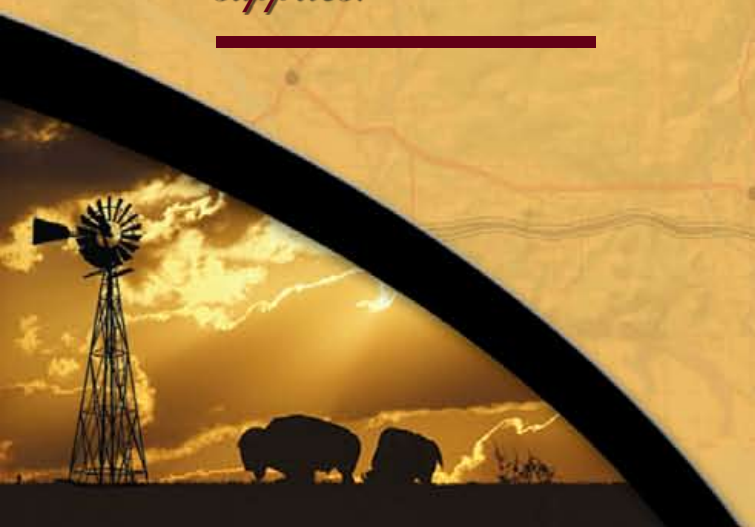
2009 Status Report

Researchers, planners, politicians, and the public must weigh the physical availability of Oklahoma's water resources, the infrastructure required to deliver that water, and the legal institutions that manage and protect supplies.

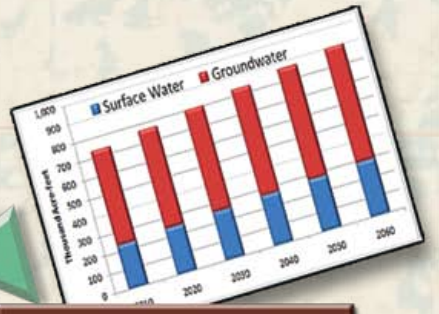
Establishing a reliable supply of water for state citizens throughout the next 50 years and beyond will be the focus of the Oklahoma Comprehensive Water Plan as it enters the third year. A reliable water supply includes, among other things, the assurance of physically available water of a suitable quality. It is therefore important to evaluate opportunities to augment existing supplies, identify new supplies suitable for certain uses, and understand trends in water quality that affect the use of water.

To accomplish these ambitious tasks, the results of technical evaluations as well as policy considerations must ultimately be reconciled. During 2009, technical findings will be integrated with alternatives discovered and vetted through extensive public input. The final OCWP will result in focused implementation of consensual water planning initiatives.



OCWP

Oklahoma Comprehensive Water Plan



Policy Development (Public Input)

Information & Analysis

Technical Studies

RELIABLE WATER SUPPLY

Water Plan Goals

- Provide safe and dependable water supply for all Oklahomans while improving the economy and protecting the environment.
- Provide information so that water providers, policy makers, and water users can make informed decisions concerning the use and management of Oklahoma's water resources.

The current update of the Oklahoma Comprehensive Water Plan, originally published in 1980, seeks to establish reliable water supply for all Oklahomans through at least the next 50 years. The OCWP's carefully designed process has received considerable attention as a national model and affirmation as the new future trend in water resources planning.

The update is utilizing an innovative two-pronged approach: inclusive and robust public participation to build sound water policy complimented by expert technical evaluation utilizing state and national authorities on water management. This approach ensures broad public input, comprehensive analysis, and realistic management strategies that will result in an effective and opportunistic plan for Oklahoma's water future.

Policy Development & Public Participation

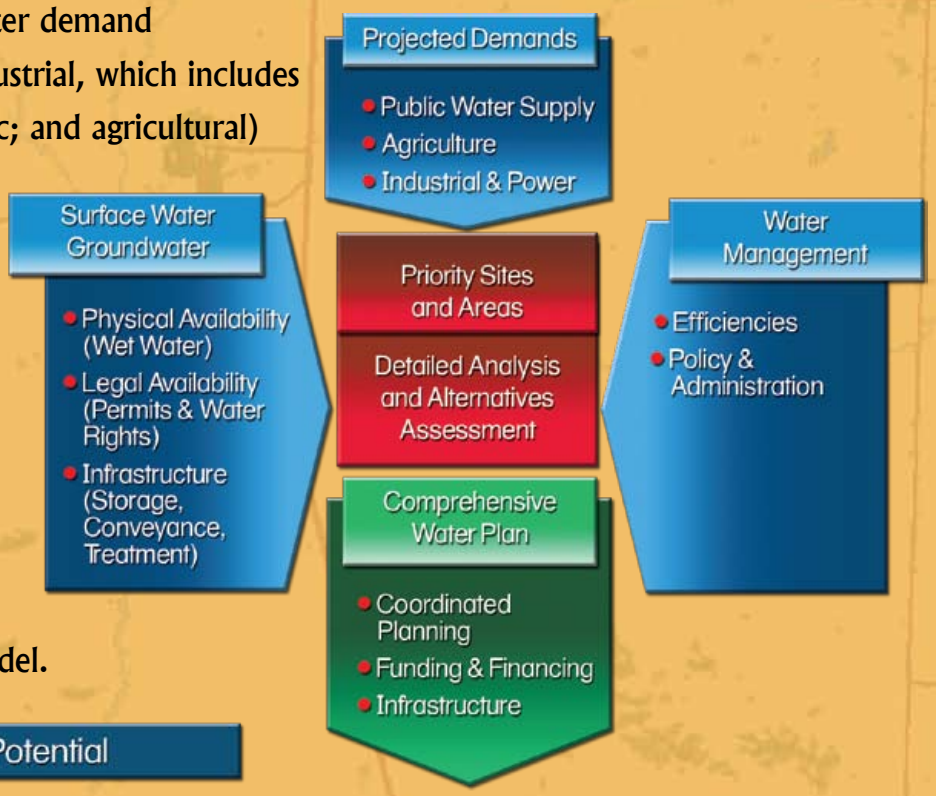
Eleven regional input meetings (RIMs) were held in the fall of 2008. At these meetings, the Oklahoma Water Resources Research Institute (OWRRI) facilitated discussions among 340 appointed participants and additional members of the public at large about the issues raised in the local input meetings (LIMs) held in 2007. The RIMs proved to be quite valuable in shaping the water planning agenda, and there is now a high level of confidence that issues most important to Oklahoma citizens have been identified. Based on an analysis of the results and comments received from the RIMs, 10 workshop themes have been identified:

