal Coliform)
Concentration (mg/L)	50	0.09	0.7	10	3	982 (#/100mL)

*A conservative assumption

3 Reservoir Modeling

3.1 BATHTUB Model

The BATHTUB model was selected to analyze the water quality issues related to Lake Arlington itself. The BATHTUB model provides the capability for calibration to observed lake data, but it does not have extensive data requirements (and can therefore be applied with existing data). BATHTUB is recognized as an effective tool for lake and reservoir water quality assessment and management, particularly where data are limited (Ernst et al., 1994).

BATHTUB is a software program used primarily for estimating nutrient loading to lakes and reservoirs, summarizing information on in-lake water quality data, and predicting the lake/reservoir response to nutrient loading (Walker 1986). It was developed and is distributed by the U.S. Army Corps of Engineers. BATHTUB contains a number of regression equations that have been calibrated using a wide range of lake and reservoir data sets. It can treat the lake or reservoir as a continuously stirred, mixed reactor, or it can predict longitudinal gradients in trophic state variables in a reservoir or narrow lake. These trophic state variables include in-lake total and ortho-phosphorus, organic nitrogen, hypolimnetic dissolved oxygen, metalimnetic dissolved oxygen, chlorophyll concentrations, and Secchi depth (transparency).

BATHTUB's nutrient balance procedure assumes that the net accumulation of nutrients in a lake is the difference between: (i) nutrient loadings into the lake (from various sources) less (ii) the nutrients carried out through outflow and the losses of nutrients through whatever decay process occurs inside the lake. The net accumulation (of phosphorus) in the lake is calculated using the following equation:

$$\text{Net accumulation} = \text{Inflow} - \text{Outflow} - \text{Decay}$$

Input data requirements for BATHTUB include: physical characteristics of the lake morphology (e.g., surface area, mean depth, length, mixed layer depth), flow and nutrient loading from various pollutant sources, precipitation and phosphorus concentrations in precipitation (measured or estimated), and measured lake water quality data (e.g., total phosphorus concentrations).

3.2 Modeling Approach

The BATHTUB water quality model was used to define the relationship between external pollutant loads and the resulting Lake Arlington water quality. This approach requires external specification of flows and pollutant concentrations entering the Lake. These flows and pollutant concentrations for both current conditions and future scenarios were obtained using PLOAD. Specific steps taken in the reservoir water quality modeling approach consisted of:

1. Defining the model inputs.
2. Calibrating the model predictions for pollutant loads and chlorophyll *a* to observed Lake Arlington data.
3. Using the calibrated model to project future water quality for a range of watershed land development scenarios.

3.3 Model Setup

This section gives an overview of the model inputs required for BATHTUB application, and how they were derived. The following categories of inputs are required for BATHTUB:

- Model Options
- Global Variables
- Reservoir Segmentation
- Tributary Loads

3.4 Model Options

BATHTUB provides a multitude of model options to estimate water quality in a reservoir. Options specified for the Lake Arlington application are shown in Table 14, with the rationale for these options discussed below. No conservative substance, such as TSS, conductivity, chlorides, etc. was simulated, so this option was not needed. The second-order option was selected for phosphorus and nitrogen. Water transparency (clarity) was not simulated. The Fischer numeric dispersion model was used for defining mixing between lake segments. Pollutant calibrations were based on lake concentrations. Model calibration is described in more detail in a later section. The use of availability factors was not required, and estimated concentrations were used to generate mass balance tables.

Table 14: BATHTUB Model Options for Lake Arlington

MODEL	MODEL OPTION

MODEL	MODEL OPTION
Conservative substance	Not Computed
Total phosphorus	Second Order
Total nitrogen	Second Order
Chlorophyll-*a*	P, N, Light, T
Transparency	Not computed
Longitudinal dispersion	Fischer-numeric
Phosphorus calibration	Concentrations
Nitrogen calibration	Not computed
Error analysis	Not computed
Availability factors	Ignored
Mass-balance tables	Estimated concentrations used

3.5 Global Variables & Atmospheric Loads

The global variables required by BATHTUB consist of:

- The averaging period for the analysis
- Atmospheric pollutants load
- Total evaporation for the period of analysis.

BATHTUB is a steady state model, whose predictions represent concentrations averaged over a period of time. A key decision in the application of BATHTUB is the selection of the length of time over which inputs and outputs should be modeled. The length of the appropriate averaging period for the BATHTUB application depends upon what is called the pollutant residence time, i.e. the average length of time that a pollutant spends in the water column before settling or flushing out of the lake. Guidance for the BATHTUB model recommends that the averaging period used for the analysis is at least twice as large as pollutant residence time for the lake of interest. For lakes like Lake Arlington with a nutrient residence time on the order of weeks to a few months, a seasonal (e.g. spring-summer) averaging period is recommended.

Daily Lake evaporation data obtained from TRWD for the years 2005 thru 2009 were analyzed to estimate average monthly and annual evaporation. Table 15 shows the estimated monthly and annual average evaporation of the Lake.

Table 15: Lake Arlington Evaporation Data

Month	Evaporation (ft)	Month	Evaporation (ft)
Jan	0.18	Jul	0.58
Feb	0.22	Aug	0.55
Mar	0.31	Sep	0.40
Apr	0.38	Oct	0.31
May	0.37	Nov	0.26
Jun	0.55	Dec	0.18
Annual Average		4.32 feet	

3.6 Reservoir Segmentation

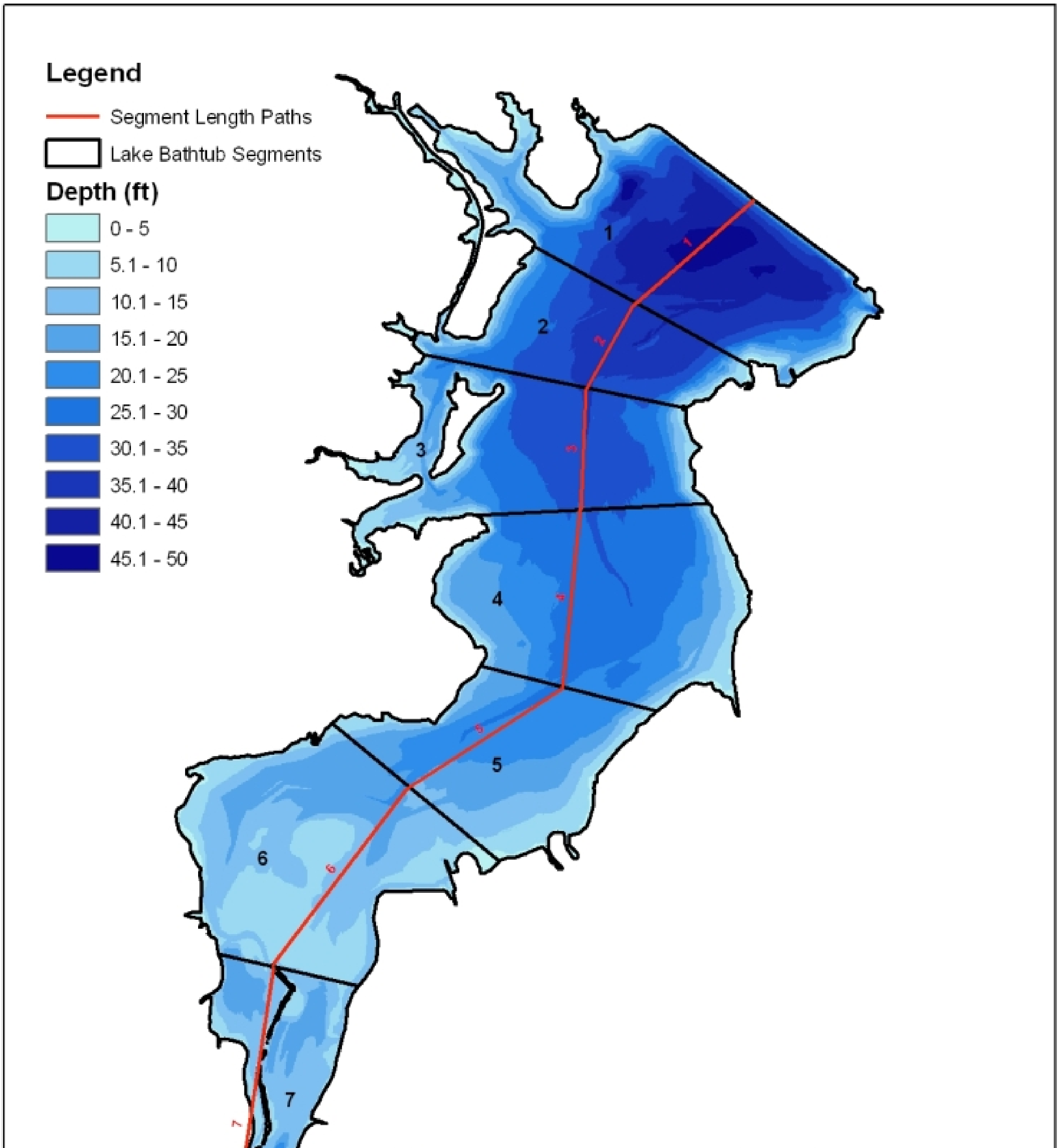
BATHTUB provides the capability to divide the reservoir into a number of individual segments, allowing prediction of the change in pollutant concentrations over that area of the reservoir. The segmentation layout selected for Lake Arlington was designed to provide spatial variation along the length of the reservoir. The Lake was divided into seven segments as shown in Figure 8. The areas of segments and watersheds for each segment were determined using GIS software.

BATHTUB requires that a range of inputs be specified for each segment. These include: segment surface area (km^2), length (km), mean water depth (m), and depth of the thermocline and mixed layer (m). Each segment's surface area, mean depth, and length were determined in GIS. It was assumed that the mixed depth was one-half the mean depth. Table 15 illustrates the segmentation data that were input into the model.

Table 16: Reservoir Segmentation Inputs

Segment	Mean Depth (ft)	Mean Depth (m)	Surface Area (acres)	Surface Area (km^2)	Length (ft)	Length (km)
1	30	9.21	372	1.50	3986	0.84
2	27	8.20	195	0.79	2760	0.53
3	23	6.95	272	1.10	1751	0.66
4	22	6.73	353	1.43	3133	0.95
5	17	5.07	230	0.93	3236	0.99

Segment	Mean Depth (ft)	Mean Depth (m)	Surface Area (acres)	Surface Area (km^2)	Length (ft)	Length (km)
6	12	3.51	347	1.40	5701	1.21
7	12	3.65	156	0.63	2157	1.74



SegmentID	Surface Area (acres)	Mean Depth (feet)	Segment Length (feet)
6	346.6	11.52	3986
1	371.8	30.21	2760
2	195.1	26.91	1751
4	353.1	22.08	3133
5	230.4	16.63	3236
7	155.7	11.97	5701
3	271.8	22.8	2157

Figure 7: Modeled BATHTUB Segments

3.7 Tributary Loads

BATHTUB requires tributary flow and pollutant concentrations for each reservoir segment in order to quantify a loading rate. The model output from PLOAD provided flow and the pollutant loads for the segments, and those annual pollutant loads and flows used to estimate pollutant concentrations in micrograms per Liter (µg/L) (or parts per billion) for input the BATHTUB model. Table 17 summarizes values from the watershed model (also properly adjusted for required BATHTUB units) that were used during the model calibration. High total nitrogen concentrations are caused by assumed septic system effluent loads that are expected to reach the Lake Arlington. These higher concentrations may not be prevalent always in the tributary flows but are predicted to occur on an annual average. Lower pollutant concentrations to Segment 3 are result of the dilution of pollutant loads from high discharges to the segment from Handley Steam Electric Station facility, but the pollutant load is comparable to other segments.

Table 17: Tributary Annual Inputs for Existing Conditions

Segment	Flow (MG)	Flow (hm^3)	TN (µg/L)	TP (µg/L)
1	1780	6.73	4296	145
2	731	2.76	12828	272
3	85252	322.71	405	8.7
4	382	1.45	15344	303
5	336	1.27	15332	302
6	626	2.37	13299	277
7	49649	187.94	9011	217

3.8 Water Quality Model Calibration

The empirical models implemented in BATHTUB are mathematical generalizations about lake behavior. When applied to data from a particular lake, actual observed lake water quality data may differ from BATHTUB predictions by a factor of two or more. Such differences reflect data limitations (measurement or estimation errors in the average inflow and outflow concentrations) or the unique features of a particular lake since no two lakes are the same. BATHTUB's "calibration factor" provides model users with a method to calibrate the magnitude of predicted lake response. The model calibrated to current conditions (against measured data from the lakes) can be applied to predict changes in lake conditions likely to result from specific management scenarios, under the condition that the calibration factor remains constant for all prediction scenarios.

BATHTUB model calibration consists of:

1. Applying the model with all the inputs specified above.
2. Comparing model results to observed water quality data.

3. Adjusting model coefficients to provide the best comparison between model predictions and observed water quality.

The BATHTUB model was initially applied with the model inputs specified above. Data are available from several sources. The USGS monitors water quality at different locations in the Lake. Two of the USGS sampling stations, 11040 and 11042 are in model Segments of 1 and 4, respectively. Similarly, water quality data is also available for raw water at the City's Pierce-Burch Water Treatment Plant (WTP) intake point. More details on the Lake Arlington monitored water quality summaries can be found in Malcolm Pirnie's *Review of Lake Arlington Water Quality* (2010) technical memo. Water quality data obtained for the period between April 2005 and November 2008 were used for calibration of the BATHTUB model for Segments 1 and 4. Since the Pierce-Burch WTP intake location is also in Segment 1, the average of mean water quality data from the USGS monitoring station and the Pierce-Burch WTP intake point were considered for calibrating the model for Segment 1.

Table 18 summarizes the actual and model-predicted water quality data for Lake Arlington. Figures 8 and 9 illustrate the total phosphorus, chlorophyll *a* and secchi depth calibration graphs. The predicted total phosphorus concentrations are well within 1% of the observed values for the segments 1 and 4. Similarly, the predicted cholorophyll a concentrations are within 5% (about 4% for segment 1 and 3% for segment 4) of their observed concentrations for segments 1 and 4. The predicted secchi depths for segments 1 and 4 are same as the observed values. Therefore, the calibrated BATHTUB model is expected to predicted the pollutant concentrations with acceptable error. The BATHTUB model will be used to predict the Lake water quality parameters including total nitrogen, hypolimnetic oxygen depletion rate, etc, in addition to total phosphorus, chlorophyll *a* and secchi depth for the future development conditions of the watershed. BATHTUB will be calibrated for all the parameters predicted using the monitoring data collected from various point on the Lake.

Table 18: Model Predictions and Monitored Water Quality of the Lake

Segment	TP (ppb)		Chlorophyll a (ppb)		Sechhi Depth (m)	
	Predicted	Observed	Predicted	Observed	Predicted	Observed
Segment 1	58.7	59	25.7	24.7	0.8	0.8
Segment 2	58.8	NA	27.0	NA	0.8	NA
Segment 3	59.0	NA	30.3	NA	0.8	NA
Segment 4	61.7	62.0	31.3	32.4	0.8	0.8
Segment 5	68.1	NA	38.2	NA	0.7	NA
Segment 6	72.1	NA	46.5	NA	0.7	NA
Segment 7	126.4	NA	70.9	NA	0.4	NA

Note: NA – Not available

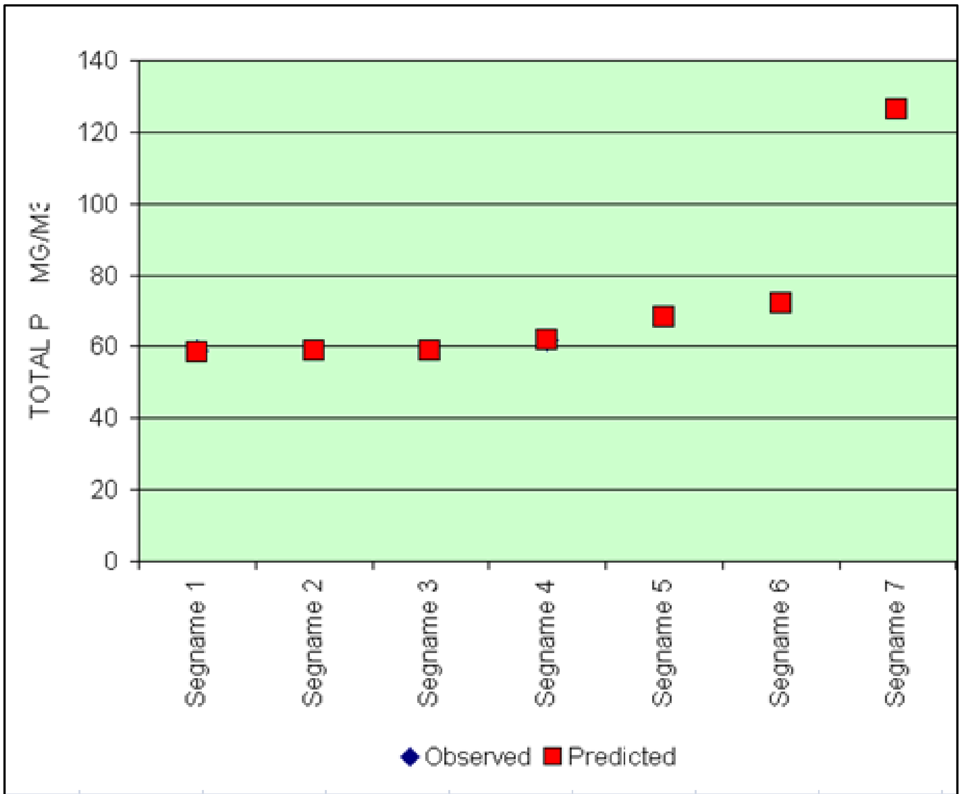
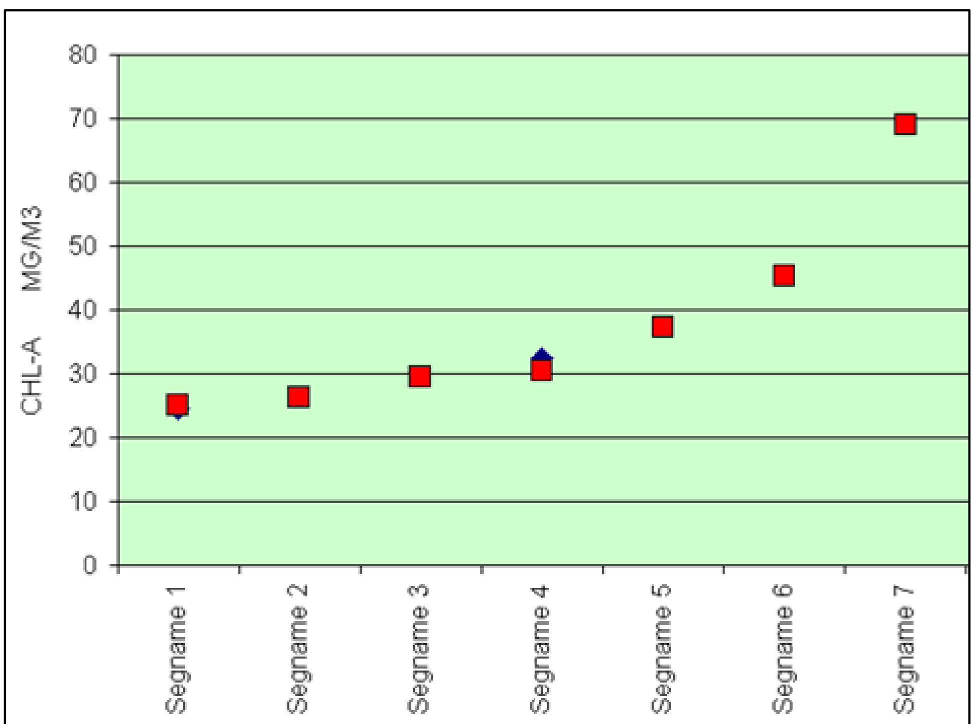


Figure 8: BATHTUB Calibration Plot for Total Phosphorus (MG/M^3 = ug/L)



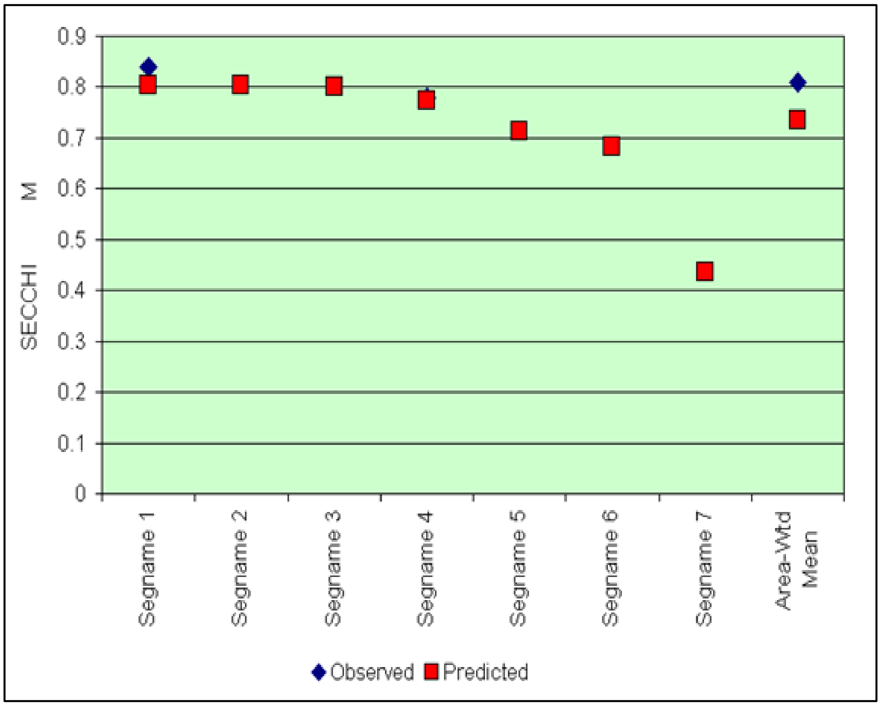


Figure 10: BATHTUB Calibration Plot for Secchi Depth (m)

3.9 Conclusions

The screening level PLOAD model was setup for the Lake Arlington watershed to predict the annual average pollutant loads to the Lake. The model input data for the model was driven from the available monitoring data and assumptions were made based on the literature and professional experience when such watershed specific monitoring data is not available. Assumptions made in the model may affect the model predictions but to our knowledge, based on the information provided by different sources such as the City of Arlington staff and NCTCOG team, all assumptions made for this task are reasonable and hence the model predicted results.

Since wastewater is predominately treated by individual septic systems, most of the nutrient loads to Lake Arlington were predicted to originate from the septic effluents. Gas well facility point sources were predicted to contribute considerable amounts of TSS load to Lake Arlington. Lake Arlington was divided into seven segments based on the bathymetric similarities of the segments for the BATHTUB reservoir model application. The predicted annual pollutant loads from PLOAD were used as input pollutant loads for BATHTUB segments and the model was calibrated to predict the pollutant level in the Lake. This calibrated reservoir will be used to test the sensitivity of the Lake water quality for the watershed future development and management scenarios.

3.10 References

Baird, C.F., Dybala, T.J., Jennings, Marshall, and Ockerman, D.J. 1996. *Characterization of nonpoint sources and loadings to the Corpus Christi Bay National Estuary Program study area: Corpus Christi Bay National Estuary Program*. CCBNEP–05, 226p.

Banks, K.K, and Wachal, D.J. 2007. City of Denton and United States Environmental Protection Agency. "*Demonstrating the Impacts of Oil and Gas Exploration on Water Quality and How to Minimize these Impacts Through Monitoring Activities and Local Ordinances*." Denton, TX.

Ernst, M. R., W. Frossard, and J. L. Mancini. 1994. *Two Eutrophication Models make the Grade*. Water Environment and Technology, November, 15-16.

National Stormwater Quality Database (NSQD) Version 3. 2008. http://rpitt.eng.ua.edu/Research/ms4/mainms4.shtml.

Pitt, R., A. Maestre, and R. Morquecho. 2005. *The National Stormwater Quality Database (NSQD, version 1.1)*. http://unix.eng.ua.edu/~rpitt/Research/ms4/mainms4.shtml.

Soil Conservation Service (1986). *Urban Hydrology for Small Watersheds*, *Technical*

Release 55. Washington, DC.

Tetra Tech. 2004. *Technical Memorandum – Task 1: Impact Analysis Town Center Stormwater*. Management Plan. Prepared for the Town of Cary.

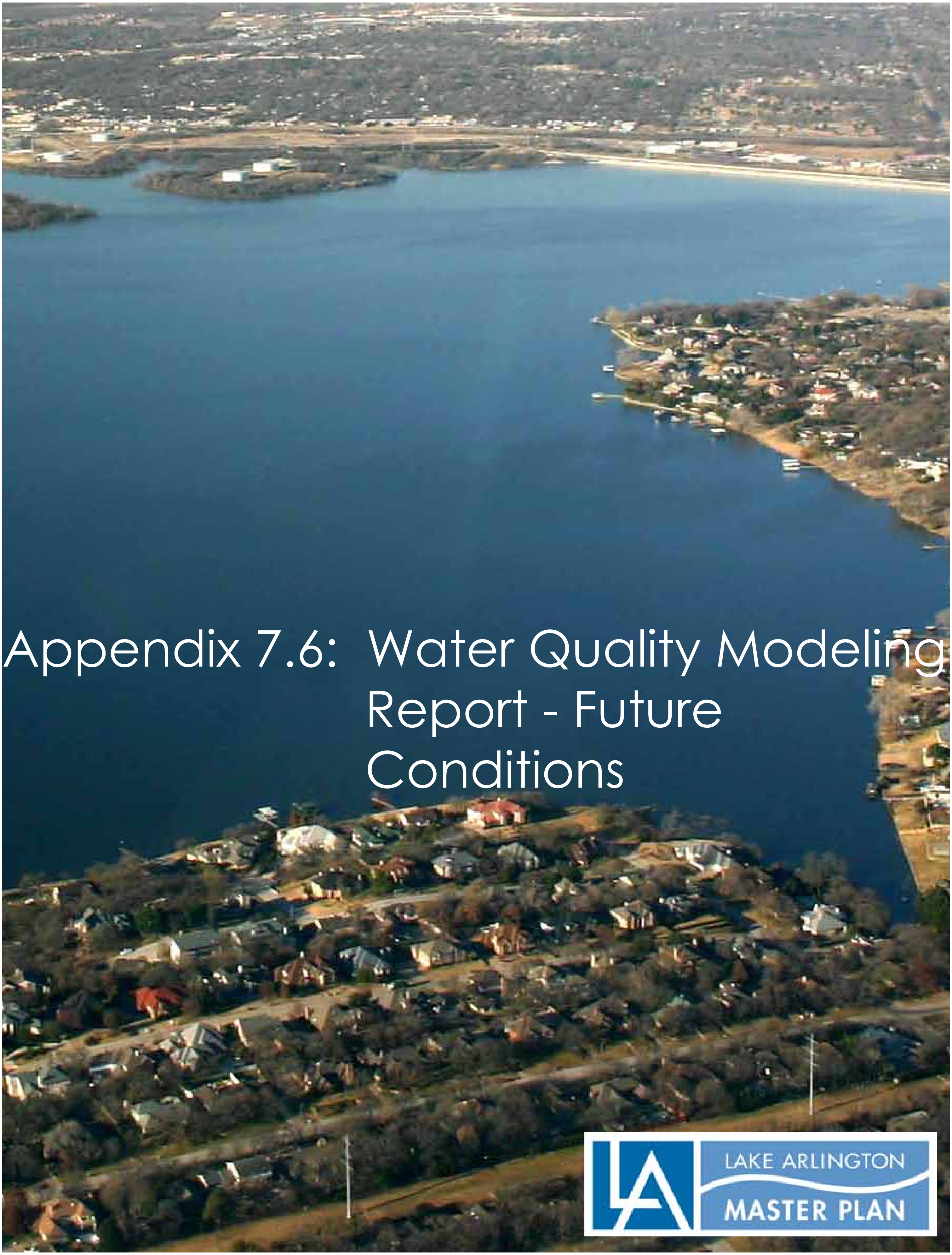
USEPA. 2001. PLOAD version 3.0, *An ArcView GIS Tool to Calculate Nonpoint Sources of Pollution in Watershed and Stormwater Projects*. U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (USEPA). 1983. *Results of the Nationwide Urban Runoff Program: Volume I - Final Report*. PB84-185552, Washington, D.C.

Wahl, K. L., and Wahl, T. L. 1995. *Determining the Flow of Comal Springs at New Braunfels, Texas*. Texas Water '95, American Society of Civil Engineers, August 16-17, 1995, San Antonio, Texas, pp. 77-86.

Walker, W. W. 1986. *Empirical Methods for Predicting Eutrophication in Impoundments; Report 3, Phase III: Applications Manual*. Technical Report E-81-9, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Appendix 7.6: Water Quality Modeling Report - Future Conditions



City of Arlington
101 W. Abram Street • Arlington, Texas 76010

Lake Arlington Master Plan - City of Arlington, Texas

Water Quality Modeling Report – Future Conditions

December 2010

Report Prepared By:

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Contents

Table Figures

Table of Tables

1 Introduction

Quantifying the response of the planned reservoir to external pollution loads is an important step in the planning and management of the watershed. Since Lake Arlington is located at the downstream end of the Village Creek, its water quality will be affected by human-induced activities in the overland area upstream of Village Creek and its tributaries. Measures need to be planed prior to future development of the watershed to prevent increased pollution in Village Creek and ultimately Lake Arlington.

Exiting conditions of Lake Arlington watershed were previously modeled and details of the modeling efforts and model calibration procedures can be found in **the Water Quality Modeling-Existing Conditions (Malcolm Pirnie, October, 2010) report**. This current report describes the procedures used to evaluate various proposed watershed protection measures. Modeling scenarios were developed to test individual water quality improvements with proposed watershed management strategies. The purpose of modeling these scenarios is to provide the municipalities in the watershed with information on the potential effect the recommended management strategy may have on selected water quality parameters in the Village Creek watershed. This will provide information to facilitate decision making by local governments about potential water quality problems and possible watershed management scenarios. The screening model scenarios include:

Scenario 1: Future water quality with existing management strategies

Scenario 2: Future water quality with proposed management strategies

The proposed measures include policies requiring the capture of excess runoff depth corresponding to the 90-percentile of rain events and treating the runoff volume corresponding to 1.5 inches of rainfall from all new development and re-development sites in the watershed, and point source (WWTP and natural gas wells) discharge control.

The fundamental model input for each of the future scenarios is the projected land uses acquired from the North Central Texas Council of Governments (NCTCOG) for each member city in the watershed. This future land cover remained essentially constant for each run to determine the effect of potential future watershed management scenarios. Evaluations of the water quality under future conditions and proposed watershed protection measures were conducted by using calibrated models for the watershed existing conditions. Details of each model scenario, including the assumptions that were made for each, **are discussed in the following sections**.

There are also a number of policies which do not readily lend themselves to analysis through modeling but which are nevertheless important for protecting water quality. For example, the explicit effect of a public education program cannot be realistically modeled. Furthermore, practical constraints limit the number of alternative scenarios that can be examined using BATHTUB. Therefore, scenarios were selected that will yield the most useful information.

2 Watershed Existing Conditions Model

The non-point source loading model under existing conditions was developed to represent existing land use and typical hydrologic conditions. PLOAD (US EPA), a GIS-based model, was employed to model the non-point source pollutants loads generated within the Village Creek/Lake Arlington watershed. Within PLOAD, the Simple Method was used for pollutants load estimation. The Simple Method calculates the pollutant loads with the following equation:

$L_P = \Sigma_u (P * P_J * R_{VU} * C_U * A_U * 2.72 / 12)$

Where: L_P = Pollutant load, lbs

P = Precipitation, inches/year

P_J = Ratio of storms producing runoff (default = 0.9)

R_{VU} = Runoff Coefficient for land use type u, $inches_{run}/inches_{rain}$

C_U = Event Mean Concentration for land use type u, milligrams/liter

A_U = Area of land use type u, acres

The Village Creek/Lake Arlington watershed is approximately 140 square miles and which was sub-divided to create 55 sub-basins for modeling. The delineation was performed using manual delineation techniques in ESRI's ArcMap software, version 9.1. The **Figure 1** shows the watershed boundary with delineated sub-watersheds.

Average annual precipitation based on rain gauge data from Dallas-Fort Worth International Airport for a 34 year period of record was used in the model. Point sources consisting of, wastewater treatment plants (WWTPs) and gas well sites were included in the model. Information about inventory, location and type of point source was obtained from the cities in the watershed. WWTPs discharge pollutant loads used in the model were estimated from the Discharge Monitoring Reports (DMRs), and other literature was used for modeling the gas well site pollutant loads. Discharges from Cedar Creek and Richland Chambers Reservoirs to Village Creek were also considered point sources and annual pollutant loads were estimated from their discharge reports and literature values. Assuming the same level of discharge will be maintained from these reservoirs to Lake Arlington in the future, the estimated annual pollutant loads used in the existing conditions model are used in the future conditions model. Additional parameters and input data used for modeling include land use, impervious factors and event mean concentrations (EMC) of pollutants. Regulatory requirements and best management practice (BMP) effectiveness was considered in the modeling, and the same level of treatment from these considerations is used when modeling the future watershed conditions. The EMCs of the modeled pollutants for major land use categories are summarized in the Table 1.

Table 1: Pollutants EMCs by Land Use Category used in PLOAD Model

Land Use	Pollutant EMC					
	TSS (mg/L)	TN (mg/L)	TP (mg/L)	COD (mg/L)	BOD (mg/L)	Fecal Coliform (cfu/100ml)
Residential	54	1.8	0.35	49	8.3	7580
Commercial	40	1.7	0.17	53	12.3	5480
Industrial	67	1.5	0.21	53	7.2	5425
Open Space	60	2.2	0.16	32	4.0	2500
Roads	74	1.9	0.22	59	6.4	1470

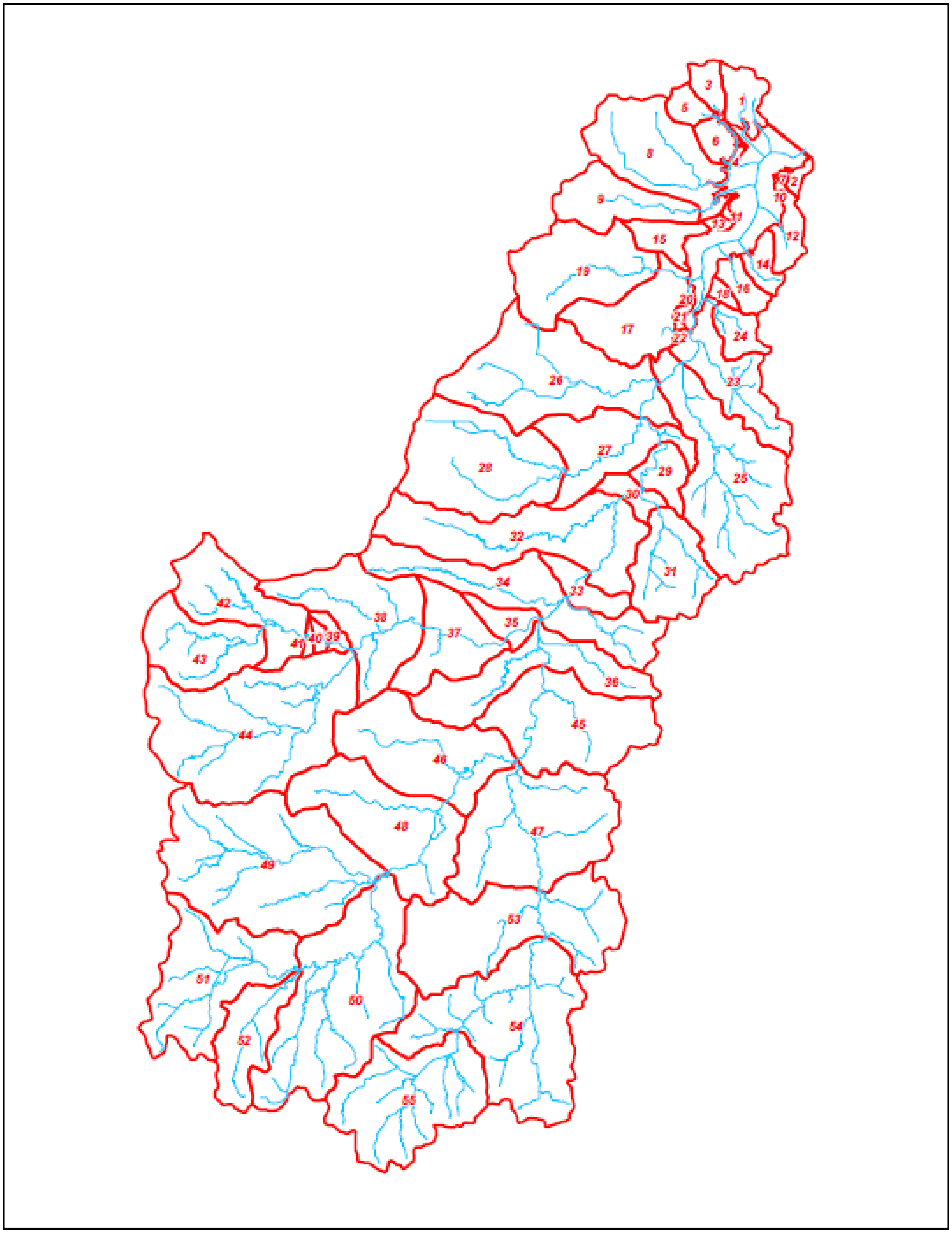


Figure 1: Modeled Sub-Basins of Lake Arlington Watershed

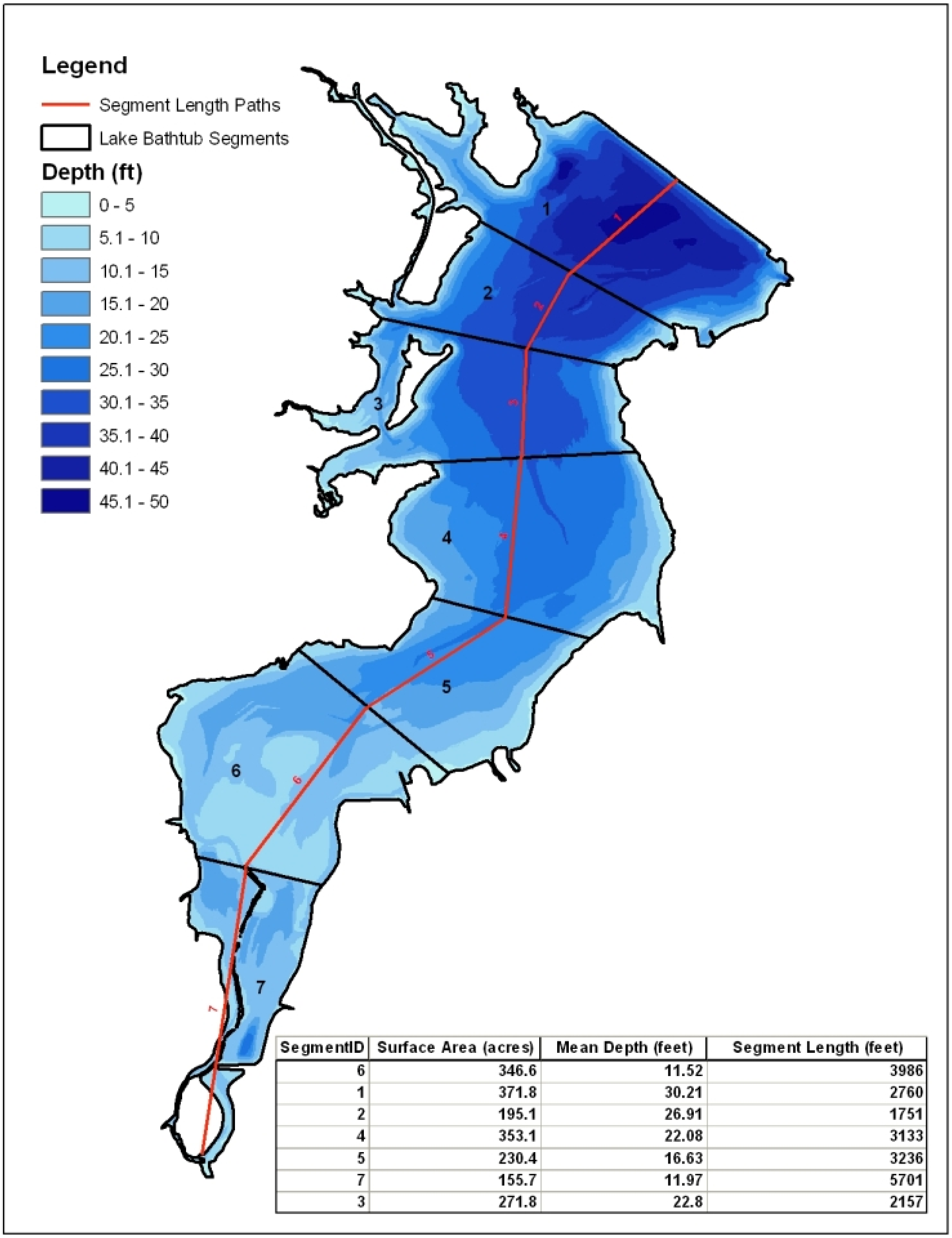
PLOAD estimated non-point source pollutant loads that would reach Lake Arlington for the purpose of predicting lake water quality. The U.S. Army Corps of Engineers BATHTUB model was employed for predicting the Lake water quality. The Primary pollutants modeled in BATHTUB are total phosphorus, total nitrogen and chlorophyll a concentration. To provide spatial variation in the predicted water quality along the length of the reservoir, Lake Arlington was divided into seven segments as illustrated in Figure 2. Reservoir model segmentation model input parameters are summarized in Table 2. The same segmentation scheme and parameters will be used for the future conditions model of the Lake water quality. Estimated pollutant loads to the Lake segments used in the BATHTUB model which were calculated as the sum of the loads during high flows and baseflows (Table 3). The United States Geological Survey (USGS) water quality monitoring data in the Lake was employed to calibrate the BATHTUB model for close prediction of future water quality.

Table 2: Reservoir Segmentation Inputs

Segment	Mean Depth (ft)	Mean Depth (m)	Surface Area (acres)	Surface Area (km^2)	Length (ft)	Length (km)
1	30	9.21	372	1.50	3986	0.84
2	27	8.20	195	0.79	2760	0.53
3	23	6.95	272	1.10	1751	0.66
4	22	6.73	353	1.43	3133	0.95
5	17	5.07	230	0.93	3236	0.99
6	12	3.51	347	1.40	5701	1.21
7	12	3.65	156	0.63	2157	1.74

Table 3: Tributary Inputs for Existing Conditions

Segment	Flow (MG)	Flow (hm^3)	TN (μg/L)	TP (μg/L)
1	1780	6.73	4296	145
2	731	2.76	12828	272
3	85252	322.71	405	8.7
4	382	1.45	15344	303
5	336	1.27	15332	302
6	626	2.37	13299	277
7	49649	187.94	9011	217



SegmentID	Surface Area (acres)	Mean Depth (feet)	Segment Length (feet)
6	346.6	11.52	3986
1	371.8	30.21	2760
2	195.1	26.91	1751
4	353.1	22.08	3133
5	230.4	16.63	3236
7	155.7	11.97	5701
3	271.8	22.8	2157

Figure 2: **Modeled BATHTUB Segments**

3 Future Conditions of Watershed

In order to model future development scenarios, it was necessary to develop procedures for estimating changes in land use and associated PLOAD parameters. The precipitation rate, phosphorus decay rate, and runoff coefficients/ EMCs associated with specific land uses were unchanged from the existing conditions model. However, future land use change in the watershed was required to understand how undeveloped land would change into developed land uses and how existing developed land uses will redevelop, and to understand how these will affect the runoff water quality. The number and discharge rates of point sources may change over time and may again affect the runoff water quality. For an example, increases in population may require increasing WWTP capacity and therefore their discharges will increase pollutant load to Village Creek and Lake Arlington.

3.1 Land Use

Most of the municipalities in the watershed area have completed a master plan for future development land use. A map of combined master plan maps of those cities was developed and that map was the primary source of information used to determine the future land use scenario for the water quality model. The existing land use map was compared with proposed master plan development map of the watershed to determine the changes in the watershed land uses for future development. **Table 4** summarizes the land use changes for the watershed and **Table 5** summarizes existing and projected percent of watershed area by land use. **Figure 3** illustrates the projected land use changes in the tributary watershed.

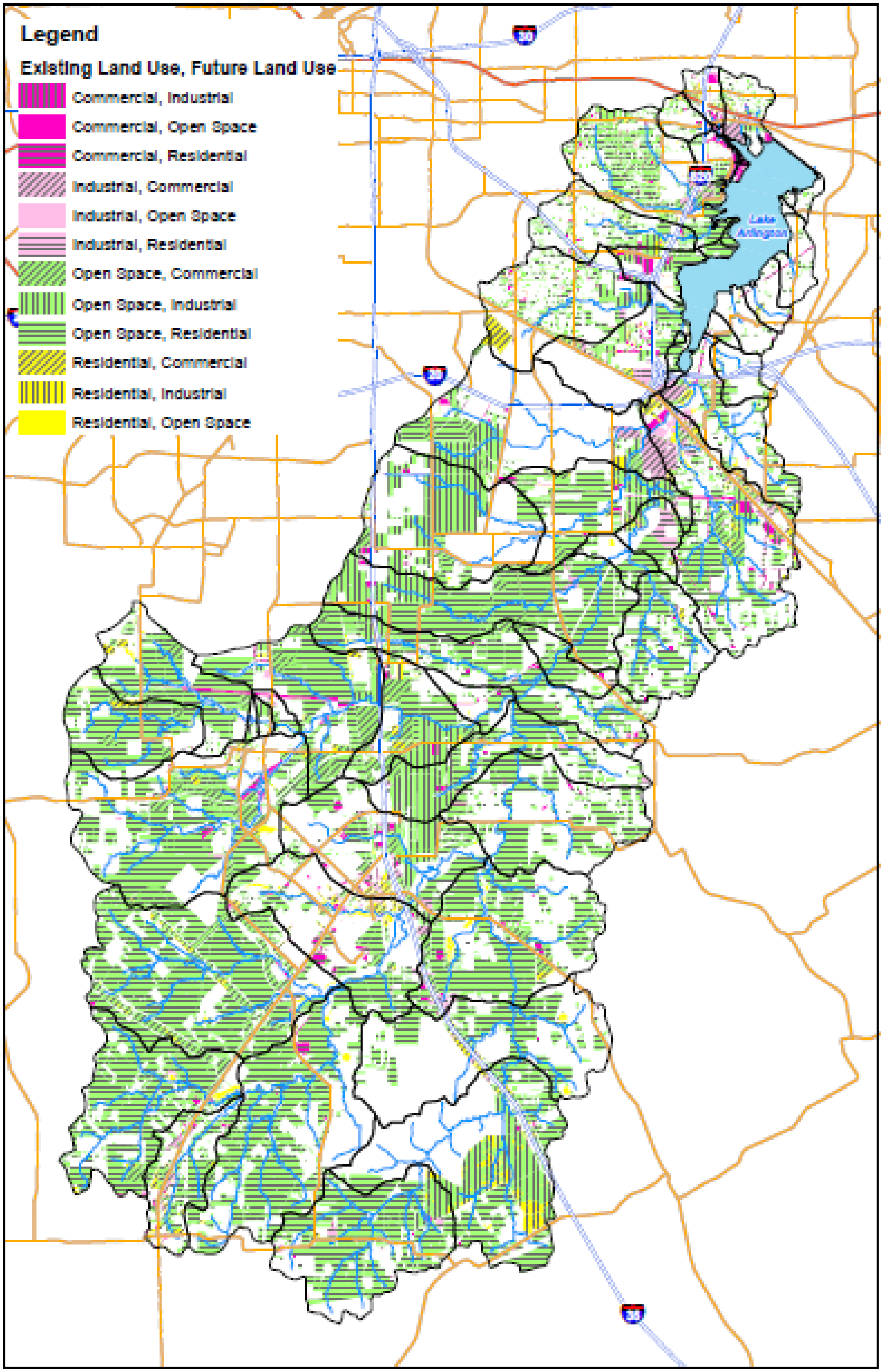
Table 4: Summary of Change in Land Use Area of Tributary Watershed

Future Land Use	Acres of Existing Land Use			
	Commercial	Industrial	Open Space	Residential
Commercial	2569	773	3307	931
Industrial	406	2136	4933	549
Open Space	242	73	2685	268
Residential	604	413	29566	21865

Table 5: Summary of Change in Land Use of Tributary Watershed

Land Use	Existing (%)	Future (%)
Commercial	5	10
Industrial	5	11
Open Space	55	4

Residential	32	72
Water Bodies	3	3


Legend
Existing Land Use, Future Land Use
Commercial, Industrial
Commercial, Open Space
Commercial, Residential
Industrial, Commercial
Industrial, Open Space
Industrial, Residential
Open Space, Commercial
Open Space, Industrial
Open Space, Residential
Residential, Commercial
Residential, Industrial
Residential, Open Space
Lake Arlington

3.2 Point Sources

In order to simulate the effect of future development on Lake Arlington, it was necessary to estimate point source loads associated with that development. Such loads will vary depending on the treatment and disposal technologies employed. **This section** describes how future point source flows were estimated for future conditions of the watershed.

3.2.1 Estimation of Future Wastewater Generation Rates

Current population of Tarrant and Johnson Counties, which cover the Village Creek watershed area, is estimated to be approximately 1.9 million, based on recently published 2010 census data by the Census Bureau's Population Estimates Program (PEP). The projected population for the watershed area, per the NCTCOG North Central Texas 2030 Demographic Forecast, would be about 2.5 million. Therefore the watershed area is expected to have an increase of about 630,000. Using a typical per capita wastewater generation rate of 70 gallons per day, the projected population will increase approximately 44 MG per day of wastewater discharges in addition to existing discharges.

3.2.2 Future Gas Wells Contribution

Natural gas wells construction is an active industry in the watershed. Construction of natural gas wells and other related activities such as service wells, drain holes, etc. are expected to export pollutants into the receiving waters. Based on current numbers of such activities in the watershed, and assuming all these wells were constructed in past ten years, the approximate rate of such gas wells development was calculated, which is detailed in the **existing conditions modeling report**. The same rate of gas well point sources is assumed for the future conditions model.

4 Future Model Scenarios

4.1.1 Scenario 1: Lake Future Water Quality with Exiting Management Strategies

This scenario evaluates the future water quality with projected land uses under existing stormwater management ordinances and other watershed management strategies currently in place for new development and re-development sites. The municipalities within the watershed have ordinances for stormwater management. In most cases, however, these ordinances are designed to reduce downstream flooding through the use of stormwater detention facilities. Such facilities are not designed to protect water quality or prevent excessive stream channel erosion, and are generally not effective in performing these functions. Rather, they are typically designed to limit post-development peak runoff rates to less than or equal to the predevelopment rates for specific return-interval storms. Even if peak flow rates of flow are properly controlled, the total volume of runoff from the site will still be much larger than under pre-development conditions.

