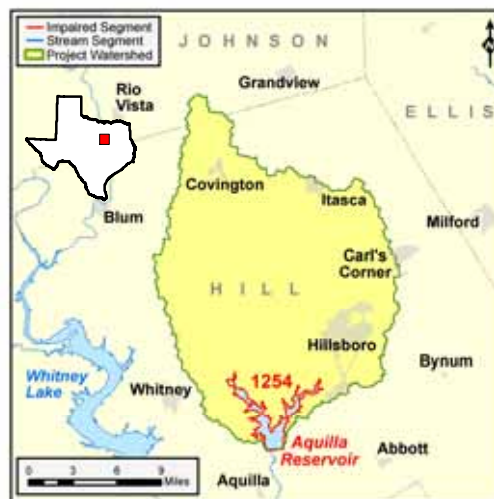


Improving Water Quality in Aquilla Reservoir

Impairment & Listing Year: The use of the reservoir as a source of drinking water was not met due to high concentrations of atrazine in treated drinking water (listed as impaired in 1998).

Location: Brazos River Basin; Hill and Johnson Counties; west of the City of Hillsboro



Safety of Drinking Water Source Restored

For the last six years, Aquilla Reservoir near Hillsboro has been the focus of concerns over drinking water. In 1997 and 1998, tests of treated drinking water by the Aquilla Water Supply District found the herbicide atrazine at levels in excess of state drinking water quality standards.

Texas law requires that the quality of water in Aquilla Reservoir be suitable as a source for drinking water, and for swimming, wading, fishing, and a healthy aquatic ecosystem. Since Aquilla Reservoir is the source of water for the treatment plant, the lake was added to the state's list of impaired waters. Because the District was not treating water to remove atrazine at that time, the levels in the reservoir were presumed to be the same as those in treated drinking water.

This threat to the quality of local drinking water triggered initiation of watershed restoration projects by the TCEQ, the Texas State Soil and Water Conservation Board (TSSWCB), and other agencies to address urban and agricultural sources of atrazine and to restore water quality in Aquilla Reservoir. The TCEQ's TMDL Program initiated a project to establish a total maximum daily load of atrazine that could be safely absorbed by the reservoir, and to develop a plan to reduce atrazine pollution. The TSSWCB led a coordinated effort to change agricultural practices that were contributing to atrazine pollution in the lake.

A key factor in the success of these projects was the coordination of activities and interested parties through the Texas Watershed Protection Committee, formed to address threats to several lakes from atrazine contamination. And at the heart of the success was the voluntary cooperation of agricultural producers in the watershed.

The goal of those efforts has been met—atrazine concentrations in the reservoir have been reduced to safe levels. Between 1998 and 2003, atrazine concentrations in the reservoir have been reduced by approximately 60 percent, to amounts lower than those required for treated drinking water.

Although there have been a few measurements that exceed the allowable amount in the reservoir, no atrazine concentrations higher than the allowable amount have been detected at the drinking water treatment plant since April of 1998. The successful paradigm developed for the Aquilla Reservoir watershed is now being used in several watersheds across the state to reduce threats to drinking water sources from atrazine and other chemicals.

Aquilla Reservoir is the sole source of drinking water for more than 18,000 residents of Hill County. Each year, thousands of visitors come to Aquilla Reservoir to fish, boat, swim, and hunt; these visitors are important contributors to the local economy. The reservoir is also home to numerous families. The response of state government, and of the stakeholders in the watershed, has helped to ensure that the quality of life

enjoyed by the residents of Hill County has been improved, and will be preserved for the future.

Description of the Aquilla Reservoir and Its Watershed

Aquilla Reservoir is designated as Segment 1254 in the TCEQ's surface water classification system. The reservoir was completed in 1983 by the impoundment of Aquilla Creek, Hackberry Creek, and Jacks Branch in the Brazos River Basin. It is located in Hill County, approximately 10 miles southwest of Hillsboro, Texas. The lake was built for water supply, flood control, and recreation, and is owned and operated by the U.S. Army Corps of Engineers. An earthen dam 11,800 feet in length controls drainage from a 255 square-mile watershed. The lake covers 3,280 surface acres at normal conditions, and has the capacity to store 33,600 acre-feet of water.