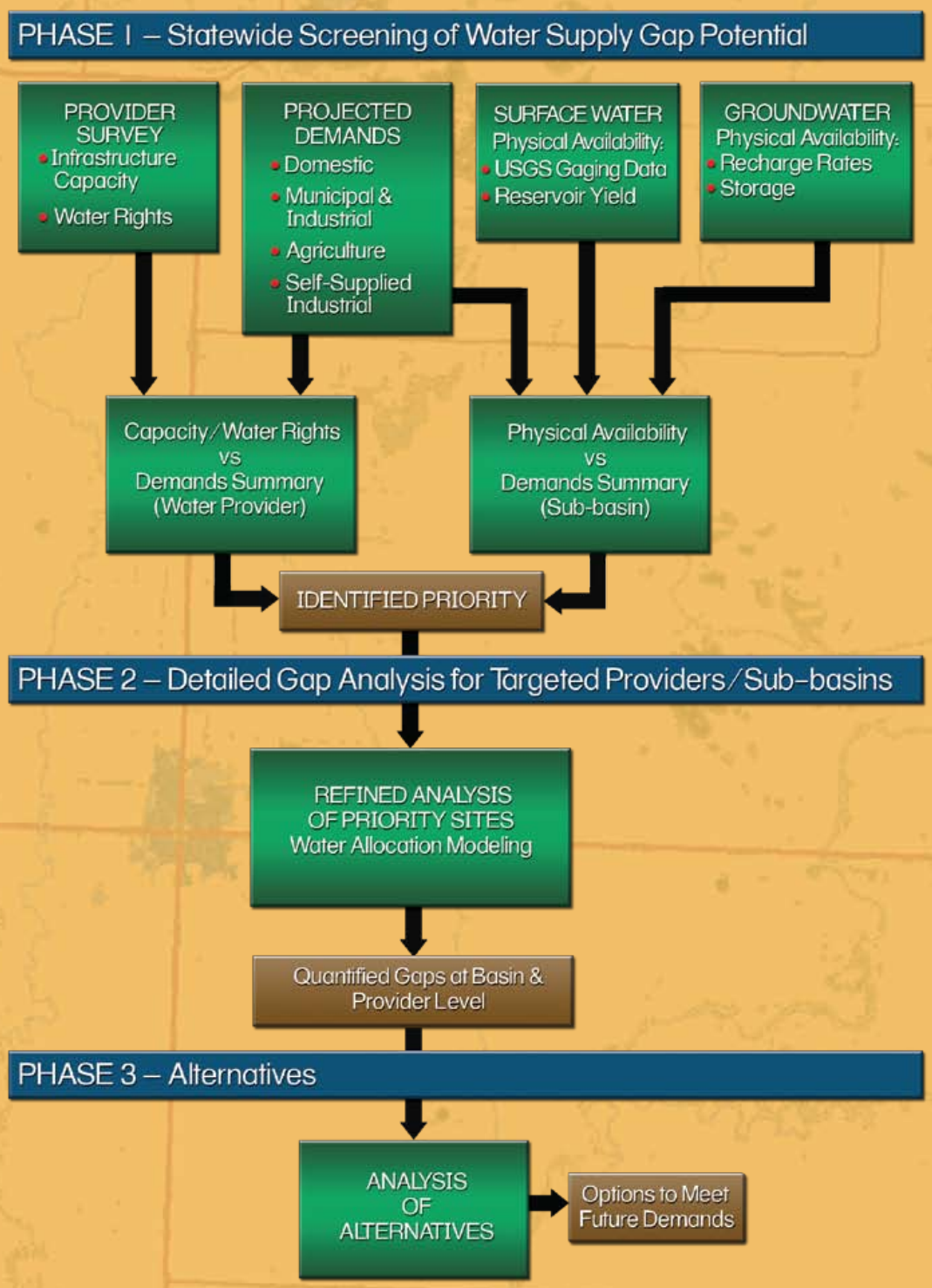
- Sustainable Water Management
  Responding appropriately to changes in population projections, economic conditions, water uses, and climate so that water supply and demand are balanced.
- Water Conservation
  Improving water use efficiency and reducing water waste.
- Water Supply Security
  Enhancing the safety and reliability of water supplies.
- Surface Water-Groundwater Relationship
  Coordinating the management of surface and groundwater resources.
- Land Use Management
  Protecting and enhancing water quality and quantity through land stewardship.
- Water Sales and Transfers
  Transferring water within the state and selling water to neighboring states.
- Intergovernmental Water Resource Management
  Effective cooperation between Oklahoma and neighboring states, tribal governments, local governments, and the federal government.
- Inter-Agency Water Resource Management
  Effective cooperation among State water management agencies.
- Stakeholder Involvement and Conflict Management
  Effectively involving citizens and non-government organizations in implementing water plan programs so that the goals of the plan will be realized.
- Relationship of the State Plan With Local and Regional Plans and Planning
  Defining the appropriate role of the State in local and regional planning while respecting regional and local differences and preserving as much local autonomy as possible.

Planning Workshops will be held June 4, August 13, and October 22 at the Metro-Tech Springlake Campus in Oklahoma City. The morning session will begin at 8:00 and the afternoon session at 2:00. Members of the public are welcome to attend as observers. Experts will be available to answer questions that arise during these workshops. The resulting recommendations will be passed on to a three-day Town Hall meeting in 2010.

Technical Studies and Research

Development continues on statewide and county-level water demand projections for all major consumptive uses (municipal/industrial, which includes public water supply; self-supplied industrial; thermoelectric; and agricultural) through 2060. Municipal/industrial projections will be estimated down to the water provider level. A major aspect of this task is development of a sophisticated computer model for use in identifying areas of potential water shortages, or "gaps." This flexible, highly configurable tool, which utilizes Geographic Information System (GIS) technology, is able to compare available supply to projected demand on-the-fly for each stream system in Oklahoma. Planners are working to better integrate groundwater supply, use, and needs into the model.