Following the intent of USEPA's MS4 NPDES stormwater program and other related regulations to reduce non-point source pollution in the form of stormwater to receiving waters, it was assumed that the BMPs commonly promoted and implemented by municipalities in the watershed could, on average, reduce pollutant levels in runoff by approximately 20%. The 20% reduction in the non-point source pollution was applied to all future developed areas, except open lands and water bodies in the watershed.

Under this scenario, all point source discharges including discharges from WWTPs, septic systems and gas well sites were modeled as having the same concentrations and loads of pollutants modeled in the existing watershed existing conditions model. The WWTP discharge loads from existing plants and future additional WWTP discharges based on projected population growth to the Lake are summarized in **Table 6**.

Table 6: WWTPs Pollutant Discharge Loads to Lake Arlington

Location or Permittee	EPA ID	Annual Loads (lb) to Lake			
		BOD5	**Nitrogen, ammonia total (as N)**	**Phosphorus, Total**	**TSS**
Johnson County Special Utility District WWTP	TX0124923	2.18E+03	1.62E+04	9.70E+02	2.72E+04
Mayfair WWTP	TX0105872	3.01E+02	6.34E+02	9.95E+01	7.61E+02
Oak Ridge Square MHP WWTP	TX0102806	2.12E+02	7.54E+01	1.89E+01	4.89E+02
RV Ranch WWTP	TX0128490	1.77E+02	7.84E+01	1.96E+01	5.44E+02
Briarhaven Wastewater Treatment Facility	TX0128503	6.22E+02	2.23E+02	5.60E+01	9.95E+02

The calculated annual TSS load from the natural gas well sites is presented in **Table 7**. It was assumed in this model, that gas well sites are projected to develop at same rate as in the existing watershed conditions model. Discharges from eastern reservoirs and Handley Steam Plant are modeled the same as the existing conditions reservoir model.

Table 7: Natural Gas Wells Point Source TSS Load

Parameter	Concentration (mg/L)	Load (lb)
TSS (mg/L)	2,745	19,684

4.1.2 Scenario 2: Lake Future Water Quality with Proposed Management Strategies

The proposed measures include a requirement to capture excess runoff corresponding to the 90th percentile of rain events depth and treating the remaining runoff corresponding to 1.5 inches of rainfall, and point source (WWTPs, septic systems, industrial dischrages and gas well sites) discharge control.

4.1.2.1 Proposed Runoff Reduction Requirement

This proposed requirement is for all new and re-development sites in the Lake Arlington watershed. Under this proposed requirement, the developer has to capture excess runoff over existing conditions runoff from their development site corresponding to 1.5 inches of rainfall depth. Representative daily rainfall data monitored over the years has indicated that the rainfall event corresponding to 90th percentile of events was about 1.5 inches for the watershed. **More details of the rainfall analysis can be found in Lake Arlington Rainfall Analysis (Malcolm Pirnie, September 2010) technical memorandum**. Under this recommendation, on a development or re-development site, the developer may be required to assess the runoff volume that is generated from the site prior to start of any land disturbing activity and volume that would be generated from the site for post development conditions of the site, for 1.5 inch rainfall event. The difference in the runoff volumes of existing conditions and future conditions of the site is the amount required to be captured on site. The runoff reduction recommendation will help reduce peak flows and downstream flooding, in addition to the pollutant load and runoff volumes. Since this requirement is applicable to new development and re-development sites, excess runoff reduction corresponding to 90th percentile of rainfall events was applied only to areas that were identified to have changing land use in the future.

4.1.2.2 Proposed Runoff Treatment Requirement

It is also recommended that all future development and re-development sites have a runoff treatment requirement. Under this requirement, runoff corresponding to 1.5 inch rain event is required to be captured and treated. Since the development sites are recommended to implement best management practices (BMPs) to reduce the excess runoff generated from developed site compared to pre-development conditions corresponding to 1.5 inch rain event, part of the runoff treatment volume requirement will be achieved through the runoff reduction BMPs. Also, if a site developer designates riparian corridors or implements a conservation subdivision, the area draining to the undisturbed areas and the undisturbed area itself will not be considered for when calculating the required runoff capture and treatment requirements.

Since the PLOAD model predicts the annual average runoff loads based on the pollutant event mean concentrations, it will not explicitly model the pollutant load reduction using the excess runoff reduction concept. Since excess runoff reduction and runoff treatment requirements combined for new development and re-development provides treatment for the first 1.5 inches of rainfall runoff, it can be safely assumed that these requirements will provide treatment for first flush volume from the sites. Traditionally first flush volume is considered to be first 0.5 inch runoff from an area and it is assumed to contain 90% total pollutant load. A literature review of pollutant removal efficiencies of various stormwater quality BMPs that are widely used is presented in **Table 8**. The portion of the runoff from new development and re-development sites that is required to be captured on-site will help reduce the pollutant load entirely (100%) for the portion captured. Also it is important to understand that proposed excess runoff capture and treatment corresponding to 1.5 inch rain depth will also reduce the pollutant load from the larger events (more than 1.5 inch events) up to first 1.5 inch of rainfall. Considering the possible pollutant removal efficiencies for treated runoff and pollutant load reduction from excess runoff reduction on new development and re-development sites, a fairly conservative assumption of approximately 90% for TSS and fecal coliform and 75% for BOD, COD, TN and TP load reduction under the proposed requirements from the new development and redevelopment sites was made. This percentage of pollutant load reduction was applied in the PLOAD model for all pollutants modeled.

Table 8: Literature Reported Stormwater BMP Removal Efficiency[1]

FECAL COLIFORM (%)	BOD (%)	COD (%)	TSS (%)	TN (%)	TP (%)
90	70	70	90	70	65

[1] Removal efficiencies shown are values reported in Georgia's Stormwater Management Manual, Volume 2, August 2001 for stormwater ponds (wet) except for the BOD and COD values, which were obtained from the Center for Watershed Protection's National Pollutant Removal Performance Database. For cases, these numbers are also comparable to the removal efficiencies of stormwater controls presented in the iSWM Design Manual for Site Development (2006).

In addition, a 20% pollutant load reduction was applied giving consideration to existing stormwater management BMPs was applied for all other developed areas. This will cover the pollutant load reduction from continuous implementation of existing BMPs, both structural (eg. detention ponds or wet lands) and non-structural (eg. street sweeping, public education, etc).

4.1.2.3 WWTPs Discharges

Enhanced nutrient removal techniques are recommended for treating the wastewater in the watershed to achieve lower concentrations of pollutants in WWTP discharges. The modeled concentrations of pollutants in WWTP discharges are summarized in **Table 9**. Additional discharge volumes for the projected future conditions of the watershed are estimated as described earlier. If the current treatment levels used in the existing conditions modeling have better discharge concentrations for the pollutants, then the current discharge levels were used in the modeling. The calculated loads from the WWTPs that reach the Lake Arlington are presented in **Table 10**.

Table 9: Modeled Effluent Concentrations of WWTPs Discharges

TSS (mg/L)	BOD5 (mg/L)	TN (mg/L)	TP (mg/L)
10	5	5	0.1

Table 10: Modeled WWTPs Effluent Discharge Pollutant Loads

Location or Permittee	EPA ID	Annual Loads (lb) to Lake			
		BOD5	Nitrogen, ammonia total (as N)	Phosphorus, Total	TSS
Johnson County Special Utility District WWTP	TX0124923	2.2E+03	1.6E+04	9.7E+01	2.7E+04
Mayfair WWTP	TX0105872	2.8E+02	6.3E+02	9.9E+00	7.6E+02
Oak Ridge Square MHP WWTP	TX0102806	5.2E+01	7.5E+01	1.9E+00	1.7E+02
RV Ranch WWTP	TX0128490	5.5E+01	7.8E+01	2.0E+00	1.7E+02
Briarhaven Wastewater Treatment Facility	TX0128503	1.6E+02	2.2E+02	5.0E+00	4.5E+02
Additional Future Discharges		3.3E+05	6.0E+05	1.2E+04	1.1E+06

4.1.2.4 Natural Gas Wells and Industrial Point Source Discharges

The proposed plan for controlling TSS loads from natural gas wells includes a requirement for runoff retention corresponding to 2 year-24 hour rainfall event. Based on the literature, a properly designed and maintained retention pond can achieve an average of about 80% reduction in TSS. Assuming runoff from 2 year-24 hour rainfall event corresponds to about 80% of total rainfall in the area, implementation of proposed retention requirement may treat 80% runoff from the site and can achieve 80% of treatment efficiency. Under this scenario, an average a gas well site point source is estimated to contribute 7,100 lbs of TSS annually to the receiving waters in the watershed.

Discharges from Handley Steam Electric facility were modeled the same as existing conditions model.

5 Model Results

Table 11 summarizes the existing and post-development PLOAD-predicted pollutant loads to Lake Arlington by BATHTUB segment. The predicted pollutant loads to the Lake showed significant increase over existing conditions for all pollutants modeled under scenario 1 (**Table 12**). Scenario 2 has resulted in decrease in TSS and BOD annual load to the Lake with a moderately low increase in TN and COD (**Table 2**). Whereas TP and fecal coliform showed moderate increases over existing conditions, the magnitude of increase was much lower in scenario 2 than scenario 1 (**Table 12**). A considerable portion (32 percent) of increased TP load under scenario 2 was predicted to be the result of increased future WWTP discharges.

Compared to scenario 1, scenario 2 was predicted to decrease a considerable pollutant load to the Lake; approximately 31 percent of total nitrogen and 70 percent of TP load (**Table 13**). It is important to note that control of nutrient loads to the Lake is essential for controlling the algal bloom and eutrophic conditions of the Lake. From the predictions, it is very obvious that for future watershed conditions with no additional management policies in place, nutrient loads to the Lake will increase very significantly and therefore the Lake may turn highly eutrophic. Point source nutrient load was predicted to contribute a major portion of the total nutrient load to the Lake, even under scenario 2 which assumed lower discharge concentrations of the WWTPs. Since majority of the wastewater generated in the watershed is treated by septic systems, the nutrient loads to the Lake from the point sources are predicted to be high. Since WWTPs are expected to provide better treatment of wastewater, in the future, if some of these septic system loads are treated by WWTPs, the nutrient loads (especially for TN) can be expected to reduce below what has been predicted by the model. Additionally, by using tertiary treatment the nitrogen levels in the WWTP discharges may be further reduced to 3 mg/L which can yield further reduction of nutrient loads from WWTPs to Lake Arlington.

The BATHTUB segment 7 of Lake Arlington receives discharges from the major stem of Village Creek, which has most of drainage area in the Village Creek/Lake Arlington watershed. Therefore, the quality of discharges to the segment 7 is expected to be impacted more from future development than the discharges into any other lake segment. Additionally, the projected wastewater discharges from future population growth, for scenario 1 and 2, was assumed to be discharging into segment 7, so the predicted pollutant load increase was more for segment 7 than others. But not all the additional wastewater may be discharged into the segment 7, some or all of the additional wastewater may be discharge into other parts of the Lake. In that case, the model predictions for future conditions are conservative for pollutant loads to segment 7.

Table 11: Pollutant Loads by Lake Segments for Modeled Scenarios

Scenario	Lake Segment	TSS (lb/yr)	TN (lb/yr)	TP (lb/yr)	COD (lb/yr)	BOD (lb/yr)	FC (counts/yr)
Existing	1	1.55E+05	5.64E+04	1.19E+03	5.92E+04	2.84E+04	3.30E+13
	2	1.55E+05	7.81E+04	1.65E+03	8.93E+04	3.99E+04	4.38E+13
	3	8.90E+06	2.88E+05	6.19E+03	2.18E+05	1.35E+05	1.16E+14
	4	3.89E+04	4.88E+04	9.60E+02	2.84E+04	2.10E+04	1.90E+13
	5	7.36E+04	4.30E+04	8.41E+02	2.52E+04	1.86E+04	1.66E+13
	6	1.54E+05	6.93E+04	1.43E+03	6.86E+04	3.34E+04	3.40E+13
	7	1.41E+07	3.73E+06	8.88E+04	3.95E+06	3.73E+06	2.19E+15
Scenario 1	1	1.46E+05	5.61E+04	1.18E+03	5.80E+04	2.92E+04	3.39E+13
	2	1.06E+05	7.65E+04	1.46E+03	4.92E+04	3.34E+04	2.56E+13
	3	8.17E+06	3.21E+05	1.20E+04	5.33E+06	1.67E+05	7.29E+14
	4	3.09E+04	4.86E+04	9.22E+02	2.21E+04	2.00E+04	1.55E+13
	5	6.18E+04	4.25E+04	7.77E+02	1.55E+04	1.70E+04	1.05E+13
	6	1.50E+05	6.93E+04	1.51E+03	8.52E+04	3.53E+04	4.36E+13
	7	5.37E+07	6.40E+06	4.36E+05	4.10E+07	1.12E+07	2.56E+16
Scenario 2	1	8.66E+04	5.59E+04	1.25E+03	5.02E+04	2.75E+04	3.14E+13
	2	1.24E+05	7.80E+04	1.67E+03	8.88E+04	3.94E+04	5.25E+13
	3	8.78E+06	2.90E+05	6.24E+03	2.53E+05	1.40E+05	1.72E+14
	4	3.59E+04	4.88E+04	9.62E+02	2.76E+04	2.09E+04	1.58E+13
	5	4.47E+04	4.29E+04	8.38E+02	2.40E+04	1.84E+04	1.44E+13
	6	1.13E+05	6.91E+04	1.77E+03	7.81E+04	3.42E+04	5.27E+13
	7	1.07E+07	4.29E+06	1.25E+05	4.33E+06	2.23E+06	3.95E+15

Table 12: Predicted Increase in Constituent Loads to Lake from Existing Conditions

Scenario	TSS	TN	TP	COD	BOD	FC
1	165%	63%	349%	950%	188%	980%
2	-16%	13%	36%	9%	-37%	75%

Table 13: Predicted Decrease in Scenario 2 Constituent Loads to Lake from Scenario 1

TSS	TN	TP	COD	BOD	FC
68%	31%	70%	90%	78%	84%

Table 14 presents the post-development PLOAD-predicted pollutant concentrations to Lake Arlington by BATHTUB segments.

Table 14: Tributary Inputs for BATHTUB Model by Modeled Scenarios

Segment	Scenario 1				Scenario 2			
	Flow (MG)	Flow (hm^3)	TN (µg/L)	TP (µg/L)	Flow (MG)	Flow (hm^3)	TN (µg/L)	TP (µg/L)
1	1786	6.76	4264	143	1781	6.74	4262	139
2	740	2.80	12366	238	721	2.73	12956	235
3	85552	323.85	449	17	85288	322.85	407	14
4	388	1.47	14961	286	383	1.45	15274	287
5	343	1.30	14791	272	338	1.28	15243	275
6	695	2.63	11978	263	631	2.39	13150	266
7	74198	280.87	8081	513	66484	251.67	6556	206

Table 15 summarizes the predicted BATHTUB reservoir water quality for the existing and future scenarios. The BATHTUB model was calibrated for total phosphorus, chlorophyll *a* and secchi depth and the model calibration was discussed in the existing water quality conditions modeling report. Under existing conditions, Lake Arlington can be considered eutrophic with a predicted area weighted mean phosphorus concentration of about 68 ug/L and a chlorophyll-*a* concentration of about 36 ug/L. In scenario 1—with no additional controls, apart from the controls required by existing policies—mean phosphorus concentration was predicted to increase by up to 119 percent of the existing concentration, with a maximum predicted phosphorus concentration of about 277 ug/L in Lake segment 7 and an area weighted concentration of about 140 ug/L. Similarly, the total nitrogen concentration under scenario 1 was predicted to increase by 15 percent with a maximum concentration of 4,212 ug/L predicted in Lake segment 7, which most of the

watershed drainage discharges into the Lake. The area weighted average for total nitrogen under scenario 1 predicted to be 2,493 ug/L, which is about 10 percent higher than that of existing conditions. The mean chlorophyll-*a* concentration under scenario 1 was predicted to increase up to 52% of the existing concentration with 34 ug/L and 93 ug/L in segments 1 and 7, respectively, with area weighted average of about 51 ug/L which is 41 percent higher than the existing conditions. Similarly, the secchi depth is predicted to decrease under scenario 1 with a maximum reduction of 0.3 m for segment 6. For segment 1, the predicted hypolimnetic oxygen depletion rate (HOD), which is measure of rate of oxygen depletion below the thermocline, was predicted during the approximated growing season Lake hypolimnetic depth of 2.5 m, was expected to increase by 19 percent with 625 mg/m3-day under scenario 1 compared to existing conditions. The BATHTUB model is generally recommended to predict HOD in the segment near the dam and the HOD predictions in the segments away from the dam are reliable only if the model is calibrated with observed data for the sections. Due to lack of monitored HOD data, no HOD predictions were made for segments of the Lake other than segment 1 and the primary concern of predicting water quality was for the section of the Lake near the dam where drinking water intakes are present. Similarly, the frequency of exceedance, presented in the **Table 17**, of a given concentration of chlorophyll *a* was predicted to increase considerably under scenario1 compared to their exceedance frequency predicted for existing conditions. For example, for a given threshold concentration for chlorophyll *a* of 30 ug/L, the area weighted frequency of exceedance was predicted to increase from 47 percent for existing conditions to 66 percent for scenario 1.

Under the scenario 2—with additional controls for runoff capture and treatment—mean phosphorus concentration was predicted to have a moderately low increase of about 2-14 percent with area weighted mean increase of 11 percent. The predicted TP concentration increase in scenario 2 was significantly lower than predicted for scenario 1. Similarly, a very minimal increase up to about seven percent for chlorophyll *a*, except for segment 7 which was predicted to decrease in chlorophyll *a* concentration is expected under scenario 2. The predicted HOD under scenario 2 for segment 1 was within two percent of the existing conditions with predicted HOD of about 537 mg/m^3-day. The predicted secchi depth for segments 1 – 6 was 0.1 m of the existing conditions of the Lake; for segment 7 the same predicted secchi depth as existing conditions is expected. Under scenario 2, the TN concentration has showed a considerable decrease over the existing conditions for all segments, with a maximum decrease of about 18 percent for segment 7.

Since, segment 7 receive discharges from largest portion of the watershed, it's obvious that the future land use scenario may influence Lake water quality in the segment or other portions near the segment 7 to higher extent. However, for modeling purposes, all the additional wastewater discharges from future population growth, about 44 MGD, were modeled to discharge to the segment 7. Even under scenario 2, with proposed enhanced nutrient treatment levels of the WWTPs discharges, major portions of the nutrient loads to the Lake were predicted to originate from the WWTPs. Therefore the high predicted nutrients loads from future additional wastewater discharges are expected to influence the water quality in the segment 7 of the Lake. Realistically, in the future, the additional discharges may or may not enter segment 7 of the Lake, so the water quality of this segment of the Lake may be better than the model predicted.

Considering all the modeling scenario results, it can be concluded that the trophic state of the Lake can be controlled with additional pollution controls. However, the degree of Lake pollution would vary greatly depending on the level of controls implemented. Segment 1, where the drinking water intake is located, is more buffered from increased nutrient loadings and may not experience significant increases in algal biomass with pollution control implementation in the watershed. Overall, scenario 2 has predicted that current conditions of the lake water quality will be maintained, and pollutant reduction BMPs at the existing development areas and implementation of additional BMPs in the watershed are expected to further improve water quality. The model predictions for watershed pollutant loads and Lake pollutant concentrations under scenario 2 are considered conservatively high as these models didn't include the possible pollutant load reduction from other BMPs proposed as part of the Lake Arlington Master Plan. For example, the Master Plan proposes the implementation of riparian corridors and conservation subdivisions for the floodways and floodplains; a recommended model ordinance for illicit discharge detection and elimination, proposed new management strategies for construction site runoff control, etc. which are expected to reduce the pollutant loads to receiving waters but are not explicitly considered in this modeling task.

Table 15: BATHTUB Model Predictions by Lake Segment

Lake Segment	Existing Conditions					Scenario 1					Scenario 2				
	TP (ppb)	TN (ppb)	Chl a (ppb)	Secchi (M)	HOD (mg/m^3-day)	TP (ppb)	TN (ppb)	Chl a (ppb)	Secchi (M)	HOD (mg/m^3-day)	TP (ppb)	TN (ppb)	Chl a (ppb)	Secchi (M)	HOD (mg/m^3-day)
1	58.7	1925	25.7	0.8	526.7	117.7	2207	34.1	0.5	624.7	66.7	1872	27.0	0.7	537.2
2	58.8	1930	27	0.8	NA	118.2	2212	36.7	0.5	NA	66.9	1877	28.6	0.7	NA
3	59	1936	30.3	0.8	NA	118.9	2220	43.0	0.5	NA	67.1	1882	32.3	0.7	NA
4	61.7	2029	31.3	0.8	NA	124.5	2298	43.7	0.5	NA	69.5	1948	33.1	0.7	NA
5	68.1	2250	38.2	0.7	NA	138.6	2486	54.9	0.5	NA	75.3	2106	40.0	0.7	NA
6	72.1	2387	46.5	0.7	NA	147.7	2604	70.8	0.4	NA	78.9	2203	48.7	0.6	NA
7	126	4273	70.9	0.4	NA	276.6	4212	92.9	0.3	NA	128.3	3518	69.1	0.4	NA
Area Wtd Mean	68.3	2258	36.4	0.7	NA	139.9	2493	51.2	0.5	NA	75.5	2109	37.9	0.7	NA

NA: No prediction were made

Table 16: Predicted Percentage Change in Constituents Concentration by Lake Segments Over Existing Conditions

Lake Segment	Scenario 1				Scenario 2			
	TP	TN	Chl a	HOD	TP	TN	Chl a	HOD
1	101%	15%	33%	19%	13.7%	-2.7%	5.1%	2%
2	101%	15%	36%	NA	13.8%	-2.8%	5.8%	NA
3	101%	15%	42%	NA	13.7%	-2.8%	6.7%	NA
4	102%	13%	40%	NA	12.7%	-4.0%	5.7%	NA
5	104%	11%	44%	NA	10.6%	-6.4%	4.7%	NA
6	105%	9%	52%	NA	9.4%	-7.7%	4.7%	NA
7	119%	-1%	31%	NA	1.5%	-17.7%	-2.5%	NA
Area Wtd Mean	105%	10%	41%	NA	10.5%	-6.6%	4.0%	NA

Table 17: Predicted Frequency (%) of Chlorophyll *a* Exceeds the Stated Concentration

Scenario	Conc. (ug/L)	Lake Segment							
		1	2	3	4	5	6	7	Area Wtd Mean
Existing	CHA>10	88.7	90.2	93.0	93.7	96.8	98.5	99.8	94.0
	CHA>20	53.7	57.0	64.1	66.1	76.9	85.4	95.8	69.6
	CHA>30	28.7	31.6	38.4	40.5	53.2	65.5	85.9	46.7
	CHA>40	15.3	17.3	22.4	24.1	35.1	47.3	73.0	30.9
	CHA>50	8.3	9.6	13.2	14.4	22.9	33.5	60.0	20.7
	CHA>60	4.7	5.5	7.9	8.7	15.0	23.6	48.4	14.1
Scenario 1	CHA>10	95.2	96.3	98.0	98.1	99.3	99.8	99.9	97.9
	CHA>20	70.9	74.8	82.3	82.9	90.6	95.8	98.5	84.2
	CHA>30	45.8	50.6	60.7	61.7	74.7	85.9	93.5	65.8
	CHA>40	28.5	32.7	42.4	43.3	57.9	72.9	85.3	49.7
	CHA>50	17.7	20.9	29.0	29.9	43.6	59.9	75.4	37.2
	CHA>60	11.1	13.5	19.9	20.6	32.5	48.3	65.3	28.0
Scenario 2	CHA>10	90.2	91.7	94.3	94.7	97.3	98.8	99.8	94.9
	CHA>20	56.9	60.4	67.9	69.2	79.0	87.0	95.5	72.3
	CHA>30	31.6	34.8	42.5	43.9	56.1	68.1	85.0	49.6
	CHA>40	17.3	19.7	25.7	26.9	37.8	50.3	71.6	33.3
	CHA>50	9.6	11.2	15.5	16.4	25.1	36.2	58.4	22.5
	CHA>60	5.5	6.6	9.6	10.2	16.7	25.9	46.7	15.4

CHA>10-60: Percent of time during growing season that chlorophyll *a* exceeds bloom criteria of 10, 20, 30, 40, 50, or 60 ug/L

6 Conclusions

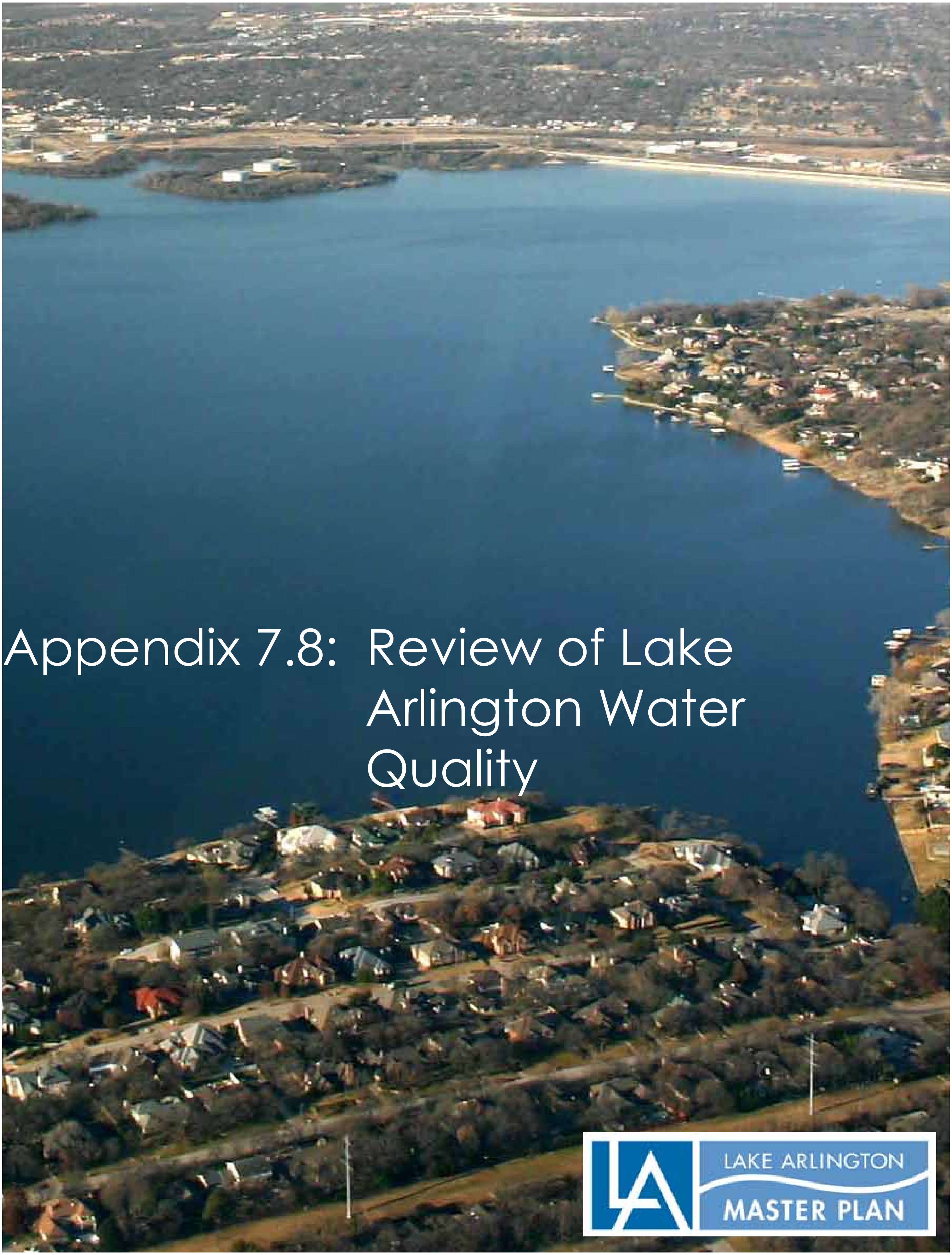
The major conclusions of the modeling effort are as follows:

- Watershed build-out would cause large (up to about 980%) increases in loads of primary constituents to Lake Arlington unless control measures were implemented.
- Point sources were predicted to contribute significant portions of the pollutant load to the Lake, both for existing and future watershed conditions.
- Pollutant loads of some of the constituents were predicted to increase even with advanced management measures and controls. However, the increases of all constituents were predicted to be small to moderate with advanced management measures and controls protecting the Lake water quality.
- Lake Arlington trophic conditions would be expected to be most sensitive to nutrient loads. Increases in phosphorus loads could be kept to low by a combination of stormwater management practices for flow capture and treatment and advanced wastewater treatment practices.
- Without control measures, land use changes and development in the watershed was predicted to cause Lake Arlington to go from a current eutrophic state to a higher level, with a predicted area weighted average of about 51 ug/L of chlorophyll *a* (Scenario 1)
- With control measures, watershed development was predicted to maintain Lake Arlington current eutrophic conditions with predicted area weighted average of about 38 ug/L of chlorophyll *a* (Scenario 2)

Mean chlorophyll-*a* values in the range of 15-30 ug/L have been cited by various authors as thresholds of impairments such as algal scums/blooms, blue-green algae domination, or taste and odor problems in drinking water reservoirs. Portions of the Lake near the dam are close to the eutrophic range of chlorophyll *a* and upper portions of the Lake, where most of the pollutant loads are received, are more eutrophic. BATHTUB results predict that uncontrolled future development in the watershed would increase in the mean chlorophyll-*a* concentration into the range of potential problems, and also increase the frequency of exceedance of the upper chlorophyll *a* threshold (Approximately 30 ug/L).

The watershed PLOAD and Lake BATHTUB modeling effort described in this report is best described as a screening-level model. The watershed model depends heavily on literature-derived parameters, and the reservoir model is calibrated to a limited dataset. As such, the results should not be interpreted as precise actual loads and concentrations, but rather as indications of whether the watershed loads and in-reservoir concentrations would experience small, moderate, or large increases in response to changing land use and development.

Appendix 7.8: Review of Lake Arlington Water Quality



LAKE ARLINGTON
MASTER PLAN

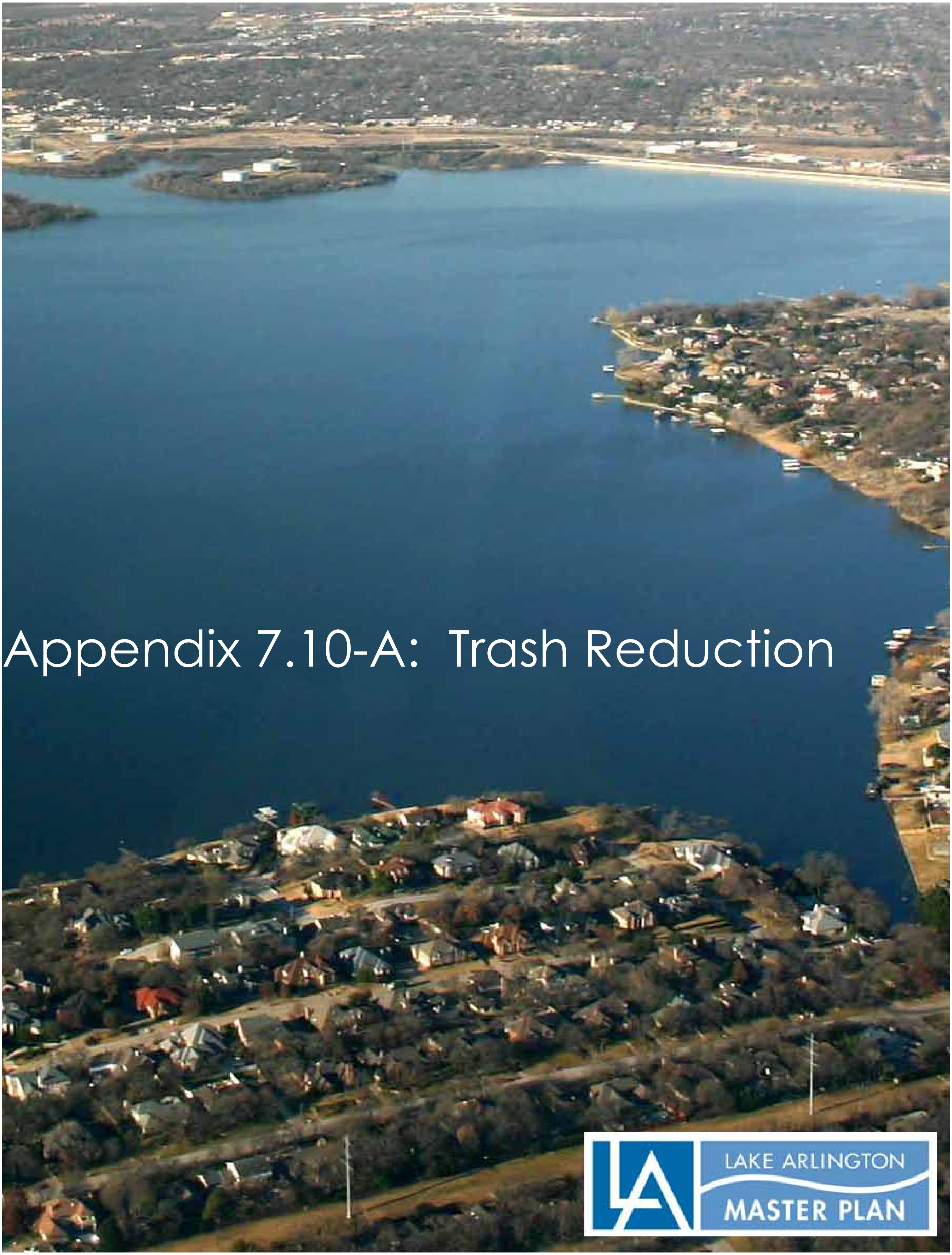
Predicted Increase in Constituent Load to Lake from Existing Conditions	Impact to Source Water Quality	Impact to Treatment Plant Operations	Potential Mitigation Strategies at WTP
165% increase in TSS	Increase in particle/sediment loading	• Decreased functioning depth of the reservoir • Increased Mn concentrations in source water intake • Increased solids from sedimentation blowdown and spent filter backwash water resulting in increased operations costs • Increased particle loading on filters resulting in increased	Installation of a pre-sedimentation basin (with pre-oxidant addition for manganese)
63% increase in TN 349% increase in TP	Increased eutrophication and algal growth, resulting in: • Increased Mn concentrations and duration of seasonal peaks in Mn concentrations • Increased MIB and geosmin concentrations • Potential increase in particle loading to the plant	• Increased eutrophication and algal growth • Potential need for additional treatment to reduce Mn concentrations	Source water control (hypolimnetic oxygenation) Pre-sedimentation with pre-oxidant addition for Mn PAC addition or GAC contactors for MIB/geosmin Advanced oxidation processes for MIB/geosmin
950% increase in COD 0% decrease in BOD 980% increase in fecal coliform	Increased wastewater loading resulting in: • Potential increase in concentrations of pathogenic microorganisms and emerging contaminants	Potential need for additional treatment processes to meet LT2ESWTR or future regulations on emerging contaminants	Multibarrier approach (e.g., UV disinfection) to remove viruses, Cryptosporidium, and other pathogenic microorganisms Advanced treatment (e.g., O_3/AOP or GAC adsorption) to remove micropollutants

Table CG-4: Impact of Future Water Quality Changes Predicted Under Scenario 1

Predicted Increase in Constituent Load to Lake from Existing Conditions	**Impact to Source Water Quality**	**Impact to Treatment Plant Operations**	**Potential Mitigation Strategies at WTP**
16% decrease in TSS	No significant impact expected	No negative impact	None required
13% increase in TN 36% increase in TP	Increased eutrophication and algal growth, resulting in: • Increased Mn concentrations and duration of seasonal peaks in Mn concentrations • Increased MIB and geosmin concentrations • Potential increase in particle loading to the plant	• Increased eutrophication and algal growth • Potential need for additional treatment to reduce Mn concentrations	Source water control (hypolimnetic oxygenation) Pre-sedimentation with pre-oxidant addition for Mn PAC addition or GAC contactors for MIB/geosmin
9% increase in COD 100% decrease in BOD 75% increase in fecal coliform	Increased wastewater loading resulting in: • Potential increase in concentrations of pathogenic microorganisms and emerging contaminants	Potential need for additional treatment processes to meet LT2ESWTR or future regulations on emerging contaminants	Multibarrier approach (e.g., UV disinfection) to remove viruses, Cryptosporidium, and other pathogenic microorganisms Advanced treatment (e.g., O_3/AOP or GAC adsorption) to remove micropollutants

Table CG-5: Impact of Future Water Quality Changes Predicted Under Scenario 2

Appendix 7.10-A: Trash Reduction



Appendix 7.10-A

BMP	BRAND/TRADEMARK NAME	COMPANY
Curb Guard/Screen Cover	Bio Curb Guard	Bio-Clean Environmental Services, Inc.
	Curb Protector - CP	Revel Environmental Manufacturing, Inc.
	DrainPac™ Curb Mesh Screen/Curb Cover	United Storm Water, Inc.
	FloGard+Plus®	Kri Star Enterprises, Inc.
	Ultra-CurbGuard	UltraTech International, Inc.
Curb Inlet	Bio-Clean Clean Water System	Bio-Clean Environmental Services, Inc.
	ClearWater BMP	Clearwater Solutions, Inc.
	DrainPac™ Curb Inlet	United Storm Water, Inc.
	EnviroPod™	Stormwater 360
	Inceptor®	Stormdrain Solutions
	P2 Filter	P2 Filter
	Triton Filter™ Curb Inlet Insert - TRC	Revel Environmental Manufacturing, Inc.
Grate Catch Basin Insert	Bio-Clean Grate Inlet Skimmer Basket	Bio-Clean Environmental Services, Inc.
	DrainPac™ Drop Inlet	United Storm Water, Inc.
	FloGard+Plus®	Kri Star Enterprises, Inc.
	Geo-Trap Filter - GT	Revel Environmental Manufacturing, Inc.
	Inceptor®	Stormdrain Solutions
	Ultra-Urban® Filter	AbTech Industries

BMP	BRAND/TRADEMARK NAME	COMPANY
Hydrodynamic Separator	BaySaver Separation Unit	BaySaver Technologies, Inc.
	Continuous Deflective Separator	CDS Technologies, Inc.
	CrystalStream Water Quality Vault	CrystalStream Technologies
	FloGard Dual Vortex®	Kri Star Enterprises, Inc.
	Stormceptor®	Rinker Materials Hydro Conduit Division
	Vortechs® System	Stormwater 360
	VortSentry®	Stormwater 360
	VortCapture®	Stormwater 360
End-of-Pipe Netting Device	Netting TrashTrap®	Fresh Creek Technologies, Inc.
	Net Tech™	Kri Star Enterprises, Inc.
Linear Radial Screen Device	Storm Flo™ Screen	Roscoe Moss Company
Litter or Trash Booms	SeaCurtain™ Debris Barrier	Kepner Plastics Fabricators, Inc.
Media Filtration	VortFilter®	Stormwater 360
Litter Collection Screen/Net		Storm Water Systems
	StormScreen	Stormwater 360
Nutient Separating Baffle Box	Bio-Clean NSBB Unit	Bio-Clean Environmental Services, Inc.
Service and Maintenance Provider	Bio Clean Environmental Services, Inc.	Bio-Clean Environmental Services, Inc.

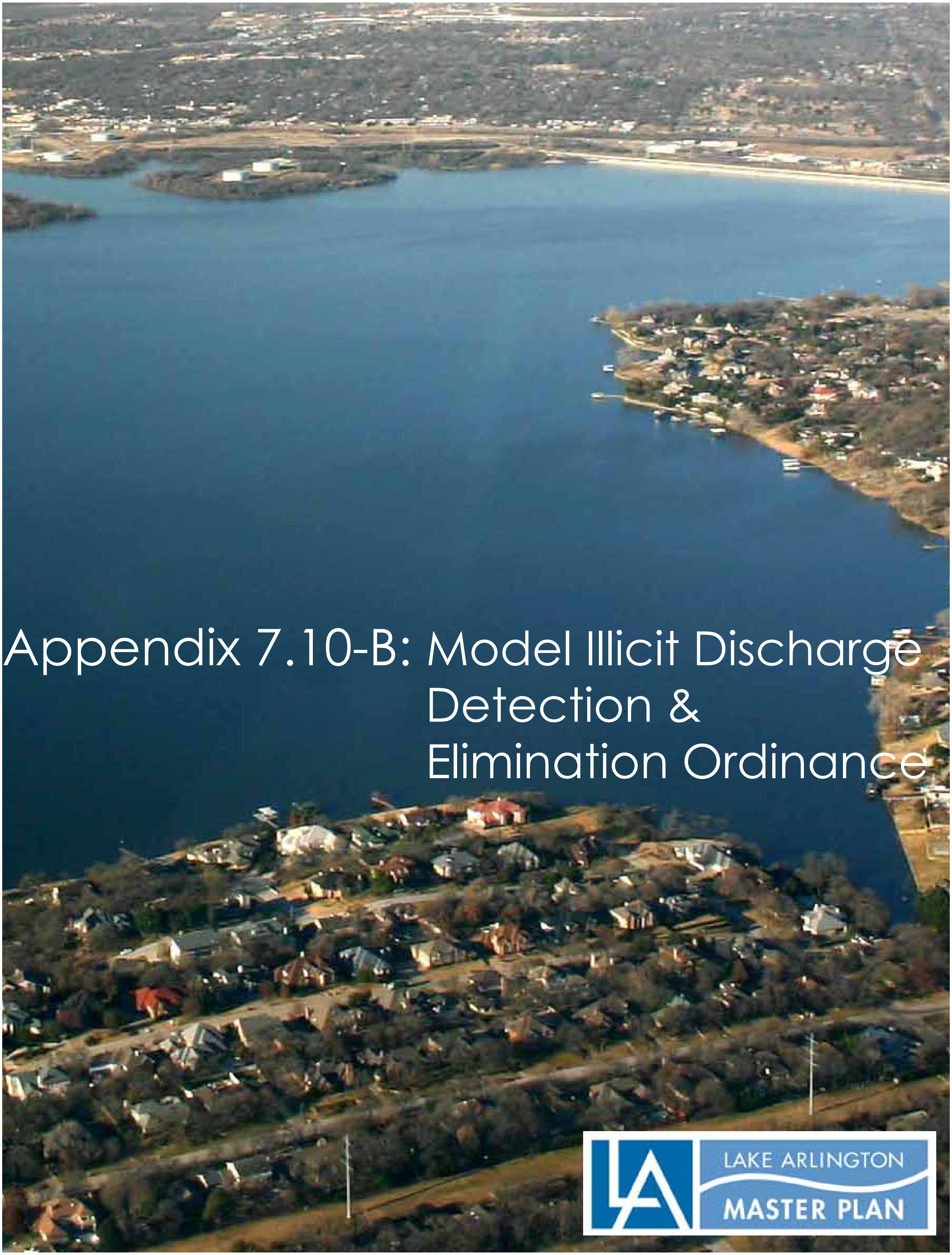
Structure Device Vendor Information

(California Coastal Commission and Plastic Debris, Rivers to Sea Project, Municipal Best Management Practices for Controlling Trash and Debris in Stormwater and Urban Runoff, Undated)

BMP	Cost	Effect on Hydraulics	Maintenance	Performance	Effect on Ecology	Comments
End-Of-Pipe Nets	Medium /High	Medium/Low	High	Medium/High	Yes	
Storm FLO™SCREEN	Medium	Medium/Low	Medium	High	Yes	Can remove smaller litter
Netting TrashTrap®	Medium /High	Medium/Low	High	Medium/High	Yes	
Outfall Screens				High	NA	At end of outfall, HYDROSCREEN CO.LLC
Channel Screens	Medium	Medium/Low	Medium/High	High	Yes	Can remove smaller litter. Www.coanda.com
Bandalog Litter Trap™	Medium /High	No	Medium	High		Traps trash to a side and hence protects from wash-off during high flows. Implemented at Satilla River, GA and Anacostia River, D.C.
Bandalong Boom Systems™	Low	No	Medium	Medium/High	No	May fail during high flows
SeaCurtain™ Debris Barrier	Low	No	Medium	Medium/High	No	May fail during high flows

Comparison of Selected In-Stream Trash Control BMPs

Appendix 7.10-B: Model Illicit Discharge Detection & Elimination Ordinance



ILLICIT DISCHARGE DETECTION AND ELIMINATION (IDDE) ORDINANCE
of the
CITY OF ______________________________

CHAPTER 1
General Provisions

100 Title

101 Purpose/Intent

102 Authority

103 Applicability

104 Administration

105 Regulatory Consistency

106 Ultimate Responsibility

CHAPTER 2
Definitions

200 Usage

201 Definitions

CHAPTER 3
Prohibitions

300 Prohibition of Illicit Discharges

301 Prohibition of Illicit Connections

CHAPTER 4
Watercourse Protection

CHAPTER 5
Industrial of Construction Activity

500 Plan and Records Review Requirements

501 Required Plans and Records Content

502 Plans Required

503 Plan and Records Standards

504 NPDES Permit

505 Notice of Intent

CHAPTER 6
Compliance Monitoring

600 Right of Entry; Inspection and Sampling

601 Search Warrants

602 Emergency Discharge

CHAPTER 7
Requirements to Prevent, Control, and Reduce Storm Water Pollutants through the Use of Best Management Practices

700 BMPs Required

701 Exceptions

702 Responsibility to Implement Best Management Practices

703 Spill Containment

CHAPTER 8
Notification of Accidental Discharges and Spills

800 Responsibility

801 Release of Hazardous Materials

802 Release of Non-Hazardous Materials

803 Notifications

804 Liability for Hazardous Spills

805 Fire Incidents

806 Written Records

807 Violations

CHAPTER 9
Violations, Enforcement and Penalties

CHAPTER 10
Miscellaneous

Chapter 1 – General Provisions

Section 100 Title

a) These regulations shall hereafter be known, cited and referred to as the Illicit Discharge Detection and Elimination Ordinance of the City of ______________________________ ____________.

Section 101 Purpose/Intent

a) The primary intent of this ordinance is to protect the health, safety, and general welfare of the citizens of the City of ______________________, Texas, through the regulation of non-storm water discharges to the city's municipal separate storm water system ("MS4") to the maximum extent practicable as required by federal and state law.

b) This ordinance establishes methods for controlling the introduction of pollutants into the City of__________________ MS4 in order to comply with requirements of the national pollutant discharge elimination system ("NPDES") permit.

c) The objectives of this objectives are:

1) To regulate the contribution of pollutants to the MS4 by storm water discharges by any person;
2) To prohibit illicit connections and non-storm water discharges to the MS4;
3) To prevent non-storm water discharges, generated as a result of spills, inappropriate dumping or disposal, to the City's MS4; and
4) To establish legal authority to carry out all inspections, surveillance, monitoring and enforcement necessary to ensure compliance with this Ordinance and the NPDES MS4 Permit.

Section 102 Authority

This Ordinance governing storm water discharges is hereby adopted by the __________________ ______ City Council, on ____________________, 2010, and shall be certified to the Probate Judge of _______________________, and to the Clerk of the City of _______________________ ______.

Section 103 Applicability

This Ordinance applies to all premises (whether developed or undeveloped) that have storm water discharges associated with any and all land uses within the City of _____________ ______, including but not limited to, residential, industrial, commercial, agricultural and construction activity.

Section 104 Administration

The <u>Storm Water Manager</u> of the City shall administer, implement, and enforce the provisions of this Ordinance and shall act as the official for the provisions of this Ordinance. Any powers granted or duties imposed may be delegated by the Director of Planning, Engineering and Permits to persons or entities acting in the beneficial interest of or in the employ of the City.

Section 105 Ultimate Responsibility
The standards set forth herein and promulgated pursuant to this article are minimum standards; therefore this article does not intend nor imply that compliance by any person will ensure that there will be no contamination, pollution, nor unauthorized discharge of pollutants.

Chapter 2 - Definitions

Section 200 Usage

a) For the purposes of this Ordinance, certain words, terms and phrases shall be used, interpreted and defined as set forth in this Chapter.

b) Definitions not expressly prescribed herein are to be construed in accordance with customary usage in municipal planning and engineering practice.

Section 201 Defintions

Accidental discharge. A discharge prohibited by this Ordinance into the MS4 which occurs by chance and without planning or thought prior to occurrence.

Adverse impact. Any deleterious effect on waters or wetlands, including their quality, quantity, surface area, species composition, aesthetics or usefulness for human or natural uses which are or may potentially be harmful or injurious to human health, welfare, safety or property or to biological productivity, diversity or stability, or which would unreasonably interfere with the enjoyment of life or property.

Best management practices ("BMPs"). Schedules of activities, prohibitions of practices, general good housekeeping practices, pollution prevention and educational practices, maintenance procedures, and other management practices to prevent or reduce the discharge of pollutants directly or indirectly to storm water, receiving waters, or storm water conveyance systems. BMPs also include treatment requirements, operating procedures, and practices to control site runoff, spillage or leaks, sludge or water disposal, or drainage from raw materials storage and construction sites.

City. The City of ________________________, a municipal corporation organized under the laws of the State of Texas.

Clean Water Act ("CWA"). The Federal Water Pollution Control Act (33 U.S.C. §§ 1251, et seq.) and any subsequent amendments thereto.

Commercial facility. Any facility associated with commercial and/or industrial activity which is not subject to an individual NPDES permit or an TCEQ general storm water permit.

Construction activity. Activities that require a land disturbing activity permit and are subject to the City's Soil Erosion and Sediment Control Ordinance and/or NPDES construction permits. Such activities include but are not limited to clearing and grubbing, grading, excavating, and demolition.

Discharge. The passing of water or other liquid through an opening or along a pipe, conduit or channel into the MS4 or into waters of the United States; the rate of flow of water, silt, or other mobile substance which emerges from a pipe, conduit or channel, usually expressed as cubic feet per second, gallons per minute or million gallons per day.

Discharger. Any person, who causes, allows, permits, or is otherwise responsible for a discharge, including without limitation, any operator of an industrial facility.

EPA. United States Environmental Protection Agency.

Facility. Any facility, industrial facility, required by the Clean Water Act to have a permit to discharge storm water associated with the industrial facility.

Hazardous Material. Any material, including any substance, waste, or combination thereof, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may cause, or significantly contribute to, a substantial present or potential hazard to human health, safety, property, or the environment when improperly treated, stored, transported, disposed of, or otherwise managed.

High-Risk Facility. Municipal landfills; other treatment, storage, or disposal facilities for municipal waste; hazardous waste treatment, storage, disposal and recover facilities; facilities subject to Emergency Planning & Community Right-to-Know Act (EPCRA), Title III, Section 313; and any other industrial or commercial facility that the Storm Water Manager determines may make or has made a substantial pollutant contribution to the MS4.