Aquilla Reservoir is the source of drinking water to Hillsboro (population: 7,072), Milford (population: 711), Bynum (population: 192), and several water supply companies (Chatt, Files Valley, Hill County, Parker, Branden-Irene). Three parks operated by the Corps of Engineers are located on the lake: Dairy Hill Ramp (12,700 visitors annually), Old School Ramp (14,300 visitors annually), and Outlet Area (6,900 visitors annually).

Atrazine and State Standards

Atrazine is an inexpensive, effective herbicide for a number of broadleaf weeds. It is used by many corn and sorghum producers to control weeds. Atrazine is also an ingredient in many residential lawn products.

In 2002, the Environmental Protection Agency (EPA) published a risk assessment of the potential human health effects associated with exposure to atrazine. The study found that atrazine is not likely to be carcinogenic to humans. However, atrazine exposure may be associated with imbalances in hormone levels in laboratory animals. These imbalances might disrupt reproductive and developmental processes. Though these

associations are not conclusively documented, the EPA considered these effects, and the exposure levels that created such concerns, in determining risk-based measures necessary to meet federal safety standards.

The state and federal standards for drinking water require that atrazine concentrations in treated water be below the maximum contaminant level (MCL) for atrazine. The MCL for atrazine is a running annual average of 3 micrograms per liter ($\mu\text{g}/\text{l}$) or lower.



The running annual average at the Aquilla Water Supply District's treatment plant for the second quarter of 1997 through the first quarter of 1998 was 4 $\mu\text{g}/\text{l}$. This violation of the drinking water standards triggered the listing of Aquilla Reservoir in 1998 as an impaired water of the state.

Total Maximum Daily Load Project

In response to the high concentrations of atrazine in the reservoir and in treated drinking water, the TCEQ's TMDL Program initiated a project to establish a total maximum daily load (TMDL) for atrazine in the reservoir, and to develop a plan to reduce atrazine pollution.

In simple terms, a TMDL determines the amount (or load) of a pollutant that a body of water can receive and still support its designated uses. This allowable load is allocated among all the controllable sources of pollution within the watershed. An implementation plan is then developed to reduce pollutant loads.

Sounds simple, but developing a TMDL is actually a very complex process. TMDLs are developed through a scientifically rigorous process of intensive data collection and analysis. The TMDL for Aquilla Reservoir was developed by the TCEQ in collaboration with the TSSWCB.

TMDL Project Findings

The TMDL project found that all atrazine loadings in Aquilla Reservoir originate from non-point sources associated with human activities. There are no natural background sources and no point source discharges. The TMDL identified roughly 63,600 acres of corn and grain sorghum production in the watershed that drains into the Aquilla Reservoir. This represents about 40 percent of the watershed. Weed-killing products are also applied periodically to urban lawns in the area, but their use is a minor source of atrazine in the Aquilla watershed.

The TMDL determined that a load reduction of approximately 25 percent would result in attainment of the water quality standards. The environmental target set for measuring the success of the TMDL implementation plan is a running annual average concentration of atrazine *in the reservoir* that does not exceed three µg/l for two consecutive years. This amount is equal to the MCL allowable in treated drinking water.

The TMDL for atrazine in Aquilla Reservoir was adopted by the TCEQ in March 2001, and was revised in June 2002 in response to comments from the EPA. The implementation plan was approved by the TCEQ in January 2002. Region 6 of the EPA approved the TMDL on October 30, 2002.

TMDL Implementation Plan

A variety of activities were required to bring about the improvement of Aquilla Reservoir. State, federal, regional, and local agencies collaborated to formulate and implement plans designed to reduce pollution in the lake, to protect against new sources of pollution, and to monitor the progress of atrazine reductions with water quality testing.