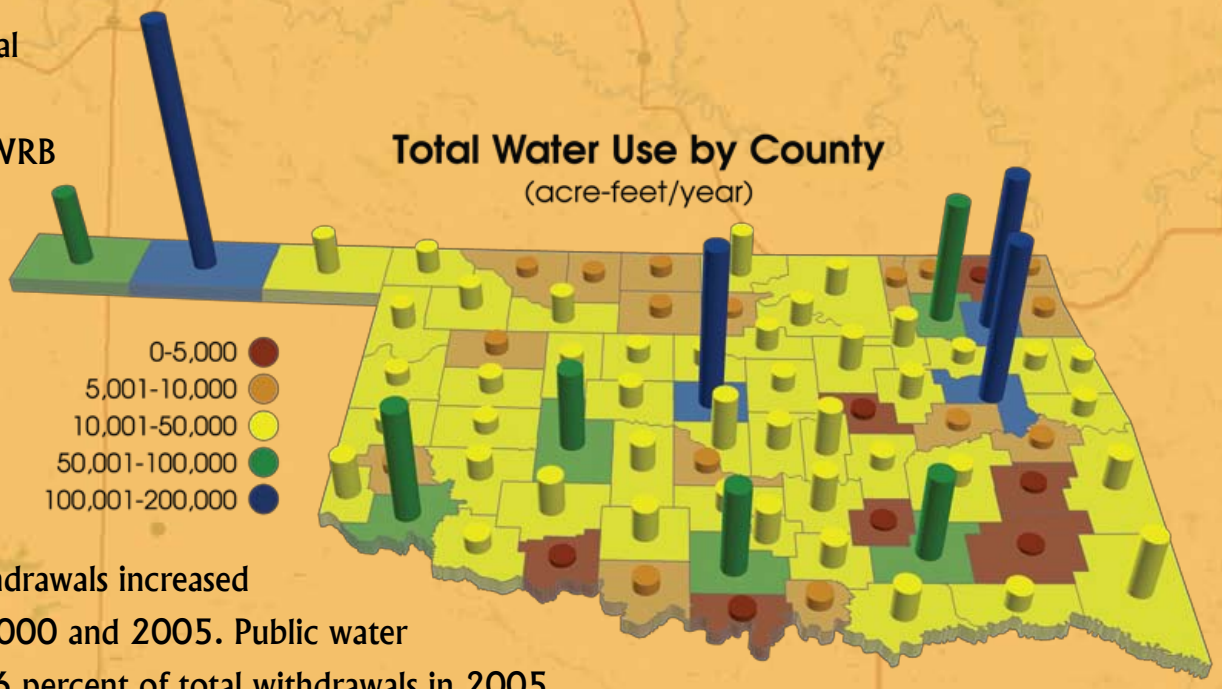




Areas with projected gaps will be studied in more detail utilizing a separate, more precise GIS water allocation model that takes into account both current and future local water management issues, such as rainfall/runoff data, reservoir storage, existing water rights, lake level requirements, potential interbasin transfers, interstate compact requirements, and other factors. The water allocation model also has significant promise for use in the OWRB's day-to-day water use permit administration.

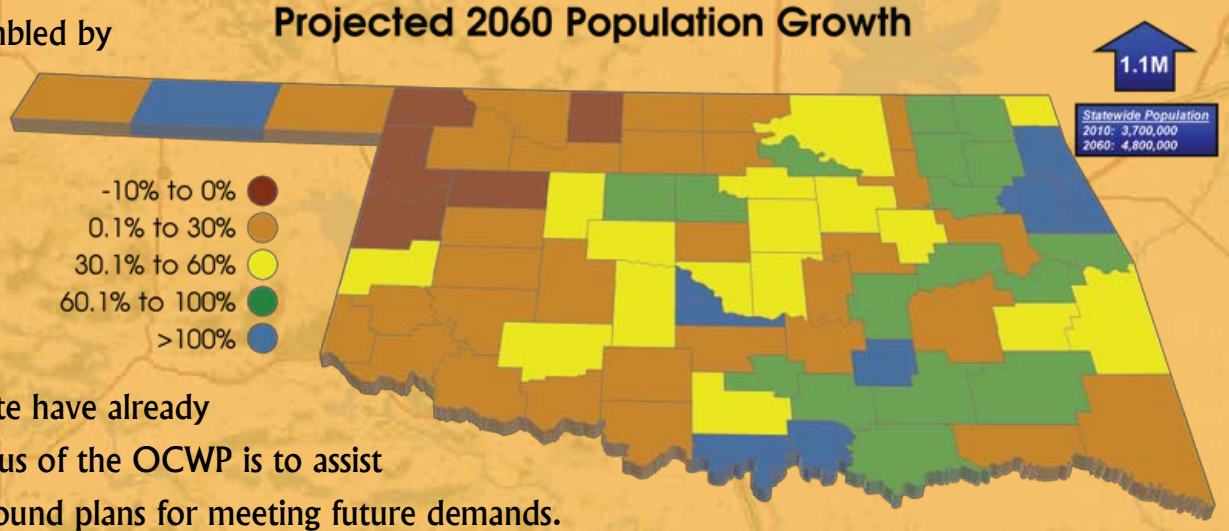
In addition, utilizing the latest USGS National Hydrography Dataset (NHD) and the Watershed Boundary Dataset (WBD), OWRB GIS specialists have reviewed and updated the state's stream system (watershed) boundaries, which form the basis for both OCWP supply/demand modeling and agency water rights administration. Existing stream gages have also been inventoried to identify surface water data gaps and future data requirements.

Preliminary statewide water withdrawal statistics, courtesy of an inventory conducted every five years by the OWRB and U.S. Geological Survey, indicate that total water usage in Oklahoma amounted to approximately 1,779 million gallons per day (1,992,413 acre-feet) in 2005. About 57 percent of that water came from surface water sources and 43 percent from groundwater sources. Total withdrawals increased by about 7 million gallons between 2000 and 2005. Public water supply, which accounted for about 36 percent of total withdrawals in 2005, was the number one use of water. Irrigation, for which about 28 percent of water was withdrawn, was second.



Exemplifying the importance of irrigated agriculture in Oklahoma, especially in the west, Texas County used far more water than any other county, approximately 194,712 acre-feet, virtually all (more than 99.8 percent) from groundwater sources. Elsewhere, intense use was largely centered around more populated regions in the state. The largest surface water user in 2005 was Mayes County (119,784 ac-ft) followed closely by Muskogee County (118,866 ac-ft).

Data on projected population growth through 2060 for every county in Oklahoma, assembled by the Oklahoma Department of Commerce, is a key component of the OCWP, especially in estimating future public water supply needs. Not surprisingly, areas of greatest use are expected to experience the largest growth. Some areas in the state have already exhibited limitations in supply. A focus of the OCWP is to assist water supply systems in developing sound plans for meeting future demands.



OCWP Technical Workgroups

Three technical environmental agency and stakeholder workgroups--two a result of legislation--were formed in 2008 to investigate various water resource management issues.

The Aquifer Recharge Demonstration Study seeks to develop criteria for evaluating potential locations and projects for recharge within Oklahoma. A technical work group has been created to develop criteria that will serve as the tool for recommending aquifer recharge projects where most feasible throughout the state.

A work group is evaluating marginal quality water supplies throughout the state, identifying potential uses of such water, and examining how to economically increase the available and beneficially usable supply of such water.