Illicit Connection. An illicit connection is defined as either of the following:

a) Any pipe, drain, open channel, connection or conveyance, whether on the surface or subsurface, that allows an illicit discharge to enter the City's MS4 including but not limited to any conveyances that allow any non-storm water discharge including sewage, process wastewater, and wash water to enter the storm drainage system and any connections to the storm drainage system from indoor drains and sinks, regardless of whether said pipe, drain, open channel, connection or conveyance had been previously allowed, permitted, or approved by the City; or
b) Any pipe, drain, open channel, connection or conveyance connected from a commercial or industrial land use to the City's MS4 which has not been documented in plans, maps, or equivalent records and approved by the City.

Illicit Discharge. Any discharge to a municipal separate storm sewer system that is not composed entirely of storm water except discharges pursuant to an NPDES permit (other than the NPDES permit for certain discharges from the municipal separate storm sewer system), discharges resulting from fire fighting activities, and other allowable non-storm water discharges.

Industrial activity. Activities subject to NPDES Industrial Permits as defined in 40 C.F.R. §122.26 (b)(14) by the EPA.

Municipal Separate Storm Sewer System (MS4 or Storm Drainage System). A conveyance or system of conveyances (including, but not limited to, sidewalks, highways, roads with drainage systems, municipal streets, inlets, catch basins, curbs, gutters, ditches, natural and man-made or altered drainage channels, reservoirs, pumping facilities, structural storm water controls, swales, or piped storm drains) owned, operated or maintained by the City of ____________________, Texas; designed or used for collecting and/or conveying storm water; not used for collecting or conveying sewage; and not part of publicly-owned sewage treatment works as defined in 40 C.F.R. § 122.2.

National Pollutant Discharge Elimination System (NPDES) Storm Water Discharge Permit. A permit issued by EPA (or by a state under authority delegated pursuant to 33 USC § 1342(b)) that authorizes the discharge of pollutants to waters of the United States and waters of the State, whether the permit is applicable on an individual, group, or general area-wide basis.

Non-Storm Water Discharge. Any discharge to the city's MS4 that is not composed entirely of storm water.

Operator. The party or parties that (either individually or groups taken together) meet the following two criteria: 1) They have operational control over the site specifications (including the ability to make modifications in specifications); 2) They have the day to day operational control of those activities at the site necessary to ensure compliance with storm water pollution prevention plan requirements and any permit conditions.

Person. Any individual, association, organization, partnership, firm, corporation or other entity recognized by law and acting as the owner or owner's agent of a premises or as a lessee of a premises.

Pollutant. Anything which causes or contributes to pollution. Pollutants may include, but are not limited to: paints, varnishes, and solvents; cleaning chemicals; degreasers; oil and other automotive fluids; non-hazardous liquid and solid wastes and yard wastes; refuse, rubbish, garbage, litter, or other discarded or abandoned objects and accumulations, so that same may cause or contribute to pollution; floatables; pesticides, herbicides, and fertilizers; hazardous substances and wastes; sewage, fecal coliform and pathogens; dissolved and particulate metals; animal wastes; wastes and residues that result from constructing a building or structure; concrete and cement; detergents (biodegradable or otherwise); and noxious or offensive matter of any kind.

Pollution. The alteration of the physical, thermal, chemical, or biological quality of, or the contamination of, any water of the State or water of the U.S., that renders the water harmful, detrimental, or injurious to humans, animal life, vegetation, or property, or to the public health, safety, or welfare, or impairs the usefulness or the public enjoyment of the water for any lawful or reasonable purpose.

Premises. Any building, lot, parcel of land, or portion of land whether improved or unimproved including facilities, adjacent sidewalks and parking strips located thereon and includes all land uses.

State. The State of Texas.

Storm Water. Any surface flow, runoff, and drainage consisting entirely of water from any form of natural precipitation, and resulting from such precipitation. It is that portion of the rainfall and resulting surface flow that is in excess of that which can be absorbed through the infiltration capacity of the surface of the basin.

Storm Water Pollution Prevention Plan. A document which describes the best management practices and activities to be implemented by a person or business to identify sources of pollution or contamination at a site and the actions to eliminate or reduce pollutant discharges to storm water, storm water conveyance systems, and/or receiving waters to the maximum extent practicable.

Structural Storm Water Control. A structural storm water management facility or device that controls storm water runoff and changes the characteristics of that runoff, including, but not limited to, the quantity and quality, the period of release or the velocity of flow.

TCEQ. Texas Commission on Environmental Quality.

Wastewater. Any water or other liquid, other than uncontaminated storm water, discharged from a facility.

Watercourse. A natural or man-made surface drainage channel or body of water (including a lake or pond) through which a water flow occurs, either continuously or intermittently.

Waters of the State. Ground-water (percolating or otherwise), lakes, bays, ponds, impounding reservoirs, springs, rivers streams, creeks, wetlands, marshes, inlets, canals inside the territorial limits of the State, and all other bodies of surface water, natural or artificial, navigable or non-navigable, and including the bed and banks of all watercourses and bodies of surface water that are wholly or partially inside or bordering the State or inside the jurisdiction of the State.

Waters of the United States. Surface watercourses and water bodies as defined in 40 CFR § 122.2, including all natural waterways and definite channels and depressions in the earth that may carry water, even though such waterways may only carry water during rains and storms and may not carry storm water at and during all times and seasons.

Chapter 3. Prohibitions.

Section 300 Prohibition of illicit discharges.

a) Prohibition. Unless otherwise excepted herein, no person now or in the future, shall spill, dump, throw, drain, make, cause to be made or continue to be made; allow others under such person's control to spill, dump, throw, drain, make, cause to be made or continue to be made; or otherwise discharge and/or dispose of into the city's MS4 or watercourses any illicit discharge, including but not limited to pollutants or waters containing any pollutants, other than storm water.

b) Exceptions. Discharges from the following activities will not be considered a source of pollutants to the MS4 and to waters of the United States when properly managed to ensure that no potential pollutants are present, and therefore shall not be considered illicit discharges unless determined to cause a violation of the provisions of the CWA or this article:

1) Water line flushing (including fire hydrant testing);
2) Landscape irrigation water and/or lawn watering;
3) Diverted stream flows;
4) Rising ground water;
5) Residential building wash water without detergents;
6) Uncontaminated ground water infiltration to storm drains;
7) Uncontaminated pumped ground water;
8) Discharges from potable water sources;
9) Foundation and/or footing drain water (not including active groundwater dewatering systems);
10) Water from crawl space pumps;
11) Air conditioning condensation;
12) Springs;
13) Street wash water;
14) Non-commercial or charity car washes;
15) Individual residential washing of vehicles;
16) Discharges from natural riparian habitat and/or wetlands;
17) Swimming pool discharges (only if dechlorinated);
18) Discharges or flow from firefighting activities and other discharges specified in writing by the official as being necessary to protect public health and safety; and
19) Any other water source not containing pollutants.
20) Discharges associated with dye testing are also allowable discharges under the terms of this section, but this activity requires written notification to and approval in writing by the official at least fourteen (14) days prior to the date of the test.

c) The prohibition shall not apply to any non-storm water discharge permitted under an NPDES permit, waiver, or waste discharge order issued to the discharger and administered under the authority of TCEQ, provided that the discharger is in full compliance with all requirements of the permit, waiver or order and other applicable laws and regulations, and provided that written approval has been granted by the City of ________________________ for any discharge to the storm drainage system/MS4.

d) With written concurrence of the Texas Commission on Environmental Quality, the City of ____________________ may exempt in writing other non-storm water discharges which are not a source of pollutants to the storm drain system or waters of the U.S.

e) A person must not improperly store, handle, or apply any pollutant in a manner that will cause its exposure to rainfall or runoff and discharge as point source or nonpoint source pollution into the City MS4 or into the waters of the U.S. except in concentrations and quantities authorized by and approved National Pollutant Discharge Elimination System discharge permit or by a plan for compliance, or as results from approved best management practices.

f) No person shall throw, deposit, leave, maintain, keep, or permit to be thrown, deposited, left, or maintained, in or upon any public or private property, driveway, parking area, street, alley, sidewalk, component of the MS4, or water of the U.S., any refuse, rubbish, garbage, litter, or other discarded or abandoned objects, articles, and accumulations, so that the same may cause or contribute to pollution. Wastes deposited in streets in proper waste receptacles for the purposes of collection are exempted from this prohibition.

Section 301 Prohibition of illicit connections.

a) Prohibition. The construction, use, maintenance or continued existence of illicit connections to the storm drainage system is prohibited.

b) Past connections prohibited. This prohibition expressly includes, without limitation, illicit connections made in the past, regardless of whether the connection was permissible under law or practices applicable or prevailing at the time of connection.

c) A person is considered to be in violation of this article if the person connects a line conveying sewage to the MS4 or allows such an illicit connection to continue.

d) Improper connections in violation of this article must be disconnected and redirected, if necessary, to an approved onsite wastewater management system or a sanitary sewer system upon approval of the city.

e) Any drain or conveyance that has not been documented in plans, maps or the equivalent and which may be connected to the MS4 shall be located by the owner or occupant of that premises upon receipt of written notice of violation from the official requiring that such locating be completed. Such notice will specify a reasonable time within which the location of the drain or conveyance is to be determined, that the drain or conveyance be identified as storm drainage system, sanitary sewer, or other, and that the outfall location or point of connection to the storm drainage system, sanitary sewer system or other discharge point be identified. Results of these investigations are to be documented and provided in writing to the official.

Chapter 4. Watercourse protection.

a) No person owning a premises or leasing a premises through which a watercourse passes shall throw, deposit, leave, maintain, keep, or permit to be thrown, deposited, left, maintained or kept in any part of a watercourse any trash, debris, excessive vegetation and other obstacles that would pollute, contaminate or significantly retard the flow of water through the watercourse.
b) A person shall keep and maintain that part of the watercourse on the premises owned or leased by such person free from any such trash, debris, excessive vegetation and other obstacles that would pollute, contaminate or significantly retard the flow of water through the watercourse.
c) A person shall only be liable under this article for trash, debris, excessive vegetation and other obstacles that originate from the premises owned or leased by such person.
d) In addition, the owner or lessee of a premise shall maintain existing privately owned structures within or adjacent to a watercourse on such premises, so that such structures will not become a hazard to the use, function or physical integrity of the watercourse.

Chapter 5. Industrial or construction activity discharges.

Section 500. Plan and Records Review Requirement

a) It shall be unlawful to commence or continue to conduct of for the Owner to allow the commencement or conduct of any commercial or industrial activity with the potential to discharge non-storm water, whether illicitly or by accident, that is not exempted under this Ordinance without first having obtained permission from the Storm Water Manager.

b) This permission shall not excuse the Owner from the need to obtain other required state and local permits or licenses.

c) Any person requesting a business permit, rezoning, permit to construct, or permit to subdivide for a property in the City of ___________________ not limited to residential, industrial, agricultural or construction activities will be subject to plan and records reviews by the Storm Water Manager.

d) A person commits an offense under this article if such person operates a facility on premises that is discharging storm water associated with industrial and/or construction activity without having obtained an NPDES permit and/or submitted a copy of the original NOI to discharge to the official.

Section 501. Required Plans and Records Content

a) It shall be the duty of the Owner of the land on which land-disturbing activity is proposed to be conducted, or his duly authorized agent, to file with the Storm Water Manager and application which shall include the Owner's CBMPP BMP Plan. A professional engineer licensed registered in the state of Texas must certify the design and construction of structural practices such as spill prevention control and countermeasures (SPCC) plan containment structures, dam construction, etc. Once a complete application, including all required submittals, has been filed, the Storm Water Manager shall accept or reject the application within fourteen (14) days of the day it is filed. Incomplete applications shall not be deemed to have been filed. If the application is rejected, the Storm Water Manager shall inform the Applicant, in writing, of the reasons for its rejection. If the Applicant, on one or more occasions, revises the CBMPP BMP Plan or submits to the Storm Water Manager additional documents or written information in connection with the application, the Storm Water Manager shall either accept the application as revised or make a written response to the Applicant of the reasons for rejection within fourteen (14) days of the day such revised CBMPP BMP Plan or additional documents or information are submitted to the Storm Water Manager.

b) In order for a Permit to be issued, the application, including all required submittals shall meet the requirements of this Ordinance in order for a Permit to be issued.

c) All applications for a Permit shall include the following information:

   1) Identify and describe the work to be performed;

   2) State the proposed use of the site;

   3) Name, address, telephone number, and cell phone number, pager number, fax telecopy number, and e-mail address, if any, of each of the following:

      i. The Applicant;

ii. The Owner of the project;

iii. The Owner of the property on which the project is to be located;

iv. The ground lessee of the property if the Applicant is not the Owner of the project or the property;

v. Contact person who is a resident of Texas if not one of the above;

vi. All contractors and subcontractors who shall implement any CBMPP; provided, however, that if the contractor and the subcontractors have not been selected when the application for a Permit is filed, the Applicant shall furnish such information to the Storm Water Manager within five (5) days of the day or days on which the contractor and/or subcontractors are selected, provided however such information shall be provided prior to any such entities beginning work on the site

vii. The QCP qualified credentialed professional who has approved the CBMPP BMP Plan (this is required for all land-disturbing activities except those related to the construction of individual single-family residences);

4) Legal description and address, if any, of the property upon which the land-disturbing activity is to be conducted and also a description of the size and particular location on the site for the proposed land-disturbing activity;

5) Each application for a Permit shall be accompanied by a map or a plot of the land on which the land-disturbing activity will be conducted and any other information that is required under the provisions of CHAPTER II.

6) Include a soil survey where topographically or geologically difficult sites are encountered which shall detail any limitations on use and development which may be restrictive to construction, drainage, soil integrity, slope stability and revegatation of property;

7) Be accompanied by three (3) sets of each category of plans and specifications as required by this Ordinance;

8) State the estimated cost of work involved, including any temporary and/or permanent BMPs erosion and sediment control measures, drainage systems and revegetation; (this is required for all land-disturbing activities except those related to the construction of individual single-family residences)

9) State the schedule of the projecting starting and completion dates of the land-disturbing activity;

10) Be signed by the Owner, or his authorized representative as provided in Section 213, who may be required to submit evidence to indicate such authority; and

11) Give such other information as reasonably may be required by the Storm Water Manager to comply with the purposes and intent of this Ordinance Code.

12) Be accompanied by a Development Plan.

13) Be accompanied by a Drainage Plan (if applicable).

Section 503. Plans Required

a) Each application for a soil erosion and sediment control Permit shall be accompanied by three (3) sets of plans BMP Plans and specifications required by this Ordinance and, if required, supporting data and affidavits prepared and signed by a QCP registered architect, landscape architect, civil Engineer, geologist, geotechnical Engineer or environmental manager.

b) Each application for a soil erosion and sediment control Permit, except applications related to the construction of an individual single-family residence, shall require a CBMPP soil erosion and sediment control plan ("Control Plan").

c) A Drainage Plan shall be required.

d) Soil engineering and engineering geology reports shall will be required if deemed necessary by the Storm Water Manager, Owner's architect, landscape architect or civil engineer and/or may also be required by the Storm Water Manager in fragile, complex or hazardous areas.

e) Development Plan.

Section 504. Plan and Records Standards

a) Persons conducting land-disturbing activities shall take all reasonable measures referred to, or provided for, in this Ordinance to protect Texas public and private property from damage caused by such activities and to reduce storm water pollution to the maximum extent practicable.

b) All plans and specifications required to be submitted, including CBMPPs BMP Plan for an individual single-family residence, should be prepared in a manner which will assure the following standards are met;

    1) Protect and preserve existing natural drainage channels.

    2) Include design provisions to retain off-site natural drainage patterns.

    3) Assure that waters drained from the development are free of point and nonpoint sources of pollutants, including eroded soil and sediment, and do not cause water problems on adjacent properties to any greater extent than occurs in the absence of development.

    4) Assure that waters are drained from the development in such a manner that will not cause erosion to any greater extent than would occur in the absence of development.

    5) Provide that all roof and foundation drains shall be discharged to natural drainage, engineered detention ponds, curb face outlets, or to a public or approved private storm drain.

    6) All drainage facilities shall be designed to carry waters to the nearest practicable drainage way as provided by the Storm Water Manager and/or other appropriate jurisdiction designated as a safe place to discharge such waters. If drainage facilities discharge other than into an approved drainage way, riprap or other erosion protection may be required.

7) All surface water flowing toward the construction area shall, to the maximum extent practicable, either be passed through the site in a protected channel or diverted by using berms, channels or sediment traps, as necessary.

8) Cut-fill operations shall be kept to a minimum.

9) Adequate provisions shall be provided to minimize drainage of surface water from the cut face of excavations or the sloping surfaces of fills.

10) Slopes shall be no steeper than are safe for the intended use and shall not endanger adjoining property as determined by the Owner's engineer. The slope stability design shall be within normally accepted engineering practice and shall be provided with surface and subsurface drainage as necessary BMPs Erosion and sediment control measures shall be designed, according to the size and slope of the disturbed areas or drainage areas, to minimize erosion and to control sediment, to the maximum extent practicable.

11) Fill shall not encroach upon natural watercourses or constructed channels in a manner so as to impede water flow or adversely affect other property owners.

12) Grading equipment shall cross natural drainage ways by the means of bridges or culverts except when such methods are not feasible and provided, in any case, that such crossings are kept to a minimum.

13) To the maximum extent practicable, sediment in runoff water must be minimized by using appropriate BMPs. Structural controls shall be designed and maintained as required to minimize erosion and pollution to the maximum extent practicable.

14) Discharges from sediment basins and traps must be conducted in a manner consistent with good engineering practices. Sediment-laden, otherwise polluted, water discharged from the site must be addressed in a manner consistent with good engineering practices and the requirements of this Ordinance.

15) BMPs Control measures shall be maintained as an effective barrier to sedimentation and erosion in accordance with the provisions of this Ordinance.

c) Plans and specifications for all land-disturbing activity which are not for and individual single-family residence shall also meet the following standards:

1) Assure that if drainage levees or flow rates currently impact or will temporarily or permanently increase onto adjacent properties, detention facilities or other acceptable remedies or conservation measures will be installed which shall include the plan and responsibility for the permanent maintenance of such facilities.

2) When a lake or pond, either new or existing, is incorporated in a development, the Owner developer shall note on his plans if the lake or pond is to be used for sediment control and/or retention during or after construction.

Section 505. NPDES Permit. Any person subject to an industrial or construction activity NPDES permit shall comply with all terms and provisions of such NPDES permit. Any person with a NPDES permit shall provide to the official a copy of the permit, a copy of the storm water pollution prevention plan and copies of all monitoring data and reports submitted to TCEQ as required by the NPDES permit.

Proof of compliance with said permit is required in a form acceptable to the official prior to the allowing of discharges to the MS4. Compliance with an NPDES permit authorizing the discharge of storm water associated with industrial activity shall be deemed compliance with the provisions of this article.

Section 506. Notice of intent (NOI). The owner and/or operator of a facility, including construction sites, required to have an NPDES permit to discharge storm water associated with industrial activity shall submit a copy of the NOI to the official. The copy of the NOI may be delivered to the official either in person or by mailing to:

Notice of Intent to Discharge Storm Water
Storm Water Management Department

Chapter 6. Compliance Monitoring.

Section 600. Right of entry; inspection and sampling.

a) Upon reasonable notice to the premises owner and person in possession thereof, the official shall be permitted to enter and inspect premises and facilities subject to regulation under this article during normal business hours as often as may be necessary to determine compliance with this article.

b) Identification issued by the city shall be presented by the official at the time of entry.

   1) If security measures are in force on a premise, then the premises owner shall make the necessary arrangements to allow access to representatives of the official for the purposes of this article. Proof of an illicit discharge or an illicit connection is not required for entry onto a premise.
   2) Owners and/or operators of a premises shall allow the authorized enforcement agency ready access to all parts of the premises for the purposes of inspection, sampling, photography, videotaping, testing, and examination; for the copying of records that must be kept under the conditions of an NPDES permit to discharge storm water; and for the performance of any additional duties as required by state and federal law.
   3) The official shall have the right to set up on any premises such devices as are necessary in the opinion of the authorized enforcement agency to conduct monitoring and/or sampling of the premises' surface flow discharges.
   4) The official may require the owner and/or operator of a premise to install monitoring equipment as necessary and to make monitoring data available to the local enforcement authority. This sampling and monitoring equipment shall be maintained at all times in a safe, calibrated and proper operating condition by the owner and/or operator at his/her/its own expense.
   5) Any temporary or permanent obstruction to safe and easy access to the premises to be inspected and/or sampled shall be promptly removed by the owner of the premises at the written or oral request of the authorized enforcement agency and shall not be replaced. The costs of clearing such access shall be borne by the owner and/or operator of the premises.
   6) Unreasonable delays in allowing the official access to a premises is a violation of this article. A person who is the operator of a premises with a NPDES permit to discharge storm water commits an offense if such person denies the official reasonable access to the permitted premises for the purpose of conducting any activity authorized or required by this article.

Section 601. Search warrants.

a) If the official has been refused access to any part of a premises from which storm water is discharged, and the authorized enforcement agency is able to demonstrate probable cause to believe that there may be a violation of this article, or that there is a need to inspect and/or sample as part of a routine inspection and sampling program designed to verify compliance with this article or any order issued hereunder, or to protect the overall public health, safety, and welfare of the community, then the authorized enforcement agency may seek issuance of a search warrant from any court of competent jurisdiction.

Section 602. Emergency discharge.

a) The official shall have the right to enter upon any and all parts of a premises for the purposes of inspection, sampling, and/or examination in the case of an emergency illicit discharge or a suspected emergency discharge as is necessary in the opinion of the official to contain an illicit discharge.
b) Reasonable notice of such entry under the circumstances must be given to the owner and occupant of a premises.
c) Entry must be made during normal business hours, if possible.
d) Identification issued by the city shall be presented at the time of entry by official personnel.

Chapter 7. Requirement to prevent, control, and reduce storm water pollutants through the use of best management practices.

Section 700. BMPs required.

a) All commercial, industrial and high-risk facilities shall identify, implement and maintain BMPs for any activity, operation, or facility which may cause or contribute to pollution or contamination of storm water, the MS4, waters of the state and/or waters of the United States.

b) Non-compliance with such BMPs will constitute a violation of this article.

Section 701. Exceptions.

a) Where BMPs are promulgated by the city or any federal, state or regional agency for any specific activity, operation, or facility which would otherwise cause the discharge of pollutants to the city's MS4 or waters of the United States, every person undertaking such activity or operation or owning or operating such facility shall comply with such requirements.

b) Compliance with such BMPs shall be deemed compliance with the provisions of this article.

c) Compliance with all terms and conditions of a valid NPDES permit authorizing the discharge of storm water associated with construction and/or industrial activity shall be deemed compliance with the provisions of this section.

Section 702. Responsibility to implement best management practices.

a) Except as set forth herein, any person engaged in activities or operations, or owning facilities or property which will or may result in pollutants entering storm water, the MS4 or the waters of the United States shall implement BMPs to the extent they are technologically achievable to prevent and reduce such pollutants.

b) The owner or operator of a commercial, industrial or high risk facility shall provide, at their own expense, reasonable protection from accidental discharge of prohibited materials or other wastes into the MS4 or watercourses through the use of these structural and non-structural BMPs.

c) Further, any person responsible for a property or premise, which is, or may be, the source of an illicit discharge, may be required to implement, at said person's expense, additional structural and non-structural BMPs to prevent the further discharge of pollutants to the MS4.

Section 703. Spill containment.

a) Spill containment facilities shall be provided when required by State or Federal regulations or when, in the judgment of the City.

b) Such facilities are necessary for the containment of any raw materials, products, wastes or other potential pollutants used or stored on the user's premises.

c) Facilities are also needed in such locations where a spill of the material may enter into the City MS4 or waters of the U.S. and cause interference or violations of the applicable NPDES permit.

Chapter 8. Notification of accidental discharges and spills.

Section 800. Responsibility.

a) Notwithstanding other requirements of law, as soon as any premises owner or person responsible for a premises, facility or operation, or responsible for emergency response for a premises, facility or operation has information of any known or suspected release of materials which is resulting or may result in illicit discharges or pollutants discharging into storm water, the MS4, waters of the state or waters of the United States, said person shall take all necessary steps to ensure the discovery, containment, and cleanup of such release so as to minimize the effects of the discharge.

Section 801. Release of hazardous materials.

a) In the event of a release of hazardous pollutants or materials into the MS4, said person shall immediately notify emergency response agencies of the occurrence via emergency dispatch services (911) and shall also notify the Storm Water Manager in person or by phone or facsimile not later than twenty-four (24) hours from the date and time of the release as to the occurrence of and the quantity of the release.

Section 802. Release of non-hazardous materials.

a) In the event of a release of non-hazardous materials, said person shall notify the ________________________ Fire Department and the Storm Water Manager in person or by phone or facsimile no later than the twenty-four (24) hours from the date and time of the release as to the occurrence of and the quantity of the release.

Section 803. Notifications.

a) Notifications in person or by phone shall be confirmed by written notice addressed and mailed to the official within three (3) business days of date of the phone or in person notice.

Section 804. Liability for Hazardous Spills.

a) The property owner and/or person responsible for the hazardous materials spill or release shall be held financially liable for the response, control, containment, equipment and materials costs (including legal fees), incurred by the City and supporting agencies.
b) The property owner and/or person responsible for the hazardous material spill may provide personnel to assist abatement, removal and remedial measures, provided such personnel have been adequately equipped and trained pursuant to the requirements of local, state and federal laws.

Section 805. Fire Incidents.

a) In fire incidents involving hazardous materials or exposure to hazardous materials, no fee will be assessed for resources normally associated with fire fighting operations.
b) Fees shall be assessed for those activities and resources associated with abatement, control and containment of the hazardous materials involvement or exposure.

Section 806. Written Records.

a) If the discharge of prohibited pollutants or materials emanates from a commercial or industrial establishment, the owner or operator of such establishment shall also retain an on-site written record of the discharge and the actions taken to prevent its recurrence.
b) Such records shall be retained for at least three years from the date of the discharge.

c) Said person shall also take immediate steps to ensure no reoccurrence of the discharge or spill.

Section 807. Violations.

a) Failure to provide notification of a release as provided above is a violation of this article.

Chapter 9. Violations, enforcement and penalties.

Section 900. Violations.

a) It shall be unlawful for any person to violate any provision of or fail to comply with any requirement of this article.

b) Any person who has violated or continues to violate any provision of this article may be subject to the enforcement actions outlined in this article or may be restrained by injunction or otherwise abated in a manner provided by law.

Section 901. Warning notice.

a) When the official determines that any person has violated or continues to violate any provision of this article or any order issued hereunder, the official may serve upon that person a written warning notice specifying the particular violation believed to have occurred and requesting that the discharger immediately investigate the matter and seek a resolution whereby any offending discharge will cease.

b) Investigation and/or resolution of the matter in response to the Warning Notice does not relieve the alleged violator of liability for any violations occurring before or after receipt of the warning notice.

c) Nothing in this subsection shall limit the authority of the official to take any action, including emergency action or any other enforcement action, without first issuing a warning notice.

Section 902. Notice of violation.

a) Whenever the authorized enforcement agency finds that a person has violated a prohibition or failed to meet a requirement of this article, the official may order compliance by written notice of violation to the responsible person.

b) This Notice of Violation shall contain:
   1) The name and address of the alleged violator;
   2) The address of the premises (when available) or a description of the building, structure or land upon which the violation is occurring or has occurred;
   3) A statement specifying the nature of the violation;
   4) A description of the remedial and/or restoration measures necessary to restore compliance with this article and a deadline for the completion of such remedial and/or restoration action;
   5) A statement of the penalty or penalties that shall or may be assessed against the person to whom the notice of violation is directed;
   6) A statement that the determination of violation may be appealed to the Storm Water Appeals Board ("board") by filing a written notice of appeal with the board within seven (7) days of service of a notice of violation; and
   7) A statement specifying that, should the violator fail to restore compliance with this article within the established time schedule, the work will be done by a designated governmental agency or a contractor and the expense thereof shall be charged to the violator as allowed hereunder and collected as allowed by law.

c) Such notice may require without limitation:
   1) The performance of monitoring, analyses, and reporting;

2) The elimination of illicit connections and/or illicit discharges;
3) That violating discharges, practices, or operations shall cease and desist;
4) The abatement or remediation of storm water pollution or contamination hazards and the restoration of any affected property;
5) Payment of an amount equal to administrative and remediation costs; and/or
6) The implementation of source control or treatment BMPs.

d) The failure of a person to comply with any lawful notice to abate issued by the official, which has not been appealed within the time allowed herein, shall be deemed a violation ofthis article.

Section 903. Emergency abatement.

a) The official is authorized to require immediate abatement of any violation of this article that constitutes an immediate threat to the health, safety or well-being of the public.

b) When the official finds that any person has violated, or continues to violate, any provision of this article, and that the person's violation(s) has (have) caused or contributed to an actual or threatened discharge to the MS4, waters of the State or waters of the United States which reasonably appears to present an imminent or substantial endangerment to the health or welfare of persons or to the environment, the official may issue an order to the violator directing it immediately to cease and desist all such violations and directing the violator to:

1) Immediately comply with all article requirements; and

2) Take such appropriate preventive action as may be needed to properly address a continuing or threatened violation, including immediately halting operations and/or terminating the discharge.

c) Any person notified of an emergency order directed to it under this subsection shall immediately comply and stop or eliminate its illicit discharge.

d) In the event of a discharger's failure to immediately comply voluntarily with the emergency order, the official may take such steps as deemed necessary to prevent or minimize harm to the MS4 or waters of the United States, and/or endangerment to persons or to the environment, including taking any and all measures required to abate and remediate the violation.

e) Any expense related to abatement and remediation undertaken by the official shall be fully reimbursed to the city by the property owner and/or responsible party as provided herein.

f) Any relief obtained under this section shall not prevent the official from seeking other and further relief authorized under this article.

Section 904. Injunctive relief and/or civil remedies.

a) It shall be unlawful for any person to violate any provision or fail to comply with any requirement of this article. If a person has violated or continues to violate the provisions of this article, the official may petition the appropriate court for a preliminary and/or permanent injunction restraining the person from activities which would create violations of this article or compelling the person to perform abatement or remediation of any violation.

b) The city, with the consent of the city council, may also initiate civil proceedings in any court of competent jurisdiction seeking monetary damages for any damages caused to the MS4 by any person, and may seek other equitable relief to enforce compliance with the provisions of this article or to force compliance with any lawful orders of the authorized enforcement agency.

c) Any and all costs of such action, including attorneys' fees, trial expenses, court costs and damages to the MS4 shall be paid by the violator as provided herein.

Section 905. Compensatory actions.

a) In lieu of enforcement proceedings, penalties, and remedies authorized by this article, the official may impose upon a violator alternative compensatory actions, such as storm drain stenciling, attendance at compliance workshops, creek cleanup, etc.

Section 906. Criminal penalties.

a) Any person that has violated or continues to violate this article shall be guilty of a violation and shall be liable to criminal prosecution to the fullest extent of the law, and upon conviction, shall be subject to a criminal penalty of not greater than five hundred dollars dollars ($500.00) per violation and/or imprisonment for a period of time not to exceed six (6) months.

b) Each act of violation and/or each day upon which any violation shall occur shall constitute a separate offense.

Section 907. Abatement and restoration of premises by the city.

a) If a violation has not been corrected pursuant to the requirements set forth in the notice of violation, or, in the event of an appeal, within seven (7) days of the decision of the Storm Water Appeals Board upholding the decision of the official, then representatives of the official may enter upon the premises and are authorized to take any and all measures necessary to abate the violation and/or restore the property.

b) Such entry shall be made during normal business hours, after giving reasonable notice to the owner and person in possession thereof, and after the presentation of proper city credentials by the official.

c) It shall be unlawful and a violation of this article for any person, owner, agent or person in possession of any premises to refuse to allow the official or designated contractor to enter upon the premises for the purposes set forth in this article.

Section 908. Appeal of notice of violation.

a) Notwithstanding the provisions of this Ordinance, any person receiving a notice of violation may appeal the determination of the official to the Storm Water Appeals Board.

b) The notice of appeal must be received within seven (7) days following the date of the notice of violation.

c) A hearing on the appeal before the code appeals board shall take place within fourteen (14) days from the date of receipt of the notice of appeal.

d) The decision of the Storm Water Appeals Board shall be final.

Section 909. Cost of abatement of the violation.

a) Within thirty (30) days after abatement of the violation by the official and/or its designee, the owner of the property shall be notified by the official of the cost of abatement, including administrative costs.

b) The property owner may file a written protest objecting to the amount of the assessment within seven (7) days. If the amount due is not paid within thirty (30) days, then the city shall proceed to collect such amounts as allowed by law.

c) Any person violating any of the provisions of this article shall become liable to the city by reason of such violation.

Section 910. Violations; public nuisance.

a) It shall be unlawful for any person to violate any provision or fail to comply with any of the requirements of this article. In addition to the enforcement processes and penalties provided, any condition caused or permitted to exist in violation of any of the provisions of this article is a threat to public health, safety, and welfare, and is declared and deemed a nuisance.

b) The official may take all appropriate measures to abate the nuisance and may institute a civil action to abate, enjoin, or otherwise compel the cessation of such nuisance as allowed by law.

Section 911. Remedies not exclusive; costs recoverable by the City.

a) The remedies listed in this article are not exclusive of any other remedies available under any applicable federal, state or local law and it is within the discretion of the authorized enforcement agency to seek cumulative remedies.

b) The city may recover all attorney's fees, trial expenses, court costs and any and all other costs and expenses associated with enforcement of this article, including, but not limited to, sampling and monitoring expenses, TCEQ fines, EPA fines and other losses resulting directly or indirectly from a violation of this article.

Chapter 10 Miscellaneous

Section 1000. Notices

Whenever the City is required or permitted to:

a) Give a notice to any party, such notice shall be in writing; or

b) Deliver a document to any party; such notice or document may be delivered by personal delivery, certified mail (return receipt requested), registered mail (return receipt requested) or a generally recognized overnight carrier, to the address of such party which is in the records of the City or is otherwise known to the City.

Section 1001. References

Whenever a chapter or section is referred to in this Ordinance, unless the context clearly indicates the contrary, such reference shall be to a chapter or section of this Ordinance.

Section 1002. Minimum Requirements

a) In interpreting and applying the provisions of this Ordinance, they shall be held to be the minimum requirements for the promotion of public health, safety, convenience, comfort, and the general welfare.

b) Where this Ordinance imposes greater restrictions than are imposed or required by other Ordinances, rules, regulations or permits, or by easements, covenants or agreements, the provisions of this Ordinance shall apply.

c) Where any other laws, Ordinances or rules, regulations or permits or restrictive conditions of other governmental or City agencies charged with land or clean water regulation impose greater restrictions than are required under the regulations of this Ordinance, such provisions shall govern.

Section 1003. Severability
The provisions of this Ordinance are severable. If any part of this Ordinance is determined by a court of competent jurisdiction to invalid, unenforceable or unconstitutional, such determination shall not affect any other part of this Ordinance.

Section 1004. Captions
The captions of articles and sections are for the purpose of reference only, and such captions shall not affect the meaning of any provision of this Ordinance.

Section 1005. Repeal of Conflicting Sections and Ordinances
All City Code sections and Ordinances or parts thereof in conflict with the provisions of this Ordinance insofar as they conflict, are repealed as of the effective date of this Ordinance, shall be repealed as of the date and time this Ordinance become effective, provided however, that neither any cause of action not any fine, forfeiture, judgment, penalty, right, bond, remedy, obligation, duty or defense accrued or in place at said date, nor any prosecution, permit, bond or complaint pending at said date shall be in any manner released affected, abated, or impaired by this Ordinance.

Section 1006. Effective Date
This Ordinance shall be published as required by law and shall become effective at 12:01 A.M. on xxxxxxxxxxxxxxxxxxxx.

OUTFALL RECONNAISSANCE INVENTORY/ SAMPLE COLLECTION FIELD SHEET

Section 1: Background Data

Subwatershed:		Outfall ID:	
Today's date:		Time (Military):	
Investigators:		Form completed by:	
Temperature (°F):	Rainfall (in.): Last 24 hours:	Last 48 hours:	Last 72 hours:
Latitutde:	Longitude:	GPS Unit:	GPS LMK #:
Camera:		Photo #s:	

Land Use in Drainage Area (Check all that apply):
- ☐ Industrial
- ☐ Ultra-Urban Residential
- ☐ Suburban Residential
- ☐ Commercial
- ☐ Open Space
- ☐ Institutional

Other: ______________________________

Known Industries: ______________________________

Notes (e.g.., origin of outfall, if known):

Section 2: Outfall Description

LOCATION	MATERIAL	SHAPE		DIMENSIONS (IN.)	SUBMERGED
☐ **Closed Pipe**	☐ RCP ☐ CMP ☐ PVC ☐ HDPE ☐ Steel ☐ Other: __________	☐ Circular ☐ Eliptical ☐ Box ☐ Other: __________	☐ Single ☐ Double ☐ Triple ☐ Other: __________	Diameter/Dimensions: __________________	In Water: ☐ No ☐ Partially ☐ Fully With Sediment: ☐ No ☐ Partially ☐ Fully
☐ **Open drainage**	☐ Concrete ☐ Earthen ☐ rip-rap ☐ Other: _____	☐ Trapezoid ☐ Parabolic ☐ Other: _____		Depth: _____ Top Width: _____ Bottom Width: _____	
☐ **In-Stream**	**(applicable when collecting samples)**				
Flow Present?	☐ Yes	☐ No	***If No, Skip to Section 5***		
Flow Description (If present)	☐ Trickle	☐ Moderate	☐ Substantial		

Section 3: Quantitative Characterization

FIELD DATA FOR FLOWING OUTFALLS				
PARAMETER		**RESULT**	**UNIT**	**EQUIPMENT**
☐Flow #1	Volume		Liter	Bottle
	Time to fill		Sec	
☐Flow #2	Flow depth		In	Tape measure
	Flow width	_____' _____"	Ft, In	Tape measure
	Measured length	_____' _____"	Ft, In	Tape measure
	Time of travel		S	Stop watch
Temperature			°F	Thermometer
pH			pH Units	HACH electrode
Ammonia			mg/L	HACH test strip
Chlorine, Total			mg/L	HACH kit
Copper, Total			mg/L	HACH kit
Phenol			mg/L	HACH kit
Detergents			mg/L	HACH kit

OUTFALL RECONNAISSANCE INVENTORY FIELD SHEET

Section 4: Physical Indicators for Flowing Outfalls Only

Are Any Physical Indicators Present in the flow? ☐ Yes ☐ No *(If No, Skip to Section 5)*

INDICATOR	CHECK if Present	DESCRIPTION	RELATIVE SEVERITY INDEX (1-3)		
Odor	☐	☐ Sewage ☐ Rancid/sour ☐ Petroleum/gas ☐ Sulfide ☐ Other:	☐ 1 – Faint	☐ 2 – Easily detected	☐ 3 – Noticeable from a distance
Color	☐	☐ Clear ☐ Brown ☐ Gray ☐ Yellow ☐ Green ☐ Orange ☐ Red ☐ Other:	☐ 1 – Faint colors in sample bottle	☐ 2 – Clearly visible in sample bottle	☐ 3 – Clearly visible in outfall flow
Turbidity	☐	See severity	☐ 1 – Slight cloudiness	☐ 2 – Cloudy	☐ 3 – Opaque
Floatables -Does Not Include Trash!!	☐	☐ Sewage (Toilet Paper, etc.) ☐ Suds ☐ Petroleum (oil sheen) ☐ Other:	☐ 1 – Few/slight; origin not obvious	☐ 2 – Some; indications of origin (e.g., possible suds or oil sheen)	☐ 3 - Some; origin clear (e.g., obvious oil sheen, suds, or floating sanitary materials)

Section 5: Physical Indicators for Both Flowing and Non-Flowing Outfalls

Are physical indicators that are not related to flow present? ☐ Yes ☐ No *(If No, Skip to Section 6)*

INDICATOR	CHECK IF PRESENT	DESCRIPTION	COMMENTS
Outfall Damage	☐	☐ Spalling, Cracking or Chipping ☐ Peeling Paint ☐ Corrosion	
Deposits/Stains	☐	☐ Oily ☐ Flow Line ☐ Paint ☐ Other:	
Abnormal Vegetation	☐	☐ Excessive ☐ Inhibited	
Poor pool quality	☐	☐ Odors ☐ Colors ☐ Floatables ☐ Oil Sheen ☐ Suds ☐ Excessive Algae ☐ Other:	
Pipe benthic growth	☐	☐ Brown ☐ Orange ☐ Green ☐ Other:	

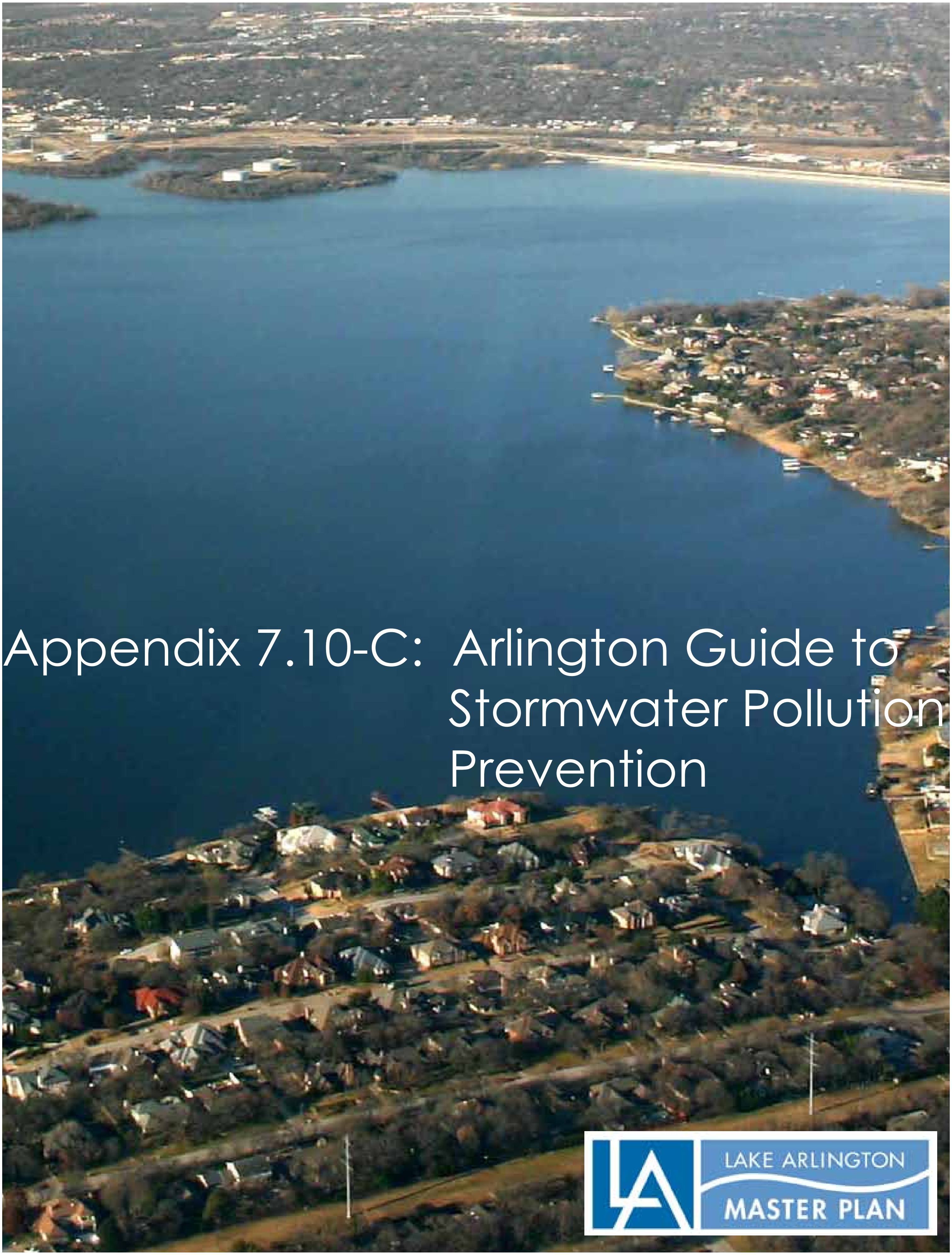
Section 6: Overall Outfall Characterization

☐ Unlikely ☐ Potential (presence of two or more indicators) ☐ Suspect (one or more indicators with a severity of 3) ☐ Obvious

Section 7: Data Collection

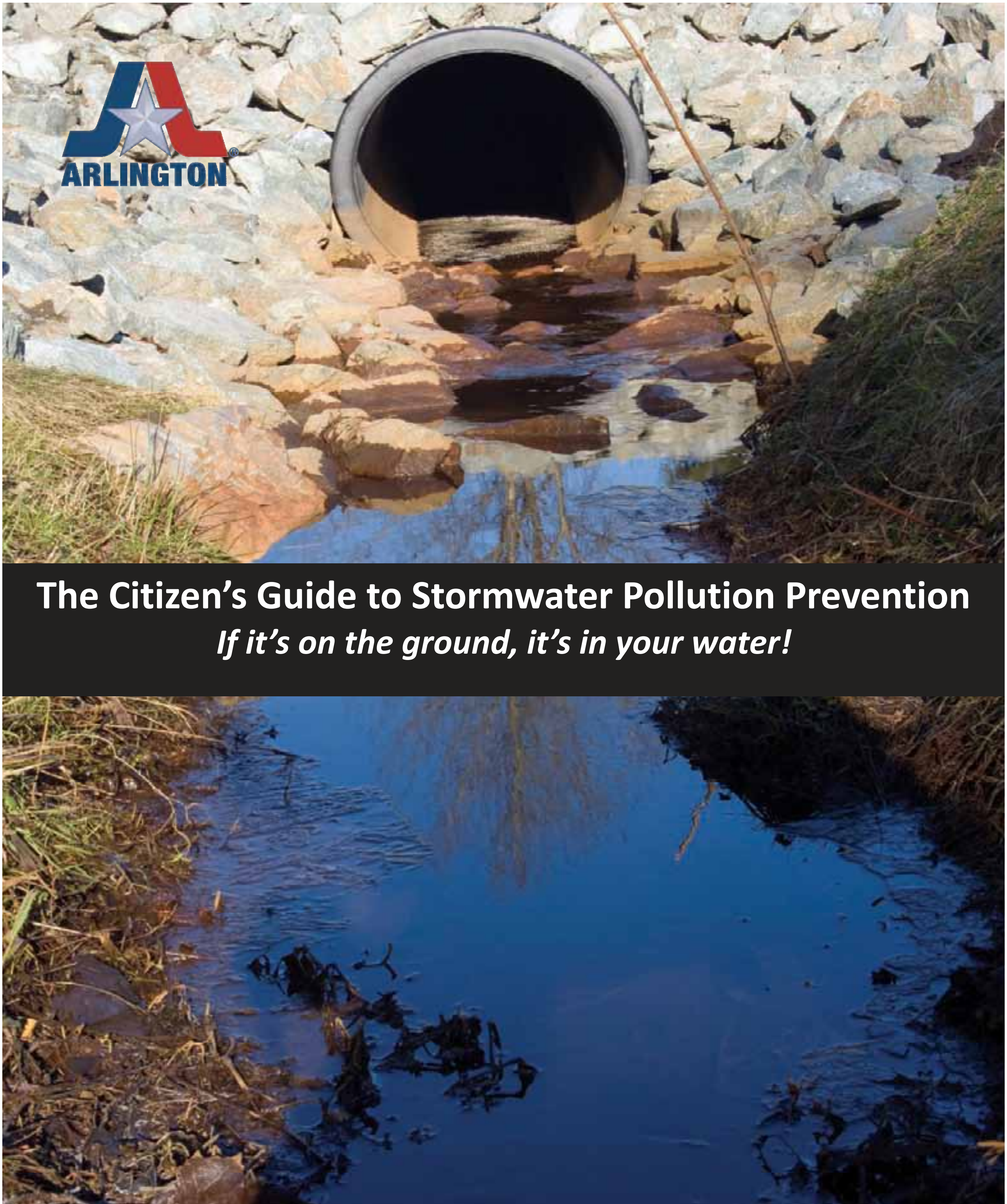
1.	Sample for the lab?	☐ Yes	☐ No		
2.	If yes, collected from:	☐ Flow	☐ Pool		
3.	Intermittent flow trap set?	☐ Yes	☐ No	If Yes, type:	☐ OBM ☐ Caulk dam

Section 8: Any Non-Illicit Discharge Concerns (e.g., trash or needed infrastructure repairs)?



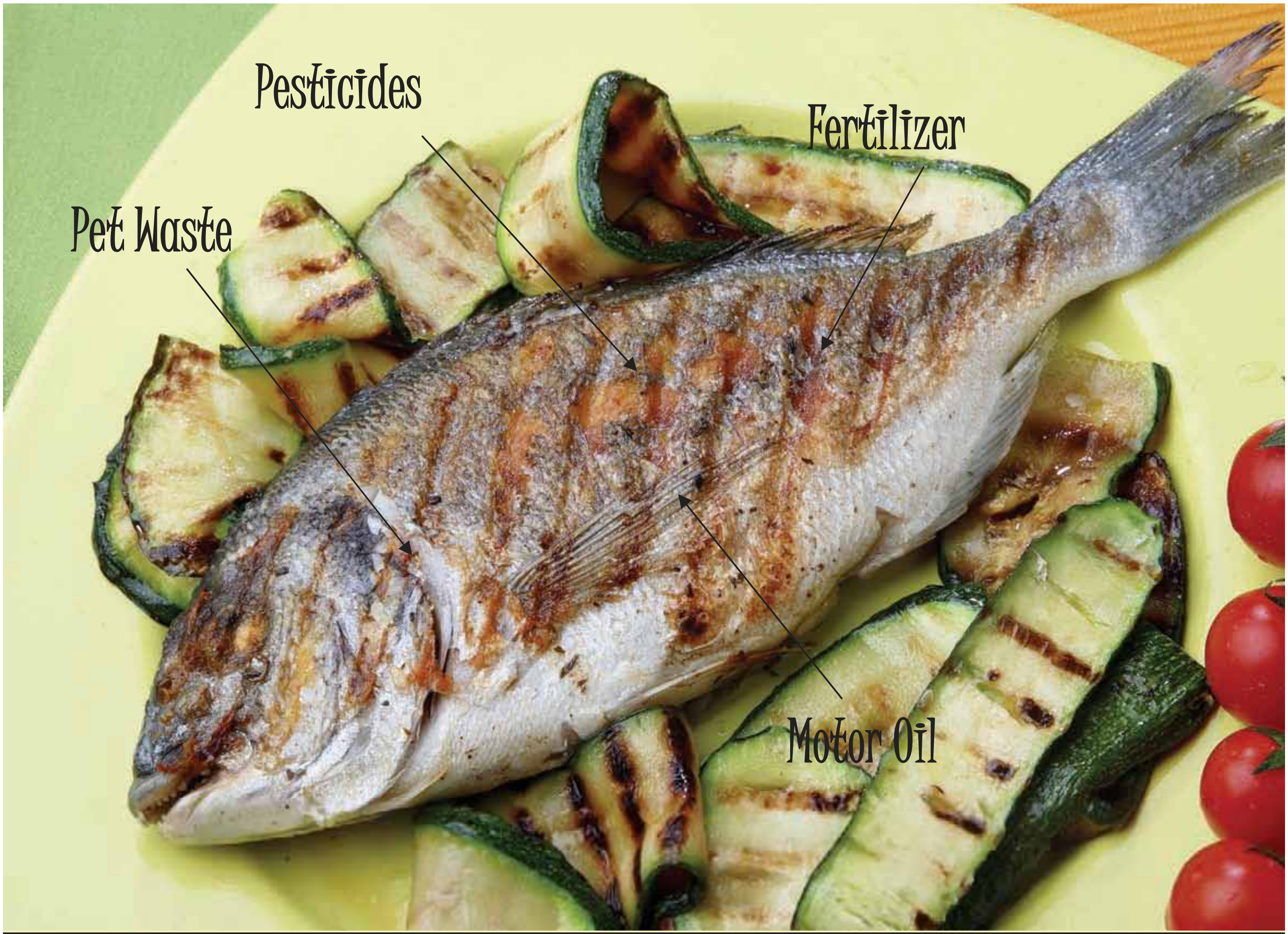
Appendix 7.10-C: Arlington Guide to Stormwater Pollution Prevention

LAKE ARLINGTON
MASTER PLAN



The Citizen's Guide to Stormwater Pollution Prevention

If it's on the ground, it's in your water!