The TCEQ and the TSSWCB had the leadership roles for implementing the project, as well as for developing the TMDL. The key groups involved

in implementing the plan at the local watershed level were agricultural producers and city governments. Regionally, the key partners were Aquilla Water Supply District, the Woodrow-Osceola Water Supply Corporation, the Hill County Appraisal District, and the Hill County Blackland Soil and Water Conservation District. The Texas Cooperative Extension (TCE) and the Texas Department of Agriculture (TDA) also implemented aspects of the project. The U.S. Army Corps of Engineers, the federal agency that owns and operates the lake, also cooperated.

Since the source of the atrazine was known, some activities were initiated before the TMDL and its implementation plan were complete. For example, the Aquilla Water Supply District began additional treatment to remove atrazine by introducing powdered, activated carbon treatment at the drinking water plant. Agricultural producers and state agencies began a number of initiatives. These efforts will be discussed in more detail in the section “Actions to Reduce Atrazine Pollution.”

The TMDL and the implementation plan provide the framework necessary to ensure that the activities in use are effective in bringing the reservoir back into compliance with the standards for its use as a source of public water supply.

Public Participation in the TMDL Project

A local stakeholder group formed in the Aquilla Reservoir watershed participated in the development of the TMDL and its implementation plan. The stakeholder group included agricultural producers and representatives of the affected water supply companies and cities. The Aquilla stakeholders prepared a survey, which was administered to agricultural producers within the watershed, to document atrazine management practices.

Actions to Reduce Atrazine Pollution

Responsibility for reducing atrazine fell primarily to agricultural producers in the watershed. Producers had help in achieving the necessary reductions from the TSSWCB, the TCEQ, other

government agencies, the Surface Water Protection Committee, and public and private groups.

Texas Watershed Protection Committee

In 1997, the Texas Watershed Protection Committee (TWPC) was originally formed under the name Surface Water Protection Committee as an advisory group to the TCEQ, in response to atrazine impairment in Aquilla Reservoir and threats to Marlin City Lake. The committee now operates independently to coordinate among agencies to prevent water pollution from herbicides and pesticides in various watersheds.

The cooperation that resulted from this inter-agency group was a key factor in the success of the state's implementation of the TMDL for Aquilla Reservoir. While the producers, the TSSWCB, and the TCEQ ultimately implemented many of the measures, most of the concepts used originated with the committee.

The TWPC is chaired by the TDA, and includes representatives from the TSSWCB, the TCEQ, the Blacklands Research Center, the Texas Cooperative Extension (TCE), the USDA-Natural Resources Conservation Service (NRCS), the Brazos River Authority, the Texas Farm Bureau, and the Brazos River Authority.

The TWPC was a driving force behind obtaining the participation of area producers. All of the implementation measures for the Aquilla Reservoir were coordinated through this committee. The TWPC identified public education and the implementation of the best management practices (BMPs) for atrazine reduction as the key strategies necessary to achieve the environmental goal. The committee worked with the TSSWCB and the TCEQ to identify the major producers within the watershed to support implementation of BMPs. Member agencies developed educational tools such as fact sheets and brochures, and information on BMPs for herbicide and pesticide use were developed for use with the state's existing continuing education program.

Synergistic Results

This cooperation also led to synergistic outcomes, like securing funds through the NRCS's

EQIP program to aid producers' implementation of BMPs. The NRCS also installed several filter strips between croplands and streams, and built a number of retention ponds to detain runoff and prevent atrazine from reaching streams. Both the TCEQ and the TSSWCB directed federal grants obtained through the Nonpoint Source Program toward activities in support of the TMDL.

The TWPC developed a statewide plan for protecting all surface waters from pesticide pollution. The plan defined the roles of the participating agencies, and outlined strategies for protecting water quality. Subcommittees were developed to address various aspects of the plan, such as education, documentation of BMPs, plan development and tracking, and data collection and management.