In late 2008, a workgroup consisting of local, state, federal, and academic water quality experts was formed to assist OWRB staff in determining a scope of work for the planned OCWP Surface Water Quality Trends Analysis. The group will establish methodologies for reporting and data collection and identify criteria for selection of stations and water quality parameters. Initial results will provide planners with invaluable information on the viability of both current and future water supplies.

Oklahoma Aquifers

Aquifers in Oklahoma range in geologic age from Cambrian (570 million years) to Quaternary (1.6 million years to present). Older formations generally consist of consolidated (solid) rocks, such as sandstone, shale, limestone, dolomite, and gypsum. Aquifers in these rocks are referred to as bedrock aquifers. Alluvial aquifers are younger deposits of unconsolidated sand, silt, and clay.

The OWRB defines major bedrock aquifers as those yielding an average of 50 gallons per minute (gpm) or more to wells, and major alluvial aquifers as those yielding, on average, at least 150 gpm. Several minor aquifers in Oklahoma also serve as important sources of water for domestic, stock, and other uses. The OWRB has identified 10 major bedrock and 11 major alluvial aquifers.

The bedrock aquifers include the Antlers, Arbuckle-Simpson, Arbuckle-Timbered Hills, Blaine, Elk City, Garber-Wellington, Ogallala, Roubidoux, Rush Springs, and Vamoosa-Ada.

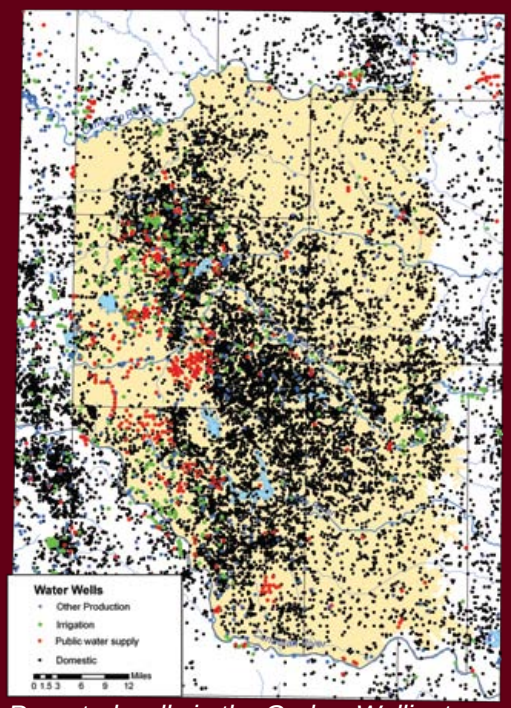
The major alluvial aquifers are the Arkansas River, Canadian River, Cimarron River, North Canadian River, North Fork of the Red River, Red River, Salt Fork of the Arkansas River, Washita River, Enid Isolated Terrace, Gerty Sand, and Tillman Terrace.

Major Aquifer	Geologic Unit	Geologic System	Age (million years ago)
Alluvial	Dune Sand Alluvium Terrace Deposits	Quaternary	1.6 - Present
Ogallala (High Plains)	Ogallala Formation	Tertiary	65 - 1.6
Antlers	Antlers Sandstone	Cretaceous	135 - 65
		Jurassic - Triassic	250 - 135
Elk City	Elk City Sandstone	Permian	290 - 250
Rush Springs	Rush Springs Sandstone Marlow Formation		
Blaine	Dog Creek Shale Blaine Formation		
Garber-Wellington (Central Oklahoma)	Garber Sandstone Wellington Formation Chase, Council Grove, and Admiral Groups		
Vamoosa-Ada	Ada Group Vamoosa Formation	Pennsylvanian	325 - 290
		Mississippian - Devonian - Silurian	438 - 325
Roubidoux (Ozark)	Cotter Dolomite Jefferson City Dolomite Roubidoux Formation Gunter Sandstone	Ordovician - Cambrian	570 - 438
Arbuckle-Simpson	Simpson Group Arbuckle Group Timbered Hills Group		
Arbuckle-Timbered Hills			
		Precambrian	4,500-570

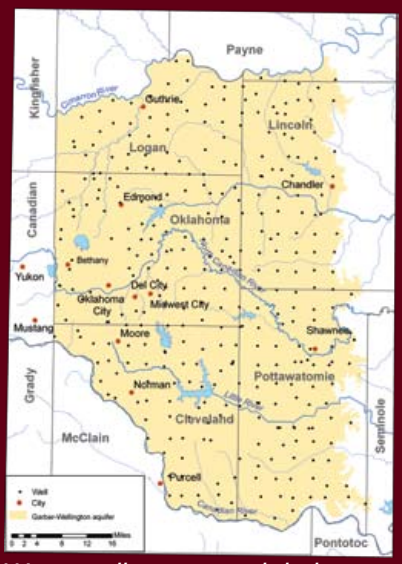
Garber-Wellington Water Management Study

The Garber-Wellington Water Management Study was initiated in June 2008 to address growing concerns about the future of water availability in central Oklahoma. The primary purpose of the study is to obtain the necessary hydrologic information to develop a water management plan that will ensure sufficient good quality water to support a growing population and economy.

The four-year investigation is a cooperative effort between the OWRB, Association of Central Oklahoma Governments (ACOG), U.S. Geological Survey (USGS), U.S. Bureau of Reclamation, Oklahoma Geological Survey (OGS), Tinker Air Force Base, and other state and federal agencies. The USGS will be key in developing a groundwater flow model to predict the impacts of long-term groundwater withdrawals on the aquifer and to simulate water management strategies.



Reported wells in the Garber-Wellington study area. OWRB records show 21,655 domestic wells, 668 irrigation wells, 550 public water supply wells, and 558 other production wells (industrial, commercial, mining, and non-irrigation agriculture).



Water wells measured during the National Water-Quality Assessment Program in the late 1980s. Wells selected for the current study are identical or very near to these wells. Comparison of measured water levels from the two studies will allow scientists to determine how aquifer storage has changed in the last 20 years.

Approximately 300 wells will be measured to help scientists answer vital questions related to the aquifer's long-term water supply potential and to identify water quality concerns. Specifically, resulting data will be compared with water level information collected by the USGS in the late 1980s to determine how aquifer storage has changed over the past 20 years.

The Garber-Wellington, also referred to as the Central Oklahoma aquifer, underlies almost 3,000 square miles, including all or part of Oklahoma, Lincoln, Cleveland, Logan, and Pottawatomie County. Wells tapping the aquifer can yield as much as 600 gallons per minute. However, the groundwater basin is being heavily utilized for domestic and public water supply to support rapid population growth in the region. In addition, although water from the Garber-Wellington is normally suitable for public water supply, in some areas natural concentrations of arsenic, chromium, selenium, and uranium exceed safe drinking water standards.