What's On Your Plate ?

Everything that goes into our storm drains makes its way to our rivers, lakes, and streams—to the places where we fish.

Never throw anything down the storm drain.

The information contained in this guide is being offering by the City of Arlington, TX through its Public Works & Transportation (PWT) Department for the use of residents of the City. Please note that the stormwater management projects, tips, and Best Management Practices (BMPs) listed in this guide are voluntary projects recommended strictly for homeowners. They are not designed for professionals required to comply with the City's or other government entity's Stormwater Regulations.

While every attempt has been made to furnish the latest and most up to date information in this guide, updates, revisions, modifications, deletions, and additions may have taken place after its production and distribution. As such, the user of this guide is not relieved of their duty to obtain any revisions and updates. PWT is not liable for the use of information in this guide that results in additional costs due to changes that occurred after the production of this guide.

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D I S C L A I M E R

A C K N O W L E D G E M E N T S

THE CITY OF ARLINGTON, DEPARTMENT OF PUBLIC WORKS & TRANSPORTATION WOULD LIKE TO THANK THE FOLLOWING PARTNERS FOR THEIR ASSISTANCE AND FOR THE USE OF THEIR MATERIALS IN THIS GUIDE:

CITY OF ARLINGTON ANIMAL SERVICES

CITY OF ARLINGTON CODE COMPLIANCE

CITY OF ARLINGTON ENVIRONMENTAL SERVICES

CITY OF ARLINGTON OFFICE OF COMMUNICATION

CITY OF ARLINGTON PARKS & RECREATION

CITY OF ARLINGTON WATER UTILITIES

CITY OF LAWRENCE, KANSAS
PUBLIC WORKS—STORMWATER DIVISION

CHARLOTTE-MECKLENBURG COUNTY

NORTH CENTRAL TEXAS COUNCIL OF GOVERNMENTS (NCTCOG)
DEPARTMENT OF ENVIRONMENT & DEVELOPMENT

PHILADELPHIA WATER DEPARTMENT
OFFICE OF WATERSHEDS

TEXAS AGRILIFE EXTENSION OFFICE

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

UNITED STATES COMPOSTING COUNCIL

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (USEPA)

TABLE OF CONTENT

INTRODUCTION

A Guide for Citizens

Robert D. Lowry, P.E.
Director, Public Works & Transportation

The City of Arlington Public Works & Transportation Department has created this guide as an attempt to foster an appreciation of the environmental concerns associated with stormwater and the work done by stormwater management practitioners.

Every year, thousands of gallons of water flow into the **municipal separate storm sewer system (MS4)**. Most people don't think about how this water is collected, or where it goes.

In order to achieve the goal of "a Clean, Green Arlington," we must work together with our local residents, civic organizations, and homeowner associations on managing stormwater in a way that will protect our valuable water resources. We all play a part in creating water pollution and must therefore all play a part in actively converting our streams, creeks, lakes, and rivers into healthy systems that local residents, along with native fish and wildlife, can use as amenities, sanctuaries, and habitats.

As a citizen of Arlington, your part can be as simple as maintaining your car properly or picking up after your pet. This guide provides you with information, steps and actions you can take to improve stormwater management on your property and in your community. These stormwater management projects will not only help protect our invaluable water sources, but they will help green the city and improve quality of life for all residents.

For more information, please visit www.arlingtontx.gov/stormwater or email stormwatereducation@arlingtontx.gov.

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What is Stormwater and Stormwater Runoff?

Stormwater is any precipitation from a storm event (rain, snow, sleet, etc).

Stormwater runoff is any precipitation that does not soak into the ground but instead runs off its surface. Non-porous or impervious surfaces such as driveways, sidewalks, and streets block precipitation from soaking naturally into the ground. Stormwater can carry and deposit chemicals and other harmful substances into surface-water bodies.

Why should you care about Stormwater?

If stormwater is not managed properly, it can harm the environment causing:

- Increased risk of flooding
- Impaired water quality
- Increased surface runoff
- Increased soil erosion

Increased risk of flooding

High intensity thunderstorms and snowstorms are common in North Central Texas. Because urban areas have many impermeable surfaces, large volumes of water can enter the MS4.

During a rain event, thousands of gallons of water must be transported away from the street as quickly as possible. If the MS4 is clogged with debris, storm systems can become blocked and overflow. Flooding can lead to loss of life, property and infrastructure damage.

Impaired water quality

Contaminants, such as oil, grease, metals, and pesticides tend to build up on surfaces in urbanized areas. The contaminants come from sources such as pavement deterioration, tire and brake pad wear, vehicle emissions and spills. The may also come from yard and garden care, and pet feces. Stormwater runoff picks up these substances and transports them DIRECTLY to lakes, streams, rivers, or wetlands. In most cases, whatever enters a storm sewer system is discharged UNTREATED into the water bodies we use for swimming and fishing and from which we get our drinking water.

Degradation of water quality can also result in a decline in plant and animal diversity.

BOX 1

STORMWATER CONTAMINANT	SOURCE
Suspended Solids/Sediment	Construction sites & roads
Nutrients (Nitrogen & Phosphorus)	Fertilizers, pet wastes, yard wastes, soaps & detergents
Metals	Cars
Oil & Grease	Cars, leaks, spills
Bacteria	Pet wastes
Pesticides and Herbicides	Yard and garden care

According to the United States Environmental Protection Agency (USEPA), pollutants in stormwater discharges remain a significant source of environmental impacts to water quality. The *National Water Quality Inventory, 2002 Report to Congress* provides a general assessment of water quality based on reports submitted by the states every 2 years under Section 305(b) of the **Clean Water Act**. This report indicates that stormwater discharges (from sources including separate storm sewers, construction, waste disposal, and resource extraction) are MAJOR causes of water quality impairment.

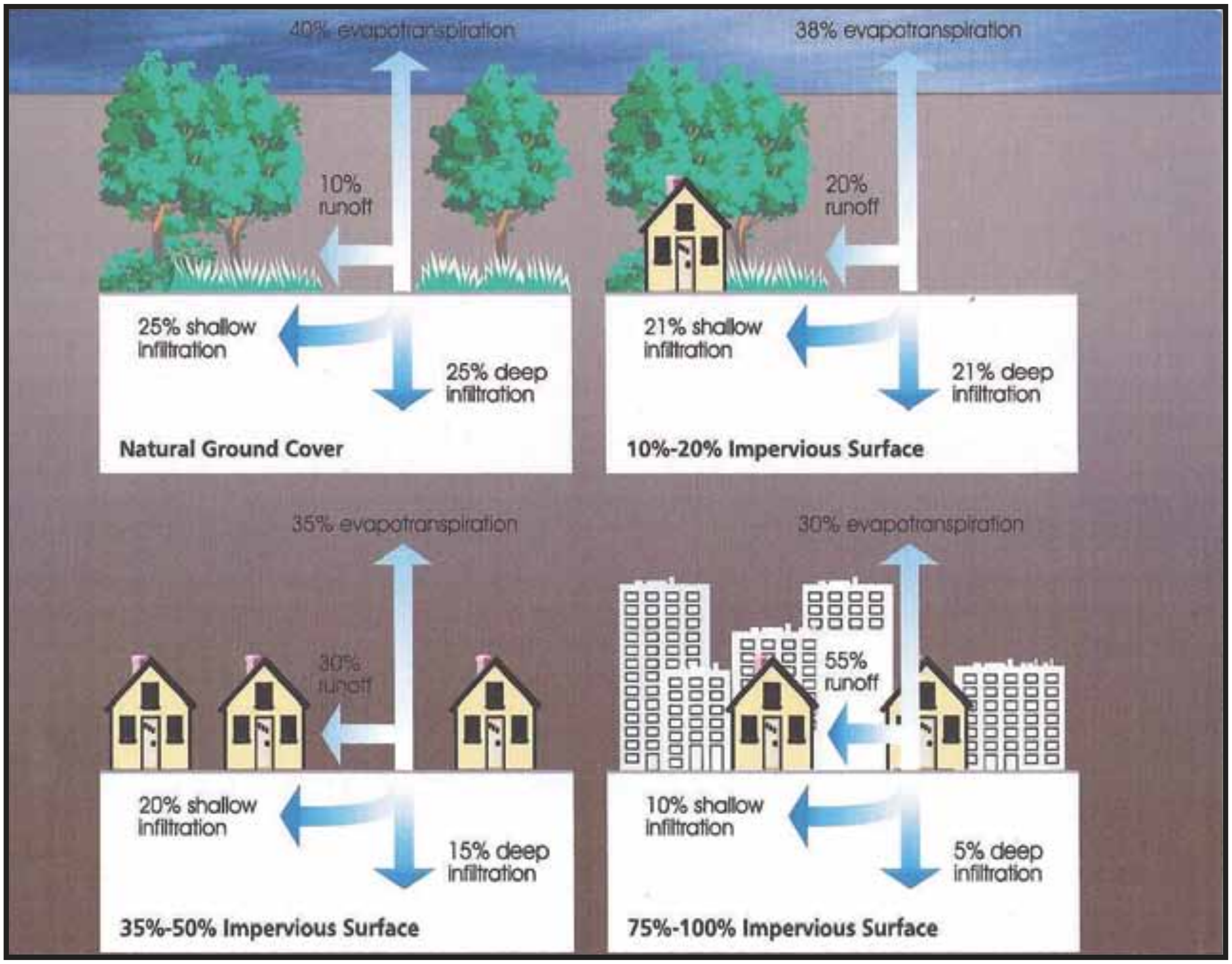
Key Terms:
CLEAN WATER ACT (CWA): the primary federal law in the United States governing water pollution. Also known as the Federal Water Pollution Control Act.

WATER QUALITY: the physical, chemical and biological characteristics of water. The term is most frequently used to explain a set of standards against which compliance can be assessed. In lay terms, it is the safety and/or purity of water.

Increased surface runoff

When materials impervious to water, such as pavement and concrete, cover the ground, runoff increases. Differences between areas with natural ground cover (before urban development) and those with impervious cover (after urban development) are shown below. As little as 10% impervious cover in an urban area can Increase surface runoff and lead to water quality problems (Source: USEPA).

Increased surface runoff means that large volumes of water enter water sources more quickly (at higher velocities) which can cause river or stream bank erosion.



Increased soil erosion

Raindrops hitting the soil's surface and the movement of water (runoff) across it cause soil erosion. Disturbed soil, lack of vegetation, or both amplify such impacts increasing erosion. Poorly controlled construction sites are also a cause of soil erosion. Not only can these sites harm aquatic environments, but adjacent properties, public roadways and drainage systems.

Example of soil disturbance or erosion.   Soil movement by rainfall is usually greatest and most noticeable during short-duration, high-intensity thunderstorms. Although the erosion caused by long-lasting and less-intense storms

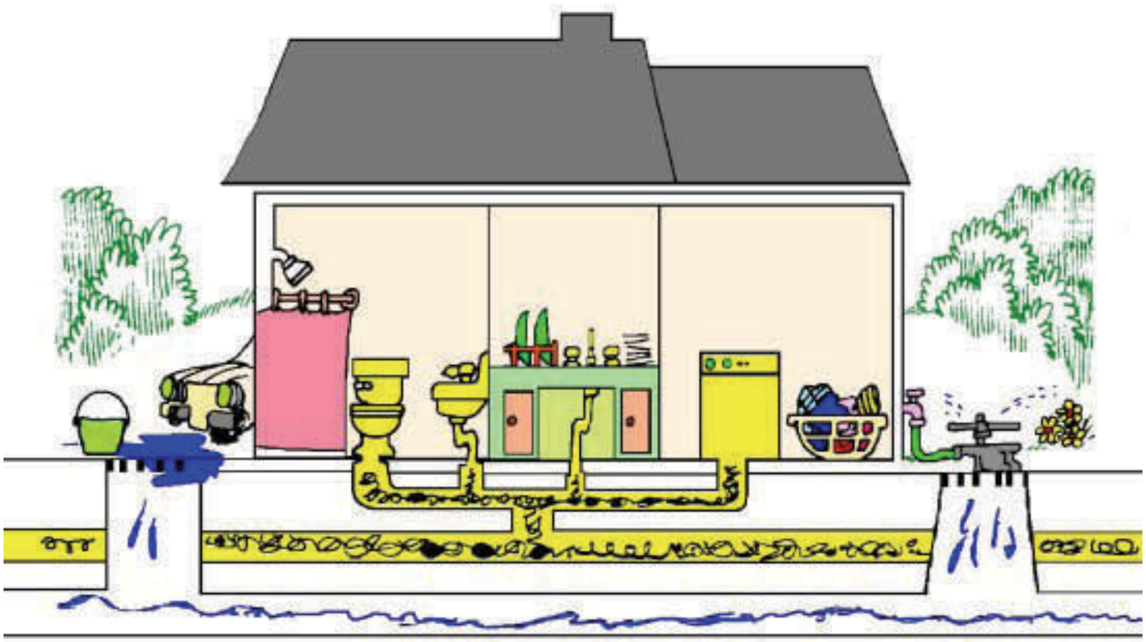
The Storm Sewer System versus Sanitary Sewer System: What's the Difference?

It's as simple as inside vs. outside.

Storm drain systems consist of natural and manmade channels and underground pipes that transport rainwater from streets, yards, rooftops, and other areas *outside* your home. This water goes directly to creeks, rivers, streams, and lakes carrying pollutants with it. Water entering the storm drain is not treated.

Sanitary Systems are composed of a branding network of pipes and manholes. This system is used to collect and transport the water (also known as wastewater) from sinks, washing machines, toilets, and other *indoor* plumbing**.** **Wastewater** entering the sanitary system flows directly to a wastewater treatment plant where it is treated, disinfected, and then released to area water sources.

These two systems are not connected.



LEFT:
The blue area in the figure represents the stormwater system (outside the home) while the yellow area represents the sanitary sewer system (inside the home).

RIGHT:
The figure shows both stormwater and sanitary underground system. Note that the systems are not interconnected.

Key Term:
WASTEWATER: Water that has been used, as for washing, flushing, or in a manufacturing process, and so contains waste products; sewage.

CHAPTER TWO

Why Stormwater is not Treated

Many people wonder why stormwater goes untreated. Here's why:

Photo courtesy of: www.dipity.com

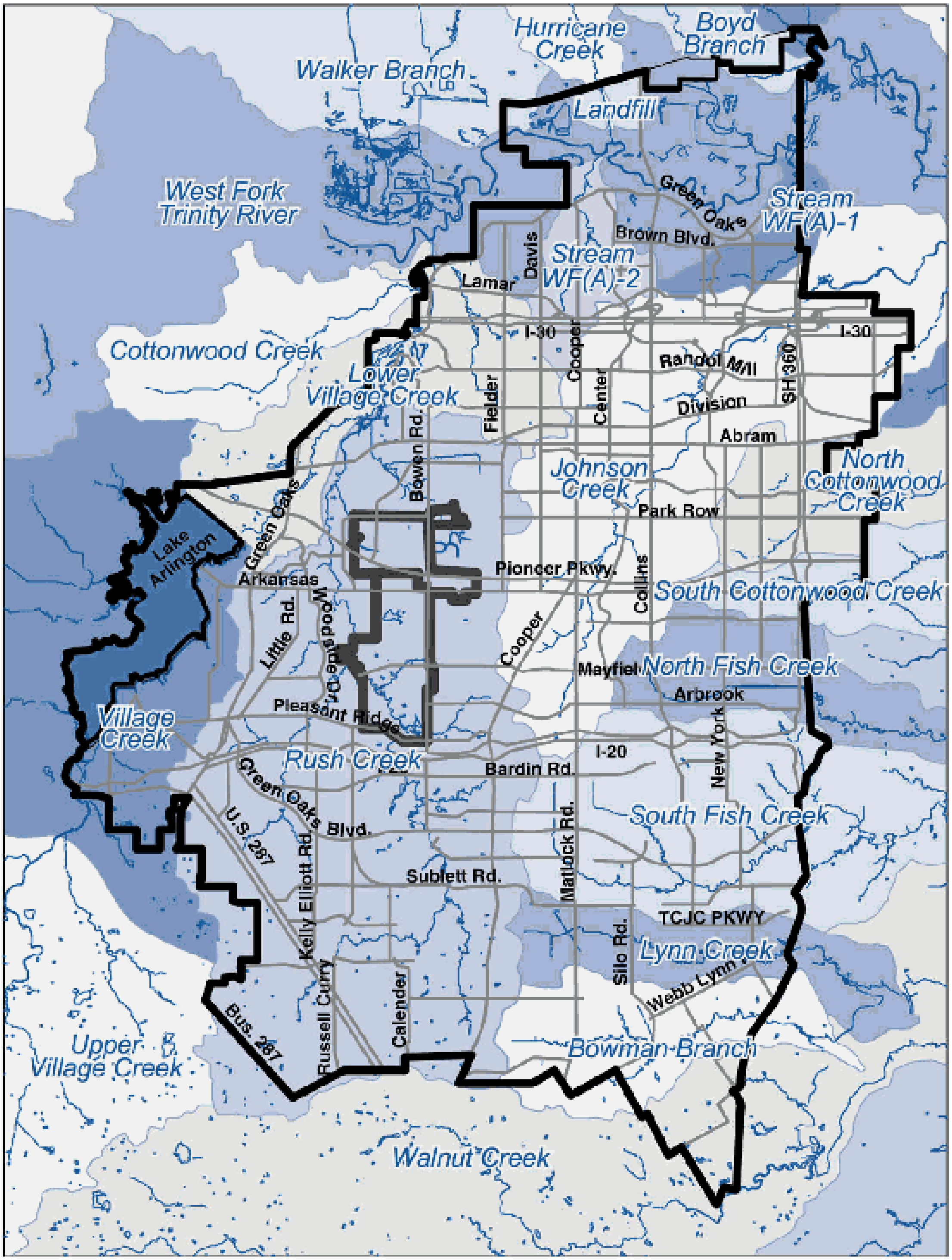
Simply, gutters (curb inlets/catch basins) are designed to prevent flooding. Their job is to remove water from the street as quickly as possible during a rainstorm or other precipitous event. The storm drain system they deposit into is designed to remove water from the streets and dispose of it quickly. The quickest way to dispose of thousands of gallons of water is to allow it to flow into rivers, lakes, or streams, *immediately.*

In addition, because stormwater comes in large amounts at unpredictable times, treating it as wastewater would be very expensive and quite unmanageable. If the sanitary and storm sewer systems were combined, many treatment plants would not be able to handle the quantity and velocities of water that intense storms produce.

Photo Courtesy of: www.canada.com

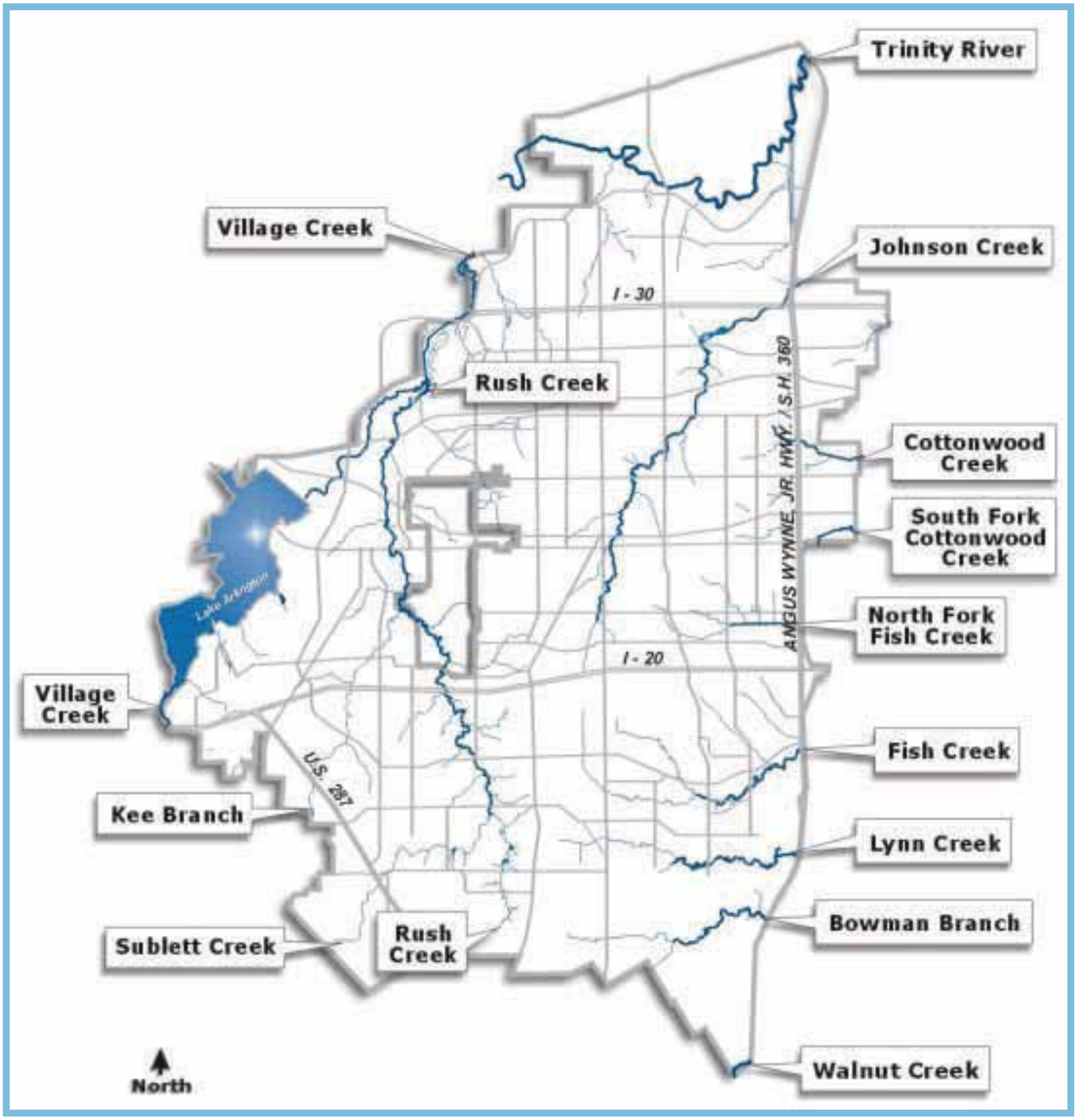
Watersheds

What is a watershed? A watershed is an area of land that catches rain and snow and drains or seeps into a water source, eventually making its way to lakes, rivers, and eventually the ocean. A watershed carries water "shed" from the land.



The Arlington, Texas Watershed. Note the interconnectedness of the water sources. Stormwater runoff flows directly to these sources.

Arlington, Texas Creek Map. ***Note:*** One of the most well-known (and problematic) creeks in Arlington is **Johnson Creek.** Johnson Creek has been the topic of extensive study by the Corps of Engineers and the City of Arlington since the early 1980s due to a history of flooding, extensive erosion and sedimentation, recreational challenges and opportunities, and important wildlife habitat. According to a 2006 report, sedimentation and erosion leading to poor water quality and unstable stream banks is the most serious threat to the ecological integrity of the Johnson Creek corridor. (Source: *Johnson Creek: A Vision of Conservation* 2006 report to the City of Arlington by Applied Ecological Services, Inc.)



The ultimate goal of stormwater management is to maintain the health of streams, lakes, rivers, and other water sources as well as aquatic life. Stormwater managers also wish to provide opportunities for human uses of water by mitigating the effects of urban development. To achieve this goal, stormwater management strives to maintain the natural hydrologic cycle, prevent an increased risk of flooding, prevent undesirable stream erosion, and protect water quality.

The federal Clean Water Act (CWA), directs all municipalities to improve stormwater quality and protect watersheds, rivers, streams, and drinking water sources. The City of Arlington Public Works & Transportation Department coordinates the citywide response to the federal and state stormwater permits that require the City to reduce stormwater pollution, and oversees other programs that respond to water quality requirements.

Rules and Regulations: CWA/NPDES/TPDES

In 1972, amendments to the Clean Water Act prohibited discharge of any pollutant from a point source into U.S. waters. The USEPA regulates stormwater through the National Pollutant Discharge Elimination System (NPDES), pursuant to subsequent amendments to the Clean Water Act. The Texas Commission on Environmental Quality (TCEQ) operates the NPDES program under the Texas Pollutant Discharge Elimination System (TPDES).

Three stormwater activities are regulated: municipal separate storm sewer systems (MS4s), industrial activities and construction activities.

Issued in 1990 under the Clean Water Act, Phase I of the USEPA's stormwater program relies on NPDES permit coverage to address stormwater runoff from:

- Medium and large municipal separate storm sewer systems (MS4s) generally serving populations of 100,000 or greater
- Eleven categories of industrial activity
- Construction activity disturbing 5 or more acres of land

Phase II regulates construction activities covering between 1 and 5 acres and regulated small MS4s. Phase II expands the Phase I program to include additional operators of MS4s in urbanized areas and operators of small construction sites. Phase II requires such operators, through the use of TPDES permits, to implement programs and practices to control polluted stormwater runoff. Phase II is intended to reduce even further adverse impacts to water quality and aquatic habitat; it institutes the use of controls on the unregulated stormwater discharge that have the greatest likelihood of causing continued environmental degradation.

Key Terms:

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES): a provision of the Clean Water Act (CWA) prohibiting discharge of pollutants into waters of the United States unless a special permit has been issued by the USEPA, a state, or where delegated a tribal government on a Native American reservation.

TEXAS POLLUTANT DISCHARGE ELIMINATION SYSTEM (TPDES): The State of Texas has assumed the authority to administer the NPDES program in Texas. The Texas Commission on Environmental Quality's TPDES program now has federal regulatory authority over discharges of pollutants into Texas surface water, except for discharges associated with oil, gas, and geothermal exploration and development activities, which are regulated by the Railroad Commission of Texas.

Under Phase I of the TPDES Stormwater Program, operators of large and medium MS4s require a TPDES permit authorizing them to discharge pollutants. Medium and large MS4 operators must submit comprehensive permit applications and are issued individual permits. A proposed stormwater management program must be developed that would meet the standard of reducing pollutants to the maximum extent practicable. Stormwater management programs for medium and large MS4s include measures to:

- Identify major outfalls and pollutant loadings
- Detect and eliminate non-stormwater discharges to the system
- Reduce pollutants in runoff from industrial, commercial, and residential areas
- Control stormwater discharges from new development and redevelopment areas

Only a select subset of small MS4s, referred to as regulated small MS4s, are required to have Phase II TPDES stormwater permits (No. TXR 040000). Regulated small MS4s are defined as (1) all small MS4s located in urbanized areas as defined by the Bureau of the Census and (2) small MS4s located outside of a UA but designated by TCEQ. An **urbanized area** comprises one or more central places plus the adjacent densely settled surrounding area (urban fringe), together having a residential population of at least 50,000. Urbanized areas in Texas have (1) an overall population density of at least 1,000 people per square mile or (2) are so designated by a regulatory agency. Regulated small MS4 operators may choose to be covered by an individual permit, by a general permit, or by a modification of an existing Phase I MS4's individual permit. Some regulated small MS4s in UAs may be eligible for a waiver from TPDES stormwater permitting requirements.

Regulated small MS4s are required to design their programs:

- To reduce their discharge of pollutants to the maximum extent practicable
- To protect water quality
- To satisfy the appropriate Clean Water Act water quality requirements

BOX 2

Urbanized Areas		*Outside Urbanized Areas*		
Place	*Population 2000*	*Place and County*	*Population 2000*	*Population Density (per sq. mile)*
Abilene, TX	107,041	Alice city, Jim Wells County	19,010	1,597.40
Amarillo, TX	179,312	Bay City city, Matagorda County	18,667	2,196.00
Austin, TX	901,920	Beeville city, Bee County	13,129	2,149.70
Beaumont, TX	139,304	Big Spring city, Howard County	25,233	1,320.40
Brownsville, TX	165,776	Borger city, Hutchinson County	14,302	1,637.90
College Station–Bryan, TX	132,500	Brenham city, Washington County	13,507	1,541.50
Corpus Christi, TX	293,925	Burkburnett city, Wichita County	10,927	1,149.50
Dallas–Fort Worth–Arlington, TX	4,145,659	Canyon city, Randall County	12,875	2,600.00
Denton–Lewisville, TX	299,823	Corsicana city, Navarro County	24,485	1,180.40
El Paso, TX–NM	648,465	Del Rio city, Val Verde County	33,867	2,194.00
Galveston, TX	54,770	Dumas city, Moore County	13,747	2,681.00
Harlingen, TX	110,770	Eagle Pass city, Maverick County	22,413	3,030.30
Houston, TX	3,822,509	El Campo city, Wharton County	10,945	1,465.80
Killeen, TX	167,976	Fort Stockton city, Pecos County	7,846	1,531.30
Lake Jackson–Angleton, TX	73,416	Gatesville city, Coryell County	15,591	1,794.20
Laredo, TX	175,586	Georgetown city, Williamson County	28,339	1,241.30
Longview, TX	78,070	Hereford city, Deaf Smith County	14,597	2,600.80
Lubbock, TX	202,225	Huntsville city, Walker County	35,078	1,135.10
McAllen, TX	523,144	Jacksonville city, Cherokee County	13,868	981.00
McKinney, TX	54,525	Kerrville city, Kerr County	20,425	1,222.50
Midland, TX	99,221	Kingsville city, Kleberg County	25,575	1,848.80
Odessa, TX	111,395	Levelland city, Hockley County	12,866	1,296.50
Port Arthur, TX	114,656	Lockhart city, Caldwell County	11,615	1,032.70
San Angelo, TX	87,969	Lufkin city, Angelina County	32,709	1,225.10
San Antonio, TX	1,327,554	Nacogdoches city, Nacogdoches County	29,914	1,185.90
Sherman, TX	56,168	New Braunfels city (Comal and Guadalupe Counties)	36,494	1,247.70
Texas City, TX	96,417			
The Woodlands, TX	89,445	Pampa city, Gray County	17,887	2,050.00
Tyler, TX	101,494	Port Lavaca city, Calhoun County	12,035	1,229.90
Victoria, TX	61,529	Port Neches city, Jefferson County	13,601	1,490.40
Waco, TX	153,198	Rio Grande City city, Starr County	11,923	1,571.60
Wichita Falls, TX	99,396	Robstown city, Nueces County	12,727	1,054.60
		San Marcos city (Caldwell and Hays Counties)	34,733	1,907.50
		Seguin city, Guadalupe County	22,011	1,157.20
		Snyder city, Scurry County	10,783	1,256.80
		Stephenville city, Erath County	14,921	1,488.30
		Sweetwater city, Nolan County	11,415	1,139.40
		Taylor city, Williamson County	13,575	1,003.20
		Uvalde city, Uvalde County	14,929	2,220.20
		Vernon city, Wilbarger County	11,660	1,439.20

Areas regulated as MS4s. (Source: Texas AgriLife Extension Office.)

Rules and Regulations: City of Arlington Stormwater Pollution Control Ordinance

In December 1996, the Arlington City Council adopted a new Storm Water Pollution Control Ordinance. The primary purpose of this ordinance is to maintain and improve the quality of surface and ground water. The Stormwater Pollution Control Ordinance prohibits the discharge of non-storm water. It also requires that management practices be implemented for certain industrial, commercial, residential, and construction activities to prevent or minimize pollutants in the rainfall runoff entering the city's storm drain system and streams.

Environmental Compliance Officers and Field Operations Specialists

The City of Arlington utilizes Environmental Compliance Officers (ECO's), Environmental Engineers, and Field Operations Specialists to oversee stormwater pollution and maintenance activities. Their duties include conducting inspections and preparing related technical reports to meet federal and state requirements; responding to hazardous materials incidents or releases to stormwater systems; pipe maintenance and cleaning, improved channelization efforts, and investigating citizen complaints. Duties also include sampling, monitoring and inspections for stormwater activities related to construction, industrial, commercial, and agricultural sites.

ABOVE: City of Arlington personnel removing a tree in a concrete channel.

RIGHT: City of Arlington personnel entering storm drain for inspection.

Stormwater Utility Fee

The current storm water fee structure and rates became effective on October 1, 2007. Under the current fee structure, every property owner pays the same unit rate based on the amount of impervious area on the property. Impervious area is defined as a surface that is resistant to infiltration by water. Several examples of impervious area include asphalt or concrete pavement, parking lots, driveways, sidewalks and buildings. Based on a study of Arlington residential property, the average square feet of impervious surface is 2800, referred to as an Equivalent Residential Unit (ERU).

The monthly fee adopted by the City Council bills per ERU. The fee structure and scheduled rates are as follows:

October 1, 2007 - $2.00
October 1, 2008 - $2.75
October 1, 2009 - $3.50
October 1, 2010 - $4.25

Residential Property
Residential parcels include any benefited property platted, zoned or used for residential development including single family, duplex, triplex, quadraplex, townhomes, manufactured homes or other improved parcel upon which buildings contain less than five dwelling units. Residential parcels will be billed based on one ERU at the scheduled rate, for the number of dwelling units.

Commercial Property
Non-residential parcels include all benefited property that is not defined as residential by the storm water utility ordinance, including commercial, industrial, institutional, multi-family and governmental property. The monthly fee for non-residential parcels is determined by dividing impervious area square footage by 2800 square feet and multiplying by the current rate – the result shall be a minimum of 1 ERU for each non-residential account.

Other Storm water Fee Information
✦ Failure to pay storm water fees promptly when due shall subject users to discontinuance of any utility services provided by the City.
✦ Apartments are considered non-residential for the purpose of the calculation of the storm water fee.
✦ Any non-residential property on which mitigation measures have been taken may be eligible for a credit to the storm water fee. The Director of Public Works and Transportation shall adjust the fee for such properties according to the actual mitigative effect of the measures taken.

For more information on the City of Arlington's Stormwater Utility fee, contact the Stormwater Fund Administrator at 817-459-6586.

Pollution Prevention for Residents

One of the key ways to achieve the goals of stormwater management is prevention. Preventing stormwater (or non-point source) pollution is more cost effective via **front-of-pipe** rather than **end-of-pipe** measures. That is, the best way to prevent pollution from entering the storm sewer system is to manage it *before* it enters the storm drain.

Municipalities, businesses and individuals can put pollution prevention measures into practice. This chapter includes information on **Best Management Practices (BMPs)** that can be utilized in preventing stormwater pollution around your home.

Pollution prevention measures and BMPs apply to everyday activities that occur inside and outside the home. These include the following categories: vehicle maintenance, lawn & garden care, pet waste, vehicle & pressure washing, swimming pool & spa drainage, litter prevention, **household hazardous waste**, tree planting, rain barrels, and rain gardens.

BOX 3

POLLUTION PREVENTION	BMPs
Home vehicle maintenance	Tree Planting
Lawn & garden care	Rain Barrels
Pet waste	Rain gardens
Vehicle & pressure washing	Backyard Composting
Swimming pool & spa drainage	
Litter prevention & proper disposal of household hazardous wastes	

Key Terms:

FRONT-OF-PIPE: Methods used to remove contaminants from air, water, waste or other similar product before they enter ecological systems.

END-OF-PIPE: Methods used to remove already formed contaminants from a stream of air, water, waste, product or similar. These techniques are called 'end-of-pipe' as they are normally implemented as a last stage of a process.

BEST MANAGEMENT PRACTICES (BMPs): permanent controls to minimize the discharge of pollutants to the MS4 or storm sewer system.

HOUSEHOLD HAZARDOUS WASTE (HHW): Leftover household products that contain corrosive, toxic, ignitable, or reactive ingredients are considered to be "household hazardous waste" or "HHW." Products, such as paints, cleaners, oils, batteries, and pesticides, that contain potentially hazardous ingredients require special care when you dispose of them.

Home Vehicle Maintenance

At-home vehicle maintenance is a common practice. Many individuals choose to repair or maintain their vehicles at home rather than visit an auto repair service center. While the actual maintenance work of personal vehicles is not a problem, the byproducts that result from this kind of work can add significant amounts of pollutants into the storm sewer system.

These byproducts (i.e. oil, grease, brake fluid, gasoline, diesel, kerosene, antifreeze, etc), all contain toxins that are harmful to fish and birds, aquatic vegetation, wildlife and humans. Maintaining and repairing vehicles at home can allow these byproducts to leach into the street and then into the storm sewer system, transporting these pollutants to area waterways.

When repairing or maintaining your vehicle at home, adopt these few simple practices that can reduce the detrimental impacts of pollutants on our local waterways. And remember two simple rules:

1. Only rainwater may be discharged to the storm sewer system.
2. Minimize the contact of rainfall & runoff with pollutants. Do this by keeping hazardous materials covered and by managing wastes responsibly.

Your Work Area

Be aware of where you work. Any drips or spills on the ground can be carried away by rainwater to a storm drain and into a nearby waterway. So:

- NEVER work on a vehicle in the street or near a storm drain.
- Work on a flat concrete surface where you can easily clean up accidental spills.
- NEVER hose down your work area unless the resulting wash water is contained and disposed of properly.
- Keep storage and work areas clean and dry.

Replacing brakes and brake parts

Follow these tips when replacing brakes and brake parts.

- Don't hose down brake pads, rotors or drums. Remember, brake pads contain copper, which can erode as the pads wear and contribute to stormwater pollution.
- Use shop cloths to wipe as much brake dust as possible from rotors and drums before using brake cleaner fluid.
- Recycle cleaner fluid by using a drip pan.
- Never discharge cleaning solutions from cleaning into the storm sewer system.

Recycling

You can recycle many of the waste products that come from maintaining your vehicle at home, including:

- Antifreeze
- Batteries
- Brake Fluid
- Degreasers
- Gasoline
- Motor Oil
- Oil Filters
- Transmission Fluid

STORMWATER FACT:
A single quart of oil can pollute 250,000 gallons of drinking water. (Source: Natural Resources Defense Council)

Changing Your Oil or other Fluids

Follow these tips for changing your oil and other fluids.

- Use funnels or pumps when handling liquid products or wastes to avoid spills.
- Capture vehicle fluids in separate drip pans or containers.
- Drain and recycle used oil filters. Poke holes in the filter and let it drain into your oil pan for several hours before you recycle them.
- If spills occur, use kitty litter, sawdust, or oil absorbent to clean spills. Apply to the spill, sweep it up and dispose of the waste in the trash.
- NEVER sweep or wash used oil products or other fluids into the storm sewer system.
- Collect your used motor oil and other fluids in separate containers and transport to the Environmental Collection Center. Be sure to verify that your waste materials are accepted at the local collection center.

Hazardous Products Associated with Home Vehicle Maintenance or Repair

BOX 4

Product	*Hazardous Property*
Antifreeze	Toxic Flammable
Auto Batteries	Corrosive Toxic
Auto Paint & Primers	Flammable Toxic
Brake and Transmission Fluid	Flammable Toxic
Carburetor Cleaner	Corrosive Toxic
Engine Cleaner and Degreasers	Flammable Toxic
Gasoline, Diesel, and Kerosene	Flammable Toxic Highly Volatile
Motor Oil	Toxic Flammable
Used Motor Oil Filter(s)	Toxic
Windshield Washer Fluid	Toxic

Lawn and Garden Care

Yard Waste entering storm drains or streams and other water sources, increases the risk of flooding and adds pollutants to the environment. Not only does yard waste cause blockages to the drainage system which can lead to localized flooding, it can also quickly "super-fertilize" streams and lakes and can lead to algae blooms and fish kills. Sweeping or blowing grass clippings, fallen leaves, or other yard waste into the street or down the storm drain can cause serious damage to the storm sewer system and to the water resources to which storm drains lead. Leaves, grass clippings and other yard waste (depending on type) should be composted, left on your lawn, or placed in acceptable containers for curbside pick-up.

If you have to use fertilizers, pesticides, and herbicides, carefully read all labels and apply products sparingly. According to surveys conducted by the Center for Watershed Protection, over 50% of lawn owners fertilize their lawns, yet only 10% to 20% perform soil tests to determine whether fertilization is even needed (CWP, 1999). Conduct a soil test on your lawn and follow the practices listed here to reduce the need to fertilize on your lawn and garden.

Grasscycling: Don't Bag It!

In an effort to save landfill space, the City of Arlington banned the curbside collection of bagged grass clippings with the adoption of the "Don't Bag It" program in 1993. According to the "Don't Bag It" program, presented by the Texas Agricultural Extension Service, leaving clippings on the lawn and allowing them to work their way back into the soil, helps produce a beautiful, green lawn.

IMPROPER DISPOSAL OF GRASS CLIPPINGS

Grass clippings from edging or mowing that fall on the streets or sidewalks must be removed and disposed of properly. Grass clippings should not be disposed of in trash dumpsters. The City of Arlington landfill will accept yard waste at a fee per truckload. Failure to dispose of yard waste properly can result in a citation and a fine.

Fertilizers & Pesticides

Fertilizers are essentially nutrients used by plants to live. Most fertilizers contain nitrogen, phosphorus, and potassium but can contain other elements as well. Just like humans, plants can only use so much food. Fertilizer that is not used by the plant is available to mix with rain and become stormwater pollution. Nutrients from fertilizers, like nitrogen and phosphorus, promote algae blooms and excessive plant growth in water. Algae deplete oxygen, making it unavailable to fish and other aquatic life. Algae blooms and excessive plants also limit much needed sunlight.

Texas homeowners pour approximately four million pounds of pesticides on their lawns and gardens each year. More pesticides per square inch are applied to a typical yard than to the most intensely sprayed farmland. An estimated 1/3 of the pesticides used at home are wasted because more is used than is needed.

Fertilizer Tips:

▲**TEST** your soil to determine the type of fertilizer needed.
▲**USE** fertilizers sparingly and apply fertilizers exactly where you want them.
▲**SLOW RELEASE (ORGANIC) FERTILIZER** does not have to be applied as frequently and the risk of burning your grass is reduced.
▲**LEAVE** grass clippings on your lawn as natural fertilizers.
▲**STORE** fertilizers in areas that are covered to avoid mixing them with rain.
▲**DO NOT** apply fertilizer if rain is predicted or on frozen ground or dormant lawns.
▲**WASH** spreader equipment on a pervious (penetrable) vegetated area, like the lawn, to allow for the natural absorption of excess fertilizer.

Pesticide Tips:

◀**DO NOT** apply any pesticides if rain is predicted.
◀**SWEEP** any pesticides from paved surfaces onto your lawn.
◀**READ** the label instructions before applying any chemical product.
◀**SPOT TREAT** areas of pest damage instead of treating the whole yard. If you have fire ants, they may be controlled or eliminated by ant baits.
◀**INSECTICIDAL SOAP** is an alternative to traditional pesticides.

Plans for caring for your lawn

WATERING PLAN

There are several grass types in the North Central Texas region. Most common forms found in Arlington are:

1. Tall Fescue (requires the most water)
2. St. Augustine
3. "Tif" Bermuda
4. Zoysia
5. Common Bermuda
6. Buffalo (requires the least water)

During the driest period of summer, lawns usually require about 1 inch of water every 6 days. If water runs off the lawn before 1 inch is applied, turn the sprinkler off, let the water soak in for about 1 hour, and then continue watering.

The best time to water is early morning, so less water is lost by evaporation. The worst time to water is in the evening because the lawn stays wet all night. This encourages disease development. Lawns watered too frequently tend to develop shallow root systems.

REMEMBER: No watering between 10am—6pm in the City all year long.

FERTILIZING PLAN

The rate of fertilizer application, the frequency of application, the ratio of nutrients in the fertilizer and the source of the nitrogen all have a great deal to do with how fast the lawn grows.

The following fertilizing plan is designed to allow the lawn to grow at a reasonable rate and still have good color.

Fertilizer Ratio (NPK)	Fertilizer Analysis	Application rate (lbs/1000 sq ft)
3-1-2	12-4-8	6
	15-5-10	5
	21-7-14	4
4-1-2	16-4-8	5
	20-5-10	4

Fertilizer application dates

Tall Fescue
Mar. 1, Sept. 15, Nov. 15

St. Augustine
Apr. 15, June 1, Sept. 1

"Tif" Bermuda
Apr.- Sept. (1st of each month)

Zoysia
May 1, June 1, Sept. 1

Common Bermuda
Apr. 15, June 1, July 15, Sept. 1

Buffalo
May 1, Sept. 1

MOWING PLAN

The "rule of thumb" for mowing home lawns is not to remove more than 1/3 of the blade surface at any one time. If you use the following mowing schedule, you no longer will need to bag your grass clippings.

Grass clippings left on your lawn will not lead to thatch, but will return valuable nutrients to the soil. They contain the necessary elements your lawn needs. Clippings are an excellent source of nitrogen for compost.

Grass type	Mower setting (inches)	Mow when this height (inches)
Tall Fescue	2	3
St. Augustine	2	3
"Tif" Bermuda	1	1
Zoysia	2	3
Common Bermuda	1	2
Buffalo	2	3

Pets and Pet Waste

Pet waste left on streets, pavement, yards, driveways, or along the sides of the road does not magically disappear or fertilize the ground. Improperly disposed animals feces can be picked up by stormwater runoff and carried into storm drains or nearby water sources. Storm drains do not connect to sanitary sewer systems and treatment facilities, so pet waste can be the cause of significant stormwater pollution and present health risks to adults, children and other pets.

Pets and children who play in yards or parks and those who garden in yards where pets defecate are at risk for infections from disease-causing viruses, bacteria and parasites found in pet waste.

Dangers of Improperly Handled Pet Waste

Some of the diseases that can be transmitted from pet waste to humans include:

- **Salmonellosis:** the most common bacterial infection transmitted to humans by other animals. Symptoms include fever, muscle aches, headache, vomiting, and diarrhea.
- **Toxocariasis:** roundworms usually transmitted from dogs to humans, often without noticeable symptoms, but may cause vision loss, rash, fever, or cough.
- **Toxoplasmosis:** A parasite carried by cats that can cause birth defects such as mental retardation and blindness if a woman becomes infected during pregnancy; also a problem for people with suppressed immune systems.
- **Campylobacteriosis:** a bacterial infection carried by dogs and cats that frequently causes diarrhea in humans.
- **Fecal Coliform Bacteria:** found in the feces of warm blooded animals; poses potential health risk for those exposed to it in water.

STORMWATER FACTS:

1. The average dog releases 3/4 pound of waste per day or 274 pounds per year. North Central Texas is home to approximately 1.2 million dogs; that's over 900,000 pounds of waste per day!

2. A days worth of poop from one large dog can contain 7,800,000,000 fecal coliform bacteria.

Other issues

Nutrients in pet waste also encourage weed and algae growth, thus causing serious problems for water quality. Pet waste contains nitrogen and phosphorus, two elements that fertilize aquatic plants and make them grow out of control. This nutrient-rich water is cloudy, green, unattractive and unhealthy for swimming, boating, fishing, or drinking. It also smells. Finally, when pet wastes decays, it uses up oxygen and releases ammonia, which can lead to fish kills.

STORMWATER FACT:
THE FERTILIZER MYTH
Contrary to popular belief, carnivorous animals, such as dogs, do not produce useable manure-fertilizer for plants. Beneficial manure-fertilizer comes from herbivores like horses and cows. These animals consume vegetation and return unused waste back to the soil to be taken up by plants.

Pet Waste Tips: Bury it, Flush it, or Trash it

- Always clean up after your pet, even in your own yard. Your pet's waste is NOT fertilizer.
- Bury your waste in a hole that is at least 5-6'' deep and cover it with soil away from gardens, ditches, storm drains, and waterways. It will decompose slowly so bury waste in different locations throughout the yard.
- Flush your pet's waste down the toilet where it will flow through the sanitary sewers for treatment.
- Throw your pet's waste in the trash. Carry disposable bags with you while you walk your pet and dispose of it in the trash when done.
- Hire a professional. Believe it or not, a number of professional pet waste disposal services exist in the North Central Texas area. These businesses will completely remove the waste from your yard and dispose of it themselves, for a fee. Check your local phone listings for more information.
- Tell others not to leave their pet's waste on the ground.

Kitty Litter

Dispose of kitty waste and litter properly. Use a two-step process to clean out the cat box.

- Scoop cat waste out of the flushable litter and, flush it down the toilet, taking care to minimize the amount of litter you flush.
- When litter is no longer usable, bag the litter and dispose of it in the trash, not in the toilet. Large amounts of litter flushed down the toilet may damage plumbing. **Never** flush any kind of litter if you have a **septic tank**!

Flea Dips

Do not pour flea dip solutions onto driveways or into the street. Flea dips usually contain an insecticide than can harm aquatic life.

REMEMBER:
It is unlawful not to pick up after your pet.

Car Washing

For many, car washing is a spring and summertime ritual. Often, citizens do not know that by washing off all of the grime that accumulates on their vehicles, that they might actually be causing harm to our local waterways.

When cars are washed on streets and driveways, that dirty water eventually ends up in rivers, streams, creeks, and lakes. Washing one car may not seem to be a problem, but collectively, car washing activity adds up to big problems for our local water sources. Pollution associated with car washing degrades water quality and also finds its way into **sediments**, impacting aquatic habitats.

STORMWATER FACT:
Car washing is a pollution problem because many metals and automotive fluids are washed off along with the soapy water. Water does not disappear when it goes down the street. It usually enters a storm drain inlet, and then flows to a waterway. Even biodegradable soap can be toxic to aquatic habitats. Just one gallon of liquid soap will pollute 200,000 gallons of water.