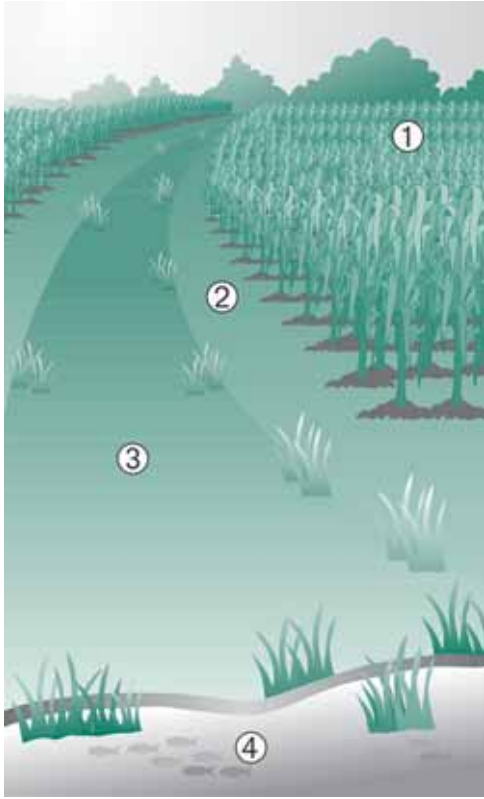
For targeted urban areas near other water bodies affected by atrazine, TWPC members prepared fact sheets about atrazine and integrated weed management for lawns. Through the Master Gardner program in cities and on TV gardening programs, the TWPC provided information about proper application and storage of herbicides and pesticides. Fact sheets and general articles were distributed to local papers, to feature columnists, and at local meetings.

TSSWCB's Atrazine Action Plan

The TSSWCB developed the Surface Water Atrazine Action Plan in order to address its part of the overall plan for water bodies identified as threatened or impaired by atrazine contamination. The plan was implemented by a multi-agency task force with the assistance of an organized professional team. This effort addressed atrazine pollution in Aquilla Reservoir and in other watersheds where it appeared that atrazine might cause impairments to lakes in the future.

The TSSWCB worked with area producers and other stakeholders to implement BMPs for atrazine reduction. They also worked with other agricultural agencies to provide training on safe pesticide application. These meetings reached hundreds of agricultural producers and led to an increased awareness of water quality in general.

Water quality sampling conducted by the TCEQ was used to measure the effectiveness of the practices. In addition, Syngenta, a private corpo-



A field of corn (1) is cultivated. Atrazine is tilled into the soil, rather than simply applied on top of the ground. Farmers may install filter strips (2) between the field and an adjacent creek (4). A grassed waterway (3) may also be used to direct runoff to the stream (4) while filtering out pollutants at the same time.

ration that markets atrazine, continued its voluntary pesticide monitoring program with the area's public water suppliers.

Partners in the program include the TSSWCB, the TCEQ, the TDA, the TPWD, the Texas Agricultural Experiment Station (TAES), the TCE, and the USDA-NRCS. Several other agencies and interested parties were involved, including the EPA, the Brazos River Authority, the Sabine River Authority, the Aquilla Water Supply District, and Syngenta (formerly Novartis).

The Atrazine Action Plan, which was coordinated in the Aquilla watershed by the Hill County Blackland Soil and Water Conservation

District (SWCD), also provided corn and sorghum producers with an opportunity to implement BMPs on their land while receiving technical and/or financial assistance. The EPA provided close to \$1 million in financial assistance for this project, and several others in atrazine-impacted watersheds, through federal nonpoint source grants. The NRCS provided funds to share the producers' costs of implementing BMPs.

In 2001, the TSSWCB developed an inventory of land management and information on the number, type, and location of BMPs that were implemented. These data are used to manage programs aimed at atrazine prevention.

Producers Take Action

In 1999, farmers in Aquilla watershed formed a Producers Atrazine Action Committee. Meetings featured speakers on water quality topics and training on pesticide application. The Producers Committee developed a list of BMPs recommended for use in the watershed, and composed a questionnaire to document adoption of BMPs over time. In addition, the committee met with pesticide dealers to increase dealers' awareness of the problem and to gain their assistance.

Adoption of the practice to incorporate herbicides into the soil upon application was already at about 33 percent of area producers at the end of the first year, and reached nearly 100 percent by the third year of the project. The TMDL project funded an economic analysis of the typical farm in the Aquilla watershed to assist in identifying the BMPs that were most feasible for immediate and future implementation in the area.