Arbuckle-Simpson Hydrology Study

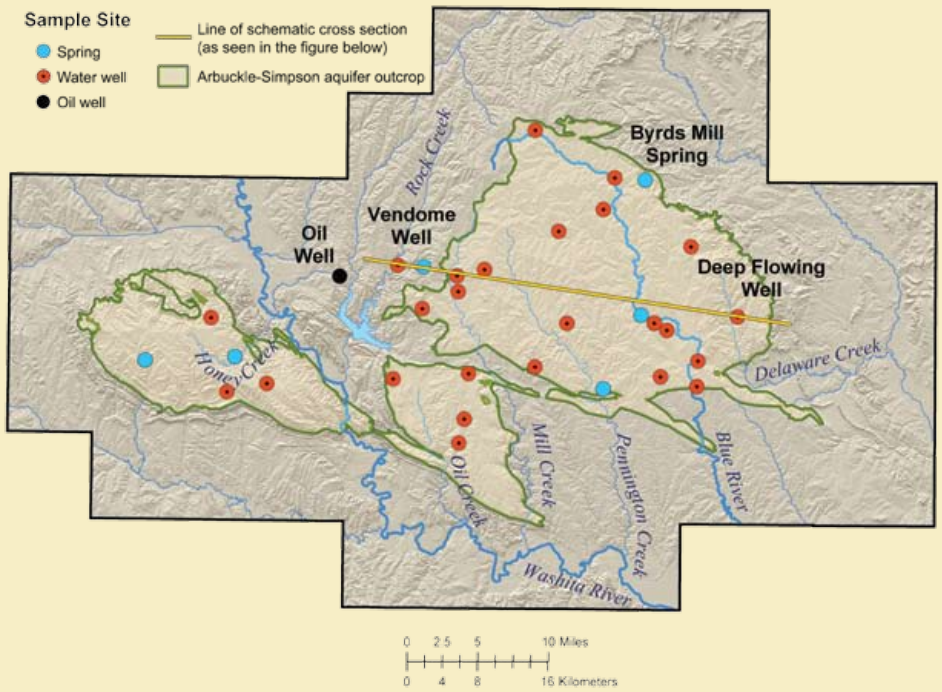
The Arbuckle-Simpson Hydrology Study, which was initiated in October 2003, is nearing completion. The hydrologic investigation is essentially complete, with researchers writing final reports. Currently, the primary focus of the Study is conducting computer simulations with the groundwater-flow model to predict the consequences of groundwater withdrawals on streamflow, evaluate the allocation of water rights, and simulate various management strategies.

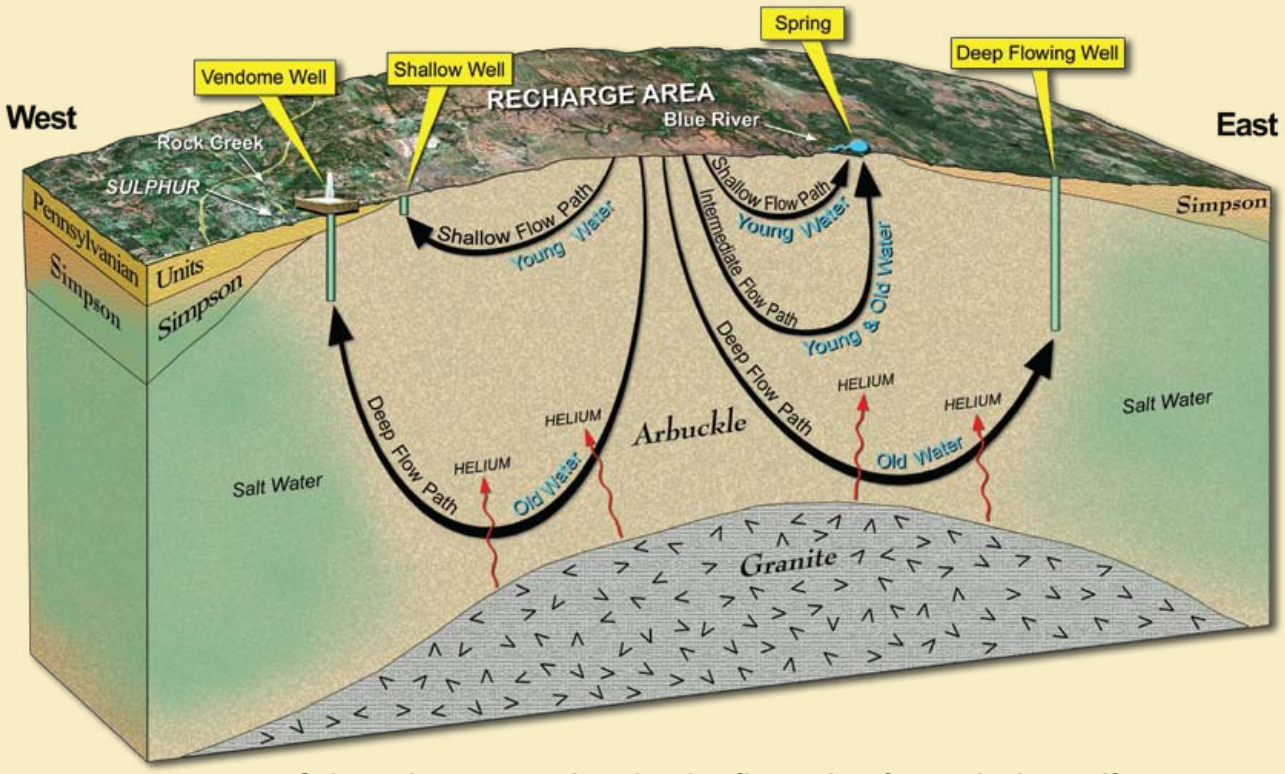
OWRB staff continue to evaluate various management strategies and methods to implement Senate Bill 288 in keeping with technical, legal, and administrative constraints. The OWRB plans to hold informal public meetings in the aquifer area in 2009 to present initial results of the simulations and to solicit input on various management strategies.

Origin and Movement of Water in the Aquifer

Groundwater in the Arbuckle-Simpson aquifer originates as precipitation falling on the aquifer outcrop (where the Arbuckle and Simpson geologic units are found at the land surface). Thus, water in the aquifer is of local origin and does not come from great distances. Precipitation falling on the outcrop infiltrates into the soil zone, where the water evaporates or is transpired by plants back to the atmosphere, or continues down into the aquifer to become groundwater.