The Problem

Washing your car is only a problem if you do not know where or how t do it correctly. The average homeowner uses 116 gallons of water to wash one car. Most commercial carwashes use 60 percent less water f the entire process than a homeowner uses just to rinse one car.

Outdoor car washing has the potential to result in high loads of nutrients, dirt, metals, and hydrocarbons entering our waterways as th detergent-rich water used to wash the grime off of cars flows down th driveway and the street. Dirty water containing soap, detergents, residue from exhaust fumes, gasoline, heavy metals from rust, metals and other elements from brake linings, rubber, trace amounts of benzene and chromium, and motor oils can wash off cars and flow directly to storm drains and into the nearest creek or stream where it can harm water quality and wildlife.

Small concentrations of detergents in streams can kill fish and their eggs, as well as inhibit their ability to reproduce. Detergents can also destroy the natural protections fish have against bacteria and parasite and can severely damage a fish's gills.

The phosphates from soap can also cause excess algae to grow in our waterways. Excessive algae growth makes water cloudy, green, unattractive, smelly, and unhealthy for swimming, boating, fishing, or drinking.

The Best Alternative

The best way to minimize the environmental effects of washing your car at home is to use a **commercial car wash facility**. Commercial carwash facilities are required to treat their wash water discharge before releasing it to the sanitary sewer system where the water is treated prior to release back into our water sources. Some facilities even recycle their wash water—reusing it several times before sending it to the sanitary sewer and water treatment facilities. Changing the way you wash your car is something that you can do to make a difference in the quality of our water sources. Proper individual actions can result in significant water quality improvement when carried out by the majority. The individual citizen can easily and economically manage this source of stormwater pollution.

Car Washing Tips

Use a commercial car wash facility where wash water is treated and cleaned before it is returned to our waterways.

If you do wash your car at home:

- Wash it on gravel, grass, or other **permeable** surfaces. Avoid washing on concrete or asphalt unless it drains into a vegetated area.
- Use plain water with a coarse sponge or, phosphate-free, water-based cleaners only.
- Use a trigger nozzle on your hose or a bucket to conserve water.
- Always empty wash buckets into sinks or toilets, never into the street or storm drain.

STORMWATER FACT:
Most car washing best management practices are inexpensive, and rely more on good housekeeping practices (where vehicles are washed, planning for the collection of wash water) than on expensive technology.

Key Terms:
SEDIMENT: Sediment is any particulate matter that can be transported by fluid flow and which eventually is deposited as a layer of solid particles on the bed or bottom of a body of water or other liquid. Sedimentation is the deposition by settling of a suspended material.

PERMEABLE: PENETRABLE; having pores or openings that permit liquids or gases to pass through; porous; pervious.

COMMERCIAL CARWASH FACILITY: A place or business equipped for washing cars and other motor vehicles.

Car Wash Fundraisers

Community car wash events are a popular means of raising money for worthwhile causes. However, car wash fundraisers can be a significant source of stormwater pollution. These events are usually held in heavily paved areas where there is little runoff control or grass to filter out harmful substances. If runoff from car washes is not properly managed, it can negatively impact our local creeks and rivers.

Wash water from car washing activities typically contains dirt (sediment), soap (detergent/surfactants), gasoline and motor oil, as well as metals and oil/grease residues from exhaust fumes and brake pads. When this dirty water is allowed to flow into storm drains, it travels directly to our local creeks and rivers without treatment. This pollution can kill or harm fish and other aquatic life and make our waterways unsafe for drinking, swimming and fishing. Alone, one car wash fundraiser event may not create a significant adverse environmental impact. But, collectively, car wash fundraiser events can contribute large amounts of polluted wash water to our local waterways.

Planning a Low Impact Car Wash Fundraiser

Consider holding your car washing fundraiser at a commercial car wash. Wash water from commercial car washes goes to sewage treatment plants rather than down a storm drain. Call your local car wash to ask if they offer fundraising options for schools, teams, and charities.

If you choose not to partner with a commercial car wash, try to incorporate these practices to reduce the overall environmental impact of your fundraiser:

- Selecting the site for your car wash is very important. When talking to property owners of shopping centers, schools or churches where you are considering holding the event, ask them where the water flows from the storm drains on the property. The best locations will have some storm water management controls in place. These controls include grass swales, sand filters, oil and grit separators, storm water management ponds, and wetlands that treat storm water before it is discharged to a stream.

Pressure Washing

What is Pressure Washing?

Pressure washing uses mechanical equipment to create a high pressure stream of water, typically ejected from a hand-held wand or nozzle. This jet of water is used for cleaning a wide variety of surfaces and objects. Depending on the application, pressure washing may be conducted with or without heated water or added cleaners.

In recent years, the use of pressure washing equipment has grown substantially. Numerous contractors provide pressure washing as a service to others, businesses purchase their own units to use in their own operations and maintenance, and many homeowners rent units or purchase low cost equipment.

Pressure washing is used to clean many things around the home, including:

- Automobiles
- Driveways
- Home exteriors
- Sidewalks
- Garages
- Roofs
- Graffiti

Pressure washing equipment is also used for stripping paint or for preparing and treating other types of surfaces.

STORMWATER FACT:
As a consumer who may employ pressure washing contractors, you can have a significant impact on the prevention of water pollution by simply choosing a contractor who follows pollution prevention guidelines and techniques. Keep in mind that as the consumer, you may also be held responsible for illegal discharges that occur on your property.

Key Terms:
PRESSURE WASHING: also known as power washing; cleaning with a machine that delivers a high-pressure water spray.

The Problem

Most pressure washing activities are conducted outside. This often results in the discharge of wastewater to the storm drainage system, unless the equipment operator takes steps to collect and dispose of it legally. Discharge of pressure washing wastewater to the storm drainage system is prohibited because it contains pollutants from the cleaning compounds used and/or from the objects or surfaces being cleaned. Even cleaners labeled "biodegradable" and "non-toxic" may be harmful to aquatic life, especially after cleaning various surfaces (e.g. home exteriors, driveways, equipment and more) that contain oils, greases, chemicals, and other substances.

Any substance, including pressure washing wastewater that enters storm drains flows directly into lakes, rivers, and streams. This water is not treated or cleaned to remove pollutants. Pollutants discharged to the storm drainage system harm fish and wildlife and contaminate recreational sites and drinking water supplies.

Pressure Washing as part of the Solution

Pressure washing is an activity that can help improve the quality of our waters when done properly. By cleaning (pressure washing) surfaces (e.g. equipment, parking lots, sidewalks, buildings, etc.), collecting the wastes (water and/or debris), and properly disposing of the wastes, there is less chance of pollutants ending up in our waterways. It is through education, proper collection and disposal that pressure washing can have a positive impact on the environment.

Consider using dry methods for surface pre-cleaning, such as using absorbents on small oil spots and sweeping up trash, debris, or dirt before washing. Remember to pick up pre-cleaning debris as soon as possible and dispose of them properly after use so that they do not enter storm drains.

DISPOSAL REQUIREMENTS AND PROHIBITIONS

Proper disposal of pressure washing wastewater, in compliance with environmental regulations, depends on the nature of the pollutants in it. It is the responsibility of the generator to determine the proper collection and disposal method for wastewater created by pressure washing. To avoid unanticipated costs, delays, and violations, this determination should always be made prior to starting any job.
All disposal methods are subject to requirements, restrictions, and prohibitions, as outlined by the City of Arlington.

Examples of Pressure Washers.

Swimming Pool and Spa Drainage

There are three options for draining your swimming pool. Please note that whichever method you choose, you must ***dechlorinate*** the water before draining occurs.

Here's how:

- Dechlorinate naturally: Allow the water to sit in the sun for 5-10 days without adding any chlorine; or
- Use a chemical dechlorination additive (contact your local pool store for options).
- Verify water is dechlorinated with a pool testing kit.

Option 1: Your Lawn
The Preferred Discharge Method

Drain ***dechlorinated*** water to the grass, turf or any area on your property that will allow the water to percolate into the ground, ***if and only if***...

- You do not cause flooding of your neighbor's property or any other adjacent property.
- The land area is sufficient to prevent erosion and runoff into a ditch, creek, or other conveyance (i.e. storm drain).
- You do not cause harm to the environment.

This water can be used to irrigate plants, saturate dry ground, or soak into mulched areas.

Option 2: The Sanitary Sewer

Drain your pool to the sanitary sewer. Most in-ground pools have a drain line connected to the sanitary sewer which can be used once the pool water has been ***dechlorinated***.

Follow these steps:

- Locate the sanitary sewer cleanout on your property or an indoor drain such as a sink or bathtub.
- Using a hose, connect a siphon or sump pump that pumps no more than 12-20 gallons per minute.
- Pump the water from the pool or spa to the cleanout or indoor drain.
- Replace all cleanout covers when finished.

DO NOT drain swimming pool or spa water to your SEPTIC SYSTEM as it may cause system failure.

It is not advisable to connect a hose to your indoor toilet to drain your swimming pool or spa. In most cases, water being pumped from your pool will drain faster than the time needed for flushing and refilling of the commode.

If you are unsure whether or not the discharge from your pool will create a problem in the sanitary sewer system or wastewater treatment plant, contact the City of Arlington Water Utilities Department at 817.459.6600.

Option 3: The Storm Drain

Swimming pool water may be discharged to the storm drain ***only*** after ***all*** of the following conditions are met:

- Other disposal methods (i.e. sanitary sewer or landscaping) are not possible.
- The pool or spa is completely ***dechlorinated.***
- The pH of the water is between 6 and 9.
- There is no discharge of filter media.
- There is no discharge of acid cleaning wastes.
- Discharge water will not pond or flow to neighboring properties.

REMEMBER: discharges into the City's Storm Drain System should be via pump and hose directly to the storm drain inlet or catch basin. DO NOT allow effluent to run down the street.

Filter Backwash

NEVER discharge filter backwash to the storm sewer system. It is a violation of the City of Arlington Code of Ordinances. This practice is illegal and you can be fined.

Disposing of filter rinse water and backwash :

- Filter backwash must be collected, contained, and discharged to the sanitary sewer.
- Cartridge filters should be rinsed in a sink, bathtub, or over a lawn or other vegetated area.
- Use a separation tank for diatomaceous earth (DE) and cellulose fiber filters to capture the DE or fibers.
- For water conservation, direct the clean water back into the pool.

See Page 37 for specific steps to drain your pool or spa.

Steps for Draining Your Swimming Pool

Try to use your lawn or the sanitary sewer when draining your pool. Use a dechlorinator such as Sodium Thiosulphate (available at pool or hardware stores, or online) to remove all traces of chlorine before discharge. Pool overflow water should be discharged onto land or other surface where there is no chance of it running off into streets or adjacent properties. If this is not possible, use the sanitary sewer system. The sewer system is designed to remove many pollutants from water. Draining should be done via pool plumbing, a gully trap, or sink. Do not discharge pool water when it is raining. Filtered backwash water **must not** be discharged into the stormwater system.

Follow these steps to properly drain your swimming pool.

1. Shut off the power to the circulation system at the circuit breaker.

2. Locate the clean-out port for the sanitary sewer line. The port is usually located in the ground and close to the home in the front yard. It may be near a water spigot. The port should have a rubber or threaded cap with a square wrench fitting and should be three to four inches in diameter. If you can't locate the port, contact a plumber. **CAUTION: Using a clean-out in the wall creates greater potential for water to back up into the house.**

3. Run a hose from the sewer clean-out port to the pool and connect it to a submersible pump. Lower the pump into the deepest part of the pool near the drain. As you drain, monitor the water's flow to ensure that the water does not backup. If the water begins to back up, stop draining and contact a professional plumber. The maximum recommended discharge rate is 12-20 gallons per minute.

4. After draining your pool, refill it as soon as possible. Direct sunlight can damage the plaster in your pool if it is left exposed. It may take a few days for the fresh water to reach the proper chemical levels, so check the levels every day for a week and add chemicals as needed.

5. If you are unsure about draining your pool, or you'd like assistance, contact a professionally licensed pool service company or plumber. By following these guidelines you can ensure your drained pool water is properly treated and recycled.

KNOW THE LAW:

It is a violation of the City of Arlington's Code of Ordinances to drain chlorinated water or filter backwash from your swimming pools or spas to the storm sewer system.

*Remember, you are responsible for the actions of your pool maintenance service. Be sure you know how your service is disposing of your pool or spa water and the filter backwash. They **must** follow all discharge requirements set forth by the City.*

Litter Prevention and Household Hazardous Waste (HHW)

LITTER

Litter is an unsightly health hazard. However, many people do not realize that litter on the ground will pollute our water. Storm water systems are designed to take rainfall into the waterways and with the run off are carried trash, litter, and chemical waste. The nature of modern cities is to have extensive paved surfaces, resulting in litter that ends up in storm water systems. Whether someone dumps an auto ashtray at a curb, or drops a candy wrapper on the ground, the result is washed, untreated, into storm water systems and then into our waterways and onto our beaches. Litter in storm water systems impacts people, animals, fish, and plants.

The impact of litter and chemicals in our waterways on aquatic life and wildlife can be devastating: fish and other aquatic animals can be poisoned; wildlife can become entangled in or suffocate from litter while searching for food; and wildlife can contract diseases from eating or being exposed to rotting substances.

Litter in the waterways can also reduce oxygen to levels that suffocate aquatic plants, animals, and fish. These conditions, in turn, affect the quality of the water we drink and the water in which we play.

STORMWATER FACTS:

1. Cigarette butts are the most littered item worldwide. An estimated 450 trillion cigarette butts are said to be littered each year.

2. The City of Arlington conducts several litter clean-up events throughout the year.

3. In the State of Texas, littering is illegal and the fine is up to $500. The fine for dumping items more than 5 pounds is up to $2,000.

Much of the litter washed into the waterways does not break down. This litter is ugly and dangerous. Broken glass and shattered plastic can result in cuts and wounds which can become infected, especially if the water quality is poor. Diseases can spread to people directly and indirectly as contaminated water enters the food chain. There is also a cost to local governments and to taxpayers, when systems must be cleaned and repaired and health issues must be treated.

Litter Prevention Tips

How can you become part of the solution? Follow these simple tips:

- Don't litter -- put trash in an appropriate receptacle.
- If you see litter, pick it up and throw it away.
- Recycle.
- Participate in local clean up days.
- If you see an area that needs to be cleaned up, report it to the appropriate government agency.

To report a litterer, call 817.459.6777 or visit www.dontmesswithtexas.org

HOUSEHOLD HAZARDOUS WASTE (HHW)

Leftover household products that contain corrosive, toxic, ignitable, or reactive ingredients are considered to be "household hazardous waste" or "HHW." Products, such as paints, cleaners, oils, batteries, and pesticides, that contain potentially hazardous ingredients require special care when you dispose of them.

Improper disposal of household hazardous wastes can include pouring them down the drain, on the ground, into storm sewers, or in some cases putting them out with the trash. The dangers of such disposal methods might not be immediately obvious, but improper disposal of these wastes can pollute the environment and pose a threat to human health.

Certain types of HHW have the potential to cause physical injury to sanitation workers, contaminate septic tanks or wastewater treatment systems if poured down drains or toilets, and present hazards to children and pets if left around the house. To avoid the potential risks associated with household hazardous wastes, it is important that people always monitor the use, storage, and disposal of products with potentially hazardous substances in their homes.

HHW Tips

- Use and store products containing hazardous substances carefully to prevent any accidents at home. Never store hazardous products in food containers; keep them in their original containers and never remove labels. Broken and leaky containers should be placed in a second container of like material (i.e. glass for corrosives, metal for flammables).
- When leftovers remain, never mix HHW with other products. Incompatible products might react, ignite, or explode, and contaminated HHW might become unrecyclable.
- Remember to follow any instructions for use and disposal provided on product labels.

BOX 5

Some environmentally friendly alternatives to household hazardous waste products.

	Household Hazardous Waste (HHW)	Alternative
Household	Air Fresheners	Simmer whole cinnamon sticks, cloves & allspice; Leave out a shallow bowl of vinegar; Odors can be absorbed by placing baking soda at the source of the problem; or put a few drops of vanilla extract in a dish.
	Batteries	Use nickel-cadmium rechargeable batteries whenever possible.
	Flea Collar	Talk with your veterinarian about natural flea control methods.
	Bleach	Natural oxygen safe bleaches are commercially available.
	Rug & upholstery cleaner	Mix 3 tbsp of borax with 1/2 quart of warm water in a spray bottle. Spray on stained area and wipe with a damp sponge.
	Glass & window cleaners	Combine 1/4 cup vinegar, 1/2 tsp liquid soap or detergent, and 2 cups of water in a spray bottle. Shake to blend.
	Oven Cleaners	Mix baking soda & water and scrub. For tough stains leave on dampened oven overnight and scrub the next day.
	Drain Cleaners	Apply a plunger or snake through lines. Or mix 1/4 cup of salt, 1/4 cup of baking soda, and 1/2 cup of vinegar. Let sit for 15 minutes, then flush with boiling water.
	Furniture Polish	1/4 cup vinegar plus a few drops of oil (olive or liquid jojoba).
Automotive	Gasoline	Do not store in areas that allow this material to mix with rain. Properly dispose of excess by taking it to a full service environmental collection center (ECC). The ECC that serves the Arlington area is located at: 6400 Bridge Street Fort Worth, TX 76112 817-871-5257 Call for more information
	Batteries	
	Used Motor Oil	
	Antifreeze	
	Automotive Fluids (transmission, brake, etc.)	
Workshop	Paint	Use water-based paints instead of oil based; use non-aerosol paints.
	Turpentine & paint thinners	Use water-based paints and avoid unnecessary brush and roller cleanup.
	Wood stains	Use water-based stains instead of oil-based stains.
Yard	Pesticides	Introduce predator insects in your yard; apply soapy water to leaves and rinse well.
	Fertilizers	Composting.
	Bug sprayers/killers	Ants: Red chili power at point of entry; Mosquitoes: remove any standing water outside; burn citronella candles/oil.

STORMWATER FACTS:

1. Americans generate an estimated 1.6 tons of HHW per year and the average home can accumulate as much as 100 pounds of HHW in the basement and garage and in storage closets.

2. One quart of used oil can pollute an acre of surface water.

Tree Planting

Trees are not only a beautiful addition to the landscape, but they also provide invaluable benefits to cities. They reduce heat by cooling and shading homes during the hot summer months, decreasing the amount of energy required to cool a home and its related electric bills. Mature trees can actually cut summer cooling costs by 40% and tree-lined blocks can even decrease local temperatures. Trees naturally clean the air of pollutants and create a neighborhood noise buffer. Trees also improve stormwater management, reducing the amount of polluted stormwater that normally would go directly into storm drains. Tree roots also allow rainwater to filter back into the soil, recharging the often thirsty water table.

How to Plant Your Tree

It is important to carefully choose the site where you will plant your tree before digging. Pay special attention to where the tree will be planted making sure that it will have plenty of clearance from obstructions as the tree matures. Overhead power lines, underground lines, sidewalks, and buildings should be given consideration before choosing the planting site.

Correct soil preparation encourages root growth reducing the difficulties already challenging the young tree. Most roots spread through the top 12" of soil in a wide periphery around the tree. Slope the side of the hole and dig or deeply **rototill** an area around the hole at least twice the diameter of the container.

Plant the tree with the top of the root ball even with the surrounding terrain. When wet conditions or heavy soil are problems, raising several inches of the root ball above ground will aid the spread of lateral roots.

Backfill with native soil or a mix of native soil and high quality top soil. Gently pack and soak with water. Add a 2-3” thick mulch layer around the tree out to the edge of the drip line, mounding the mulch at the outer edge to create a bowl effect. Be careful not to let the mulch touch the trunk of the tree. The best time to plant trees in the Arlington area is between December and March.

Key Terms:
ROTOTILL: To cultivate or dig with a rotiller.

Approved Tree List for Arlington, Texas (Source: City of Arlington Parks & Recreation - Forestry Division)

BOX 6

Shade Trees	Ornamental Trees
Texas Ash	Mexican Buckeye
White Ash	Red Buckeye
Eastern Red Cedar	Texas Buckeye
Arizona Cypress	Carolina Buckthorn
Bald Cypress	Crepe Myrtle
Cedar Elm	Desert Willow
Lacebark Elm	Eve's Necklace
Black Hickory	Hawthorne
Ashe Juniper	Possumhaw Holly
Southern Magnolia	Yaupon Holly
Ashleaf Maple	Blue Point Juniper
Caddo Maple	Hollywood Juniper
Bigelow Oak	Wichita Blue Juniper
Blackjack Oak	Little Gem Magnolia
Bur Oak	Honey Mesquite
Chinquapin Oak	Texas Persimon
Durand Oak	Mexican Plum
Escarpment Live Oak	Redbud
Lacey Oak	Rose of Sharon
Live Oak	Soapberry
Post Oak	Flame-leaf Sumac
Shumard Oak	Downy Viburnum
Southern Live Oak	Texas Chastetree
Texas Red Oak	
Pecan	
American Sycamore	
Black Walnut	

For more information on tree planting in Arlington visit: www.naturallyfun.org

Rain Barrels

A rain barrel collects and stores stormwater runoff from rooftops that would otherwise be lost to runoff and diverted to storm drains and streams. By detaining (temporarily holding) water, rain barrels help add capacity to the city's sewer system and reduce sewer overflows to creeks, rivers, lakes, and other water sources. The collected rain water can be reused for irrigation to water lawns, gardens, window boxes or street trees. Rain barrels can be purchased on-line or they can be built.

Advantages

Lawn and garden watering make up nearly 40% of total household water use during the summer. A rain barrel collects water and stores it for when you need it most -- during periods of drought -- to water plants, wash your car, or to top a swimming pool. It provides an ample supply of free "soft water" to homeowners, containing no chlorine, lime or calcium making it ideal for gardens, flower pots, and car and window washing.

Rainwater harvesting will lighten the load on water wells as well as public water supplies. It prevents overtaxing of wastewater treatment plants, and saves you money and energy (decreased demand for treated tap water). Diverting water from storm drains also decreases the impact of runoff to streams, rivers, and lakes. Therefore, a rain barrel is an easy way for you to have a consistent supply of clean, fresh water for outdoor use. And best of all it's FREE!

Purchasing a (Ready-Made) Rain Barrel

Ready-made rain barrels can be purchased from a number of companies, including hardware and garden supply stores. Below are just a few sources. ***(This listing does not constitute an endorsement by the City of Arlington).***

BOX 7

Ace Hardware (different models available) (866.290.5334) www.acehardware.com	Gaiam (produces the Great American Rain Barrel) (877.989.6321) www.gaiam.com
Plow & Hearth (several available including a pop-up barrel that folds flat when not needed) (800.494.7544) www.plowhearth.com	Rain Barrel sources (offers an extra large system) (866.912.9719) www.rainbarrelsource.com
Spruce Creek company (produces the Spruce Creek Rainsaver) (800.940.0187) www.sprucecreekrainsaver.com	Urban Garden Center (offers the Urban Rain Barrel) (866.923.1922) www.urbangardencenter.com

Building your own Rain Barrel

Tools:
- 7/8” to 1” spade drill bit
- Electric jigsaw
- Hacksaw
- Electric drill
- Utility knife
- Marker

Supplies:
1—55 gallon plastic barrel
2—3/4” plastic faucets
1—3/4” female coupling
1—skimmer basket
1—roll of Teflon tape
1—all purpose caulk or plumbing sealant
1—12” x 12” piece of fiberglass window screen
2—4 concrete cinder blocks
1—downspout flex elbow


55 gallon barrel


Skimmer basket

STEP ONE: TOP HOLE
1. Use skimmer basket to trace template on barrel.
2. Pre-drill a small hole using spade bit.
3. Make sure to drill inside the line.
4. Use a jigsaw to cut out hole following the inside line.

STEP TWO: UPPER DRAIN (OVERFLOW)
1. Mark holes at least 2” from top of barrel.
2. Use drill bit to drill hole.
3. Screw plastic faucet into hole. Use utility knife as needed to alter hole.
4. Wrap 3/4” coupling threads in Teflon tape and caulk and screw onto faucet *inside* the barrel.

THE UPPER DRAIN SHOULD ALWAYS BE LEFT IN THE OPEN POSITION TO KEEP THE BARREL FROM OVERFLOWING.

STEP THREE: BOTTOM DRAIN
1. Mark holes at least 2” from bottom of barrel.
2. Use drill bit to drill hole.
3. Screw plastic faucet into hole. Use utility knife as needed to alter hole.
4. Remove faucet, wrap threads in tape, caulk threads, and replace faucet.
5. Caulk area where faucet and barrel meet to reduce leakage.

STEP FIVE: BASKET
1. Cut fiberglass window screen to fit basket.
2. Affix screen to lip of basket using caulk/plumbing sealant.
3. Allow several hours to dry and place in top hole.

STEP SIX: BASE AND DOWNSPOUT
1. Place concrete blocks under your selected downspout as a raised base to allow room for a watering can or to screw on a hose to the lower drain.
2. Cut the downspout with a hacksaw about 4' above the top of the barrel lid (top hole).
3. Attach downspout flex elbow to the downspout.
4. Direct the flex elbow into the skimmer basket on top of your barrel.

TIPS FOR USING YOUR RAIN BARREL
1. Make sure your barrel is clean and free of chemicals before use.
2. Make sure all caulk is thoroughly dry before using your rain barrel.
3. Disconnect the barrel from downspout during winter months to avoid the formation of damaging ice.
4. ENJOY making a difference and reducing stormwater pollution.

For more information on building rain barrels and rain barrel construction workshops, contact the City of Arlington Water Conservation Coordinator at 817.459.6628 or visit _www.SaveArlingtonWater.com_.

Completed rain barrel

STORMWATER FACT:
Whether you buy or build a rain barrel, the most important thing to remember is that they are only effective at stormwater management when the stored water is emptied in between storms, making room in the barrel for the next storm.

Rain Gardens

A rain garden is a garden which takes advantage of rainfall and stormwater runoff in its design and plant selection. Usually, it is a small garden which is designed to withstand the extremes of moisture and concentrations of nutrients, particularly nitrogen and phosphorus, that are found in stormwater runoff. Rain gardens are sited ideally close to the source of the runoff and serve to slow the stormwater as it travels downhill, giving the stormwater more time to infiltrate and less opportunity to gain momentum and erosive power.

On the surface, a rain garden looks like an attractive garden. It may support habitat for birds and butterflies, it may be a formal landscape amenity or it may be incorporated into a larger garden as a border or as an entry feature. What makes it a rain garden is in how it gets its water and what happens to that water once it arrives in the garden.

Below the surface of the garden, a number of processes are occurring which mimic the hydrologic action of a healthy forest. Soils are engineered and appropriate plants selected for the rain garden. The garden is a small **bioretention cell** in which stormwater is cleaned and reduced in volume once it enters the rain garden. Nitrogen and phosphorus levels and overall sediment loads in the stormwater are reduced by the action of the plants and growing media on the water. Multiple rain gardens over an area will have a positive cumulative effect on both the volume and quality of stormwater run off.

What does a rain garden cost?

The cost of a rain garden will vary depending on who does the work and where the plants come from. If you grow your own plants or borrow plants from neighbors there can be very little or no cost at all. If you do all the work but use purchased plants, a rain garden will cost approximately $3 to $5 per square foot. If a landscaper does everything, it will cost approximately $10 to $12 per square foot.

It might seem easiest to sow native wildflower seed over the garden , but experience shows that seeding a rain garden has its problems. Protecting the seeds from wind, flooding, weeds, and garden pests is very difficult, and the rain garden will be mostly weeds for the first two years. Growing plugs from seed indoors or dividing a friend's plants is much better. If you grow plugs, start them about four months before moving them to the rain garden. When the roots have filled the pot and the plants are healthy, they may be planted in the rain garden.

Photo courtesy of: www.apwa.net

Key Terms:
BIORETENTION CELL: A shallow planted depression designed to retain or detain stormwater before it is infiltrated or discharged downstream (also known as a rain garden).

For more information on how to design and install a rain garden visit: www.lowimpactdevelopment.org

For a list of native plants to use in your rain garden, visit The City of Arlington's Forestry website at www.naturallyfun.org

Backyard Composting

Research has shown that compost and composted products can help reduce water pollution (Source: US Composting Council 2008). Compost products can be used directly and indirectly to prevent pollution or remediate polluted water and by replacing polluting activities with less polluting alternatives.

Organic wastes, such as leaves, branches, grass clippings and other yard waste products, are a major source of nonpoint source (or stormwater) pollution. The process of composting takes these raw materials and stabilizes them under controlled conditions. Stabilizing the material takes the nutrients, such as nitrogen, and ties them up in the compost's organic matter. The nutrients are slowly released over time, increasing the opportunity for up-take by plants and reducing downstream water pollution problems.

What is Backyard Composting?

Backyard composting refers to a variety of practices individuals can use to manage organic materials at home. All backyard composting techniques use the natural activity of bacteria, fungi, and other soil organisms to decompose organic materials and return them to the soil. Decomposed organic material—compost—is essential to healthy gardens and landscapes.

Benefits of Backyard Composting

Using compost has several positive benefits as related to Stormwater Pollution Prevention. Backyard composting can be the most economical and environmental way to manage organic materials produced at home. The benefits include:

- Reduces the need for chemical pesticides because it contains beneficial microorganisms that protect your plants from diseases and pests.
- Reduces or eliminates your use of synthetic fertilizers used in gardens and other yard areas.
- Reduces herbicide use from using composted mulches for weed suppression.
- Reduces soil loss from erosion because of improved soil structure.
- Use of compost improves any soil. Compost makes soil better able to absorb and retain moisture reducing runoff, erosion, and irrigation needs.
- Diverts organic material from landfills – Keeping these materials at home prolongs the life of landfills and reduces the expenses and environmental impacts associated with them.

Composting Methods

There are several different composting methods, including cold composting, hot composting, vermicomposting (worms), in-vessel composting (industrial), Bokashi composting, high fiber composting, tunnel composting , and Windrow (agricultural).

The cold and hot composting methods are listed here.

Cold Composting (Cool & Easy)

With this method, compost is ready in six months to two years. This practice does not destroy weed seeds, runners, or plant diseases.

Advantages

- Low maintenance
- Can add materials as they become available

Disadvantages

- Doesn’t heat up enough to kill weed seeds
- May create unpleasant odors if carbon/nitrogen ratio and the balance between wet and dry materials are not maintained

Tools

- Garden fork
- Water hose with spray head
- Compost bin (optional)
- Burlap scraps or black plastic to cover top of pile (optional)

Ingredients

- Grass clippings
- Brown leaves
- Twigs
- Water

Directions

1. Set compost bin or start pile in an area where water does not puddle when it rains, preferably in a shaded spot near a water source.
2. Put yard trimmings in bin or pile as collected from garden clean-up or mowing. Moisten dry materials as they are added. Mix grass clippings with leaves or composting materials already in pile.

3. Chop or shred woody trimmings over ½ inch diameter if adding large amounts.
4. Cover top of compost with burlap scrap or black plastic to keep pile moist but not too wet.

Your compost is ready when material at the bottom of the bin looks like dark, rich soil. When ready pull aside undecomposed materials to start a new batch. Harvest the finished compost to use in the garden or other yard areas.

Hot Composting (Hot & Fast)

This approach requires more maintenance but produces compost in batches that are ready in one to four months. This practice destroys most plant diseases, weeds, and weed seeds.

Advantages
• Heats up enough to kill most weed seeds and pathogens
• Uses space efficiently

Disadvantages
• Labor intensive
• Must be built all at once, requiring storage of materials until enough is collected
• Requires careful control of moisture and carbon/nitrogen ratio

Tools
• Garden fork
• Water hose with spray head
• Compost thermometer
• Compost bin (optional)
• Burlap or black plastic to cover top of pile (optional)

Ingredients
• Grass clippings or other high-nitrogen material
• Brown leaves
• Twigs
• Water

Directions
1. Set compost bin or start pile in an area where water does not puddle when it rains, preferably in a shaded spot near a water source.
2. Chop or shred woody trimmings over ½ inch diameter if adding large amounts.
3. Place about 6 inches of brown materials at bottom of bin or pile.
4. Add 1 or 2 inches of green material – grass clippings, green leaves, cottonseed meal, etc.
5. Mix layers with a garden fork (optional) and moisten dry materials (not optional).
6. Repeat steps 3 and 4 until the pile is at least 3 f t. x 3 f t. x 3 f t., or until the bin is full.
7. Monitor the heat in pile using a compost thermometer. Turn the pile once it has heated and starts to cool (about one week). Using a garden fork, move the material, shaking it in order to add air around the particles.
8. Repeat step 7 in about one week. Repeat until pile does not reheat after turning.

Let the compost cure for two weeks before using.

REMEMBER: Using compost before it is ready can damage plants and can also introduce weed seeds and root damaging organic acids to your garden or yard.

Compost is ready when...

- It smells earthy—not sour, putrid, or like ammonia
- It no longer heats up after it is turned or wetted
- It has a crumbly texture and looks like dark soil

What to put in your compost bin/pile

MATERIAL	USE: Y/N	COMMENTS
Algae or seaweed	Yes	Good nutrient source.
Animal wastes (bird, cat, dog feces or cat litter)	No	Droppings from pets (and litter) may contain disease organisms.
Ash from coal or charcoal	No	May contain materials that harm plants. Best to exclude.
Ashes from wood fireplace or stove	No	Too alkaline for our clay soils. Can cause nutrient imbalance problems.
Cardboard	Yes	Use if it cannot be recycled. Best if shredded into small pieces. Glue is usually organic.
Cottonseed meal	Yes	Can be a source of nitrogen in the fall when green grass clippings are scarce.
Diseased plants	No	Piles often do not get hot enough to destroy all plant disease organisms.
Dryer lint	Yes	May need to be moistened. (If high synthetic, may not decompose, but is not harmful).
Food scraps	Yes	May attract rodents and other pests if not buried at least 6” to 12” deep in pile.
Hair	Yes	Add moisture and mix thoroughly in pile.
Manure (horse, cow, pig, sheep, goat, chicken, rabbit)	Yes	Excellent source of Nitrogen. Due to high water content, should be mixed with drier materials.
Newspaper	Yes	Use if cannot be recycled. Shredding is recommended before use. Most inks today are safe for garden use.
Pine cones and needles	Yes; use sparingly	Recommended shredding and adding in small quantities. Other compost materials with neutralize their acidic effect.
Sawdust and wood shavings	Yes; but may need to add nitrogen	Have a high carbon content. Do not use sawdust from pressure-treated wood.
Weeds	Yes, but not seeds or spreading roots	Annual weeds that have not gone to seed can be used. Plants that spread by roots or runners should be dried thoroughly before adding to compost.

Summing it Up: Preventing Pollution Starts with You

Pollution prevention and good stormwater management is essential to protecting water quality. All activities from agriculture, urban development, industrial, and RESIDENTIAL activities influence how much stormwater will enter our water sources and what potential pollutants it will carry. EVERYONE is responsible for working to reduce the impacts of stormwater runoff.

Remember these pollution solutions:

- ✓ Do **not** dispose of household hazardous wastes in sinks, toilets, or storm drains.
- ✓ Use a commercial carwash that treats or recycles its wastewater, or wash your car on your lawn so that water infiltrates the ground. Washing your car and degreasing auto parts in your driveway can send detergents and other contaminants through storm sewer systems.
- ✓ Do **not** dump automotive fluids into storm drains. In some cases this has the same result as dumping these materials directly into a water body.
- ✓ Repair leaks and dispose of used auto fluids and batteries at designated drop-off or recycling locations.
- ✓ When walking your pet, remember to pick up wastes and dispose of them properly. Pet waste can be a major source of bacteria and excess nutrients in local waters. Flushing pet waste is the best disposal method.
- ✓ Use pesticides and fertilizers sparingly. Excess fertilizers and pesticides applied to lawns and gardens wash into storm sewers and pollute streams.
- ✓ Do not water your lawn too much, as it causes runoff.
- ✓ Compost or mulch yard wastes. Yard clippings and leaves can wash into storm drains and contribute nutrients and organic matter to streams.
- ✓ Use non-colored mulch from native trees whenever possible.
- ✓ Use pest control methods minimizing pesticide applications whenever possible.
- ✓ Cover piles of dirt or mulch used in landscaping projects.
- ✓ Inspect your septic system every 3 years and pump your tank as necessary. Leaking and poorly maintained septic systems release nutrients and pathogens—bacteria and viruses—that can be picked up by stormwater and discharged into nearby water bodies. Such pathogens can cause public health problems and environmental concerns.
- ✓ Volunteer in your City's next litter clean-up event.
- ✓ Attend public hearings or meetings on stormwater so that you can express your concerns.
- ✓ Report all stormwater violations to the City.
- ✓ Keep learning about stormwater runoff and tell a friend!


NO ONE WANTS TO SEE YOUR BUTT!
PLEASE DISPOSE OF CIGARETTES PROPERLY!

Help your kids Discover Stormwater

Call 817.459.6587

or email

stormwatereducation@arlingtontx.gov

for a free stormwater activity book. *

** while supplies last*

BE A PART OF THE POLLUTION SOLUTION!

ENTER YOUR CONTACT INFORMATION INTO OUR VOLUNTEER DATABASE & WE'LL CONTACT YOU WHEN OPPORTUNITIES ARISE.

WWW.ARLINGTONTX.GOV/STORMWATER
CLICK ON "VOLUNTEERING"

303 (d) Waterbody - A list of lakes, rivers, and streams that have been designated as impaired or threatened by a pollutant(s) for which one or more TMDLs are needed. Impaired means that the water is not meeting state water quality standards.

319 - The section of the Federal Clean Water Act that deals with nonpoint pollution.

Best Management Practice (BMP), nonstructural - Strategies implemented to control stormwater runoff that focus on pollution prevention such as alternative site design, zoning and ordinances, education, and good housekeeping measures.

Best Management Practice (BMP), structural - Engineered devices implemented to control, treat, or prevent stormwater runoff pollution.

Biofiltration - The use of vegetation (usually grasses or wetland plants) to filter and treat stormwater runoff as it is conveyed through an open channel or swale.

Bioretention - The use of vegetation in retention areas designed to allow infiltration of runoff into the ground. The plants provide additional pollutant removal and filtering functions while infiltration allows the temperature of the runoff to be cooled.

Buffer zone - A designated transitional area around a stream, lake, or wetland left in a natural, usually vegetated state so as to protect the waterbody from runoff pollution. Development is often restricted or prohibited in a buffer zone.

Catchbasin - An inlet to a storm or combined sewer equipped with a sediment sump, and sometimes a hood, on its outlet pipe to the sewer. Catchbasins can collect some of the sediment and debris washed off the streets, and help to provide a water seal against the venting of sewer gases. Catchbasins should be cleaned out regularly to function properly.

Catchment - See Watershed.

Combined sewer system - A sewer system that conveys stormwater runoff along with sanitary sewage and industrial waste.

Conveyance - The process of water moving from one place to another.

Detention - The storage and slow release of stormwater following a precipitation event. Detention is used for both pollutant removal, stormwater storage, and peak flow reduction. Both wet and dry detention methods can be applied.

Discharge - The volume of water that passes a given location within a given time period.

Erosion - Removal of soil particles by wind or water.

Eutrophication - Nutrient enrichment (nitrogen, phosphorus, and carbon) from sewage effluent, runoff, or atmospheric deposition to surface waters. This process can increase the growth potential for algae and aquatic plants. Excessive eutrophication can leave waterbodies devoid of most life, impede navigation, and result in aesthetic nuisances.

Filter Strip - Grassed strips situated along roads or parking areas that remove pollutants from runoff as it passes through, allowing some infiltration, and reductions of velocity.

Floatables - Materials found in runoff that are buoyant, such as polystyrene, plastic, some organic material, or cigarette butts.

Groundwater - Water that flows below the ground surface through saturated soil, glacial deposits, or rock.

Hydrology - The science addressing the properties, distribution, and circulation of water across the landscape, through the ground, and in the atmosphere.

Illicit connection - Any discharge to a municipal separate storm sewer that is not composed entirely of stormwater and is not authorized by an NPDES permit, with some exceptions (e.g., discharges due to firefighting activities)

Illicit discharges - Discharges of non-stormwater to the storm drainage system. Examples are discharges from internal floor drains, appliances, industrial processes, sinks, and toilets that are connected to the nearby storm drainage system. These discharges should be going to the sanitary sewer system, a holding tank, an on-site process water treatment system, or a septic system.

Impervious surface - A surface that cannot be penetrated by water such as pavement, rock, or a rooftop and thereby prevents infiltration and generates runoff.

Imperviousness - The percentage of impervious cover within a defined area.

Impoundment - A natural or man-made containment for surface water.

Infiltration - The process or rate at which water percolates from the land surface into the ground. Infiltration is also a general category of BMP designed to collect runoff and allow it to flow through the ground for treatment.

Integrated Pest Management (IPM) - The practice of using biological and physical measures to control pests while minimizing or eliminating the use of synthetic chemical pesticides.

National Pollutant Discharge Elimination System (NPDES) - National Pollutant Discharge Elimination System, the two-phased surface water quality program authorized by Congress as part of the 1987 Clean Water Act. This federally mandated system is used for regulating point source and nonpoint stormwater discharge. The second phase of the program requires local governments to implement the following six minimum measures:

1. Public Education and Outreach
2. Public Participation/ Involvement
3. Illicit Discharge Detection and Elimination
4. Construction Site Runoff Control
5. Post-Construction Runoff Control
6. Pollution Prevention / Good Housekeeping

Natural buffer - A variable width area maintained with natural vegetation between a pollutant source and a waterbody that provides natural filtration and other forms of protection.

Nonpoint-source pollutants - Pollutants from many diffuse sources. Nonpoint-source pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters, and even underground sources of drinking water.

Outfall - The point of discharge from a river, pipe, drain, etc. to a receiving body of water.

Point-source pollutants - Pollutants from a single, identifiable source such as a factory or refinery.

Pollutant loading - The total quantity of pollutants in stormwater runoff.

Polluted runoff - Rainwater or snowmelt that picks up pollutants and sediments as it runs off roads, highways, parking lots, lawns, agricultural lands, logging areas, mining sites, septic systems, and other land-use activities that can generate pollutants.

Porous pavement and pavers - Alternatives to conventional asphalt that utilize a variety of porous media, often supported by a structural matrix, concrete grid, or modular pavement, which allow water to percolate though to a sub-base for gradual infiltration.

Retention - The process of collecting and holding surface and stormwater runoff with no surface outflow.

Runoff - Water from rainfall, snowmelt, or otherwise discharged that flows across the ground surface instead of infiltrating the ground.

Sanitary sewer system - Underground pipes that carry only domestic or industrial wastewater to a sewage treatment plant or receiving water.

Sedimentation - A solid-liquid separation process utilizing gravitational settling to remove soil or rock particles from the water column.

SSO (sanitary sewer overflow) - Wastewater entering sanitary sewers may be so great, because of blockage, a lack of capacity, inflow and infiltration, or other reasons, that the collection system or sewage treatment plant cannot handle the increased flow. As a result, untreated sewage empties directly into receiving waters, often from manholes or up through sewer connections.

Storm sewer system - A system of pipes and channels that carry stormwater runoff from the surfaces of building, paved surfaces, and the land to discharge areas.

Stormwater - Water derived from a storm event or conveyed through a storm sewer system.

Stormwater utility - A utility established to generate a dedicated source of funding for stormwater pollution prevention activities where users pay a fee based on land-use and contribution of runoff to the stormwater system.

Surface water - Water that flows across the land surface, in channels, or is contained in depressions on the land surface (e.g. runoff, ponds, lakes, rivers, and streams).

Swale - A natural or human-made open depression or wide, shallow ditch that intermittently contains or conveys runoff. Can be used as a BMP to detain and filter runoff.

Total maximum daily load (TMDL) - The maximum allowable loading of a pollutant that a designated water body can assimilate and still meet numeric and narrative water quality standards. TMDLs were established by the 1972 Clean Water Act

Urban (metropolitan) runoff - Runoff derived from urban or suburban land-uses that is distinguished from agricultural or industrial runoff sources.

Water (hydrologic) cycle - The flow and distribution of water from the sky, to the Earth's surface, through various routes on or in the Earth, and back to the atmosphere. The main components are precipitation, infiltration, surface runoff, evapotranspiration, channel and depression storage, and groundwater.

Water quality - The biological, chemical, and physical condition of a waterbody; a measure of the ability of a waterbody to support beneficial uses.

Watershed - The land area, or catchment, that contributes water to a specific waterbody. All the rain or snow that falls within this area flows to the waterbodies as surface runoff, in tributary streams, or as groundwater.

Additional Resources

City of Arlington Public Works & Transportation
817.459.6550

Stormwater Pollution Prevention Hotline
(Report Polluters)
817.459.6599

Stormwater Education Coordinator
817.459.6587
stormwatereducation@arlingtontx.gov

Parks & Recreation Department
817.459.5474

Residential Recycling Coordinator
(Recycling, Composting)
817.459.6778

Water Conservation Coordinator
(Rain Barrels, Smart Yards, etc)
817.459.6628

Stormwater Fund Administrator
(Stormwater Utility Fee)
817.459.6586

United States Environmental Protection Agency (USEPA)
http://www.epa.gov/nps/pubs.html

Texas AgriLife Extension Service
http://texasextension.tamu.edu

Texas Commission on Environmental Quality
http://www.tceq.state.tx.us

City of Arlington Stormwater
http://www.arlingtontx.gov/stormwater

City of Arlington Green Team
http://www.arlingtontx.gov/greenteam

City of Arlington Parks & Recreation
http://www.naturallyfun.org

North Central Texas Council of Governments (NCTCOG)
http://www.nctcog.org

Natural Resources Defense Council (NRDC)
http://www.nrdc.org

City of Fort Worth, TX
http://www.fortworthgov.org

City of Dallas
http://www.wheredoesitgo.com

The Arlington Green Team helps Arlington commercial properties go green. Find out more at www.ArlingtonGreenTeam.com

NEED A SPEAKER?

DO YOU WANT TO KNOW MORE ABOUT STORMWATER AND OTHER ENVIRONMENTAL ISSUES?

Then call today to schedule a presentation fo your group. Learn about stormwater, litter, sustainability, water pollution prevention, an more!

Presentations are tailor-made, just for you!

Schedule today by calling 817.459.6587 or emailing
stormwatereducation@arlingtontx.gov

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City of Arlington
Public Works & Transportation Department
Stormwater Management
PO Box 90231 MS 01-0220
Arlington, TX 76004-3231
www.arlingtontx.gov/stormwater
817.459.6550

THE FERTILIZER MYTH

Contrary to popular belief, carnivorous animals, such as dogs, do not produce useable manure-fertilizer for plants. Beneficial manure-fertilizer comes from herbivores like horses and cows. These animals consume vegetation and return unused waste back to the soil to be taken up by plants.

FAQs

Q: Why doesn't the sewage treatment plant clean this water before it reaches the waterway?

A: Sewage treatment plants only process wastewater from indoor plumbing. These plants do not treat rainwater.

Q. Other animals such as squirrels, rabbits, and birds already "use the facilities" outdoors. Why should I worry about my pet?

A: The waste from the number of pets in Arlington cannot be adequately or naturally absorbed into the environment.

Q: Should I pick up pet waste in my own yard?

A: Yes, absolutely! During a rain storm, this waste can be washed out of your yard, down a street and find its way into the storm sewer system. In addition, when waste is not removed, it leaves large quantities of nutrients that can burn out grasses by overfeeding them, creating a spotty looking yard. Pet waste can also attract rats—reason enough to keep your yard cleared!

DID YOU KNOW?

It is a violation of the City of Arlington's Code of Ordinances to leave your pet's waste on public property or private property (not your own).

ARLINGTON®

FOR MORE INFORMATION ABOUT STORMWATER POLLUTION PREVENTION OR PET WASTE ISSUES

CONTACT

THE CITY OF ARLINGTON

PUBLIC WORKS AND TRANSPORTATION

101 W. Abram Street

P. O. Box 90231 MS 01-0220

Arlington, TX 76004-3231

817-459-6587

Email: stormwatereducation@arlingtontx.gov

or visit

http://www.arlingtontx.gov

http://www.dfwstormwater.com/petwaste

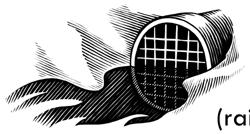
Rev. 09/09

OUR WATER
Take it personally!

PET WASTE AND STORM WATER POLLUTION:

A Pet Owner's Guide To Protecting Water Quality

What is Stormwater Runoff?



Stormwater runoff is any precipitation (rain, sleet, snow, or hail) that flows over land instead of seeping into the ground. In developed areas like Arlington, rainwater travels over paved areas, settles in gutters and ditches, and flows through storm drains. Stormwater is NOT treated and can pollute oceans, rivers, streams, creeks, and lakes.

Pet Waste & Stormwater

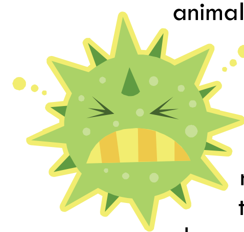
Pet waste left on streets, pavement, yards, driveways, or along the sides of the road does not magically disappear or fertilize the ground. Improperly disposed animals feces can be picked up by stormwater runoff and carried into storm drains or nearby water sources. Storm drains do not connect to sanitary sewer systems and treatment facilities, so pet waste can be the cause of significant stormwater pollution and present health risks to adults, children and other pets.

Pets and children who play in yards or parks and those who garden in yards where pets defecate are at risk for infections from disease-causing viruses, bacteria and parasites found in pet waste.

Dangers of Improperly Handled Pet Waste

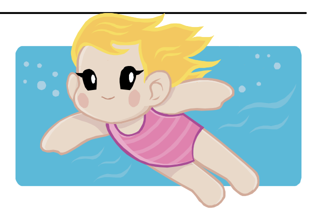
Some of the diseases that can be transmitted from pet waste to humans include:

- **Salmonellosis:** the most common bacterial infection transmitted to humans by other animals. Symptoms include fever, muscle aches, headache, vomiting, and diarrhea.

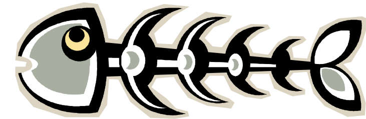


- **Toxocariasis:** roundworms usually transmitted from dogs to humans, often without noticeable symptoms, but may cause vision loss, rash, fever, or cough.
- **Toxoplasmosis:** A parasite carried by cats that can cause birth defects such as mental retardation and blindness if a woman becomes infected during pregnancy; also a problem for people with suppressed immune systems.
- **Campylobacteriosis:** a bacterial infection carried by dogs and cats that frequently causes diarrhea in humans.
- **Fecal Coliform Bacteria:** found in the feces of warm blooded animals; poses potential health risk for those exposed to it in water.

Other Issues

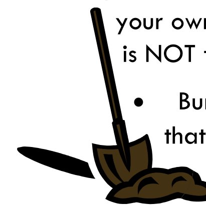


Nutrients in pet waste also encourage weed and algae growth, thus causing serious problems for water quality. This nutrient-rich water is cloudy, green, unattractive and unhealthy for swimming, boating, fishing, or drinking. Finally, when pet wastes decays, it uses up oxygen and releases ammonia, which can lead to fish kills.