The BMPs being used most in the watershed are:

- *Shallow incorporation.* Rather than spreading atrazine on the surface to control weeds, farmers began tilling the herbicide into the soil during the annual application.
- *Filter strips.* These were installed between cropland and streams to contain pollutants. Also, retention ponds were built to detain runoff and prevent atrazine from reaching streams. Instead of ploughing fields directly adjacent to waterways, a strip of land is planted with perennial vegetation between the

field and the water body to slow runoff and filter out pollutants.

- *Grade stabilization.* A wide range of structures were designed to stabilize the grade of water channels. This also slowed erosion and deterred gullies from forming. Retention ponds were sometimes built below these structures to detain runoff and allow for further removal of atrazine.



- *Grassed waterways.* Channels (natural and constructed) that carry water were planted with perennial vegetation to slow runoff and help filter out pollutants.

- *Terraces.* Earthen embankments, channels, or combinations of ridges and channels were built across slopes to prevent runoff.



- *Education.* Numerous meetings and training classes have been held in the watershed; continuing education classes are ongoing. Technical assistance has been provided to producers by field representatives of various state and federal agencies. Brochures, fact sheets, and guidelines for safe application have been made widely available.

Awareness of groundwater quality also increased because of the surface water project. Several county wells have been tested for various contaminants, and local landowners have been introduced to the Tex*A*Syst rural well-head protection program.

Source Water Assessment and Protection Program

More recently, this program of the TCEQ carried out an assessment to verify the origin of atrazine and other potential contaminants, and to

determine the intrinsic susceptibility of the reservoir to pollution from these sources. An individual source water assessment was conducted for each public water system regulated by the state. The assessment methods are scientifically defensible and are based on the most accurate, readily available environmental data.

For the Aquilla assessment, the Source Water Assessment and Protection (SWAP) Program first identified a 1,000-foot buffer zone around the edge of the reservoir to serve as the key area in which to manage potential atrazine pollution. Due to the small size of the buffer zone in comparison to the large size of the watershed, activities on or near the lake should be easier for project participants to manage.

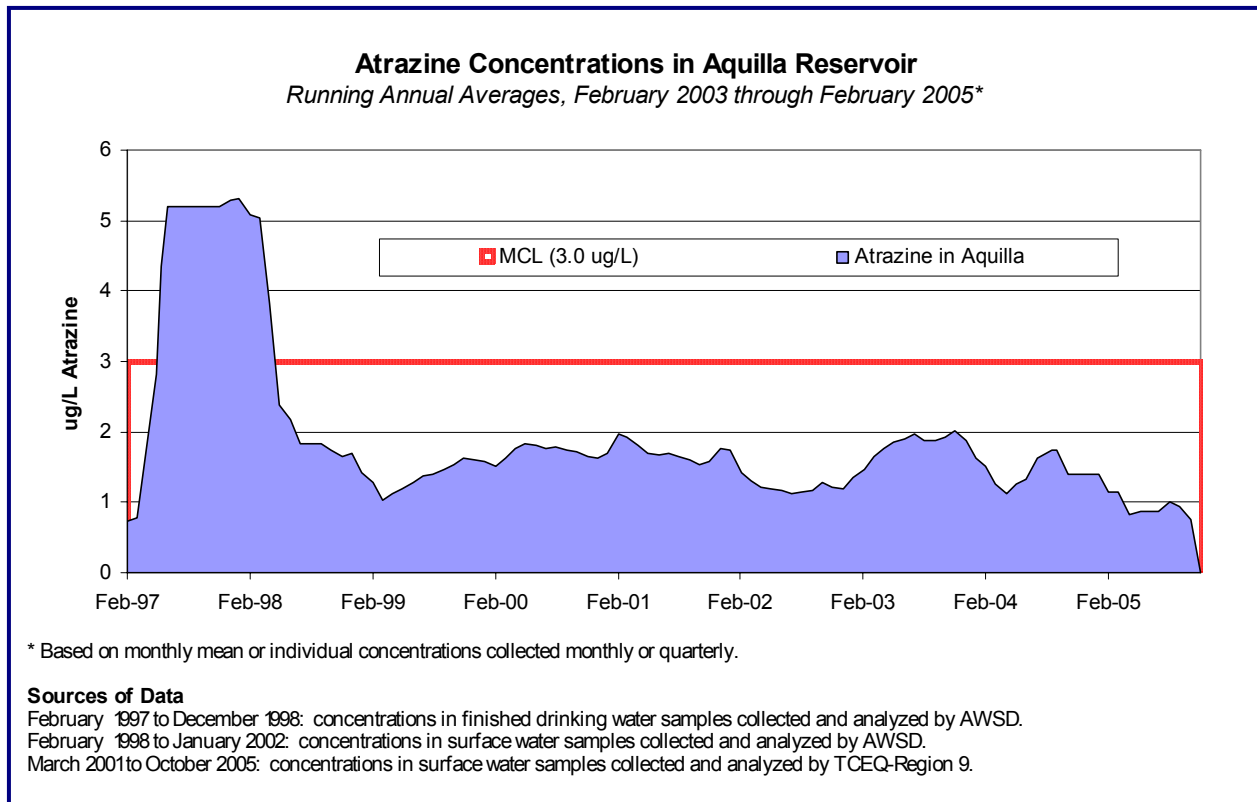
A comprehensive inventory was completed, showing 661 individual, potential sources of contamination, primarily within the buffer zone, such as atrazine storage areas or croplands. This assessment is being used to assist the public in developing an improved understanding of the source of their water. It also supports the identification and implementation of the best management practices to protect the reservoir.