Water in the aquifer is constantly flowing and generally flows in the same direction as runoff, from topographically high areas to topographically low areas, to discharge at springs and streams. Typically, the time from precipitation entering the Arbuckle-Simpson aquifer to discharge at springs, streams, or wells is less than 60 years, which for groundwater is a rapid flow system. However, not all water in the Arbuckle-Simpson aquifer discharges in a short period of time. Some of the water may take a deeper and longer flow path before discharging. Water flowing along these longer paths may take thousands of years to reach a discharge point.



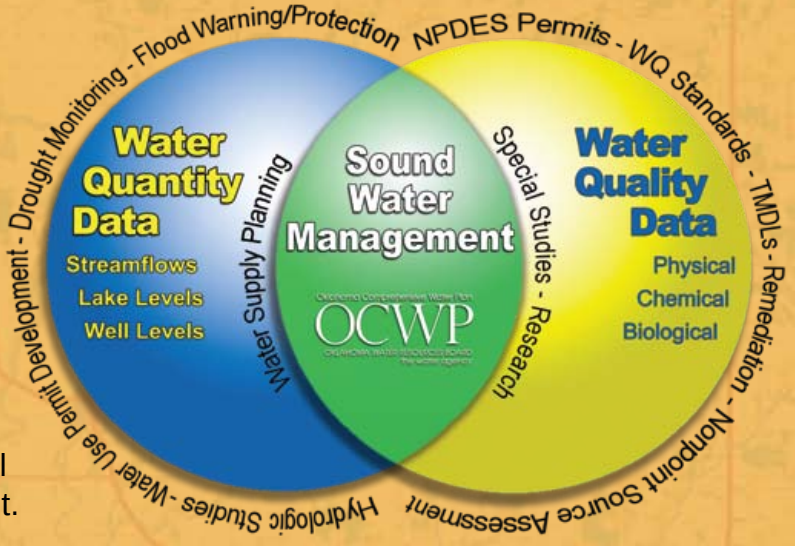


Schematic cross-section showing flowpaths of water in the aquifer.

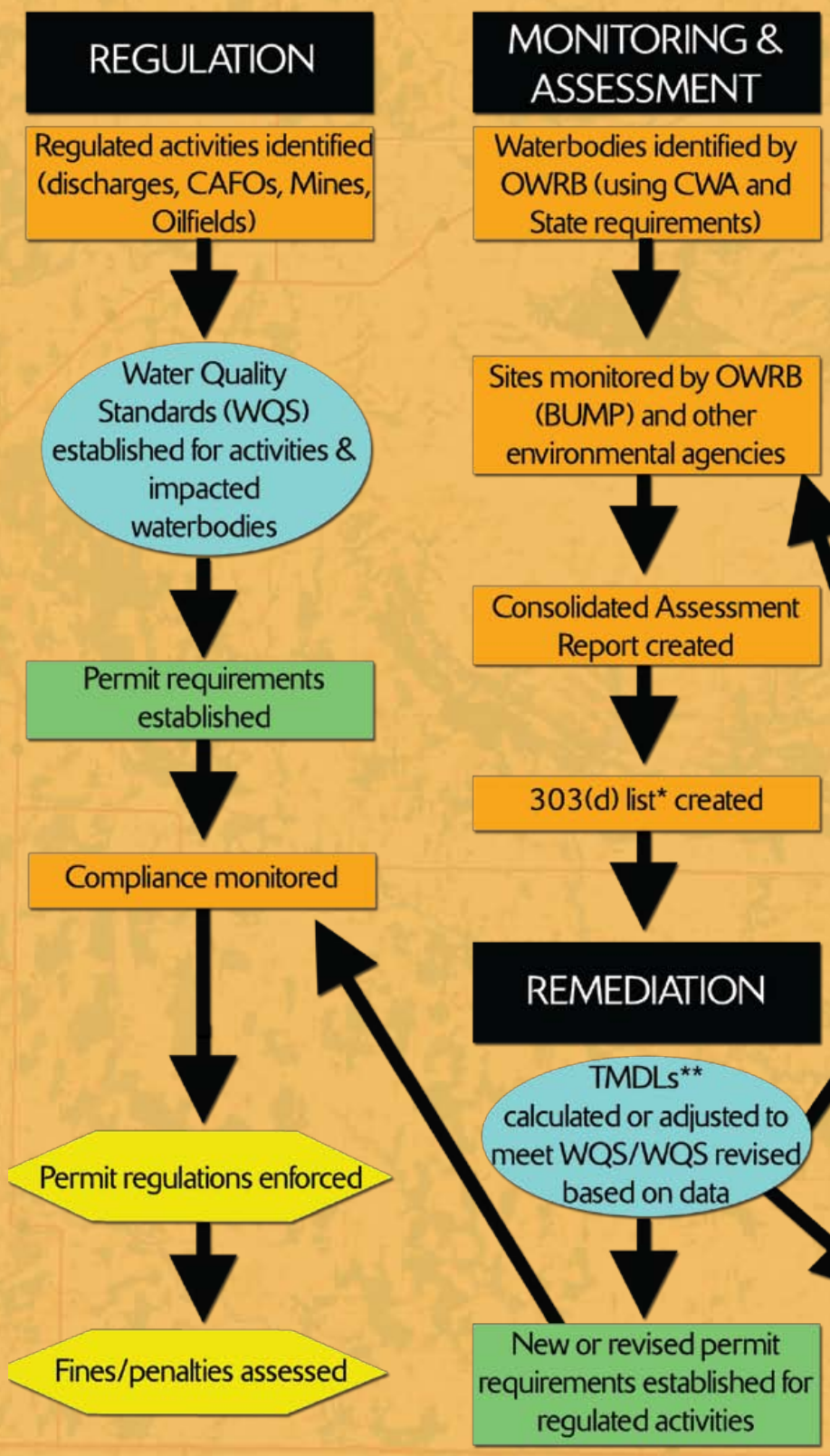
For more information, see USGS Fact Sheet 2009-3013, "Geochemistry of the Arbuckle-Simpson Aquifer" by Scott Christenson, Andrew G. Hunt, David L. Parkhurst, and Noël I. Osborn (in press).

Data for Decision Making

Data is a critical component of water management. It plays an integral role in water rights administration, water availability studies, planning, drought monitoring, water quality management, interstate water compacts, and countless other efforts.



The OWRB works closely with numerous state and federal agencies to gather and utilize all the data necessary for sound water resource management. Hydrologic studies enable water use permit decisions and even help protect citizens from flooding and drought. Stream and lake remediation efforts are focused through the collection of sufficient physical, chemical, and biological data, all resulting in cleaner waters for drinking and the environment. Increasingly, water quantity information is utilized to make quality-related decisions and vice-versa. But this data must be timely, dependable, and accurate to arm decision makers with the tools necessary for managing and protecting the surface and groundwaters of Oklahoma.