What can you do to help?

- Always clean up after your pet, even in your own yard. Your pet's waste is NOT fertilizer.



  - Bury your waste in a hole that is at least 5-6" deep and cover it with soil away from gardens, ditches, storm drains, and waterways. It will decompose slowly so bury waste in different locations throughout the yard.
- Flush your pet's waste down the toilet where it will flow through the sanitary sewers for treatment.

- Carry disposable bags with you while you walk your pet.
- Throw your pet's waste in the trash.
- Tell others not to leave their pet's waste on the ground.

Hazardous Products Associated with Home Vehicle Maintenance or Repair

Product	*Hazardous Property*
Antifreeze	Toxic Flammable
Auto Batteries	Corrosive Toxic
Auto Paint & Primers	Flammable Toxic
Brake and Transmission Fluid	Flammable Toxic
Carburetor Cleaner	Corrosive Toxic
Engine Cleaner and Degreasers	Flammable Toxic
Gasoline, Diesel, and Kerosene	Flammable Toxic Highly Volatile
Motor Oil	Toxic Flammable
Used Motor Oil Filter(s)	Toxic
Windshield Washer Fluid	Toxic

Many of these products are accepted for disposal at the Environmental Collection Center in Fort Worth, TX. For more information, call 817.459.6777 or 817.392.EASY (3279).

For more information on home vehicle maintenance and stormwater pollution prevention contact:

The City of Arlington

Public Works & Transportation

101 W. Abram Street

P.O. Box 90231 MS 01-0220

Arlington, TX 76004-3231

817.459.6587

http://www.arlingtontx.gov

Email: stormwatereducation@arlingtontx.gov

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Rev. 09/09

PUTTING THE BRAKES ON WATER POLLUTION: *Stormwater Pollution Prevention & Home Auto Maintenance*

Tips for Repairing or Maintaining Your Vehicle at Home

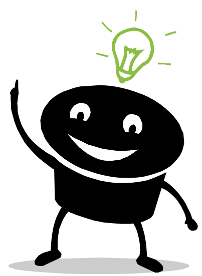
The Basics

At-home vehicle maintenance is a common practice. Many individuals choose to repair or maintain their vehicles at home rather than visit an auto repair service center. While the actual maintenance work of personal vehicles is not a problem, the byproducts that result from this kind of work can add significant amounts of pollutants into our storm sewer system.

These byproducts (i.e. oil, grease, brake fluid, gasoline, diesel, kerosene, antifreeze, etc), all contain toxins that are harmful to fish and birds, aquatic vegetation, wildlife and humans. Maintaining and repairing vehicles at home can allow these byproducts to leach into the street and then into the storm sewer system, transporting these pollutants to area waterways.

When repairing or maintaining your vehicle at home, adopt these few simple practices that can reduce the detrimental impacts of pollutants on our local waterways. And remember two simple rules:

1. Only rainwater may be discharged to the storm sewer system.
2. Minimize the contact of rainfall & runoff with pollutants. Do this by keeping hazardous materials covered and by managing wastes responsibly.



Your Work Area

Be aware of where you work. Any drips or spills on the ground can be carried away by rainwater to a storm drain and into a nearby waterway. So:

- NEVER work on a vehicle in the street or near a storm drain.
- Work on a flat concrete surface where you can easily clean up accidental spills.
- NEVER hose down your work area unless the resulting wash water is contained and disposed of properly.
- Keep storage and work areas clean and dry.

Replacing brakes and brake parts

Follow these tips when replacing brakes and brake parts.

- Don't hose down brake pads, rotors or drums. Remember, brake pads contain copper, which can erode as the pads wear and contribute to stormwater pollution.
- Use shop cloths to wipe as much brake dust as possible from rotors and drums before using brake cleaner fluid.
- Recycle cleaner fluid by using a drip pan.
- Never discharge cleaning solutions from cleaning into the storm sewer system.

Changing Your Oil or other Fluids

Follow these tips for changing your oil and other fluids.

- Use funnels or pumps when handling liquid products or wastes to avoid spills.
- Capture vehicle fluids in separate drip pans or containers.
- Drain and recycle used oil filters. Poke holes in the filter and let it drain into your oil pan for several hours before you recycle them.
- If spills occur, use kitty litter, sawdust, or oil absorbent to clean spills. Apply to the spill, sweep it up and dispose of the waste in the trash.
- NEVER sweep or wash used oil products or other fluids into the storm sewer system.

- Collect your used motor oil and other fluids in separate containers and transport to the Environmental Collection Center. Be sure to verify that your waste materials are accepted at the local collection center.

Recycling

Did you know that you can recycle many of the waste products that come from maintaining your vehicle at home?

- Antifreeze
- Batteries
- Brake Fluid
- Degreasers
- Gasoline
- Motor Oil
- Oil Filters
- Transmission Fluid

where there is little runoff control or grass to filter out harmful substances. For more information on Car Wash Fundraisers and stormwater pollution, contact the City of Arlington, Environmental Services Department.

What can I do?

Use a commercial car wash facility where wash water is treated and cleaned before it is returned to our waterways.

If you do wash your car at home:

- Wash it on gravel, grass, or other permeable surfaces. Avoid washing on concrete or asphalt unless it drains into a vegetated area.
- Use plain water with a coarse sponge or biodegradable, phosphate-free, water-based cleaners only.
- Use a trigger nozzle on your hose or a bucket to conserve water.
- Always empty wash buckets into sinks or toilets, never into the street or storm drain.

For More Information on Car Washing & Stormwater

Contact

The City of Arlington

Public Works & Transportation

101 W. Abram Street

P.O. Box 90231 MS 01-0220

Arlington, TX 76004-3231

817-459-6587

or visit

http://www.arlingtontx.gov

Email: stormwatereducation@arlingtontx.gov

Rev. 09/09

Car Washing & Stormwater: The Dirty Truth About Washing Your Car at Home

The Dirty Facts About Car Washing

For many, car washing is a spring and summertime ritual. Often, citizens do not know that by washing off all of the grime that accumulates on their vehicles, that they might actually be causing harm to our local waterways.

Water entering storm drains, unlike water that enters sanitary sewers, does not undergo treatment before it is discharged into our waterways. So, when cars are washed on streets and driveways, that dirty water eventually ends up in rivers, streams, creeks, and lakes.

Washing one car may not seem to be a problem, but collectively, car washing activity adds up to big problems for our local water sources. Pollution associated with car washing degrades water quality and also finds its way into sediments, impacting aquatic habitats.

The Problem

Washing your car is only a problem if you do not know where or how to do it correctly. The average homeowner uses 116 gallons of water to wash one car. Most commercial carwashes use 60 percent less water for the entire process than a homeowner uses just to rinse one car.

Outdoor car washing has the potential to result in high loads of nutrients, dirt, metals, and hydrocarbons entering our waterways as the detergent-rich water used to wash the grime off of cars flows down the driveway and the street. Dirty water containing soap, detergents, residue from exhaust fumes, gasoline, heavy metals from rust, metals and other elements from brake linings, rubber, trace amounts of benzene and chromium, and motor oils can wash off cars and flow directly to storm drains and into the nearest creek or stream where it can harm water quality and wildlife.

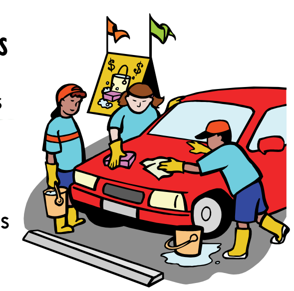
Small concentrations of detergents in streams can kill fish and their eggs, as well as inhibit their ability to reproduce. Detergents can also destroy the natural protections fish have against bacteria and parasites and can severely damage a fish's gills.

The phosphates from soap can also cause excess algae to grow in our waterways. Excessive algae growth makes water cloudy, green, unattractive, smelly, and unhealthy for swimming, boating, fishing, or drinking.

The Best Alternative

The best way to minimize the environmental effects of washing your car at home is to use a commercial car wash facility. Commercial carwash facilities are required to treat their wash water discharge before releasing it to the sanitary sewer system where the water is treated prior to release back into our water sources. Some facilities even recycle their wash water—reusing it several times before sending it to the sanitary sewer and water treatment facilities. Changing the way you wash your car is something that you can do to make a difference in the quality of our water sources. Proper individual actions can result in significant water quality improvement when carried out by the majority. The individual citizen can easily and economically manage this source of stormwater pollution.

Car Wash Fundraisers



Car Wash Fundraisers can be a significant source of stormwater pollution. These events are usually held in heavily paved areas

What's wrong with draining my spa, pool, or filter backwash to the street or storm drain?

Street drains and storm drains lead to rivers, lakes, stream, and creeks. Chlorine, bromine, algaecides, biocides, water conditioners, stabilizers, and other chemicals in pool water are toxic to fish and other aquatic life. Diatomaceous earth (DE), cellulose fiber, and sand particles from backwash water can fill in the spaces in the stream bed gravel, preventing oxygen from reaching fish eggs and young fish. DE and cellulose fiber can also clog fish gills.

Report Illegal Discharges to the Storm Sewer System

The City of Arlington
Stormwater Pollution
Reporting Hotline
817-459-6599

KNOW THE LAW:

It is a violation of the City of Arlington's Code of Ordinances to drain chlorinated water or filter backwash from your swimming pools or spas to the storm sewer system.

Remember, you are responsible for the actions of your pool maintenance service. Be sure you know how your service is disposing of your pool or spa water and the filter backwash. They ***must*** *follow all discharge requirements set forth by the City.*

This brochure is one of a series of brochures designed to inform you about stormwater pollution prevention.

Other topics include:

Automotive maintenance at home
Automotive maintenance for businesses
Car Washing
General Pollution Prevention
Lawn Care
Pest Control
Pet Waste

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For more information on pools and spas and stormwater pollution prevention contact:

The City of Arlington
Public Works and Transportation
101 W. Abram Street
P.O. Box 90231 MS 01-0220
Arlington, TX 76004-3231
817-459-6587
http://www.arlingtontx.gov
Email: stormwatereducation@arlingtontx.gov

Rev. 09/09

STORMWATER POLLUTION PREVENTION: SWIMMING POOLS AND SPAS

GUIDELINES FOR PROPER SWIMMING POOL OR SPA DRAINAGE

It’s all very simple!

There are three options for draining your swimming pool. Please note that whichever method you choose, you must ***dechlorinate*** the water before draining occurs.
Here’s how:

- Dechlorinate naturally: Allow the water to sit in the sun for 5-10 days without adding any chlorine; or
- Use a chemical dechlorination additive (contact your local pool store for options).
- Verify water is dechlorinated with a pool testing kit.

Option 1: Your Lawn
The Preferred Discharge Method

Drain ***dechlorinated*** water to the grass/turf/or any area on your property that will allow the water to percolate into the ground, ***if and only if***...

- You do not cause flooding of your neighbor’s property or any other adjacent property.
- The land area is sufficient to prevent erosion and runoff into a ditch, creek, or other conveyance (i.e. storm drain).
- You do not cause harm to the environment.

This water can be used to irrigate plants, saturate dry ground, or soak into mulched areas.

Option 2: The Sanitary Sewer

Drain your pool to the sanitary sewer. Most in-ground pools have a drain line connected to the sanitary sewer which can be used once the pool water has been ***dechlorinated***.

Follow these steps:

- Locate the sanitary sewer cleanout on your property or an indoor drain such as a sink or bathtub.
- Using a hose, connect a siphon or sump pump that pumps no more than 50 gallons per minute.
- Pump the water from the pool or spa to the cleanout or indoor drain.
- Replace all cleanout covers when finished.

DO NOT drain swimming pool or spa water to your SEPTIC SYSTEM as it may cause system failure.

It is not advisable to connect a hose to your indoor toilet to drain your swimming pool or spa. In most cases, water being pumped from your pool will drain faster than the time needed for flushing and refilling of the commode.

If you are unsure whether or not the discharge from your pool will create a problem in the sanitary sewer system or wastewater treatment plant, contact the City of Arlington Water Utilities Department at 817.459.6600.

Option 3: The Storm Drain

Swimming pool water may be discharged to the storm drain ***only*** after ***all*** of the following conditions are met:

- Other disposal methods (i.e. sanitary sewer or landscaping) are not possible.
- The pool or spa is completely ***dechlorinated.***
- The pH of the water is between 6 and 9.
- There is no discharge of filter media.
- There is no discharge of acid cleaning wastes.
- Discharge water will not pond or flow to neighboring properties.

Filter Backwash

NEVER discharge filter backwash to the storm sewer system. It is a violation of the City of Arlington Code of Ordinances. This practice is illegal and you can be fined.

Disposing of filter rinsewater and backwash :

- Filter backwash must be collected, contained, and discharged to the sanitary sewer.
- Cartridge filters should be rinsed in a sink, bathtub, or over a lawn or other vegetated area.
- Use a separation tank for diatomaceous earth (DE) and cellulose fiber filters to capture the DE or fibers.
- For water conservation, direct the clean water back into the pool .

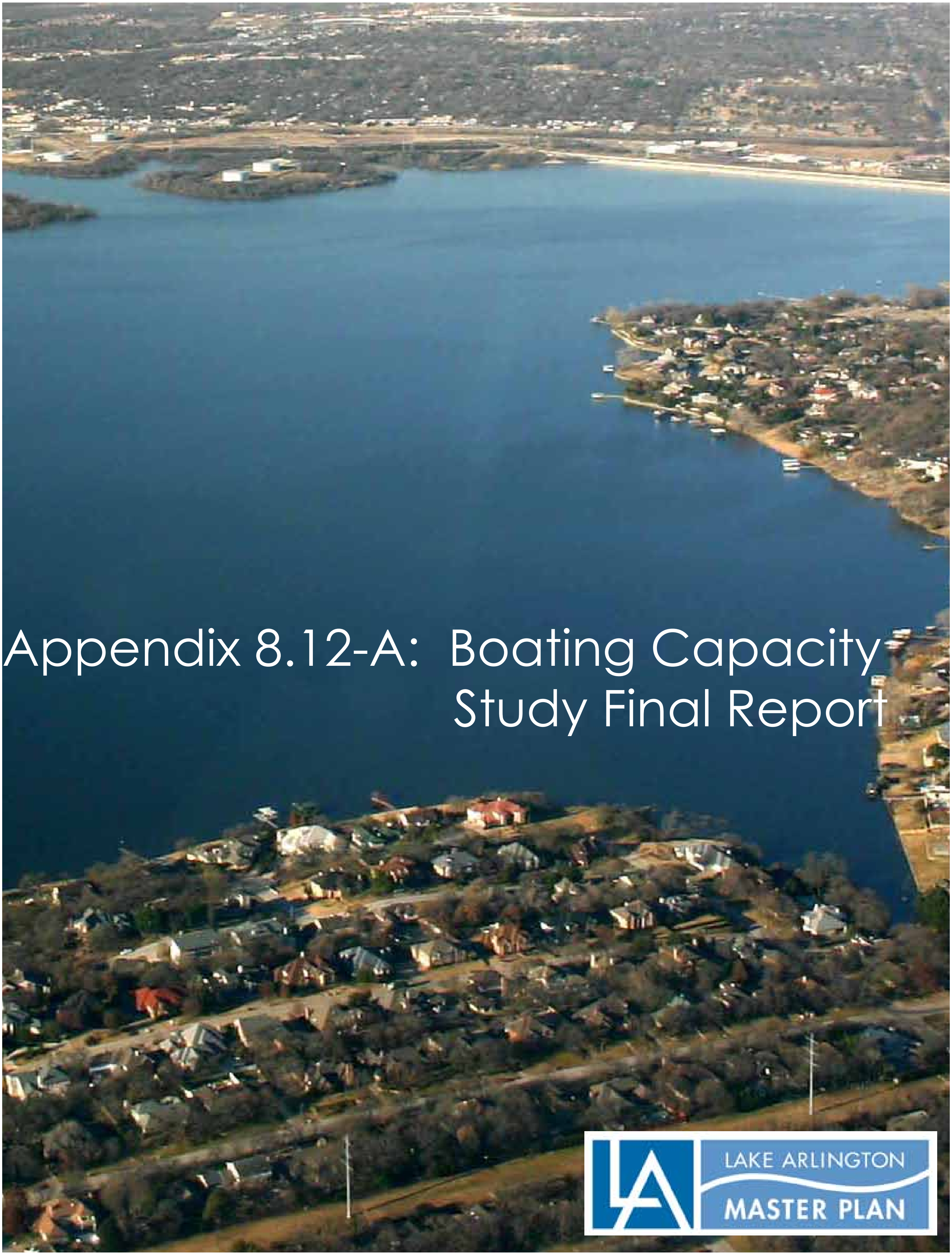
Appendix 8.11: Approved Plant List

LAKE ARLINGTON MASTER PLAN

Plant Name	Other Name(s)	Grouping
Adiantum capillus-veneris	Maidenhair fern	Ferns and Vines
Alamo vine	*Merremia dissecta*	Ferns and Vines
American water-willow	*Justicia americana*	Forbs
Andropagon glomeratus	Bushy bluestem	Grasses and Sedges
Arundo donax	Giant reed; Giant cane; Arundo	Grasses and Sedges
Ash; Fresno	*Fraxinus berlandieriana*	Woody
Aster, spiny	*Chloracantha spinosa*	Forbs
Baccharis neglecta	Baccharis, Roosevelt weed	Woody
Baccharis, Roosevelt weed	*Baccharis, neglecta*	Woody
Bacopa mommieri	Water hyssop	Forbs
Bagpod sesbania	*Sesbania vesicaria*	Forbs
Bald cypress	*Taxodium distichum*	Woody
Beardgrass, bushy	*Andropogon glomeratus*	Grasses and Sedges
Beggars'-ticks, cutleaf	*Bidens frondosa*	Forbs
Beggars'-ticks, smooth	*Bidens laevis*	Forbs
Bermuda grass	*Cynodon dactylon*	Grasses and Sedges
Bidens frondosa	Cutleaf beggars'-ticks	Forbs
Bidens laevis	Smooth beggars'-ticks	Forbs
Big saction	*Sporobolus wrightii*	Grasses and Sedges
Black Willow	*Salix nigra*	Woody
Bluestem, bushy	*Andropogon glomeratus*	Grasses and Sedges
Bluestem, K.R.	*Bothriochloa ischaemum*	Grasses and Sedges
Boneset, late	*Eupatorium serotinum*	Forbs
Bothriochloa ischaemum	King Ranch (K.R.) bluestem	Grasses and Sedges
Brickellia dentata	Gravelbar brickellbush	Woody
Brickellia eupatorioides var gracillima	Slender brickellbush	Woody
Brickellbush, gravelbar	*Brickellia dentata*	Woody
Brickellbush, slender	*Brickellia eupatorioides var gracillima*	Woody
Broadleaf uniola	*Chasmanthium latifolium*	Grasses and Sedges
Bushy bluestem	*Andropogon glomeratus*	Grasses and Sedges
Buttonbush	*Cephalanthus occidentalis*	Woody
Cane, giant; Arundo	*Arundo donax*	Grasses and Sedges
Cardinal flower	*Lobelia cardinalis*	Forbs
Carex emoryi	Emory sedge	Grasses and Sedges
Carpetgrass; St. Augustine	*Stenotaphrum secundatum*	Grasses and Sedges
Carrizo cane; Common reed	*Phragmites australis (communis)*	Grasses and Sedges
Carya illinoinensis	Pecan; Nuece	Woody
Cedar elm	*Ulmus crassifolia*	Woody
Cephalanthus occidentalis	Buttonbush; Button willow	Woody
Chasmanthium latifolium	Inland sea oats; Creek oats; Fish-on-a-pole grass	Grasses and Sedges
Chloracantha spinosa	Spiny aster; Devil weed; Mexican devil weed	Forbs
Cissus incisa	Cow itch; Possum grape	Ferns and Vines
Cladium mariscus	Sawgrass	Grasses and Sedges
Clematis pitcher	Purple leather flower	Ferns and Vines
Common morning glory	*Ipomoea cordatotriloba*	Ferns and Vines
Common reed; Carrizo cane	*Phragmites australis (communis)*	Grasses and Sedges
Common umbrella sedge	*Cyperus odoratus*	Grasses and Sedges
Cordgrass, gulf	*Spartina spartinae*	Grasses and Sedges
Cow itch; Possum grape	*Cissus incisa*	Ferns and Vines
Creek oats; Fish-on-a-pole grass; Sea oats, inland	*Chasmanthium latifolium*	Grasses and Sedges
Cuscuta sp	Dodder	Ferns and Vines
Cutleaf beggars'-ticks	*Bidens frondosa*	Forbs
Cynodon dactylon	Bermuda grass	Grasses and Sedges
Cyperus ochraceus	Pond flatsedge	Grasses and Sedges
Cyperus odoratus	Common umbrella sedge	Grasses and Sedges
Cypress, bald	*Taxodium distichum*	Woody
Dallisgrass	*Paspalum dilatatum*	Grasses and Sedges
Dewberry; Zarzamora	*Rubus trivialis*	Ferns and Vines
Dodder	*Cuscuta sp*	Ferns and Vines
Eastern gamagrass	*Tripsacum dactyloides*	Grasses and Sedges
Eastern sycamore	*Platanus occidentalis*	Woody
Eleocharis interstincta	Knotted spikesedge	Grasses and Sedges
Eleocharis rostellata	Tussock spikesedge	Grasses and Sedges
Elm, cedar	*Ulmus crassifolia*	Woody
Emory sedge	*Carex emoryi*	Grasses and Sedges
Equisetum laevigatum	Horsetail; Scouring rush	Ferns and Vines
Eragrostis hyponides	Teal lovegrass	Grasses and Sedges
Eupatorium serotinum	Late boneset	Forbs
Fern, Lindheimer shield	*Thelypteris ovata var lindheimeri*	Ferns and Vines

Plant Name	Other Name(s)	Grouping
Frogfruit, Turkeytangle	*Phyla nodiflora*	Forbs
Frostweed, Iceplant; Iceweed	*Verbesina virginica*	Forbs
Fuirena simplex	Porcupine sedge	Grasses and Sedges
Gamagrass eastern	*Tripsacum dactyloides*	Grasses and Sedges
Giant reed; Giant cane; Arundo	*Arundo donax*	Grasses and Sedges
Goldeneye plateau	*Viguiera dentata*	Forbs
Goldenrod tall	*Solidago altissima*	Forbs
Grape muscadine	*Vitis cinerea*	Ferns and Vines
Grape mustang	*Vitis mustangensis*	Ferns and Vines
Gravelbar brickellbush	*Brickellia dentata*	Woody
Greenbriar, sawleaf	*Smilax bona-nox*	Ferns and Vines
Gulf cordgrass	*Spartina spartinae*	Grasses and Sedges
Hairyseed paspalum	*Paspalum pubiflorum*	Grasses and Sedges
Horsetail; Scouring rush	*Equisetum laevigatum*	Ferns and Vines
Hydrocotyle ranunculoides	Floating water pennywort	Forbs
Hydrocotyle verticillata	Whorled water pennywort	Forbs
Hyssop, water	*Bacopa mommieri*	Forbs
Iceplant; Frostweed	*Verbesina virginica*	Forbs
Indigo Lindheimer; scarlet-pea	*Indigofera lindheimeriana*	Woody
Indigofera lindheimeriana	Lindheimer indigo; Lindheimer scarlet-pea	Woody
Inland sea oats; Creek oats; Fish-on-a-pole grass	*Chasmanthium latifolium*	Grasses and Sedges
Ipomoea cordatotriloba	Commom morning glory	Ferns and Vines
Ivy, poison	*Toicodendron radicans*	Ferns and Vines
Juglans microcarpa	Little walnut; Nogalito	Woody
Justicia americana	American water willow	Forbs
King Ranch (K.R.) bluestem	*Bothriochloa ischaemum*	Grasses and Sedges
Knotgrass	*Paspalum distichum*	Grasses and Sedges
Knotted spikeshedge	*Eleocharis interstincta*	Grasses and Sedges
Late boneset	*Eupatorium serotinum*	Forbs
Leather flower purple	*Clematis pitcheri*	Ferns and Vines
Lindheimer indigo; Lindheimer scarlet pea	*Indigofera lindheimeriana*	Woody
Lindheimer senna	*Senna lindheimeriana*	Grasses and Sedges
Lindheimer's muhly	*Muhlenbergia lindheimeri*	Grasses and Sedges
Little walnut; Nogalito	*Juglans microcarpa*	Woody
Lobelia cardinalis	Cardinal flower	Forbs
Lovegrass teal	*Eragrostis hyponides*	Grasses and Sedges
Ludwigia sp	Water primrose	Forbs
Maidenhair fern	*Adiantum capillus-veneris*	Ferns and Vines
Mentha spicata	Wild mint	Forbs
Merremia dissecta	Alamo vine	Ferns and Vines
Mexican ash; Fresno	*Fraxinus berlandieriana*	Woody
Mint, Spearmint, Peppermint	*Mentha spicata*	Forbs
Morning glory, common	*Ipomoea cordatotriloba*	Ferns and Vines
Morus rubra	Red mulberry	Woody
Muhlenbergia lindheimeri	Lindheimer's muhly	Grasses and Sedges
Muhly, Lindheimer's	*Muhlenbergia lindheimeri*	Grasses and Sedges
Mulberry, red	*Morus rubra*	Woody
Netleaf Hackberry	*Celtis reticulata*	Woody
Nogalito; Little walnut	*Juglans microcarpa*	Woody
Nuece Pecan	*Carya illinoinensis*	Woody
Fraxinus berlandieriana	Mexican Ash; Fresno	Woody
Ludwigia octovalvis	Tall water primrose	Forbs
Ludwigia peploides	Floating water primrose; Verdolago de agua	Forbs
Panicum virgatum	Switchgrass	Grasses and Sedges
Parkinsonia aculeata	Retama	Woody
Paspalum dilatatum	Dallisgrass	Grasses and Sedges
Paspalum distichum	Knotgrass	Grasses and Sedges
Paspalum langei	Rustyseed paspalum	Grasses and Sedges
Paspalum pubiflorum	Hairyseed paspalum	Grasses and Sedges
Paspalum urvillei	Vaseygrass	Grasses and Sedges
Paspalum, hairyseed	*Paspalum pubiflorum*	Grasses and Sedges
Paspalum, rustyseed	*Paspalum langei*	Grasses and Sedges
Pecan, Nuece	*Carya illinoinensis*	Woody
Pencilpod sesbania	*Sesbania macrocarpa*	Forbs
Pennywort, floating	*Hydrocotyle ranunculoides*	Forbs
Pennywort, whorled	*Hydrocotyle verticillata*	Forbs
Phragmites australis (communis)	Common reed; Carrizo cane	Grasses and Sedges
Phyla nodiflora	Frogfruit; Turkeytangle	Forbs
Platanus occidentalis	Eastern sycamore	Woody
Plateau goldeneye	*Viguiera dentata*	Forbs

Plant Name	Other Name(s)	Grouping
Poverty weed, Roosevelt weed, baccaharis	*Baccharis neglecta*	Woody
Purple leatherflower	*Clematis pitcheri*	Ferns and Vines
Purslane, sea	*Sesuvium sp*	Forbs
Red mulberry	*Morus rubra*	Woody
Retama	*Parkinsonia aculeata*	Woody
Rhynchospora colorata	White-top sedge	Grasses and Sedges
River fern; Lindheimer shield fern	*Thelypteris ovata var lindheimeri*	Ferns and Vines
Roosevelt weed baccharis	*Baccharis neglecta*	Woody
Rubus trivialis	Dewberry; Zarzamora	Ferns and Vines
Rush, scouring; horsetail	*Equisetum laevigatum*	Ferns and Vines
Rustyseed paspalum	*Paspalum langei*	Grasses and Sedges
Sacahuiste	*Spartina spartinae*	Grasses and Sedges
Sacaton, big	*Sporobolus wrightii*	Grasses and Sedges
Salix nigra	Black willow	Woody
Sawgrass	*Cladium mariscus*	Grasses and Sedges
Sawleaf greenbriar	*Smilax bona-nox*	Ferns and Vines
Scarlet pea, Lindheimer; Lindheimer indigo	*Indigofera lindheimeriana*	Woody
Scouring rush	*Equisetum laevigatum*	Ferns and Vines
Sea oats, inland; Creek oats; Fish on a pole grass	*Chasmanthium latifolium*	Grasses and Sedges
Sea purslane	*Sesuvium sp*	Forbs
Sedge, emory	*Carex emoryi*	Grasses and Sedges
Sedge, porcupine	*Fuirena simplex*	Grasses and Sedges
Sedge, umbrella	*Cyperus odoratus*	Grasses and Sedges
Sedge, white-top	*Rhyncospora colorata*	Grasses and Sedges
Senna lindheimeriana	Lindheimer senna	Forbs
Sesbiana drummondii	Rattlebox sesbania	Forbs
Sesbiana macrocarpa	Pencilpod sesbania	Forbs
Sesbania vesicaria	Bagbod sesbania	Forbs
Sesbania, bagbod	*Sesbania vesicaria*	Forbs
Sesbania, rattlebox	*Sesbiana drummondii*	Forbs
Sesbania, pencilpod	*Sesbiana macrocarpa or exaltada*	Forbs
Sesuvium sp	Sea purslane	Forbs
Slender brickellbush	*Brickellia eupatorioides var gracillima*	Woody
Smilax bona-nox	Sawleaf greenbriar	Ferns and Vines
Smooth beggars'-ticks	*Bidens laevis*	Forbs
Solidago altissima	Tall goldenrod	Forbs
Spartina spartinae	Gulf cordgrass	Grasses and Sedges
Spearmint, Peppermint, Wild mint	*Mentha spicata*	Forbs
Spikerush	*Eleocharis interstincta*	Grasses and Sedges
Spikerush	*Eleocharis rostellata*	Grasses and Sedges
Spikeshedge, knotted	*Eleocharis interstincta*	Grasses and Sedges
Spikeshedge, tussock	*Eleocharis rostellata*	Grasses and Sedges
Spiny aster; Devil weed; Mexican devil weed	*Chloracantha spinosa*	Forbs
Spiny hackberry; Granjeno	*Celtis ehrenbergiana (or pallida)*	Woody
Sporobolus wrightii	Big Sacaton	Grasses and Sedges
St. Augustine grass; Carpetgrass	*Stenotaphrum secundatum*	Grasses and Sedges
Starrush whitetop	*Rhyncospora colorata*	Grasses and Sedges
Stenotaphrum secundatum	St. Augustine grass; Carpetgrass	Grasses and Sedges
Sugar hackberry	*Celtis laevigata*	Woody
Switchgrass	*Panicum virgatum*	Grasses and Sedges
Sycamore, eastern	*Platanus occidentalis*	Woody
Tall Goldenrod	*Solidago altissima*	Forbs
Tall water-primrose	*Ludwigia octovalvis*	Forbs
Taxodium distichum	Bald cypress	Woody
Teal lovegrass	*Eragrostis hyponides*	Grasses and Sedges
Thelypteris ovata var lindheimeri	River fern; Lindheimer shield fern	Ferns and Vines
Toicodendron radicans	Poison Ivy	Ferns and Vines
Tripsacum dactyloides	Eastern gamagrass	Grasses and Sedges
Tussok spikeshedge	*Eleocharis rostellata*	Grasses and Sedges
Ulmus crassifolia	Cedar elm	Woody
Uniola, broadleaf	*Chasmanthium latifolium*	Grasses and Sedges
Vaseygrass	*Paspalum urvillei*	Grasses and Sedges
Verbesina virginica	Frostweed; Iceplant; Iceweed	Forbs
Viguiera dentata	Plateau goldeneye	Forbs
Walnut; Nogalito	*Juglans microcarpa*	Woody
Water cress	*Rorippa nasturtium-aquaticum*	Forbs
Water hyssop	*Bacopa mommieri*	Forbs
Water primrose, floating	*Ludwigia peploides*	Forbs
Water primrose, tall	*Ludwigia octovalvis*	Forbs
Water-willow, american	*Justicia americana*	Forbs
White-top sedge	*Rhyncospora colorata*	Grasses and Sedges
Whorled water pennywort	*Hydrocotyle verticillata*	Forbs
Wild mint	*Mentha spicata*	Forbs



Appendix 8.12-A: Boating Capacity Study Final Report

LAKE ARLINGTON MASTER PLAN

2010
A Study of Recreational Boating Use on Lake Arlington, Texas

A Study of Recreational Boating Use on Lake Arlington, Texas has been produced by the Human Dimensions of Natural Resources Lab in the Department of Recreation, Park and Tourism Sciences at Texas A&M University.

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TABLE OF CONTENTS

TABLE OF FIGURES

STUDY PURPOSES

The objectives of the Lake Arlington carrying capacity study are to:

1. Characterize existing use (e.g., type of watercraft, time of use, etc.) occurring on Lake Arlington;
2. Identify areas of use, conflict, and displacement across the lake and among boating groups;
3. Identify areas on the lake that might require managerial attention (e.g., safety concerns); and
4. Identify areas around the lake for potential shoreline development projects;

METHODOLOGY

Site Visit

On February 26, 2010 the Texas AgriLife Research study team conducted a boat tour of Lake Arlington and a site visit of the surrounding area. The team also met with staff members of the City of Arlington to kick off the study effort, clarify the scope of work, and initiate data collection. The site visit and tour also provided an opportunity to make professional observations and develop perceptions of Lake Arlington's size and configuration, shoreline characteristics, recreation and access facilities, and geographic nature.

Study Area

The map displayed In Figure 1 illustrates the location of Lake Arlington and the study area from which we drew respondents.

Figure 1. Lake Arlington Study Area

Sampling

The major basis for this study effort and our findings is a survey of lake users and potential users. The survey examined how recreationists are currently using the lake, their perceptions of future development and lake management, and their future needs. Data for the survey were collected via two sources: 1) a City of Arlington-supplied mailing list of lake permit holders, and 2) a random sample of lakeshore property owners and residents living near the lake. Below is a description of how each of these samples were collected.

<u>City of Arlington Supplied Mailing List:</u> The City of Arlington provided names and postal addresses for people who had purchased a boating permit (day use and annual use) for Lake Arlington (*n*=1,471). The entire list was included in this sample. There were several households with multiple permits. In these cases each permit holder at that address received a survey.

<u>County-Wide List:</u> An additional portion of the sample was drawn from the 2010 Certified County Appraisal Rolls for Tarrant County using a random systematic method. The county tax roll was filtered to identify residential property owners based on state property tax codes. ArcGIS 9.3 was used to create a 100 foot buffer around Lake Arlington to target shoreline property owners (191 of these were selected) and a five mile buffer to target a wider potential user group (1,200 of these names were selected) for a total of one thousand four hundred (1,391) names.

Instances of overlap occurred among these listings. In order to avoid sending multiple surveys to a single household, lake permit holders were first removed from both the 100 foot buffer and the five mile buffer. Additionally, property owners from the 100 foot buffer were removed from the five mile buffer.

In June 2010, a letter was sent to a total of 2,862 individuals from the combined lists of permit holders (1,471), property owners within the 100 foot buffer (191), and property owners within 5 miles (1,200) of Lake Arlington. The letter invited recipients to access an online survey or to tear off and return a request card to receive a paper survey and postage-paid return envelope. This provided respondents with the option of completing the survey online or receiving a hard copy survey in the mail to complete. Those requesting a paper survey were sent a survey packet containing a paper copy of the survey questionnaire and a postage paid return envelope. One postcard reminder was sent to all potential respondents over the weeks following through the last week of June 2010.

Ninety (90) letters were returned owing to incorrect or outdated addresses. Eighty seven (87) of those were from the permit list. A presumed 2,772 letters were delivered and a total of 454 completed surveys were returned for an overall response rate of 16.4%. Final calculations indicated that 21.5% (n=297) of lake permit holders responded, 26% (n=49) of lakeshore property owners responded, and 9% (n=108) of property owners within 5 miles responded. Within the overall 454 returned surveys:

- Lake Arlington boat permit holders made up 65.5%
- Property owners within five miles of Lake Arlington made up 23.5%
- Property owners within 100 feet of Lake Arlington made up 11%

Response rates were influenced by time constraints that did not allow further follow-up with potential respondents. Two slightly different survey forms were used to shorten the survey for any given respondent. For example, items/questions related to boating group and special places on the lake were only assigned to one half of the sample. This method reduced the overall number of respondents to a few select questions but allowed for meaningful representation on those items while also allowing for a shorter form and less time invested by respondents. In the results section notations are occasionally made related to an "A" and "B" survey indicating that only respondents who received that form answered those questions.

Response rates are consistent with past research targeting the "general population" and offer reliable estimates of the target population within plus/minus five percent (5%) (Groves, 2006). Overall response rates and variation among the sub-groups are also a direct product of issue salience; i.e., the relevance of the survey to individual respondents. Past research has illustrated that issue salience has a stronger influence on response rate than does survey length (Bean & Roszowski, 1995; Sheehan & McMillan, 1999; Watt, 1999).

A blank copy of each version of the survey form is attached as **Appendix A**.

RESULTS

The results of the Lake Arlington Survey presented below are based on 454 responses. The number of people who responded to different questions is included for most measures and varies some depending on the number of people who answered that question. For example, a large portion of the survey was completed only by those individuals who considered themselves to be active boaters on Lake Arlington while the remainder only completed sections related to broader management and development issues

Results are related in the order that questions were asked in the survey. Each table below displays the results of a question or questions in the survey. The question is noted at the top of each table.

SECTION 1: RESPONDENTS' BOATING EXPERIENCE ON LAKE ARLINGTON

There were several questions that asked about boating experiences on Lake Arlington. Included below are tables that convey information about peoples' use of the lake. Most respondents (375, 83%) had boated on Lake Arlington and had been boating on the lake for an average of just over 12 years and considered themselves active boaters (boated on the lake in the last year). Respondents indicated they had boated an average of approximately 27 days on Lake Arlington in the past 12 months.

Question: Have you ever boated on Lake Arlington before?

Answer		Response	%
Yes		375	83%
No		79	17%
Total		454	100%

Much of the information conveyed in this section was provided by the 375 people who had boated on the lake. Questions in this section were not relevant to those who had never boated on Lake Arlington.

Question: If "Yes", how many years have you been an active boater on Lake Arlington?

Mean	12.4
Median	8.0
St. Dev.	12.1
Count	375

Question: Are you currently an active boater on Lake Arlington? (Have you used the Lake in the past 12 months?)

Answer		Response	%
Yes		374	83%
No		80	17%
Total		454	100%

Question: If you answered "No" on the previous question, please tell us the year of your last boating experience on the Lake.

Statistic	Value
Mean	1998
Median	2005
Standard Deviation	12.1
Total Responses	67

Question: About how many days did you spend on the lake over the last 12 months?

Statistic	Value
Mean	26.8
Median	15
St. Dev.	47.3
Count	303

There were a number of different watercraft used on the lake. Fishing and/or bass boats are the most common followed by ski boats, personal watercraft such as jet skis (PWC), kayaks and sail boats. Given that respondents may own several different boat types they were also asked what they used most often. They indicated using the same types of boats most often, with fishing and ski boats being used much more often than any other type. When respondents (n=9) indicated "other" as the type of watercraft, they listed answers like "fishing tube", wind surfer and cabin cruiser but none was listed more than once. The same trend resulted when people were asked how they used their boats. Most fished (42%) with the next highest use being cruising up and down the lake (20%).

Question: What type(s) of watercraft do you use?

Answer	Responses
Fishing or bass boat	160
Ski boat	96
Personal Watercraft (PWC; e.g., Jet Ski)	58
Kayak	37
Sailboat	31
Wakeboard boat	24
Pontoon boat	15
Canoe	14
High performance boat	2
Other (Please specify)	9

Question: Which of these watercraft do you use most often on the lake?

Answer		Responses	%
Fishing or bass boat		131	43%
Ski boat		67	22%
Personal Watercraft (PWC; e.g., Jet Ski)		33	11%
Sailboat		24	8%
Kayak		15	5%
Wakeboard boat		17	5%
Pontoon boat		9	3%
Canoe		5	1%
High performance boat		0	0%
Other (Please specify)		6	2%
Total		307	100%

Question: What activity do you most often use your boat for on the lake?

Answer		Response	%
Fishing		130	42%
Cruising up and down the lake		61	20%
Towing inflatables/water toys		33	11%
Wakeboarding		28	9%
Skiing		22	7%
Competition/racing		15	5%
Exercise		12	4%
Other (Please specify)		7	2%
Total		308	100%

Most respondents, almost two-thirds (63%), indicated they were not boating as often as they would have liked. Available time and work commitments appear to have been the main reasons. Beyond available time and work there were two other factors that seem to inhibit some users. These factors were water depth and litter. Forty four percent (44%) of respondents believe that the lake is too shallow and 32% believe that there was too much litter in the water.

Question: Do you boat as often as you would like on Lake Arlington?

Answer		Response	%
No		233	63%
Yes		139	37%
Total		372	100%

Question: I don't boat as often as I would like because…

Answer	Strongly Disagree n (%)	Disagree n (%)	Neutral n (%)	Agree n (%)	Strongly Agree n (%)	Response	Mean
Areas of the Lake are too shallow	35 (15)	54 (24)	37 (16)	65 (28)	37 (16)	228	3.07
Work commitments keep me away from boating on the Lake	40 (18)	47 (21)	26 (11)	92 (41)	22 (10)	227	3.04
I no longer have enough time	44 (19)	50 (22)	43 (19)	72 (32)	19 (08)	228	2.88
There's too much litter in the water	46 (20)	61 (27)	49 (21)	40 (18)	33 (14)	229	2.79
At times, the water surface is too rough	40 (18)	68 (30)	52 (23)	57 (25)	12 (05)	229	2.71
Poor water quality	44 (19)	63 (28)	70 (31)	42 (18)	9 (04)	228	2.60
It's too hot in summer	59 (26)	53 (23)	56 (25)	53 (23)	8 (03)	229	2.55
Other boaters are inconsiderate	46 (20)	76 (33)	61 (27)	37 (16)	10 (04)	230	2.52
It's too crowded	50 (22)	80 (35)	58 (25)	33 (15)	7 (03)	228	2.42
The behavior of other boaters is unsafe	65 (29)	63 (28)	64 (28)	26 (11)	9 (04)	227	2.34
The Lake is too small	69 (30)	72 (32)	40 (18)	37 (16)	10 (04)	228	2.33
Public access is inconvenient	82 (35)	91 (40)	32 (14)	22 (10)	1 (01)	228	1.99
Shoreline owners/residents are inconsiderate	93 (41)	80 (35)	46 (20)	7 (03)	3 (01)	229	1.90
My family no longer has an interest in boating	99 (43)	77 (33)	37 (16)	15 (07)	1 (01)	229	1.87
I can't afford to go boating	135 (59)	50 (22)	28 (12)	13 (06)	3 (01)	229	1.69
I have no way to access the Lake	142 (62)	63 (28)	13 (06)	8 (03)	2 (01)	228	1.53
I'm no longer physically able	166 (72)	36 (16)	15 (07)	10 (04)	3 (01)	230	1.47
I have no interest in boating	171 (75)	40 (17)	16 (07)	2 (01)	0	229	1.34

SECTION 2: RESPONDENTS' USE OF LAKE ARLINGTON

On average respondents travelled about five miles to use Lake Arlington and most used the lake with family and friends (63%) in a group size that averaged between three and four (3.6) people.

Question: How far by road (in miles) do you travel to Lake Arlington?

Statistic	Value
Mean	5.2
Median	4
St. Dev.	6.5
Count	363

Question: How many people are usually in your boating group?

Statistic	Value
Average	3.6
Median	3.0
St. Dev.	3.4
Count*	171

**Only respondents using survey form B completed this item*

Question: Which of the following best describes your boating group?

Answer		Response*	%
Family		58	33%
Family and friends		54	31%
By yourself		26	15%
Friends		20	11%
Organized outing group		7	4%
Multiple families		4	2%
Business associates		0	0%
Other (Describe)		5	3%
Total		174	100%

**Only respondents using survey form B completed this item*

The next two questions were open ended questions. Each asked the respondent to generally identify characteristics about lake Arlington that they did, or did not, like.

Question: What did you like best about your visits to Lake Arlington?

More than 50% of the responses to this question were related to how "close" the lake was to home which made using it "convenient" and "easy to access." Many residents clearly see the lake as a local resource and appreciate that it is close to home. There were also a number of responses that related to the lack of crowds, feeling safe while boating, appreciation for the no alcohol policy, enjoying socializing with friends and family, and fishing.

Question: What did you like least about your visits to the Lake Arlington?

There were no answers to the "what you like least" question that stood out as much as the convenient access answer above. However, there were many responses related to the small size of the lake, the shallow and/or fluctuating water level, and litter and other debris on the shore and floating in the water. Fifteen (15) respondents commented that the no swimming rule was something they did not like.

When asked about the number of people encountered on the lake, most (72%) felt there were neither too many nor too few. This suggests that the number was acceptable. About 19% would like to have seen fewer people. The number of people they encountered was also what most (60%) expected to encounter while 20% indicated that there were fewer people on the lake than they had expected. Most respondents also indicated that the number they saw either had no influence on their enjoyment (62%) or that it "detracted a little" from enjoyment (22%).

Question: How do you feel about the number of people you encountered on your visits to the Lake?

Answer		Response	%
Would like to have seen a lot more people		8	2%
Would like to have seen a few more people		26	7%
Neither too many nor too few people		261	71%
Would like to have seen a few less people		57	15%
Would like to have seen a lot less people		17	5%
Total		369	100%

Question: How did the number of people you saw on the lake compare with what you expected to see on your visits to Lake Arlington?

Answer		Response	%
A lot less than I expected		27	7%
A little less than I expected		48	13%
About what I expected		207	56%
A little more than I expected		31	9%
A lot more than I expected		8	2%
I didn't really have any expectations		44	12%
Other:		4	1%
Total		369	100%

Question: How did the number of people you saw affect your overall enjoyment of your visits to Lake Arlington?

Answer		Response	%
Added a lot to my enjoyment		27	7%
Added a little to my enjoyment		26	7%
No effect on my enjoyment		225	61%
Detracted a little from my enjoyment		78	22%
Detracted a lot from my enjoyment		12	3%
Total		368	100%

The number of boats on the lake does not appear to have made people feel unsafe as 96% indicated feeling at least "moderately safe" with 68% feeling very to "extremely safe." Feelings about safety related to the behavior of other boaters mimicked feelings about number of boats, with 93% feeling at least "moderately safe" given the behavior of other boaters they encountered. Results below provide some additional insight regarding where on the lake people may be concerned with safety. Most respondents (66%) did not feel there was an area of the lake where they felt unsafe. The 34% who did feel unsafe indicated they felt unsafe in the far western and southern zones of Lake Arlington (Zones 1 and 6 on the map shown below, Figure 2).

Question: In light of the number of boats you saw on the Lake this season, please rate how safe you felt while boating.

Question	Not at all safe 1 n (%)	2 n (%)	Moderately safe 3 n (%)	4 n (%)	Extremely safe 5 n (%)	Responses
How safe did you feel?	1 (01)	12 (03)	105 (30)	141 (39)	106 (29)	365

Statistic	Value*
Mean	3.93
Standard Deviation	0.85
Total Responses	365

**Based on 5 point scale from "Not at all safe" to "Extremely safe"*

Question: In light of the behavior of other boaters on the Lake this season, please rate how safe you felt while boating.

Question	Not at all safe 1 n (%)	2 n (%)	Moderately safe 3 n (%)	4 n (%)	Extremely safe 5 n (%)	Responses
How safe did you feel?	4 (01)	21 (06)	114 (31)	137 (38)	87 (24)	363

Statistic	Value*
Mean	3.78
Standard Deviation	0.91
Total Responses	363

**Based on 5 point scale from "Not at all safe" to "Extremely safe"*

We asked respondents to provide information about places on the lake that they might use or avoid. Figure 2 below was shown in the survey questionnaire, and people were asked to refer to specific zones to indicate where their use occurred or how they felt about regions of the lake.

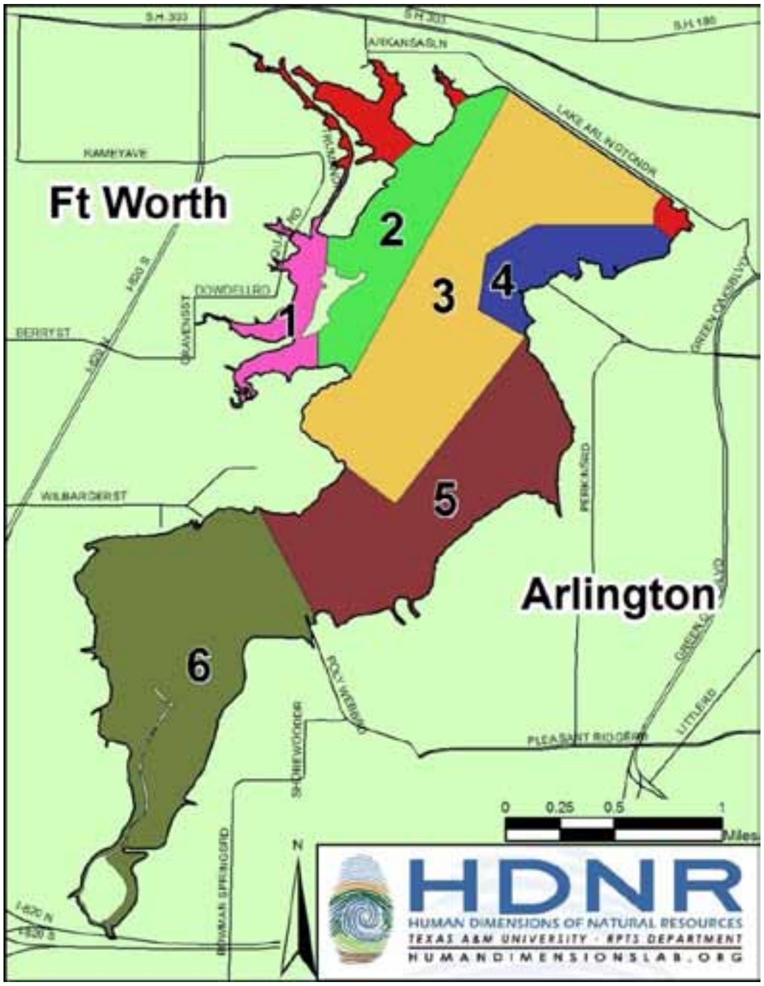

Figure 2. Lake Arlington Use Zones

Most respondents (84%) launched boats or otherwise started their use on the eastern shoreline in zones 4, 5 & 6. This is to be expected since there are more ramps and homes with docks on the east side. Where respondents spent time was more dispersed with only Zone 1 on the western shore seeing relatively little use. Only 9% of respondents indicated any use in that zone. When asked if there were any “special places” they had on the lake, those indicating yes, most often indicated zones 4, 5 & 6. Many more respondents indicated that there were places on the lake that they avoided, primarily zones 1 & 6.

Question: Where was your normal starting location?

Zone number	1 n (%)	2 n (%)	3 n (%)	4 n (%)	5 n (%)	6 n (%)	Responses
Response	4 (01)	22 (06)	34 (09)	154 (42)	61 (17)	90 (25)	365

Question: Indicate the zone(s) where you spent most time.