Monitoring to Track Environmental Changes

Since 1999, the TCEQ and the Aquilla Water Supply District have been sampling water quality in the reservoir to track progress toward achieving goal set out in the TMDL. Water samples have been collected from the reservoir and from some of its tributaries. Some samples of storm water runoff have also been collected from the tributaries.

As of September of 2003, the running annual average concentration of atrazine has been less than the target of 3 µg/l.

Even after the TMDL goal has been met, monitoring will be continued on a quarterly schedule to ensure that atrazine concentrations remain at a safe level. The quarterly monitoring will be conducted by regional staff of the TCEQ's Surface Water Quality Monitoring program.



Reducing Atrazine in Other Watersheds

In 1998 and 2000, nine other lakes and one river in Texas were listed as threatened because of atrazine concentrations. A water body is classified as threatened when data indicate that one of its uses—in this case, as a source of drinking water—is not yet impaired, but data indicates that it may soon be.

The 10 water bodies identified as threatened were:

- Bardwell Reservoir, Segment 0815
- Big Creek Lake, Segment 0303A
- Joe Pool Lake, Segment 0838
- Lavon Lake, Segment 0821
- Lake Tawakoni, Segment 0507
- Lake Waxahachie, Segment 0816
- Little River, Segment 1213
- Marlin City Lake System, Segment 1242A
- Navarro Mills Lake, Segment 0817
- Richland-Chambers Reservoir, Segment 0836

The activities developed and implemented for the Aquilla watershed were also used to reduce atrazine pollution in these watersheds. All have

been removed from the 303(d) List, though they are still being monitored as waters of concern.

Success With Aid of Many Helping Hands

Texas has used a comprehensive, collaborative approach to reducing atrazine impairments and threats to sources of drinking water. Agricultural producers responded effectively with the assistance of state and federal agencies. Atrazine concentrations have been reduced to safe levels that comply with TCEQ standards. The TMDL project of the TCEQ and TSSWCB served an essential coordinating function, focusing resources to meet restoration needs.

A suite of BMPs for controlling atrazine pollution in surface water has been developed and tested. These BMPs have been effectively used in eight watersheds around the state, and can be used throughout the state to prevent further threats to surface water from atrazine pollution.

Together, the citizens of Texas and their government worked effectively to achieve our shared goals of preserving both a strong economy and a healthy environment.