Water Quality Management in Oklahoma

Water quality management in Oklahoma is achieved through State statutes and administrative rules that have been adopted in accordance with the federal Clean Water Act (CWA), applicable federal regulations, and State pollution control and administrative procedure statutes, and implemented by State environmental agencies.

To protect, maintain, and improve water quality throughout the State are the principal goals of all water quality management activities. These goals can only be achieved by setting clear guidelines to ensure that existing water quality is not unduly impacted and by establishing a comprehensive monitoring and assessment program to ensure the guidelines are followed.

Oklahoma's Water Quality Standards establish water quality benchmarks for State waterbodies, which in turn lead to the development of permitting regulations and pollution control programs. As a consequence, the Standards guide State monitoring and assessment activities. Conversely, since Standards are dynamic, monitoring and assessment activities can also lead to additions and revisions to the Standards.

***The 303(d) list, required by the CWA every two years, provides identification and priority ranking of waterbodies that do not meet WQS, as well as a plan to develop TMDLs to achieve WQS for each of these waterbodies.*

***A Total Maximum Daily Load (TMDL) is a calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards.*

Water Use Laws & Procedures

Oklahoma law requires any person who uses groundwater or water from a stream in Oklahoma for agricultural, industrial, public water supply, and other non-domestic purposes to obtain a permit from the Oklahoma Water Resources Board (OWRB). Use of water for domestic purposes (by an individual or family for households; farm and domestic animals up to the normal grazing capacity of the land; irrigation of garden, orchard, and lawn areas of 3 acres or less; and non-household uses of 5 acre feet or less annually) is exempt from the permit requirement. Water is permitted in units called “acre feet.” One acre foot equals the amount that would cover one acre of land with water one foot deep, or 325,851 gallons.

An application for a long-term water permit (one year or more) is reviewed by OWRB staff to determine preliminarily if it meets the requirements of law for that kind of permit (see below). If so, the applicant must give public notice of the application as directed by OWRB staff. If a valid protest is received, a hearing is held by a Hearing Examiner. In any case, after the notice period the application is considered based on the applicable law and a final decision is made (approval or disapproval, in whole or in part) by the OWRB members in a monthly business meeting. Processing of an application for long-term use of water generally takes 60 to 90 days from the date of filing, unless there are protests or other delays. Protested applications normally require an additional 30 to 60 days or more prior to final action by the OWRB members. OWRB business meetings are usually held the second Tuesday of every month at the OWRB’s Oklahoma City office.

State statutes provide that an application for a short-term water permit (90 days or less) can be approved by the OWRB Executive Director without notice to the public. These short-term permits are usually for lesser amounts and cannot be renewed.

Stream Water Permitting

Water running in a definite stream in Oklahoma is considered public water and can be used by any person who obtains a permit for non-domestic use. In general, the first person to apply for a stream water right establishes a right superior to later applicants. To obtain a stream water permit, an applicant must establish the following: (1) unappropriated water is available, (2) the applicant needs the water and will put it to a beneficial use, (3) the proposed use will not interfere with domestic use or existing permitted uses, and (4) any use of the water outside its own stream system will not interfere with uses inside its stream system.

Each stream water permit will specify the amount of water permitted and the length of time for which it is permitted. The full amount must be fully utilized either for one year in each seven-consecutive-year period or in accordance with a long-term schedule of use.

Beneficial Uses*
- Agriculture
- Irrigation
- Municipal
- Industrial
- Recreation
- Fish and wildlife

*including but not limited to

Groundwater Permitting

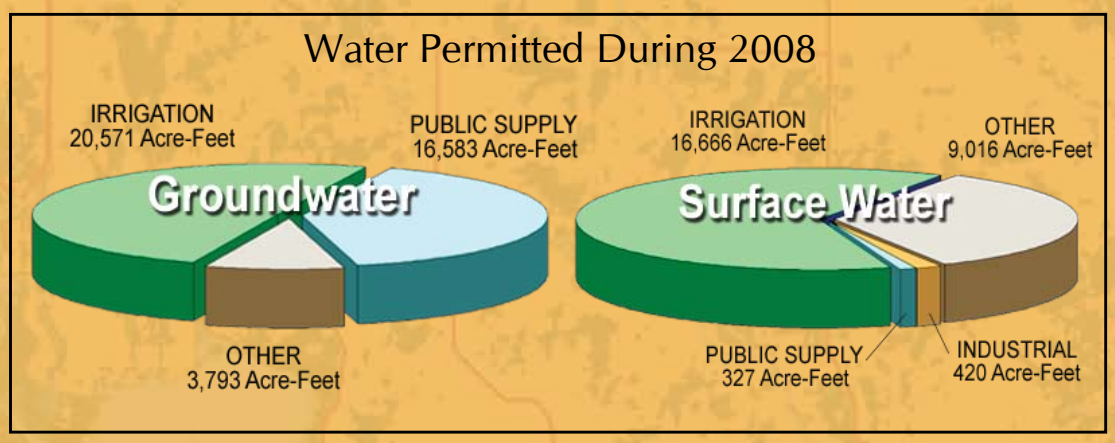
In Oklahoma, groundwater belongs to the land surface owner and may be used subject to the Oklahoma Groundwater Law. A permit is required for non-domestic use.

The law provides for the OWRB to study the state’s aquifers and make determinations of how much can be withdrawn each year (the “maximum annual yield”) while assuring that the groundwater basin will last at least 20 years. The maximum annual yield is divided into an equal proportionate share for each acre of land over the basin. “Regular” permits are issued for these basins. Generally, the amount of a regular permit is based on the equal proportionate share multiplied by the number of acres owned or leased by the applicant.

Groundwater wells must be drilled and completed in compliance with minimum standards set by the OWRB. For a complete list of licensed drillers, go to www.owrb.ok.gov.

If an aquifer’s maximum annual yield and equal proportionate share have not yet been determined, the law provides that a temporary permit (renewed annually) can be issued for 2 acre feet per acre of land. Eventually, when the aquifer’s maximum annual yield is determined, the temporary permit will be converted to a regular permit and the authorized amount will be adjusted to the equal proportionate share.