Zone number	1 n (%)	2 n (%)	3 n (%)	4 n (%)	5 n (%)	6 n (%)	Responses
Response	32 (09)	98 (27)	155 (42)	88 (24)	168 (46)	87 (24)	365

Percentages do not add to 100 due to multiple responses

Question: Do you have a place or area on the Lake that you consider special?

Answer		Response*	%
Yes		85	44%
No		107	56%
Total		192	100%

**Only respondents using survey form A completed this item*

Question: If "Yes", referring to the map, in what zone does this special place lie?

Zone number	1 n (%)	2 n (%)	3 n (%)	4 n (%)	5 n (%)	6 n (%)	Responses
Response	7 (08)	10 (12)	6 (07)	26 (30)	15 (18)	21 (25)	85

Question: Why is this place special?

Among the 85 people who completed this open ended question, answers given most often included: access to the yacht club, smooth water and good fishing.

Question: Are there any locations on Lake Arlington you deliberately avoided?

Answer		Responses	%
Yes		215	60%
No		145	40%
Total		360	100%

Question: If “Yes” please identify the area(s) you avoided.

Zone number	1 n (%)	2 n (%)	3 n (%)	4 n (%)	5 n (%)	6 n (%)	Respondents
Response*	80 (37)	29 (13)	16 (07)	12 (06)	17 (08)	132 (61)	215

**Percentages do not add to 100 because multiple responses were allowed per individual respondent.*

Question: Why did you avoid those locations?

More than 20% of those responding to this open ended question specifically said they avoided the zone selected because of “shallow water.” Depth was the issue noted most often, with submerged obstacles, “rowdy” people, trash and debris also receiving many comments.

Question: Are there any places on Lake Arlington where you have felt unsafe?

Answer		Response	%
Yes		123	34%
No		239	66%
Total		362	100%

Question: Identify the area(s) you felt unsafe.

Zone number	1 n (%)	2 n (%)	3 n (%)	4 n (%)	5 n (%)	6 n (%)	Respondents
Response*	61 (49)	19 (15)	6 (05)	4 (03)	7 (05)	47 (38)	123

**Percentages do not add to 100 because multiple responses were allowed per individual respondent.*

Question: Why did you feel unsafe in those places?

Many of the responses about feeling unsafe were directed factors such as: “rowdy” people on the shore “playing loud music” and “shouting”; and shallow water. Out of the 123 comments, only ten (10) mentioned unsafe boaters.

In general respondents did not feel that activities should be restricted to certain areas of Lake Arlington. Seventy percent (71%) said they would not want activities restricted by zone. Among the 29% who did feel that activity should be restricted to zones, there was support for restricting jet skis, high performance boats and skiing/wakeboarding across all zones with the highest counts in zone 6. Zone 6 is the shallowest area of Lake Arlington and is currently a no skiing zone.

Most respondents (78%) also felt that Lake Arlington should be managed for all types of recreational boating. Among the 22% (n=93) who felt there was some need for restriction almost all (n=76, 82%) felt that high performance boats were not suitable on the lake. To a lesser extent some respondents did not feel that wakeboarding or PWC were suitable (n=31 and n=30 respectively). There was almost no opposition to canoeing/kayaking, sailing or fishing as lake activities.

Question: Would you like to see some activities restricted to certain areas of the Lake?

Answer		Response	%
Yes		104	29%
No		255	71%
Total		359	100%

Question: Select an activity and corresponding zone (from the map) where you would like to see the activity restricted (reduced or removed from that zone).

Question*	Zone 1 n	Zone 2 n	Zone 3 N	Zone 4 N	Zone 5 N	Zone 6 n
PWCs (e.g., Jet Ski)	28	23	30	30	27	41
High performance boating	21	22	21	27	21	41
Skiing/Wakeboarding	24	23	21	25	20	44
Canoeing/Kayaking	4	8	11	6	6	9
Sailing	8	6	8	10	7	12
Other (please specify)	1	2	2	6	3	2

**Multiple responses were accepted for this item*

Question: Do you feel that Lake Arlington should be managed to support all recreational boating activities?

Answer		Response	%
Yes		328	78%
No		93	22%
Total		421	100%

Question: If no, which of the following activities do you feel are NOT suitable for Lake Arlington?

Answer		Response	% of those saying "no"*
High performance (speed) boats		76	82%
Wakeboarding		31	33%
PWC (e.g., Jet Ski)		30	32%
Waterskiing		21	23%
Towing inflatables		19	21%
Sailing		5	05%
Canoeing/Kayaking		7	07%
Fishing		3	03%
Other activities (please specify)		9	09%

**Percentages do not add to 100 because multiple responses were allowed per individual respondent.*

Respondents did not feel that conditions were crowded out on the water or at access points on Lake Arlington. Over 75% felt that conditions on the water were only moderately crowded or less, and 65% felt that conditions were moderately crowded, or less so, at access points. Only 5% of respondents scored crowding on the water at the upper end of the scale (7 or 8) and only 9% scored at the upper end regarding crowding at access points like boat ramps.

Question: Using the following scale, how would you describe the boating conditions <u>out on the water</u> during your visits to Lake Arlington?

Not at all crowded 0 n (%)	1 n (%)	2 n (%)	3 n (%)	Moderately crowded 4 n (%)	5 n (%)	6 n (%)	7 n (%)	Extremely crowded 8 n (%)
7 (02)	38 (11)	50 (14)	100 (28)	73 (20)	65 (18)	9 (02)	16 (04)	2 (01)

Statistic	
Mean	3.44
Standard Deviation	1.60
Total Responses	360

Question: Using the following scale, how would you describe the boating conditions at access points (e.g., boat ramp) during your visits to Lake Arlington?

Not at all crowded 0	1	2	3	Moderately crowded 4	5	6	7	Extremely crowded 8
5 (01)	30 (08)	44 (12)	79 (22)	79 (22)	66 (18)	24 (07)	16 (04)	18 (05)

Statistic	Value*
Mean	3.90
Standard Deviation	1.86
Total Responses	361

*Based on the 9 point scale from 0 "Not at all crowded" to 8 "Extremely crowded."

SECTON 3: MANAGEMENT OF LAKE ARLINGTON

Respondents were asked to score 16 items on a scale from "strongly oppose" (1) to "strongly support" (5) related to possible management actions on Lake Arlington. The actions that received the most support were related to developing the fish stock (mean 4.23) and dredging the lake to improve depth (mean 4.06). Respondents also tended to agree that training should be required for operating PWC (mean 3.78) and that development standards should be set for shoreline retaining walls (mean 3.46). On the other hand, respondents were not supportive of restricting activities. They were least supportive of restrictions "by day of week or during peak use" like "holidays" (mean 2.19) and were also less likely to support a ban on PWC (mean 2.44) or zoning for certain uses by place (mean 2.80). A large majority of respondents (82%) did not believe more controls were needed "to prevent conflicts … between lake users" or (80%) to "prevent damage to the environment by boaters." Overall, support for more control over lake activities was weak though there was some support for rules/restrictions related to the use of PWC. With regard to marina development as a management action, there was no strong consensus for or against development, with 22% of the respondents being neutral. There was also no strong support of the installation of more boat ramps.

Question: Given the conditions you observed on Lake Arlington, how do you feel about each of the following potential management actions?

Question	Strongly Oppose n (%)	Oppose n (%)	Neutral n (%)	Support n (%)	Strongly Support n (%)	Responses	Mean
Develop the fish stock to improve fishing on the Lake	8 (02)	5 (01)	68 (19)	92 (26)	183 (51)	356	4.23
Dredge the Lake to improve depth	9 (03)	19 (05)	71 (20)	96 (27)	157 (45)	352	4.06
Require training for the operation of personal watercraft	13 (04)	38 (11)	71 (20)	125 (35)	109 (31)	356	3.78
Require development standards for shoreline retaining walls	14 (04)	26 (07)	147 (41)	120 (34)	49 (14)	354	3.46
Provide more aggressive enforcement of safety rules and regulations	20 (06)	47 (13)	115 (33)	106 (30)	66 (18)	354	3.43
Cite boaters whose music can be heard more than 100 feet from their boat	26 (07)	51 (14)	103 (29)	98 (28)	76 (22)	354	3.42
Require training for all watercraft operators	26 (07)	62 (18)	119 (34)	92 (26)	55 (15)	354	3.25
Establish "off limits" zones to protect sensitive resources	28 (08)	72 (20)	104 (29)	97 (27)	54 (15)	355	3.22
Restrict personal watercraft use to designated areas only	63 (18)	57 (16)	71 (20)	85 (24)	78 (22)	354	3.16
Provide more improved public access to the Lake	27 (08)	58 (16)	150 (43)	81 (23)	37 (11)	353	3.12
Allow marina development along the shoreline	57 (16)	70 (20)	78 (22)	96 (27)	54 (15)	355	3.06
Expand the number of marina slips	36 (10)	55 (16)	155 (44)	72 (20)	37 (10)	355	3.05
Install more public boat ramps	39 (11)	99 (28)	120 (34)	60 (17)	35 (10)	353	2.87
Zone the water surface to provide specific uses at specific places	58 (16)	92 (26)	98 (28)	74 (21)	31 (09)	353	2.80
Ban personal watercraft on public holidays	90 (26)	100 (28)	107 (30)	28 (08)	27 (08)	352	2.44
Restrict activities by day of week during peak use periods (e.g., holidays)	109 (31)	106 (30)	103 (29)	28 (08)	6 (02)	352	2.19

Question: Do you feel that more controls are needed on Lake Arlington to prevent conflicts from occurring between lake users?

Answer		Response	%
Yes		78	18%
No		354	82%
Total		432	100%

Question: If “Yes”, what conflicts and how should they be managed?
Seventy eight (78) people provided a comment on this question. Most had to do with behavior of other boaters for example, “coming too close” when skiing, or were related to use of wakeboards, skis andPWC. Some were concerned

about shoreline use and suggested more police were needed. Several felt that the parking lot they used became too crowded at times and that people we not considerate in making room for others to launch boats.

Question: Do you feel that more controls are needed on the lake to prevent damage to the environment by boaters?

Answer		Response	%
Yes		85	20%
No		341	80%
Total		426	100%

Question: If “Yes”, what kinds of environmental damage did you see and how should they be controlled?
Among the 85 people who completed this question, answers related to trash, litter and debris in and around the lake made up the overwhelming majority.

While a small majority (55%) of respondents felt that current facilities were adequate, many (45%) felt that some additional services and facilities should be available to users. A large majority (80%) would support up to a 20% increase in the fees charged (both annual and day use) to support services and upkeep of Lake Arlington. Litter pick up, park amenities and code enforcement were all seen as reasonable ways to spend additional fee revenues.
A small majority (57%) felt that marina development was acceptable on Lake Arlington. Among those who felt it was acceptable just over 60% felt fewer than 40 slips would be an acceptable capacity size for a marina.

Question: Are there certain facilities or services that should be offered on Lake Arlington that currently are not available?

Answer		Response	%
Yes		189	45%
No		234	55%
Total		423	100%

Question: If “Yes”, what kinds of facilities or services?
The addition of a marina, boat docks/boat storage, fuel sales and bait shop were mentioned most often.

Question: Would you support a 20% increase (to $30 annually & $6 daily) in the permit fee if it were used to assist with upkeep of the lake?

Answer		Response	%
Yes		342	80%
No		83	20%
Total		425	100%

Question: If “Yes”, which of the following would you prefer to see the money spent on?

Question	Responding Yes n (%)	Responding Yes to 20 % Increase
Picking up litter	234 (68)	342
Upgrade park amenities	181 (53)	342
Code enforcement	150 (44)	342
Other (please specify)	72 (21)	342

Percentages do not add to 100 due to multiple responses

Respondents who said “other” to the question of how to spend new fee revenues most often said that fish stocking and dredging would be good ways to spend the money. Twelve percent of those who commented (n=9) suggested cleaning up trees and stumps in the water.

Question: Do you feel that new marina development is acceptable on Lake Arlington?

Answer		Response	%
Yes		242	57%
No		180	43%
Total		422	100%

Question: If “Yes”, what size marina is acceptable?

Answer		Response	%
Fewer than 20 slips		47	19%
20 to 39 slips		104	43%
40 to 59 slips		62	26%
60 or more slips		28	12%
Total		241	100%

Question: Have you noticed important (positive or negative) changes at the lake in the last five years?

Answer		Response	%
Yes		124	30%
No		297	70%
Total		421	100%

If “Yes”, would you please describe those changes?
Most comments on this question were positive. Better police presence, better boat ramp maintenance and attempts to clean up the lake have been noticed and appreciated.

Respondents were asked about 17 possible issues (developed through input during public meetings and previous research) and to what extent each may present a problem associated with Lake Arlington. Each issue was scored on a scale from 1 “Not a problem” to 4 “Big problem.” Fish habitat (mean 3.25), change in the lake’s water level (mean 3.24) and litter on shoreline (mean 3.05) were scored as moderate to big problems. Poorly constructed bulkheads (mean 2.91) and polluted water (mean 2.90) were scored as moderate problems while pulling inflatable toys, engine noise and public access were scored lowest of the 17 items, as slight problems.

Question: To what extent did you find each of the following to be a problem on Lake Arlington?

Question	Not a problem n (%)	Slight problem n (%)	Moderate problem n (%)	Big problem n (%)	Unable to comment n (%)	Responses	Mean
Changes in the lake's water level	21 (09)	35 (16)	54 (24)	88 (40)	23 (10)	221	3.26
Fish habitat	44 (20)	20 (09)	55 (25)	46 (21)	56 (25)	221	3.23
Litter on shoreline	27 (12)	51 (23)	53 (24)	67 (30)	24 (11)	222	3.05
Polluted water in the lake	55 (25)	40 (18)	47 (21)	39 (18)	40 (18)	221	2.86
Wildlife habitat	82 (37)	29 (13)	31 (14)	28 (13)	49 (22)	219	2.69
Improper disposal of human waste	97 (44)	32 (14)	17 (08)	12 (05)	64 (29)	222	2.62
Inadequate public toilet facilities on the lake	65 (30)	48 (22)	48 (22)	30 (13)	30 (13)	221	2.60
Poorly constructed bulkheads along shoreline	69 (31)	44 (20)	33 (15)	13 (06)	61 (28)	220	2.79
Erosion of the shoreline	70 (32)	53 (24)	40 (18)	23 (10)	34 (16)	220	2.54
Loud music played from watercraft	72 (33)	56 (25)	37 (17)	24 (11)	32 (15)	221	2.49
Debris at launch ramps	76 (34)	52 (23)	40 (18)	20 (09)	34 (15)	222	2.48
Large wakes from boats	84 (38)	52 (24)	34 (15)	21 (10)	30 (14)	221	2.37
Poorly constructed docks	97 (44)	50 (23)	28 (13)	17 (08)	29 (13)	221	2.24
The speed of other boaters	97 (44)	52 (24)	29 (13)	12 (05)	30 (14)	220	2.21
Engine noise from boats	122 (55)	38 (17)	22 (10)	10 (05)	30 (13)	222	2.05
Lack of public access to the lake	127 (58)	31 (14)	25 (11)	15 (07)	23 (10)	221	1.99
Inflatables/water toys trailing watercraft	135 (61)	35 (16)	15 (07)	4 (02)	31 (14)	220	1.91

Only respondents using form A answered these questions

Question: Have you ever taken a boater education/safety class before?

Answer		Response	%
Yes		179	42%
No		245	58%
Total		424	100%

SECTION 4: CHARACTERISTICS OF SHORELINE PROPERTY OWNERS

Property owners adjacent to the lake were asked about issues that would apply only to them. Seventy (16%) respondents indicated that they had a home on Lake Arlington and, for all 70, it was their primary residence. Homes had been owned an average of 10 years. Thirty-nine (56%) had a bulkhead, dock or slip associated with their property. Twenty (51%) of the 39 who had a bulkhead indicated that it had been damaged. However, there was little detailed information about the nature or cause of that damage.

Related to two homeowner issues, questions were asked about whether they displayed a home address on their dock or slip and if they were aware of the “flowage easement” that extends into lake front property. Of the 23 who indicated having a dock or slip, only three (8%) said that they have their street address posted on the structure. Awareness of the “flowage easement” was split evenly among the shoreline property owners, with 52% indicating that they were not aware of the easement.

Question: Do you have a home on Lake Arlington?

Answer		Response	%
Yes		70	16%
No		356	84%
Total		426	100%

Question: How long have you owned the residence on the lake?

Statistic	Value*
Average	10
Median	7
St. Dev.	8
Count	70 owners

**Number of years*

Question: Is your home on Lake Arlington your primary residence?

Answer		Response	%
Yes		70	100%
No		0	0%
Total		70	100%

Question: Does your property have a bulkhead, dock or slip?

Answer		Response	%
Yes		39	56%
No		31	44%
Total		39	100%

Question: Has your waterfront (e.g., bulkhead, dock or slip) been damaged?

Answer		Response	%
Yes		20	51%
No		19	49%
Total		39	100%

Question: Do you display your house address on your dock or boat slip?

Answer		Response	%
Yes		3	8%
No		37	92%
Total		40	100%

Question: Are you aware of the "flowage easement" around Lake Arlington?

Answer		Response	%
Yes		33	48%
No		36	52%
Total		69	100%

SECTION 5: RESPONDENT DEMOGRAPHICS

The group's demographic characteristics are described in tables below. The average age of respondents was just over 55 years. They were predominantly white/Caucasian (87%) and male (79%). Most respondents (63%) had at least a four year college degree and indicated an income more than $75,000 (71%). While most were employed full time (57%) approximately 21% of the group were retired and not working.

Age of respondents

Statistic	Value*
Average	55.1
Median	55
St. Dev.	13.5
Count	422

**Years of age*

Gender

Answer		Response	%
Male		336	79%
Female		88	21%
Total		424	100%

Race/ethnicity

Answer		Response	%
Hispanic		7	2%
White, not of Hispanic origin		366	87%
Black or African-American		19	5%
Native American or Alaskan Native		8	2%
Asian or Pacific Islander		5	1%
Other (Please specify)		16	4%
Total		421	100%

Education level

Answer		Response	%
8th grade or less		0	0%
9th to 11th grade		6	1%
12th grade (high school graduate)		37	9%
13-15 years (some college)		115	27%
16 years (college graduate)		122	29%
17+ years (some graduate work)		59	14%
Masters, Doctoral or Professional Degree		87	20%
Total		426	100%

Employment status

Answer		Response	%
Employed, full time		243	57%
Homemaker		13	3%
Employed, part time		14	3%
Retired, but working full time		2	1%
Retired, working part time		38	9%
Retired, not working		89	21%
Unemployed		11	3%
Student		5	1%
Other (Please specify)		8	2%
Total		423	100%

Household income before taxes

Answer		Response	%
Less than $25,000		10	3%
$25,000 - $49,999		42	11%
$50,000 - $74,999		73	18%
$75,000 - $99,999		73	18%
$100,000 - $149,999		85	22%
$150,000 - $199,999		55	14%
$200,000 - $249,999		26	7%
$250,000 - $299,999		8	2%
$300,000 or more		20	5%
Total		392	100%

SUMMARY OF KEY FINDINGS AND RECOMMENDATIONS

Key Findings

Respondents' Use of Lake Arlington

- Most respondents had boated on Lake Arlington. Of those who had, most had boated within the last 12 months.
- The most popular watercraft used by respondents were fishing or bass boats, ski boats, and personal watercraft (PWC).
- The most popular activities on the lake were fishing, cruising, towing inflatables, and wakeboarding.
- Respondents most often boated with family and friends.

Ares of Use, Conflict and Displacement

- Overall, there was little indication of crowding, conflict and/or displacement in the use of Lake Arlington by boaters.
- Areas that respondents most often avoided were Zone 6 and Zone 1, the far south and west segments.
- Areas that respondents most often felt unsafe were Zone 6 and Zone 1, the far south and west segments.
- Respondents indicated the depth of the water, submerged obstacles, and "rowdy" people as reasons for avoiding these areas of the lake and/or for feeling unsafe.
- In response to encountering others on Lake Arlington over the 2009 boating season, for the most part, respondents indicated not feeling crowding. Additionally, they indicated that the number of other boaters encountered was:
    - Consistent with what they had expected;
    - Had little effect on their enjoyment; and
    - Did not significantly impact their perceived safety.
- When asked if some activities should be restricted to certain areas of the lake, most respondents indicated that they were comfortable with the current activity use patterns occurring on the lake. The only boat type considered inappropriate was "high performance boats".

Areas of Lake Arlington Requiring Potential Managerial Action

- Most respondents did not feel additional controls were required to manage conflict on or damage to the lake.
- The most salient issues that respondents felt were problematic on the lake were:
    - Litter along the shoreline;
    - Shallow water
    - Changes in the lake's water level; and
    - Fish habitat.
- Potential management actions receiving strongest support focused on:
    - Requiring training for the operation of PWC;
    - Developing fish stock to improve fishing on the lake; and
    - Dredging the lake to improve depth.

- There was strong support for up to a 20% increase in permit fees that would generate revenue to be spent on litter collection, upgrading park amenities, and code enforcement.
- There was no strong opposition to the development of standards or guidelines for shoreline structures such as retaining walls, docks and piers.

Suitable Development on Lake Arlington

- Respondents were somewhat split on the issue of providing additional facilities or services on Lake Arlington. Specifically, with regard to marina development, a slight majority were accepting of the proposition. Of these, most were in favor of a development that had a capacity of 40 boat slips or less.

Recommendations

Based on the survey described above, the site visit to Lake Arlington, and the study team's professional experience on similar projects, the following recommendations are offered for consideration:

1. Overall, the current management practices being used for Lake Arlington are providing a satisfactory recreational experience and a safe environment for users of the lake. At this time, it does not appear necessary to implement additional zoning or more intensive use restrictions (except with regard to two types of watercraft as discussed below). The study team recommends that the City's current management practices be continued, with consideration of the enhancements described below.
2. Other team members working on the Master Plan are studying litter, debris and "floatables" control and management practices within the Lake Arlington watershed. We recommend that those best management practices (BMPs) be implemented in order to minimize "litter" which was one of the major detrimental factors identified in the survey. We also recommend that the City increase its litter and trash disposal activities around the lake, such as adding more trash cans at access points. We also recommend that related public education be increased. This education could include signs directly around the lake and within the watershed.
3. In the survey, lake users indicated a willingness to pay higher user fees, if the related revenues were used for the direct benefit of Lake Arlington. We recommend that the City implement regular, periodic user fee rate increases in order to fund at least a portion of the improvements and enhancements described below. These rate increases should be based upon a cost-of-service approach that clearly describes and defines the funded activities, as well as the beneficiaries.
4. In order to fund projects and enhancements that have more broad-based beneficiaries, the City should consider using money from its General Fund or other sources. The survey showed that users and residents appreciate the proximity and quality of Lake Arlington. The City might also consider the implementation of a "flowage easement" fee associated with the land around the lake (the "littoral zone") where additional operations or enforcement activities are needed. Residents within this zone clearly benefit from improved operations on Lake Arlington.
5. The survey identified the need to make improvements and enhancements to the three existing parks on Lake Arlington. We understand that the Arlington and Fort Worth parks departments have, or in the process of developing, master plans for these parks. We recommend that improvements be made in accordance with those plans, as funds permit.
6. Logs and other large debris were identified as safety hazards and detrimental factors affecting recreational boating on Lake Arlington. We recommend that the City consider the implementation of a program to

periodically patrol the lake, remove such debris, and properly dispose of it. The frequency of such patrols will depend on the amount of debris and should decrease over time. Many lake operators have work barges or other equipment that can be used for such “snag” operations. Such operations not only improve the recreation experience for boaters, but they also prevent damage to private property such as docks, piers and boat houses, and they minimize potential damage to intake structures and dam facilities.

7. We recommend that the City work with Texas Parks & Wildlife Department (TPWD) to continue conducting periodic fish habitat studies of Lake Arlington, in conjunction with other implementation steps that result from the Master Plan. Such studies would identify means and methods for improving the fishing by enhanced construction of structures (such as rock placed along the bottom of retaining walls) and public education. Although State funding for stocking programs is becoming more limited, many lake owners develop cooperative agreements and stocking programs with fishing organizations such as Trout Unlimited.
8. The survey determined that lakeshore owners are not generally opposed to development of uniform standards for structures such as piers, docks and retaining walls. Other members of the Master Planning team are developing recommended standards and templates. We recommend that the City adopt policies and procedures implementing those standards in order to enhance the recreational experience by boaters and other lake users, and to protect the investment made by the City and private property owners. It is important that those standards include safety practices such as mounting the street address on each structure; requiring lights or reflectors on structures that protrude into the lake; and regulating the distance that structures can extend into the lake. We also recommend the City actively educate property owners about the flowage easement, and communicate to lakeshore property owners the standards governing the construction of shoreline structures and shoreline improvements.
9. We understand that the water level of Lake Arlington is determined by the amount of water diverted from the lake for treatment purposes, and the City’s contract with the Tarrant Regional Water District (which operates a regional system of reservoirs), and possibly others. Per that contract, the City does not have control over the lake level. We recommend that the City continually look for opportunities to keep a more stable lake level.
10. The south end of Lake Arlington has been identified as an area that is very shallow, especially when the lake is below elevation 543.0 feet. Although this shallow depth and debris lodged in the area produce safety issues, the area also exhibits some beneficial characteristics. We understand that during some months, waterfowl inhabit the area, and the shallow areas are enjoyed by kayakers, canoeists and fishermen. Dredging activities are very expensive because of the costs associated with permitting, materials handling and spoil disposal. Unless there are significant water quality or quantity reasons, it may not be practical or advisable to dredge a large portion of Lake Arlington. However, the City should study the feasibility of dredging access lanes or canals in the southern portion of the lake in order to improve access and water flow.
11. The only new regulations or use restrictions that were widely supported in the survey relate to “high performance boats” and training for PWC operators. As the owner of Lake Arlington, the City likely has the authority to limit the horsepower rating on power boats using the lake. Other entities such as the Lower Colorado River Authority and the Guadalupe-Blanco River Authority have enacted regulations that govern the operation of water craft on their lakes. We recommend that the City study such a regulation in consultation with City police and/or TPWD game wardens that would be responsible for enforcing a related ordinance. We also recommend that the City work with TPWD and the US Coast Guard Auxiliary on the establishment of educational programs, training programs and possibly licensing for PWC operators.

12. The survey results indicate that there is little opposition to, and possibly some justification for, the development of a marina on Lake Arlington, especially if that marina provides additional services to boaters using the lake. The most logical location for a new marina would be on the west side of the lake because it would not impact the residential areas on the east side, and it would not duplicate existing launch and dockage facilities on the east side. Other sections of the Master Plan provide information on the standards to be used for marina design and construction. If the marina is located on the southwest side of the lake in the shallower areas, we recommend that the developer be required to dredge and maintain a safe access channel from the marina into open water. For any new marina on Lake Arlington, some of the facilities that will require the approval and permitting of the City of Arlington. The City should maintain its authority to approve the number, location and size of marinas located on the lake. Because of the speculative nature of marinas, we also recommend that the City approve and permit such facilities on an incremental basis so that each phase proves its viability before a new phase or increment is approved. For example, the survey showed general support for a marina with 20 to 60 slips, with the highest acceptability in the range of 20 to 40 slips. If requested, we recommend that the City consider approving a marina within this range as a logical first phase of development.

REFERENCES

Bean, A. G., & Roszkowski, M. J. (1995). The long and short of it. *Marketing Research, 7*(1), 20-26.

Groves, R. M. (2006). Nonresponse rates and nonresponse bias in household surveys. *Public Opinion Quarterly, 70,* 646-675.

Sheehan, K. B., & McMillan, S. J. (1999). Response variation in e-mail surveys: An exploration. *Journal of Advertising Research, 39*(4), 45-54.

Watt, J. H. (1999). Internet systems for evaluation research. In G. Gay & T. Bennington (Eds.), *Information technologies in evaluation: social, moral, epistemological and practical implications* (pp. 23-44). San Francisco: Josey-Bass.

APPENDICES

SECTION A: YOUR BOATING EXPERIENCE ON LAKE ARLINGTON (LA)

1. Have you ever boated on Lake Arlington before?
   ☐ Yes ☐No **(If "No", skip to Section C)**

   1a. If "Yes", how many years have you been an active boater on Lake Arlington? (If less than 1, enter 1)
   _______Number of Years

2. Are you currently an active boater on Lake Arlington? (*Have you used the Lake in the past 12 months*)
   ☐ Yes ☐No **(If "Yes", skip to question 4 below)**

3. **If you answered "No" on the previous question,** please tell us the year of your last boating experience on the Lake, **then skip to question 8.** Year: ________ (e.g., 2003)

4. About how many days did you spend on the Lake over the last 12 months? __________Number of days (0 - 365)

5. What type(s) of watercraft do you use on Lake Arlington? *(Check each type of boat you use)*
   - ☐ Ski boat
   - ☐ Fishing or bass boat
   - ☐ Pontoon boat
   - ☐ Kayak
   - ☐ Canoe
   - ☐ Wakeboard boat
   - ☐ High performance boat
   - ☐ Personal Watercraft (PWC, e.g., Jet Ski)
   - ☐ Sailboat
   - ☐ Other (Please specify) ________________

6. Which of these watercraft do you use **most often on the Lake**? (*Check only one*)
   - ☐ Ski boat
   - ☐ Fishing or bass boat
   - ☐ Pontoon boat
   - ☐ Kayak
   - ☐ Canoe
   - ☐ Wakeboard boat
   - ☐ High performance boat
   - ☐ Personal Watercraft (PWC; e.g., Jet Ski)
   - ☐ Sailboat
   - ☐ Other (Please specify) ______________________

7. What activity do you **most often** use your boat for on the Lake? (*Check only one*)
   - ☐ Skiing
   - ☐ Exercise
   - ☐ Wakeboarding
   - ☐ Towing inflatables/water toys
   - ☐ Fishing
   - ☐ Cruising up and down the Lake
   - ☐ Competition/racing
   - ☐ Other (Please specify) ______________________

8. Do you boat as often as you would like on Lake Arlington?
   ☐ Yes ☐No **(If "Yes" skip to Question 10)**

9. Please indicate to what extent the following statements reflect factors that inhibit your ability to boat as often as you would like?
   (C*ircle one number for each statement that best reflects your opinion*)

I don't boat as often as I would like because…	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
a. I have no interest in boating	1	2	3	4	5
b. I'm no longer physically able	1	2	3	4	5
c. I can't afford to go boating	1	2	3	4	5
d. It's too hot in summer	1	2	3	4	5

Question 9, continued	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
e. It's too crowded	1	2	3	4	5
f. I have no way to access the Lake	1	2	3	4	5
g. The Lake is too small	1	2	3	4	5
h. The behavior of other boaters is unsafe	1	2	3	4	5
i. Areas of the Lake are too shallow	1	2	3	4	5
j. Poor water quality	1	2	3	4	5
k. Other boaters are inconsiderate	1	2	3	4	5
l. Public access is inconvenient	1	2	3	4	5
m. I no longer have enough time	1	2	3	4	5
n. Work commitments keep me away from boating on the Lake	1	2	3	4	5
o. My family no longer has an interest in boating	1	2	3	4	5
p. Shoreline owners/residents are inconsiderate	1	2	3	4	5
q. At times, the water surface is too rough	1	2	3	4	5
r. There's too much litter in the water	1	2	3	4	5

10. How far by road do you travel to Lake Arlington? (*Write 0 if your home or boat is on the shoreline*)

_______ One way distance in miles

11. Do you have a place or area on Lake Arlington that you consider special?

☐ Yes ☐ No **(If "No" please skip to SECTION B)**

11a. If "Yes" referring to the map on the right, in what zone does this special place lie?

Zone _________

12. Why is this place special? (*Please explain*)

____

____

____

____

____

____

____

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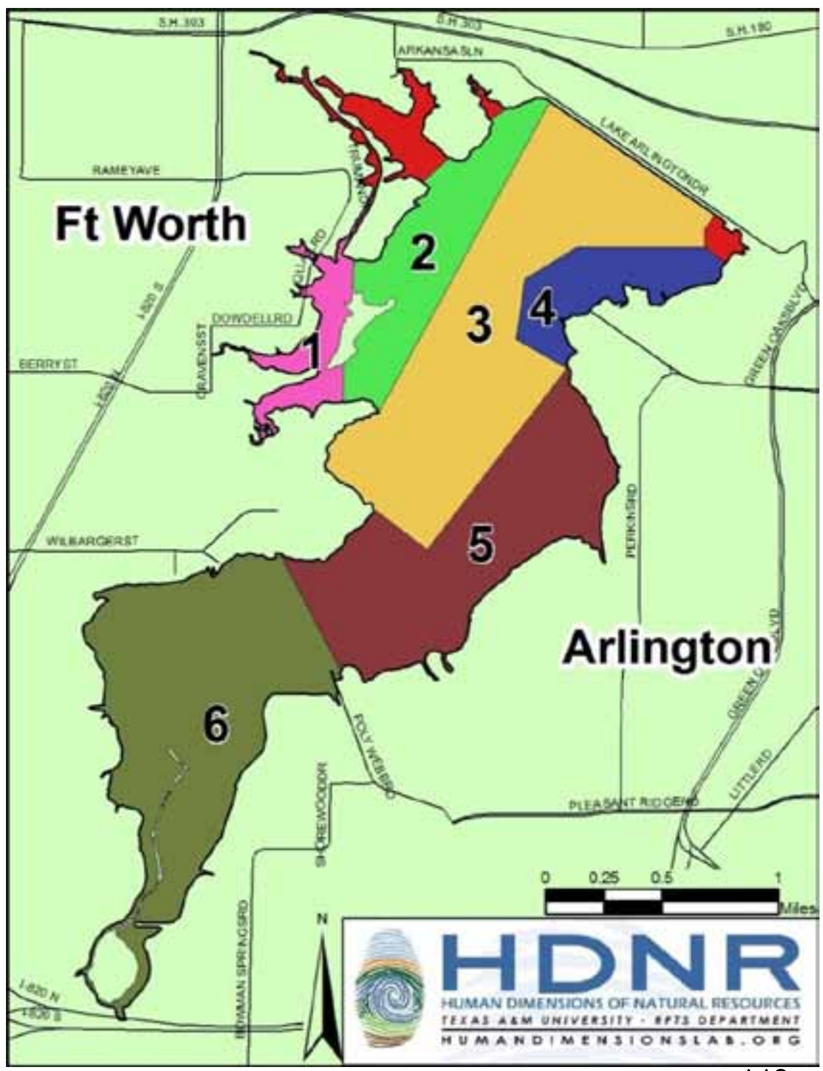
____



SECTION B: Your use of the Lake

The following questions address your boating experiences on Lake Arlington

13. What did you like **best** about your visits to Lake Arlington?

____

____

14. What did you like **least** about your visits to Lake Arlington?

____

____

15. How do you feel about the **number of people you encountered** on your visits to the Lake? (*Check only one*)
    - ☐ Would like to have seen a lot more people
    - ☐ Would like to have seen a few more people
    - ☐ Neither too many nor too few people
    - ☐ Would like to have seen a few less people
    - ☐ Would like to have seen a lot less people

16. How did the **number of people you saw on the lake compare** with what you expected to see on your visits to Lake Arlington? (*Check only one*)
    - ☐ A lot less than I expected
    - ☐ A little less than I expected
    - ☐ About what I expected
    - ☐ A little more than I expected
    - ☐ A lot more than I expected
    - ☐ I didn't really have any expectations
    - ☐ Other: _________________________

17. How did the **number of people you saw affect your overall enjoyment** of your visits to Lake Arlington? (*Check only one*)
    - ☐ Added a lot to my enjoyment
    - ☐ Added a little to my enjoyment
    - ☐ No effect on my enjoyment
    - ☐ Detracted a little from my enjoyment
    - ☐ Detracted a lot from my enjoyment

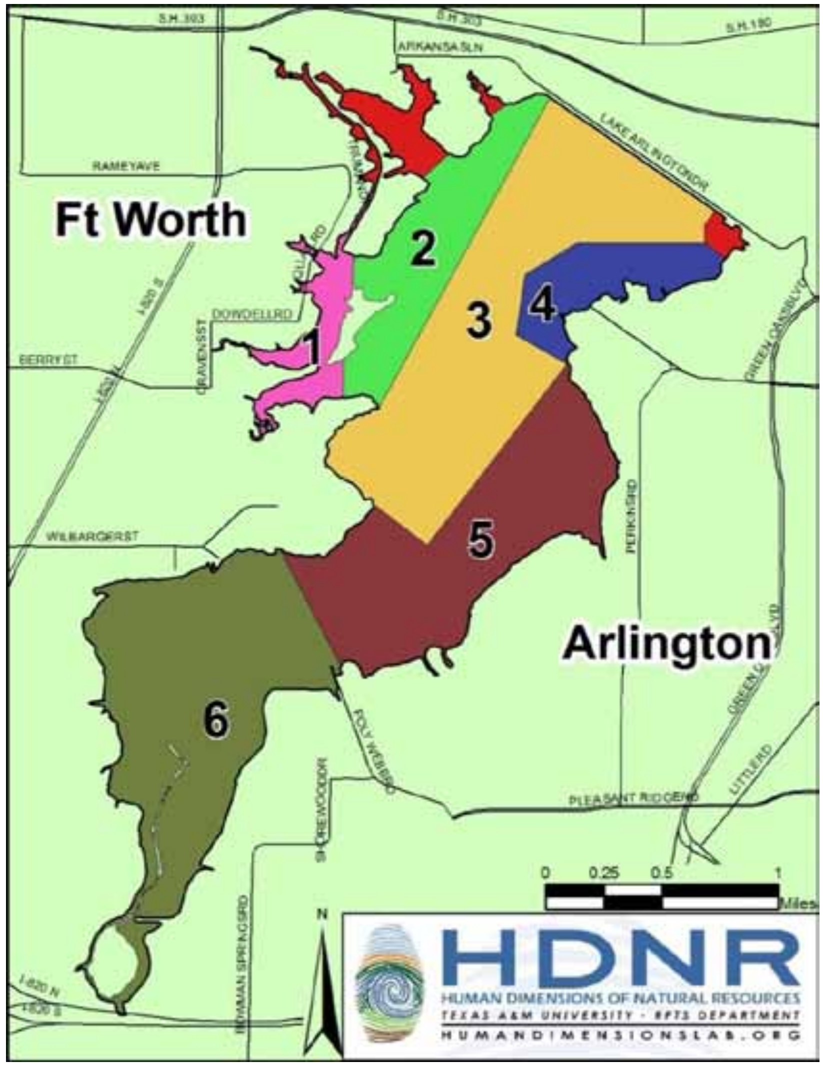
18. In light of the **number of boats** you saw on the Lake this season, please rate how safe you felt while boating: (*Circle only one number below*)

1	2	3	4	5
Not at all safe		Moderately safe		Extremely safe

19. In light of the **behavior of other boaters** on the Lake this season, please rate how safe you felt while boating: (*Circle only one number below*)

1	2	3	4	5
Not at all safe		Moderately safe		Extremely safe

We would like to know about areas of Lake Arlington. Please select the zones from the map below that BEST estimate your boating activity.



20. Where was your normal starting location? (*Write in only one*)
    Zone #_____

21. Indicate the area(s) where you spent most timeat Lake Arlington.
    Zone(s)# ___________________

22. Are there any locations on Lake Arlington you deliberately avoided?
    ☐ Yes ☐ No **(If "No" skip to 25)**

23. Identify the area(s) you avoided.
    Zone(s) #___________________

24. Why did you avoid those locations?
____
____
____
____
____

25. Are there any places on Lake Arlington where you have felt unsafe?
    ☐ Yes ☐ No **(If "No" skip to 28)**

26. Identify the area(s) where you felt unsafe.
    Zone(s) #___________________

27. Why did you feel unsafe in those places?
____
____

28. Would you like to see some activities restricted to certain areas of the Lake? ☐ Yes ☐ No **(If "No" skip to 30)**

29. Select an activity and corresponding zone (from the map) where you would like to see the activity restricted (reduced or removed from that zone). (multiple answers accepted)	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Personal watercraft (e.g., Jet Ski)	☐	☐	☐	☐	☐	☐
High performance boating	☐	☐	☐	☐	☐	☐
Skiing/Wakeboarding	☐	☐	☐	☐	☐	☐
Canoeing/Kayaking	☐	☐	☐	☐	☐	☐
Sailing	☐	☐	☐	☐	☐	☐

Other ___________________	☐	☐	☐	☐	☐	☐

30. Using the following scale, how would you describe the boating conditions **out on the water** during your visits to Lake Arlington? (Circle only one number below)

0	1	2	3	4	5	6	7	8
Not at all crowded				Moderately crowded				Extremely crowded

31. Using the following scale, how would you describe the boating conditions **at access points** (e.g., boat ramp) during your visits to Lake Arlington? (Circle only one number below)

0	1	2	3	4	5	6	7	8
Not at all crowded				Moderately crowded				Extremely crowded

32. Given the conditions you observed on Lake Arlington, how do you feel about each of the following potential management actions? (*Circle one number for each statement that best reflects your opinion*)	Strongly Oppose	Oppose	Neutral	Support	Strongly Support
a. Provide more improved public access to the Lake	1	2	3	4	5
b. Zone the water surface to provide specific uses at specific places	1	2	3	4	5
c. Provide more aggressive enforcement of safety rules and regulations	1	2	3	4	5
d. Expand the number of marina slips	1	2	3	4	5
e. Cite boaters whose music can be heard more than 100 feet from their boat	1	2	3	4	5
f. Restrict personal watercraft use to designated areas only	1	2	3	4	5
g. Establish “off limits” zones to protect sensitive resources	1	2	3	4	5
h. Allow marina development along the shoreline	1	2	3	4	5
i. Require training for the operation of personal watercraft	1	2	3	4	5
j. Require development standards for shoreline retaining walls	1	2	3	4	5
k. Require training for all watercraft operators	1	2	3	4	5
l. Ban personal watercraft on public holidays	1	2	3	4	5
m. Restrict activities by day of week during peak use periods (e.g., holidays)	1	2	3	4	5
n. Install more public boat ramps	1	2	3	4	5
o. Develop the fish stock to improve fishing on the Lake	1	2	3	4	5
p. Dredge the Lake to improve depth	1	2	3	4	5

SECTION C: LAKE MANAGEMENT

The following questions address your boating experience on Lake Arlington

33. Do you feel that more controls are needed on Lake Arlington to **prevent conflicts from occurring between lake users**?

☐ Yes ☐ No **(If “No” skip to 35)**

34. If “Yes”, what conflicts and how should they be managed? ____

____

____

35. Do you feel that more controls are needed on the Lake to prevent damage to the environment by boaters?

☐ Yes ☐ No **(If "No" skip to 37)**

36. If "Yes", what kinds of environmental damages did you see and how should they be controlled?__________________

37. Are there certain facilities or services that should be offered on Lake Arlington that currently are not available?

☐ Yes ☐ No **(If "No" skip to 39)**

38. If "Yes", what kinds of facilities or services? ____________________________________

39. Would you support a 20% increase (to $30 annually & $6 daily) in the permit fee if it were used to assist with upkeep of the Lake?

☐ Yes ☐ No **(If "No" skip to 41)**

40. If "Yes", which of the following would you prefer to see the money spent on? (Check all that apply)

☐ Picking up litter
☐ Upgrade park amenities
☐ Code enforcement
☐ Other (please specify) ________________________________

41. Have you noticed important (positive or negative) changes at the Lake in the last five years?

☐ Yes ☐ No **(If "No" skip to 43)**

42. If "Yes", would you please describe those changes? ____________________________________

43. Information about various impacts you may have noticed at the Lake would be helpful to lake managers. To what extent did you find each of the following to be **a problem** on Lake Arlington? (*Circle one number for each statement that best reflects your opinion*)	Not a problem	Slight problem	Moderate problem	Big problem	Unable to comment
a. Litter on shoreline	1	2	3	4	5
b. Improper disposal of human waste	1	2	3	4	5
c. Loud music played from watercraft	1	2	3	4	5
d. Engine noise from boats	1	2	3	4	5
e. Poorly constructed docks	1	2	3	4	5
f. Changes in the Lake's water level	1	2	3	4	5
g. Debris at launch ramps	1	2	3	4	5
h. Inadequate public toilet facilities on the Lake	1	2	3	4	5
i. Erosion of the shoreline	1	2	3	4	5
j. Large wakes from boats	1	2	3	4	5
k. Inflatables/water toys trailing watercraft	1	2	3	4	5
l. Lack of public access to the Lake	1	2	3	4	5

Question 43, continued	Not a problem	Slight problem	Moderate problem	Big problem	Unable to comment
m. The speed of other boaters	1	2	3	4	5
n. Fish habitat	1	2	3	4	5
o. Polluted water in the Lake	1	2	3	4	5
p. Wildlife habitat	1	2	3	4	5
q. Poorly constructed bulkheads along shoreline	1	2	3	4	5

44. Have you ever taken a boater education/safety class before? ☐ Yes ☐ No

45. Do you feel that new marina development is acceptable on Lake Arlington?
☐ Yes ☐ No (**If "No" skip to** 46)

45a. If "Yes", what size marina is acceptable? (Check only one)

☐ Fewer than 20 slips

☐ 20 to 39 slips

☐ 40 to 59 slips

☐ 60 or more slips

46. Do you feel that Lake Arlington should be managed to support all recreational boating activities?
☐ Yes ☐ No **(If "Yes" skip to SECTION D)**

47. If no, which of the following activities do you feel are NOT suitable for Lake Arlington? (*Check all that apply*)

☐ Waterskiing
☐ Wakeboarding
☐ PWC (e.g., Jet Ski)
☐ Towing inflatables
☐ Sailing
☐ Canoeing/Kayaking
☐ Fishing
☐ High performance (speed) boats
☐ Other activities (please specify)___________

SECTION D. SHORELINE PROPERTY OWNERS

48. Do you have a home on Lake Arlington? ☐ Yes ☐ No **(If "No" skip to SECTION E)**

49. How long have your owned the residence on the Lake? _____ Number of years (if less than 1 year, enter 1)

50. Is your home on Lake Arlington your primary residence? ☐ Yes ☐ No **(If "Yes" skip to 52)**

51. If not, approximately how many days did you spend there during the past 12 months? _______ Number of days

52. Does your property have a bulkhead, dock or slip?
☐ Yes ☐ No **(If "No" skip to 56)**

53. Has your waterfront (e.g., bulkhead, dock or slip) been damaged?

☐ Yes ☐ No **(If "No" skip to 55)**

54. What was the cause of the damage?____

____

____

55. Do you display your house address on your dock or boat slip? ☐ Yes ☐ No

56. Are you aware of the "flowage easement" (five feet above full pool) around Lake Arlington? ☐ Yes ☐ No

SECTION E: HOUSEHOLD INFORMATION

The following information will help us to better understand the characteristics of boaters using Lake Arlington and make predictions about lake use in the future. Your answers are strictly confidential

57. What year were you born? ______________________

58. What is your gender? ☐ Male ☐ Female

59. Which of the following indicates your level of education? (*Check one*)

- ☐ 8th grade or less
- ☐ 9th to 11th grade
- ☐ 12th grade (high school graduate)
- ☐ 13-15 years (some college)
- ☐ 16 years (college graduate)
- ☐ 17+ years (some graduate work)
- ☐ Masters, Doctoral, or Professional Degree

60. Which of the following best describes your employment status? (*Check one*)

- ☐ Employed, full time
- ☐ Homemaker
- ☐ Employed, part time
- ☐ Retired, but working full time
- ☐ Retired, working part time
- ☐ Retired, not working
- ☐ Unemployed
- ☐ Student
- ☐ Other (Please specify) ____________________

61. Please tell us which of the following best indicates your race or ethnic group?

Ethnicity

- ☐ Hispanic
- ☐ White, not of Hispanic origin

Race

- ☐ Black or African-American
- ☐ Native American or Alaskan Native
- ☐ Asian or Pacific Islander
- ☐ Other (Please specify) __________________

62. Which of the following best describes your household income before taxes? (*Check one*)

- ☐ Less than $25,000
- ☐ $25,000 - $49,999
- ☐ $50,000 - $74,999
- ☐ $75,000 - $99,999
- ☐ $100,000 - $149,999
- ☐ $150,000 - $199,999
- ☐ $200,000 - $249,999
- ☐ $250,000 - $299,999
- ☐ $300,000 or more

63. Please use the space below to let us know if there is anything else you would like to tell us about your experience on Lake Arlington?

Thank you for completing this questionnaire. We appreciate you taking the time to share your thoughts. Please insert this questionnaire in the enclosed postage-paid envelope and return.

LAKE ARLINGTON BOATING STUDY

Code:__________

SECTION A: YOUR BOATING EXPERIENCE ON LAKE ARLINGTON (LA)

1. Have you ever boated on Lake Arlington before?
   ☐ Yes ☐No **(If "No", skip to Section C)**

   1a. If "Yes", how many years have you been an active boater on Lake Arlington? (If less than 1, enter 1)
   _______Number of Years

2. Are you currently an active boater on Lake Arlington? (*Have you used the Lake in the past 12 months*)
   ☐ Yes ☐No **(If "Yes", skip to question 4 below)**

3. **If you answered "No" on the previous question,** please tell us the year of your last boating experience on the Lake, **then skip to question 8.** Year: ________ (e.g., 2003)

4. About how many days did you spend on the Lake over the last 12 months? __________Number of days (0 - 365)

5. What type(s) of watercraft do you use on Lake Arlington? *(Check each type of boat you use)*
   - ☐ Ski boat
   - ☐ Fishing or bass boat
   - ☐ Pontoon boat
   - ☐ Kayak
   - ☐ Canoe
   - ☐ Wakeboard boat
   - ☐ High performance boat
   - ☐ Personal Watercraft (PWC, e.g., Jet Ski)
   - ☐ Sailboat
   - ☐ Other (Please specify) ________________

6. Which of these watercraft do you use **most often on the Lake**? (*Check only one*)
   - ☐ Ski boat
   - ☐ Fishing or bass boat
   - ☐ Pontoon boat
   - ☐ Kayak
   - ☐ Canoe
   - ☐ Wakeboard boat
   - ☐ High performance boat
   - ☐ Personal Watercraft (PWC; e.g., Jet Ski)
   - ☐ Sailboat
   - ☐ Other (Please specify) ______________________

7. What activity do you **most often** use your boat for on the Lake? (*Check only one*)
   - ☐ Skiing
   - ☐ Exercise
   - ☐ Wakeboarding
   - ☐ Towing inflatables/water toys
   - ☐ Fishing
   - ☐ Cruising up and down the Lake
   - ☐ Competition/racing
   - ☐ Other (Please specify) ______________________

8. Do you boat as often as you would like on Lake Arlington?
   ☐ Yes ☐No **(If "Yes" skip to Question 10)**

---

9. Please indicate to what extent the following statements reflect factors that inhibit your ability to boat as often as you would like?
   (C*ircle one number for each statement that best reflects your opinion*)

I don't boat as often as I would like because…

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
s.	I have no interest in boating	1	2	3	4	5
t.	I'm no longer physically able	1	2	3	4	5
u.	I can't afford to go boating	1	2	3	4	5
v.	… summer	1	2	3	4	5

Question 9, continued	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
w. It's too crowded	1	2	3	4	5
x. I have no way to access the Lake	1	2	3	4	5
y. The Lake is too small	1	2	3	4	5
z. The behavior of other boaters is unsafe	1	2	3	4	5
aa. Areas of the Lake are too shallow	1	2	3	4	5
bb. Poor water quality	1	2	3	4	5
cc. Other boaters are inconsiderate	1	2	3	4	5
dd. Public access is inconvenient	1	2	3	4	5
ee. I no longer have enough time	1	2	3	4	5
ff. Work commitments keep me away from boating on the Lake	1	2	3	4	5
gg. My family no longer has an interest in boating	1	2	3	4	5
hh. Shoreline owners/residents are inconsiderate	1	2	3	4	5
ii. At times, the water surface is too rough	1	2	3	4	5
jj. There's too much litter in the water	1	2	3	4	5

10. The following are some strategies people have used to avoid obstacles they may face in starting, continuing, or increasing their involvement in recreational boating. Please read each statement below and circle the number indicating the extent to which **each statement describes your response to start, continue, or increase your participation** in recreational boating on **LAKE ARLINGTON**.

In response to the obstacles I experienced, I: (*Circle one number for each statement that best reflects your opinion*)	Clearly does not describe my feelings	Somewhat does not describe my feelings	My feelings are neutral on this	Somewhat describes my feelings	Clearly describes my feelings
a. Decided I would boat at another area of Lake Arlington	1	2	3	4	5
b. Decided that if I boated on Lake Arlington in the future, I would boat at earlier and/or later times of the day	1	2	3	4	5
c. Told myself that there was nothing I could do about it, so I just enjoyed the experience for what it was	1	2	3	4	5
d. Talked to someone who could do something concrete about the problem	1	2	3	4	5
e. Decided that if I boated on Lake Arlington in the future, I would boat on the weekdays rather than weekends	1	2	3	4	5
f. Avoided certain locations (e.g., dam, or shallows)	1	2	3	4	5
g. Told myself it was unreasonable to expect that things should have been different at this location	1	2	3	4	5
h. Planned not to return to Lake Arlington	1	2	3	4	5
i. Boated on nearby lakes	1	2	3	4	5
j. Tried to view this condition or situation in a positive way	1	2	3	4	5
k. Decided that the problem was a one-time occurrence	1	2	3	4	5
l. Boated less often	1	2	3	4	5

11. How far by road do you travel to Lake Arlington? (*Write 0 if your home or boat is on the shoreline*)

_______ One way distance in miles

12. Please indicate how you feel about the Lake by responding to each of the statements below. (*Circle one number for each statement that best reflects your opinion*)		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
a.	Lake Arlington is the best lake for the activities that I enjoy most	1	2	3	4	5
b.	I have a strong emotional bond to the Lake	1	2	3	4	5
c.	I can't imagine a better lake for what I like to do	1	2	3	4	5
d.	I feel the Lake is a part of me	1	2	3	4	5
e.	I feel a strong sense of belonging to the Lake	1	2	3	4	5
f.	The Lake is one of the few places where I can be myself	1	2	3	4	5
g.	I really enjoy the Lake	1	2	3	4	5
h.	The Lake means a lot to me	1	2	3	4	5
i.	The time spent boating on the Lake allows me to bond with my family and friends	1	2	3	4	5
j.	I associate special people in my life with the Lake	1	2	3	4	5

SECTION B: Your use of the Lake

The following questions address your boating experiences on Lake Arlington

13. How many people are usually in your boating group? __________ Number of people

14. Which of the following best describes your boating group? (*Check one*)

- ☐ By yourself
- ☐ Family
- ☐ Multiple families
- ☐ Family and friends
- ☐ Friends
- ☐ Organized outing group
- ☐ Business associates
- ☐ Other (*Describe*)___________________________

15. What did you like **best** about your visits to Lake Arlington?

____

____

16. What did you like **least** about your visits to Lake Arlington?

____

____

17. How do you feel about the **number of people you encountered** on your visits to the Lake? (*Check only one*)

- ☐ Would like to have seen a lot more people
- ☐ Would like to have seen a few more people
- ☐ Neither too many nor too few people
- ☐ Would like to have seen a few less people
- ☐ Would like to have seen a lot less people

18. How did the **number of people you saw on the Lake compare** with what you expected to see on your visits to Lake Arlington? (*Check only one*)

- ☐ A lot less than I expected
- ☐ A little less than I expected
- ☐ About what I expected
- ☐ A little more than I expected
- ☐ A lot more than I expected
- ☐ I didn't really have any expectations
- ☐ Other: _________________________

19. How did the **number of people you saw affect your overall enjoyment** of your visits to Lake Arlington? (*Check only one*)

- ☐ Added a lot to my enjoyment
- ☐ Added a little to my enjoyment
- ☐ No effect on my enjoyment
- ☐ Detracted a little from my enjoyment
- ☐ Detracted a lot from my enjoyment

20. In light of the **number of boats** you saw on the Lake this season, please rate how safe you felt while boating: (*Circle only one number below*)

1	2	3	4	5
Not at all safe		Moderately safe		Extremely safe

21. In light of the **behavior of other boaters** on the Lake this season, please rate how safe you felt while boating: (*Circle only one number below*)

1	2	3	4	5
Not at all safe		Moderately safe		Extremely safe

We would like to know about areas of Lake Arlington. Please select the zones from the map below that BEST estimate your boating activity.

22. Where was your normal starting location? (S*elect only one*)
    Zone #_____

23. Indicate the area(s) where you spent most time.
    Zone(s) #__________________

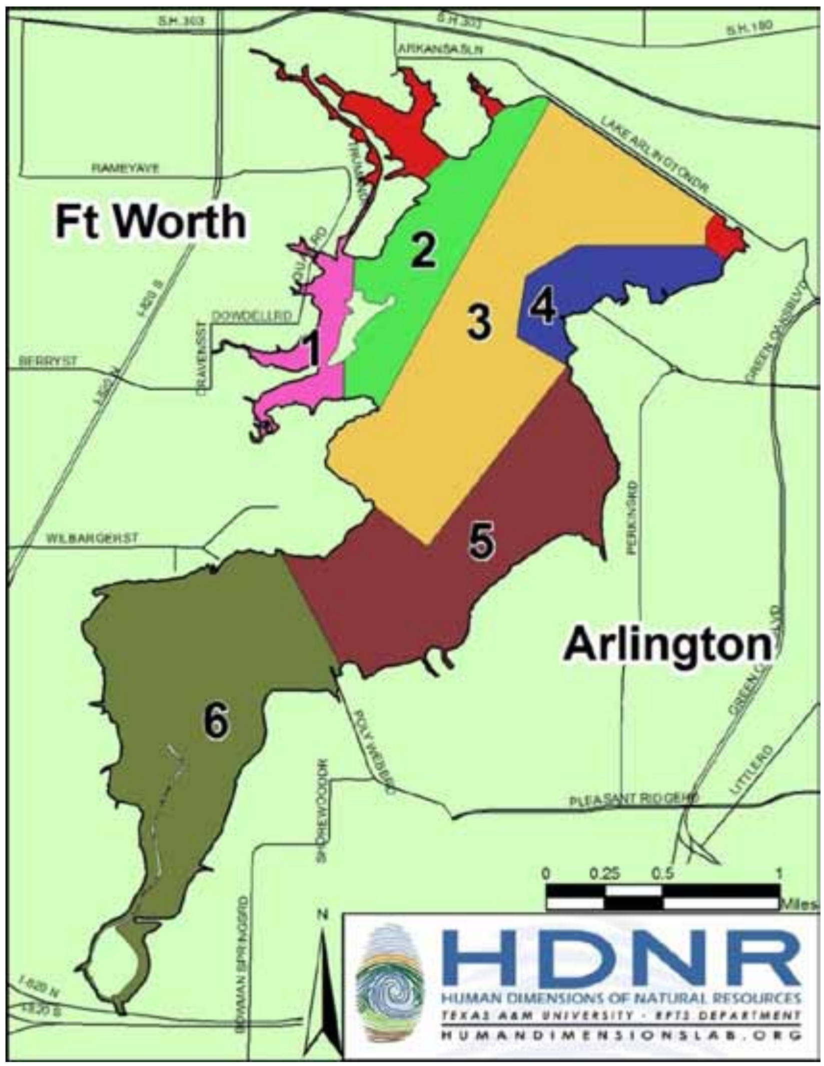
24. Are there any locations on Lake Arlington you deliberately avoided?
    ☐ Yes ☐ No **(If "No" skip to 27)**

25. Identify the area(s) you avoided.
    Zone(s) #__________________

26. Why did you avoid those locations?
____
____
____
____
____

27. Are there any places on Lake Arlington where you have felt unsafe?
    ☐ Yes ☐ No **(If "No" skip to 30)**

28. Identify the area(s) where you felt unsafe.
    Zone(s) #__________________



29. Why did you feel unsafe in those places? ____

____

30. Would you like to see some activities restricted to certain areas of the Lake? ☐ Yes ☐ No **(If "No" skip to 32)**

31. Select an activity and corresponding zone (from the map on the preceding page) where you would like to see the activity restricted (reduced or removed from that zone). (multiple answers accepted)	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Personal watercraft (e.g., Jet Ski)	☐	☐	☐	☐	☐	☐
High performance boating	☐	☐	☐	☐	☐	☐
Skiing/Wakeboarding	☐	☐	☐	☐	☐	☐
Canoeing/Kayaking	☐	☐	☐	☐	☐	☐
Sailing	☐	☐	☐	☐	☐	☐
Other ___________________	☐	☐	☐	☐	☐	☐

32. Using the following scale, how would you describe the boating conditions **out on the water** during your visits to Lake Arlington? (Circle only one number below)

0	1	2	3	4	5	6	7	8
Not at all crowded				Moderately crowded				Extremely crowded

33. Using the following scale, how would you describe the boating conditions **at access points** (e.g., boat ramp) during your visits to Lake Arlington? (Circle only one number below)

0	1	2	3	4	5	6	7	8
Not at all crowded				Moderately crowded				Extremely crowded

34. Given the conditions you observed on Lake Arlington, how do you feel about each of the following potential management actions? (*Circle one number for each statement that best reflects your opinion*)	Strongly Oppose	Oppose	Neutral	Support	Strongly Support
q. Provide more improved public access to the Lake	1	2	3	4	5
r. Zone the water surface to provide specific uses at specific places	1	2	3	4	5
s. Provide more aggressive enforcement of safety rules and regulations	1	2	3	4	5
t. Expand the number of marina slips	1	2	3	4	5
u. Cite boaters whose music can be heard more than 100 feet from their boat	1	2	3	4	5
v. Restrict personal watercraft use to designated areas only	1	2	3	4	5
w. Establish "off limits" zones to protect sensitive resources	1	2	3	4	5
x. Allow marina development along the shoreline	1	2	3	4	5
y. Require training for the operation of personal watercraft	1	2	3	4	5

	Strongly Oppose	Oppose	Neutral	Support	Strongly Support
z. Require development standards for shoreline retaining walls	1	2	3	4	5

Question 34, continued	Strongly Oppose	Oppose	Neutral	Support	Strongly Support
aa. Require training for all watercraft operators	1	2	3	4	5
bb. Ban personal watercraft on public holidays	1	2	3	4	5
cc. Restrict activities by day of week during peak use periods (e.g., holidays)	1	2	3	4	5
dd. Install more public boat ramps	1	2	3	4	5
ee. Develop the fish stock to improve fishing on the Lake	1	2	3	4	5
ff. Dredge the Lake to improve depth	1	2	3	4	5

SECTION C: LAKE MANAGEMENT

The following questions address your boating experience on Lake Arlington

35. Do you feel that more controls are needed on Lake Arlington to **prevent conflicts from occurring between lake users**?
    ☐ Yes ☐ No **(If "No" skip to 37)**

36. If "Yes", what conflicts and how should they be managed? ______________________________
____
____

37. Do you feel that more controls are needed on the Lake to prevent damage to the environment by boaters?
    ☐ Yes ☐ No **(If "No" skip to 39)**

38. If "Yes", what kinds of environmental damages did you see and how should they be controlled?__________
____
____

39. Are there certain facilities or services that should be offered on Lake Arlington that currently are not available?
    ☐ Yes ☐ No **(If "No" skip to 41)**

40. If "Yes", what kinds of facilities or services? ______________________________
____
____

41. Would you support a 20% increase (to $30 annually & $6 daily) in the permit fee if it were used to assist with upkeep of the Lake?
    ☐ Yes ☐ No **(If "No" skip to 43)**

42. If "Yes", which of the following would you prefer to see the money spent on? (check all that apply)
    - ☐ Picking up litter
    - ☐ Upgrade park amenities
    - ☐ Code enforcement
    - ☐ Other (please specify) ____________________

43. Have you noticed important (positive or negative) changes at the Lake in the last five years?
    ☐ Yes ☐ No **(If "No" skip to 45)**

44. If "Yes", would you please describe those changes? ____

____

____

45. Have you ever taken a boater education/safety class before? ☐ Yes ☐ No

46. Do you feel that new marina development is acceptable on Lake Arlington?
☐ Yes ☐ No **(If "No" skip to 47)**

46a. If "Yes", what size marina is acceptable? (Check only one)

☐ Fewer than 20 slips

☐ 20 to 39 slips

☐ 40 to 59 slips

☐ 60 or more slips

47. Do you feel that Lake Arlington should be managed to support <u>all</u> recreational boating activities?
☐ Yes ☐ No **(If "Yes" skip to SECTION D)**

48. If no, which of the following activities do you feel are NOT suitable for Lake Arlington? (*Check all that apply*)

☐ Waterskiing
☐ Wakeboarding
☐ PWC (e.g., Jet Ski)
☐ Towing inflatables
☐ Sailing
☐ Canoeing/Kayaking
☐ Fishing
☐ High performance (speed) boats
☐ Other activities (please specify)___________

SECTION D. SHORELINE PROPERTY OWNERS

49. Do you have a home on Lake Arlington? ☐ Yes ☐ No **(If "No" skip to SECTION E)**

50. How long have your owned the residence on the Lake? _____ Number of years (if less than 1 year, enter 1)

51. Is your home on Lake Arlington your primary residence? ☐ Yes ☐ No **(If "Yes" skip to 53)**

52. If not, approximately how many days did you spend there during the past 12 months? ______ Number of days

53. Does your property have a bulkhead, dock or slip?
☐ Yes ☐ No **(If "No" skip to 57)**

54. Has your waterfront (e.g., bulkhead, dock or slip) been damaged?
☐ Yes ☐ No **(If "No" skip to 56)**

55. What was the cause of the damage?____

____

____

56. Do you display your house address on your dock or boat slip? ☐ Yes ☐ No

57. Are you aware of the "flowage easement" (five feet above full pool) around Lake Arlington? ☐ Yes ☐ No

SECTION E: HOUSEHOLD INFORMATION

The following information will help us to better understand the characteristics of boaters using Lake Arlington and make predictions about Lake use in the future. Your answers are strictly confidential

58. What year were you born? ______________________

59. What is your gender? ☐ Male ☐ Female

60. Which of the following indicates your level of education? (*Check one*)
- ☐ 8th grade or less
- ☐ 9th to 11th grade
- ☐ 12th grade (high school graduate)
- ☐ 13-15 years (some college)
- ☐ 16 years (college graduate)
- ☐ 17+ years (some graduate work)
- ☐ Masters, Doctoral, or Professional Degree

61. Which of the following best describes your employment status? (*Check one*)
- ☐ Employed, full time
- ☐ Homemaker
- ☐ Employed, part time
- ☐ Retired, but working full time
- ☐ Retired, working part time
- ☐ Retired, not working
- ☐ Unemployed
- ☐ Student
- ☐ Other (Please specify) ____________________

62. Please tell us which of the following best indicates your race or ethnic group?

Ethnicity
- ☐ Hispanic
- ☐ White, not of Hispanic origin

Race
- ☐ Black or African-American
- ☐ Native American or Alaskan Native
- ☐ Asian or Pacific Islander
- ☐ Other (Please specify) __________________

63. Which of the following best describes your household income before taxes? (*Check one*)
- ☐ Less than $25,000
- ☐ $25,000 - $49,999
- ☐ $50,000 - $74,999
- ☐ $75,000 - $99,999
- ☐ $100,000 - $149,999
- ☐ $150,000 - $199,999
- ☐ $200,000 - $249,999
- ☐ $250,000 - $299,999
- ☐ $300,000 or more

64. Please use the space below to let us know if there is anything else you would like to tell us about your experience on Lake Arlington?

Thank you for completing this questionnaire. We appreciate you taking the time to share your thoughts. Please insert this questionnaire in the enclosed postage-paid envelope and return.

Appendix B – Contact Letter

Texas A&M Letterhead

Date

Name/Address

Dear John/Jane Doe:

The City of Arlington has partnered with researchers at Texas A&M University to study recreational boating use and users on Lake Arlington. You have been carefully selected to participate in the study as part of a random sample that represents potential users/visitors to the area lakes. Findings from the investigation will, in part, guide the development of the City's master plan for the lake.

Provided below is web link to access an online survey. If you would prefer a hard copy to complete, please detach and return the postage-paid postcard and we'll return a survey packet to you in the mail. Your prompt attention to the survey is appreciated. Your participation in this study is voluntary, but very important. The survey explores a range of issues relating to your perceptions of current recreational use occurring on the lake, lake conditions, and preferences for lake management. Rest assured, your answers will remain anonymous and completely confidential. Only aggregated results will be reported to the City. Once the study is complete, <u>all</u> names and addresses will be destroyed. We WILL NOT sell or distribute your name and address to any other party. The questionnaire should take approximately 20 minutes to complete.

If you have any questions or concerns about completing the questionnaire or about being in this study, you may contact me at 979-862-3794. The Institutional Review Board (IRB) at Texas A&M University, which provides oversight for the protection of subjects' personal/privacy rights, has approved this study. If you have any concerns about your rights as a participant in this study, you may contact the Human Subjects Protection Program Office via email (irb@tamu.edu) or by telephone at 979-458-4067.

To access the weblink, please type the following address in your browser:
http://www.sitetobedetermined.com

We appreciate and value your time and opinion.

Sincerely,

Gerard Kyle
Associate Professor

Appendix C – Reminder

Dear Sir/Madam:

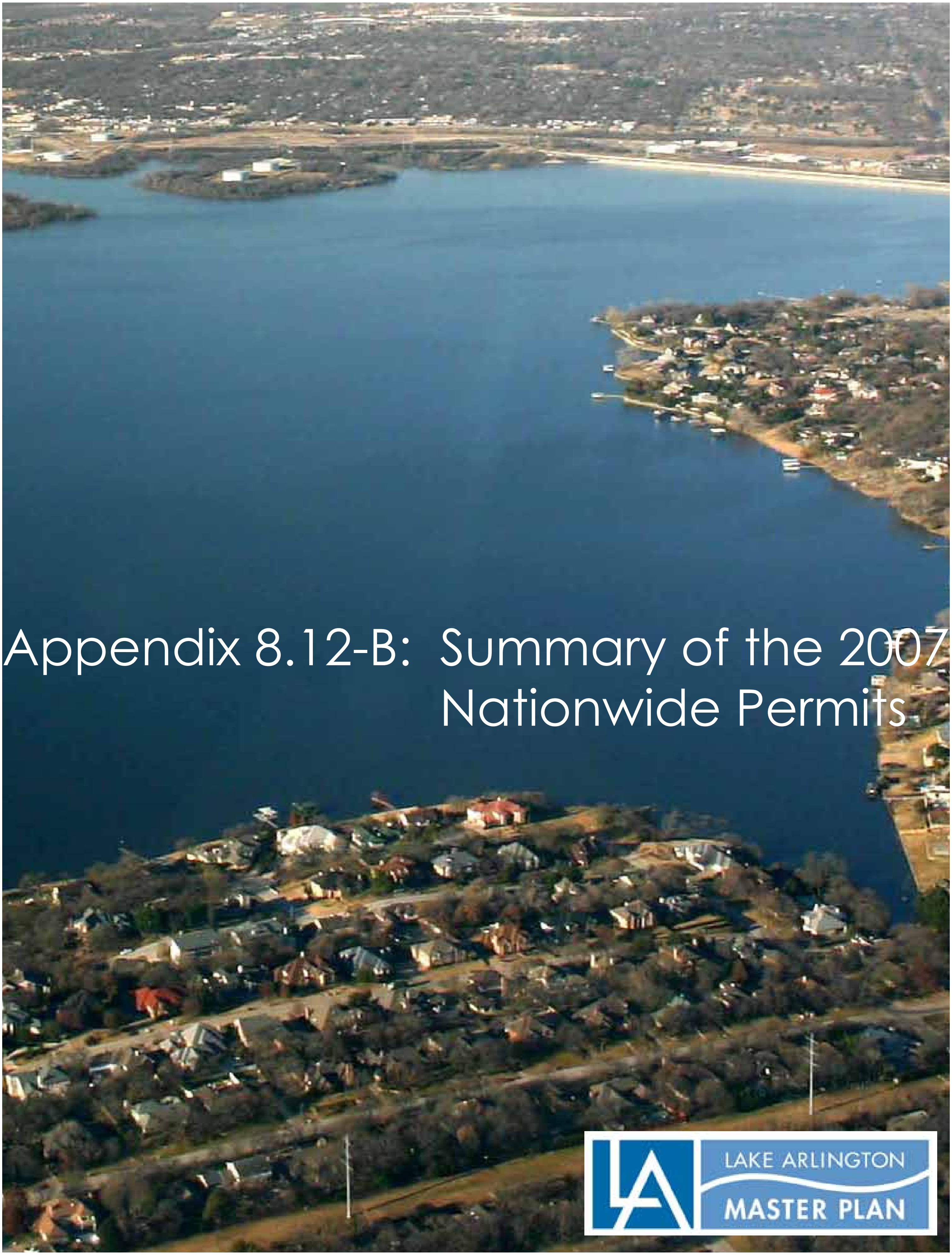
Recently, you were mailed a questionnaire about your preferences and boating use on Lake Arlington. If you have already completed the questionnaire online or requested a hard copy, we thank you and express our sincere appreciation.

If you haven't already completed the survey, please do so at your earliest convenience. We understand that you are busy and may not have gotten around to completing the questionnaire. We are looking to forward to your feedback. If you have any questions about the survey, please call my office at: (979) 862-3794.

Thank You!

Gerard Kyle, Ph.D
Texas A&M University

Appendix 8.12-B: Summary of the 2007 Nationwide Permits



Summary of the 2007 Nationwide Permits[1]

Nationwide Permit	Statutory Authority	Limits	Pre-Construction Notification (PCN) Threshold	Delineation Required?	Applicable Waters	Changes in 2007	Other Information
NWP 1 – Aids to Navigation	10	none	PCN not required	no	navigable waters of the U.S.	none	
NWP 2 – Structures in Artificial Canals	10	none	PCN not required	no	navigable waters of the U.S.	none	
NWP 3 – Maintenance	10/404					removed provision for the restoration of uplands to new NWP 45	
(a) Repair, rehabilitation, or replacement of previously authorized, currently serviceable structures or fills		authorizes only minor deviations for maintenance	PCN not required	no	all waters of the U.S.	none	does not authorize maintenance dredging for the primary purpose of navigation or beach restoration; does not authorize new stream channelization or stream relocation projects
(b) Discharges associated with removal of accumulated sediments and debris in the vicinity of existing structures, including intake and outfall structures and associated canals		200 feet from structure; minimum necessary to restore capacity intake or outfall or associated canal	all activities	yes	all waters of the U.S.	added maintenance dredging/ excavation provision for intakes, outfalls, and canals from NWP 7; 200 linear foot limit doesn't apply to removal of sediments from intake or outfall structures or canals	also authorizes placement of rip rap to protect the structure
(c) Temporary structures, fills, and work necessary to conduct maintenance activity			PCN not required	no	all waters of the U.S.	added temporary structures, fills, and work associated with the maintenance activity	temporary fills must be removed in their entirety and the affected areas returned to pre-construction elevations
NWP 4 – Fish and Wildlife Harvesting, Enhancement, and Attraction Devices and Activities	10/404	none	PCN not required	no	all waters of the U.S.	moved provision for shellfish seeding to NWP 27	does not authorize impoundments or artificial reefs; does not authorize covered oyster trays or clam racks
NWP 5 – Scientific Measurement Devices	10/404	25 cubic yards for weirs and flumes	PCN not required	no	all waters of the U.S.	removed PCN requirement	
NWP 6 – Survey Activities	10/404	25 cubic yards for temporary pads	PCN not required	no	all waters of the U.S.	added exploratory trenching and temporary pads	does not authorize fills for roads; does not authorize permanent structures
NWP 7 – Outfall Structures and Associated Intake Structures	10/404	none	all activities	yes	all waters of the U.S.	changed title; also authorizes modification of these structures; moved maintenance dredging/ excavation activities to NWP 3	activity must comply with National Pollutant Discharge Elimination System Program

[1] This table is intended to provide **general** information on the nationwide permits published in the March 12, 2007, *Federal Register* (72 FR 11092). Prospective users of the nationwide permits should read the text of the nationwide permits, general conditions, and definitions to assess whether a particular nationwide permit could authorize a specific project. Prospective users should also review the pre-construction notification requirements of the nationwide permits and contact the appropriate Corps district to determine if any regional conditions have been imposed on the nationwide permits.

Nationwide Permit	Statutory Authority	Limits	Pre-Construction Notification (PCN) Threshold	Delineation Required?	Applicable Waters	Changes in 2007	Other Information
NWP 8 – Oil and Gas Structures on the Outer Continental Shelf	10	none	all activities	no	navigable waters of the U.S.	changed title; clarified that PCN is required for all activities	limited to facilities in areas leased by the Minerals Management Service of the Department of the Interior
NWP 9 – Structures in Fleeting and Anchorage Areas	10	none	PCN not required	no	navigable waters of the U.S.	none	applies to structures, buoys, and other devices placed in anchorage or fleeting areas established by the U.S. Coast Guard
NWP 10 – Mooring Buoys	10	none	PCN not required	no	navigable waters of the U.S.	none	
NWP 11 – Temporary Recreational Structures	10	none	PCN not required	no	navigable waters of the U.S.	none	structures must be removed within 30 days after use discontinued
NWP 12 – Utility Line Activities	10/404	1/2 acre	• a section 10 permit is required • mechanized land clearing in forested wetlands for the right-of-way • discharges that result in the loss of >1/10 acre	yes, if PCN required	see text of NWP	apply the PCN requirement for discharges that result in loss of >1/10 acre to all utility line activities, not just substations; added temporary structures, fills, and work associated with the utility line activity	temporary fills must be removed in their entirety and the affected areas returned to pre-construction elevations
utility lines			• utility line exceeds 500 linear feet in waters of the U.S. • utility line runs parallel to a stream bed within jurisdictional area		all waters of the U.S.		must restore area to pre-construction contours
utility line substations					non-tidal waters of the U.S., except non-tidal wetlands adjacent to tidal waters		
foundations for overhead utility line towers, poles, and anchors					all waters of the U.S.		separate footings for each tower leg should be used where feasible
access roads			• above-grade permanent access roads exceeding 500 feet; • permanent access roads constructed with impervious materials		non-tidal waters of the U.S., except non-tidal wetlands adjacent to tidal waters		access roads must be constructed to minimize adverse effects to waters of the U.S.

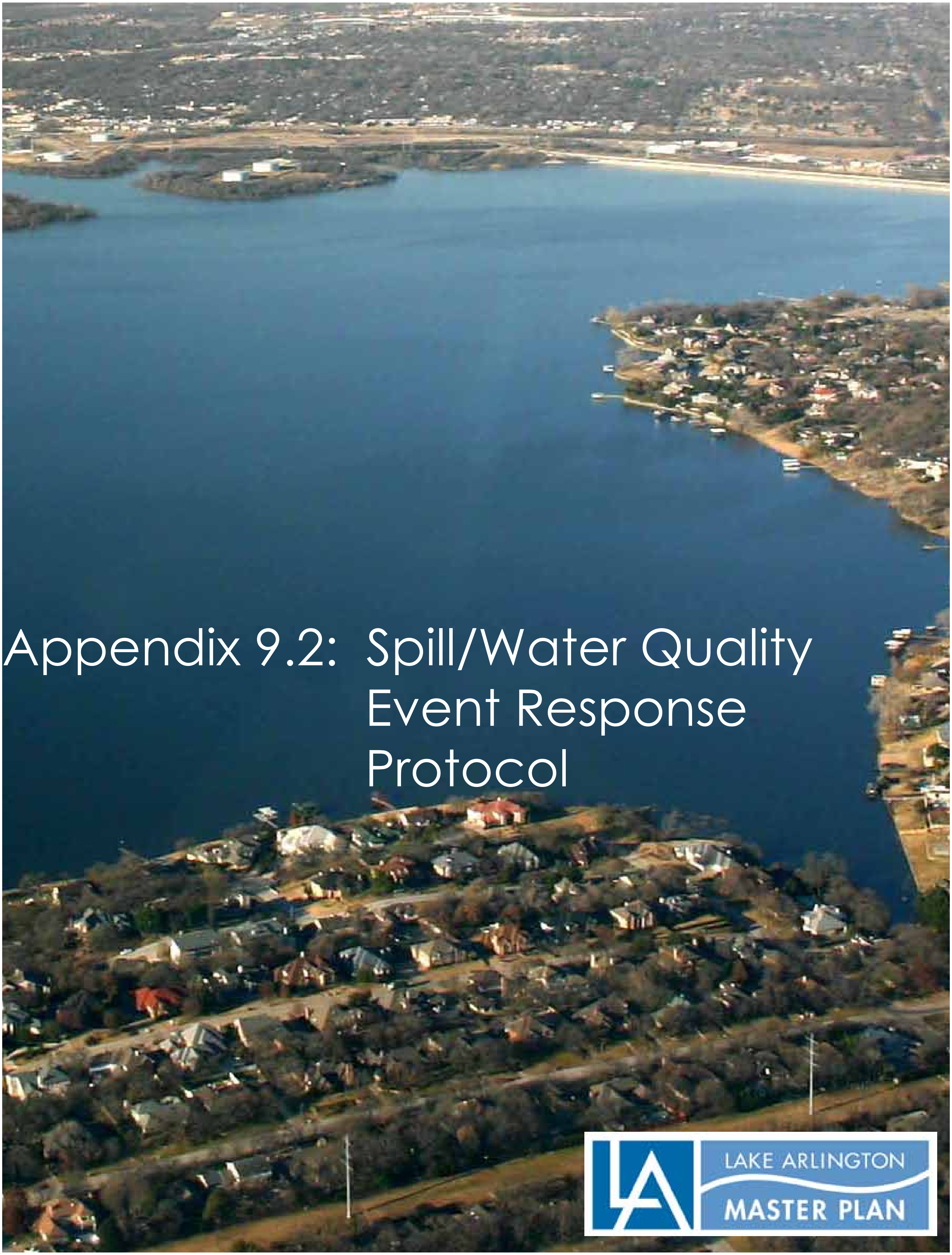
Nationwide Permit	Statutory Authority	Limits	Pre-Construction Notification (PCN) Threshold	Delineation Required?	Applicable Waters	Changes in 2007	Other Information
NWP 13 – Bank Stabilization	10/404	• 500 feet along the bank (unless waived by DE) • 1 cubic yard per running foot (unless waived by DE)	• >500 linear feet in length • >1 cubic yard per running foot along bank below OHWM or HTL • discharges into special aquatic sites	yes, if PCN required	all waters of the U.S.	authorizes discharges into special aquatic sites, provided district engineer issues written waiver	activity cannot impair surface water flow into or out of waters of the U.S.
NWP 14 – Linear Transportation Projects	10/404	• 1/2 acre in non-tidal waters • 1/3 acre in tidal waters	• >1/10 acre • discharges into special aquatic sites	yes, if PCN required	all waters of the U.S.	removed requirement for compensatory mitigation proposal with PCN; stream channel modifications must be minimum necessary to construct or protect the linear transportation project; authorizes temporary structures, fills, and work necessary to construct the linear transportation project	temporary fills must be removed in their entirety and the affected areas returned to pre-construction elevations; does not authorize storage buildings, parking, lots, train stations, aircraft hangars, or other non-linear transportation features
NWP 15 – U.S. Coast Guard Approved Bridges	404	none	PCN not required	no	navigable waters of the U.S.	none	causeways and approach fills for bridges are not authorized by this NWP; those activities require separate section 404 authorization
NWP 16 – Return Water From Upland Contained Disposal Areas	404	none	PCN not required	no	all waters of the U.S.	none	water quality issues addressed through section 401 certification process
NWP 17 – Hydropower Projects	404	none	all activities	yes	all waters of the U.S., except section 10 waters	reworded text, but terms and limits remain unchanged	applies to activities licensed by the Federal Energy Regulatory Commission or activities exempt from licensing requirements
NWP 18 – Minor Discharges	10/404	• 25 cubic yards discharged below plane of OHWM/HTL • 1/10 acre of waters of the U.S.	• >10 cubic yards discharged below plane of OHWM/HTL • discharges into special aquatic sites	yes, if PCN required	all waters of the U.S.	expanded the 1/10 acre limit to include all waters of the U.S., not just special aquatic sites; does not authorize discharges for stream diversions	does not authorize discharges for stream diversions
NWP 19 – Minor Dredging	10/404	25 cubic yards below plane of OHWM/ MHWM	PCN not required	no	navigable waters of the U.S.	none	does not authorize dredging or degradation through siltation of coral reefs, submerged aquatic vegetation beds, anadromous fish spawning areas, or wetlands
NWP 20 – Oil Spill Cleanup	10/404	none	PCN not required	no	all waters of the U.S.	authorize clean-up of polychlorinated biphenyls under 40 CFR Part 761	authorizes activities subject to the National Oil and Hazardous Substances Pollution Contingency Plan and any existing state contingency plan
NWP 21 – Surface Coal Mining Operations	10/404	none	all activities	yes	all waters of the U.S.	changed title; include activities processed under integrated permit processing procedures	prospective permittee must receive written authorization prior to commencing the activity

Nationwide Permit	Statutory Authority	Limits	Pre-Construction Notification (PCN) Threshold	Delineation Required?	Applicable Waters	Changes in 2007	Other Information
NWP 22 – Removal of Vessels	10/404	none	• if vessel listed or eligible for National Register of Historic Places • activities in special aquatic sites	yes, if PCN required	all waters of the U.S.	restructured text; added PCN requirement for activities in special aquatic sites	does not authorize maintenance dredging, shoal removal, or river bank snagging; disposal of removed vessel in waters of the U.S. may require separate authorizations from EPA and Corps
NWP 23 – Approved Categorical Exclusions	10/404	none	PCN not required, except for certain activities stated in RGL	yes, if PCN required	all waters of the U.S.	clarified that some activities may require PCN; provided COE web site with RGLs for NWP 23; added reference to RGL 05-07, which provides the current categorical exclusions	categorical exclusions must be approved by the Office of the Chief of Engineers
NWP 24 – Indian Tribe or State Administered Section 404 Program	10	none	PCN not required	no	navigable waters of the U.S.	added Indian Tribe Section 404 programs as eligible; listed states that have assumed section 404 permitting authority	does not authorize activities in navigable waters that require only a section 10 permit
NWP 25 – Structural Discharges	404	none	PCN not required	no	waters of the U.S.	none	structure may require section 10 permit if located in navigable waters of the U.S.; does not authorize structures that support buildings or similar structures
NWP 27 – Aquatic Habitat Restoration, Establishment, and Enhancement Activities	10/404	none	all activities, except for those that require reporting (e.g., activities under a binding agreement between the landowner and an agency)	yes, if PCN required	all waters of the U.S.	added shellfish seeding; requires reporting for Federal agency agreements; added state cooperating agencies; revised terminology; revised to include wetland actions documented by NRCS or USDA Technical Service Provider pursuant to NRCS Field Office Technical Guide standards; removed restriction limiting use by mitigation bank to those approved under mitigation banking guidelines; no conversion of natural wetlands or streams (except for relocation)	does not authorize stream channelization, relocation or conversion of tidal waters, or conversion of natural wetlands or streams (except for relocation activities); notification required for reversion activities
NWP 28 – Modifications of Existing Marinas	10	activities limited to authorized marina area	PCN not required	no	navigable waters of the U.S.	none	does not authorize dredging, additional slips, dock spaces, or expansion in waters of the U.S.
NWP 29 – Residential Developments	10/404	• 1/2 acre • 300 linear feet of stream bed, but DE can waive for intermittent and ephemeral	all activities	yes	non-tidal waters of the U.S., except non-tidal wetlands adjacent to tidal waters	moved provisions (including subdivision provision) for residential developments from NWP 39 to NWP 29; added ephemeral streams to 300 linear foot limit; removed restrictions on who could use NWP	

Nationwide Permit	Statutory Authority	Limits	Pre-Construction Notification (PCN) Threshold	Delineation Required?	Applicable Waters	Changes in 2007	Other Information
NWP 30 – Moist Soil Management for Wildlife	404	none	PCN not required	no	non-tidal waters of the U.S.	removed term limiting use to government-owned or managed property; clarified that it is limited to non-tidal waters	authorizes only on-going activities; does not authorize construction of new dikes, roads, water control structures, etc.; does not authorize conversion of wetlands to uplands; does not authorize impoundments
NWP 31 – Maintenance of Existing Flood Control Facilities	10/404	maintenance baseline approved by district engineer	all activities	yes	all waters of the U.S.	added levees to list of examples of flood control facilities	PCN must indicate location of dredged material disposal sites and baseline information
NWP 32 – Completed Enforcement Actions	10/404	• 5 acres of non-tidal waters • 1 acre of tidal waters • also see text of NWP	PCN not required	no	all waters of the U.S.	changed acreage limit applicability from "wetlands" to "waters"	
NWP 33 – Temporary Construction, Access, and Dewatering	10/404	none	all activities	yes	all waters of the U.S.		associated primary activity must be authorized by Corps or U.S. Coast Guard, or be exempt from permit requirements; PCN must include restoration plan
NWP 34 – Cranberry Production Activities	404	10 acres, but activity cannot result in net loss of wetland acreage	all activities	yes	section 404 waters only	clarify that PCN is required only once during time NWP is valid	does not authorize discharges in waters of the U.S. for attendant features, such as warehouses, processing facilities, or parking areas
NWP 35 – Maintenance Dredging of Existing Basins	10	dredging to previously authorized depths or controlling depths, whichever are less	PCN not required	no	navigable waters of the U.S.		dredged material must be deposited at upland site
NWP 36 – Boat Ramps	10/404	• 50 cubic yards, unless waived by DE • 20 foot width, unless waived by DE	• >50 cubic yards • >20 feet wide	yes, if PCN required	all waters of the U.S., except special aquatic sites	district engineer can waive 50 cubic yard limit and/or 20 foot width limit	section 10 permit required if dredging navigable waters is necessary for access to boat ramp
NWP 37 – Emergency Watershed Protection and Rehabilitation	10/404	none	all activities	yes	all waters of the U.S.	added abandoned mine land reclamation activities with no coal extraction; added Emergency Conservation Program activities administered by Farm Service Agency	in general, permittee should wait until district engineer issues verification, but may proceed immediately if there is an unacceptable hazard to life or significant loss of property or economic hardship will occur
NWP 38 – Cleanup of Hazardous and Toxic Waste	10/404	none	all activities	yes	all waters of the U.S.		does not authorize the establishment of new disposal sites or the expansion of existing disposal sites

Nationwide Permit	Statutory Authority	Limits	Pre-Construction Notification (PCN) Threshold	Delineation Required?	Applicable Waters	Changes in 2007	Other Information
NWP 39 – Commercial and Institutional Developments	10/404	• 1/2 acre • 300 linear feet of stream bed but DE can waive for intermittent and ephemeral	all activities	yes	non-tidal waters of the U.S., except non-tidal wetlands adjacent to tidal waters	add ephemeral streams to 300 linear foot limit; PCN for all activities; move residential developments to NWP 29; remove subdivision provision	does not authorize construction of new golf courses, new ski areas, or oil and gas wells
NWP 40 – Agricultural Activities	404	• 1/2 acre • 300 linear feet of stream bed for ditch relocation, but DE can waive for intermittent and ephemeral	all activities	yes	non-tidal waters of the U.S., except non-tidal wetlands adjacent to tidal waters	add ephemeral streams to 300 linear foot limit; PCN for all activities; add farm ponds (but no fills in perennial streams or aquaculture ponds); remove restrictions on who could use NWP; remove provisions relating to USDA participants	NWP can be used for agricultural activities, regardless of whether applicant is USDA participant; does not authorize aquaculture ponds
NWP 41 – Reshaping Existing Drainage Ditches	404	none	reshape greater than 500 linear feet of drainage ditch	yes, if PCN required	non-tidal waters of the U.S., except non-tidal wetlands adjacent to tidal waters	removed prohibition for permanent sidecasting; as-built capacity of ditch is to be used as baseline	reshaping drainage ditch cannot increase capacity of ditch or drain additional waters of the U.S.; does not authorize relocation of drainage ditches constructed in waters of the U.S.
NWP 42 – Recreational Facilities	404	• 1/2 acre • 300 linear feet of stream bed but DE can waive for intermittent and ephemeral	all activities	yes	non-tidal waters of the U.S., except non-tidal wetlands adjacent to tidal waters	add ephemeral streams to 300 linear foot limit; PCN for all activities; remove requirement to integrate into landscape and not substantially change pre-construction grades or contours; expanded list of examples of authorized activities	authorizes variety of recreational facilities, except for hotels, restaurants, racetracks, stadiums, arenas, or similar facilities (these may be authorized by NWP 39)
NWP 43 – Stormwater Management Facilities	404	• 1/2 acre • 300 linear feet of stream bed but DE can waive for intermittent and ephemeral	all activities involving expansion or construction of SWM facilities	yes, if PCN required	non-tidal waters of the U.S., except non-tidal wetlands adjacent to tidal waters	added ephemeral streams to 300 linear foot limit; PCN required for expansion of existing SWM facilities and construction of new SWM facilities; removed 1/10 acre PCN threshold for maintenance	does not authorize construction of new SWM facilities in perennial streams; maintenance does not require PCN if limited to restoring original design capacities
NWP 44 – Mining Activities	10/404	1/2 acre	all activities	yes	non-tidal waters of the U.S., except non-tidal wetlands adjacent to tidal waters	NWP can be used for any mining activity, except coal mining	PCN must include reclamation plan if reclamation is required by other statutes
NWP 45 – Repair of Uplands Damaged by Discrete Events	10/404	Restore uplands to pre-event ordinary high water mark	all activities	yes	all waters of the U.S.	New NWP from 2002 NWP 3(iii); removed 50 cubic yard limit; authorizes bank stabilization to protect restored uplands; clarified that upland can be restored without permit to OHWM or high tide line	PCN must be submitted to district engineer within one year of date of damage; work must start or be under contract within two years of date of damage

Nationwide Permit	Statutory Authority	Limits	Pre-Construction Notification (PCN) Threshold	Delineation Required?	Applicable Waters	Changes in 2007	Other Information
NWP 46 – Discharges in Ditches	404	1 acre	all activities	yes	certain types of non-tidal ditches constructed in uplands, and determined to be waters of the U.S.	new NWP	NWP does not authorize discharges into ditches constructed in streams or other waters of the U.S., or in streams that have been relocated in uplands.
NWP 47 – Pipeline Safety Program Designated Time-Sensitive Inspections and Repairs	10/404	none	none	no	all waters of the U.S.	new NWP	permittee must participate in Pipeline Repair and Environmental Guidance System
NWP 48 – Existing Commercial Shellfish Aquaculture Activities	10/404	existing project area	• project area > 100 acres • reconfiguration of the activity • change in species • change in culture methods • dredge harvesting, tilling, or harrowing in SAV	yes, if PCN required	navigable waters of the U.S.	new NWP	molluscan species only; project area usually defined as area for which state or local agency has issued a lease or permit for aquaculture activities; for those activities that do not require a PCN, permittees must submit report (report required only once during 5-year period)
NWP 49 – Coal Remining Activities	10/404	limited to sites that were previously mined for coal, but new mining may be conducted in adjacent areas if the newly mined area is less than 40 percent of the area being remined plus any unmined area needed for reclamation	all activities	yes	non-tidal waters of the U.S.	new NWP	permittee must demonstrate net increase in aquatic resource functions through reclamation; activities must be authorized by the Department of Interior (DOI), Office of Surface Mining (OSM), or by states with approved programs under Title IV and V of the Surface Mining Control and Reclamation Act of 1977 or are currently being processed as part of an integrated permit processing procedure; prospective permittee must receive written authorization prior to commencing the activity
NWP 50 – Underground Coal Mining Activities	10/404	none	all activities	yes	non-tidal waters of the U.S., except non-tidal wetlands adjacent to tidal waters	new NWP	activities must be authorized by the Department of Interior (DOI), Office of Surface Mining (OSM), or by states with approved programs under Title V of the Surface Mining Control and Reclamation Act of 1977 or are currently being processed as part of an integrated permit processing procedure; if reclamation required, a copy of the plan must be submitted with PCN; does not authorize coal preparation and processing activities outside of the mine site (these may be authorized by NWP 21); prospective permittee must receive written authorization prior to commencing the activity



Appendix 9.2: Spill/Water Quality Event Response Protocol

LAKE ARLINGTON
MASTER PLAN

Spill/Water Quality Event Response

Updated __________ (date)

The following is the protocol to follow if a call should come in notifying the City of Arlington ("Arlington") of a spill or event that could impact water quality within Lake Arlington or the Village Creek Watershed. **Please record the information as detailed and accurately as possible.**

1. When the initial call comes into any Arlington office, please collect the following information:

   a. The caller's name, entity: ____

   b. The caller's phone number: ____

   c. Where the caller is calling from: ____

   d. What has occurred (the reason for the call):
   ____

   ____

   e. Date and Time of call: ____

   f. Date and Time of event: ____

   g. Your name and division: ____

   h. Arlington employee notified of call, date and time:
   ____

2. When the initial call is made, the Arlington employee will contact the first person on the following list. In the event that the first person cannot be reached, try the next employee on the list and continue until someone is reached. All names on this list have been trained in the protocol that follows.

Employee and Position	Home Phone	Cell Phone	Personal Cell

3. Immediately email ________ and ________ notifying them of the spill event. Their email addresses are shown below:

4. After being notified, the initial Arlington contact will scan and email the first page of this form to water quality personnel from the Water Resource Services Division. Division personnel will then proceed as follows:

   a. Make a call back to the contact/person who made the initial call into Arlington to verify the information, get the current status of the situation, and obtain any further information:

      i. Verify information taken:

         Confirmed: ________ If there are discrepancies, record corrected information below:

         ____

         ____

      ii. Obtain accurate physical address, county and directions to site:

         ____

         ____

         ____

      iii. Get name(s) & phone numbers of any contact or agency people at site (list each environmental agency represented):____

         ____
         ____
         ____
         ____

      iv. Obtain a list of other agencies that have been contacted concerning this event such as Texas Railroad Commission, TCEQ, Emergency Management Coordinators, & others:

         ____
         ____
         ____
         ____

      v. ____

      vi. Obtain a list of any parties called for or engaged in cleanup, if known (examples are trucking firm/contractors/others):____

         ____
         ____

5. Determine who is in control of the site: ______________________________________

6. Gather additional information on the event (such as what substances are involved, hazardous conditions, injuries at site, presence of dead fish or other aquatic life):

____

____

____

____

7. Determine if the site is near or threatening a currently-flowing stream or intake structure for a body of water? If so, list name & map GPS Coordinates, if known:
____
____
____

8. The following calls should be made by the primary Division personnel being mobilized. Check or indicate who was called, time of call and any additional comments or concerns:
   a. Call Fire Department, Environmental Services Division, laboratory and/or treatment plant personnel to mobilize (in the following order):

Employee Name and Position	**Home Phone**	**Cell Phone**	**Contacted/Date and Time**

   b. Call TCEQ Spill Response Hot Line and Regional Office (see reference section for numbers) to confirm call has been made to report the event (record TCEQ contact name, date and time):
   ____
   ____

   c. Call TPWD “Spills and Kills” Team (see reference section for number) (record date and time):
   ____
   ____

   d. Call Arlington Director of Water Utilities at ________________, if not already contacted (record date and time):____
   ____

   e. List additional calls, if necessary: ____

9. Mobilization:

Use an official Arlington vehicle & **CHECK GAS BEFORE LEAVING**.
Equipment will be found in the spill response kit located in ________________, but confirm the list of equipment and supplies shown below:

Inventory equipment prior to leaving for event investigation:

1) Data sonde: ________________ Standardized: ___________________
2) Sample bucket: ___________
3) Map book:_______________
4) Digital camera: ___________ Battery check: ___________ Disc space: _____
5) Ice chest: _________
6) Rubber gloves: __________
7) Sample bottles: ____________
8) Waders and rubber boots: _____________
9) Drinking water or Gatorade: ___________
10) Disposable camera: _____________
11) Notebook: ___________ Pen: ____________ Markers: ____________
12) Paper towels: ________________ Wet wipes: _____________
13) Ziplock bags: ___________
14) Insect repellant: ____________
15) First aid kit: ___________
16) Flashlight: ____________
17) Sunblock: ____________
18) Arlington ID badge and business cards: _____________

10. After arriving at site. **(Please note: Do not assume responsibility at the site or actively participate in spill cleanup or containment, if other agencies are responsible. You are primarily there to observe, monitor water quality, if necessary, and relay information to Arlington personnel, operations or other downstream users.)**

a. Assess situation. Confirm existing information. Note additional information or corrections:

____

____

b. Report into the primary Arlington contact to relay information at following number: _________________________

c. Site information:

1) Visual observation and notes:

____

____

2) Actions taken at site:

____

____

____

3) Responsible party information (names, company, phone numbers):

____

____

4) Other parties on site (governmental entities, hazmat crews, environmental clean up crews – company names, employees at site, phone numbers, if available):

____

____

5) Time line information: ____

____

11. At Arlington, during event investigation:

a. Contact Arlington Office of Public Communications:

Employee Name and Position	**Home Phone**	**Cell Phone**	**Contacted/Date and Time**

b. Contact the following additional personnel:

Name and Position	Home Phone	Cell Phone	Office Phone

c. Calculate approximate time of travel to headwaters of Lake Arlington. The following persons from the Engineering Department can help with the estimate based on flow rate of impacted stream/body of water.

Employee Name and Position	Home Phone	Cell Phone	Contacted/Date and Time

d. Begin research on product or chemicals involved. Attach information.

e. Weather conditions in area of event:

____

____

f. Flow conditions, if known: ____

____

____

____

____

____

____

g. Notify any downstream operations or utilities that could be affected. List those operations or utilities contacted, person(s) notified at utilities and time.

____

____

____

Additional Notes or Sketch of Site:

Ap