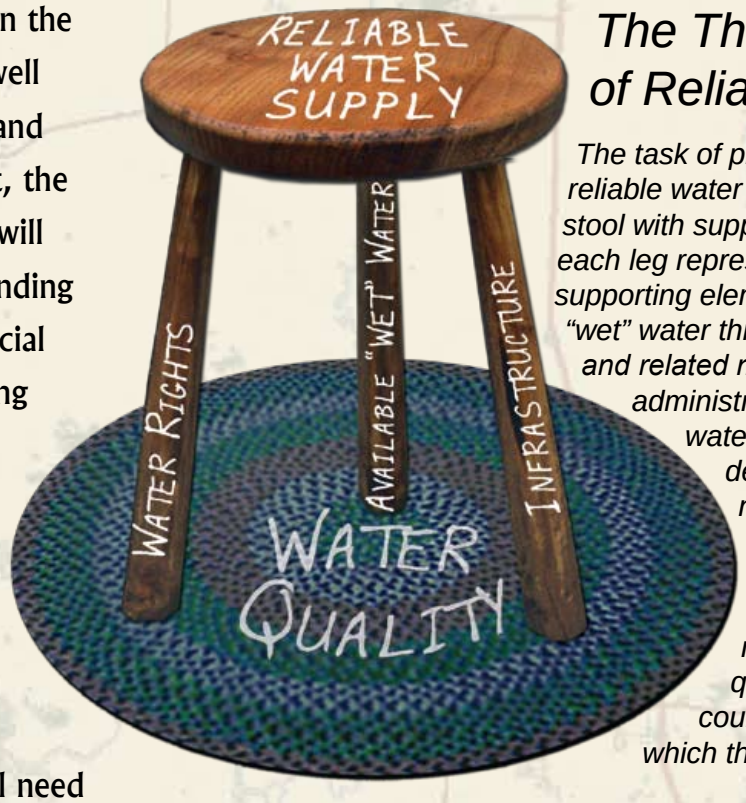
In order to obtain a regular or temporary permit, an applicant must prove the following: (1) the applicant owns or leases the land surface, (2) the land lies over a groundwater basin, (3) the proposed use will be beneficial, and (4) waste of groundwater will not occur (i.e., groundwater will not be wasted due to excessive losses nor pollution).



Infrastructure: A Key Limiting Factor to Economic Development

Reliable water supply is dependent upon the infrastructure required to deliver it as well as the financing opportunities to build and maintain that infrastructure. As a result, the Oklahoma Comprehensive Water Plan will build upon existing state and federal funding programs, including the OWRB's Financial Assistance Program, to meet the growing needs of water providers in Oklahoma.

The OCWP update will assist in providing vital information to better understand Oklahoma's water and wastewater infrastructure needs. Furthermore, the OCWP will help planners and financiers prioritize critical need areas where inadequate treatment and/or delivery create a barrier between water and its users and limit local economic development.



The Three-Legged Stool of Reliable Water Supply

The task of providing Oklahomans with reliable water supply is like a three-legged stool with supply symbolizing the seat and each leg represented by three primary supporting elements: determining available "wet" water through technical studies and related means, fair and efficient administration of water rights, and water/wastewater infrastructure development. Each of the legs not only supports our reliable supply goal, but each supports and is dependent upon the other in Oklahoma's water management scheme. Water quality, another vital component, could be considered the rug upon which the stool sits.

The American Recovery and Reinvestment Act of 2009, passed by Congress and signed by President Obama in February, compliments ongoing Water Plan initiatives by providing an immediate shot-in-the-arm for Oklahoma's water and wastewater systems. The Act, part of the Administration's stimulus package to promptly energize the nation's economy and create jobs, included $62 million for "shovel ready" water and wastewater infrastructure projects in Oklahoma. Specifically, the stimulus package appropriated $31 million each for Oklahoma's Clean Water and Drinking Water State Revolving Fund loan programs. Congress also set aside $70 million in stimulus funds for USDA Rural Development's Water and Wastewater Loans and Grants.

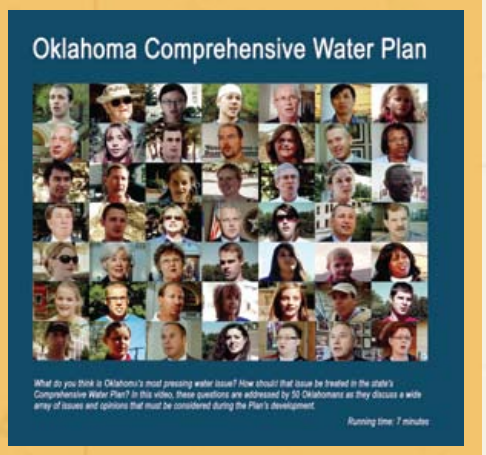
Water Conservation Grant Program

The Oklahoma Water Conservation Grant Program, administered by the OWRB and created through passage of House Bill 3135 last year, makes available a total of $35,000 during the 2009 grant cycle for the implementation of pilot water conservation projects in Oklahoma communities. Innovative projects that can serve as models for other communities will be given the most serious consideration. Specific program criteria that will enhance opportunities for selection include projects that will result in significant or measurable water efficiency improvements or water savings. The amount of matching funds and/or in-kind contributions provided by the applicant will also receive priority.

Projects eligible for Oklahoma Water Conservation Program grants include community conservation demonstration projects, water use accounting programs, retrofit projects, school education projects, xeriscape demonstration gardens, and information campaigns on capturing and using harvested rainwater and gray water. Eligible applicants include cities and towns, schools, non-profit corporations, and rural water districts. OWRB rules governing the program are being finalized.

The Oklahoma Water Conservation Grant Program's initial implementation is being funded through existing Oklahoma Comprehensive Water Plan appropriations. Individual grant awards for any proposal, plan, or project are limited to a maximum of $7,000. The deadline for submittal of grant applications was February 20, 2009.

OCWP Video Demonstrates Citizen Awareness



Oklahoma citizens were captured on video candidly discussing what they believed to be the most pressing water issues facing the state. Shot in October 2008 at various locations, the short documentary video underscores the vast array of issues and opinions that must be considered during the development of the OCWP. Participants included random individuals at public locations, such as the Oklahoma City Zoo, downtown Oklahoma City Library, and Oklahoma State University Campus, as well as former and current State officials, including Governor Brad Henry.

The issues raised by video participants were often identical or very similar to issues elicited through the OCWP's formal public input process, including water conservation, water quality, water rights, drought, flooding, and how water supply is directly linked with economic growth.

To view the video, go to www.owrb.ok.gov and click on "OCWP Video" under "featured" or e-mail the OWRB at pubinfo@owrb.ok.gov.

OWRB Recognized for Water Plan Public Input

In November, during the 18th Annual Celebration of Environmental Excellence, the OWRB was named the 2008 recipient of the Keep Oklahoma Beautiful Team Builders Award.

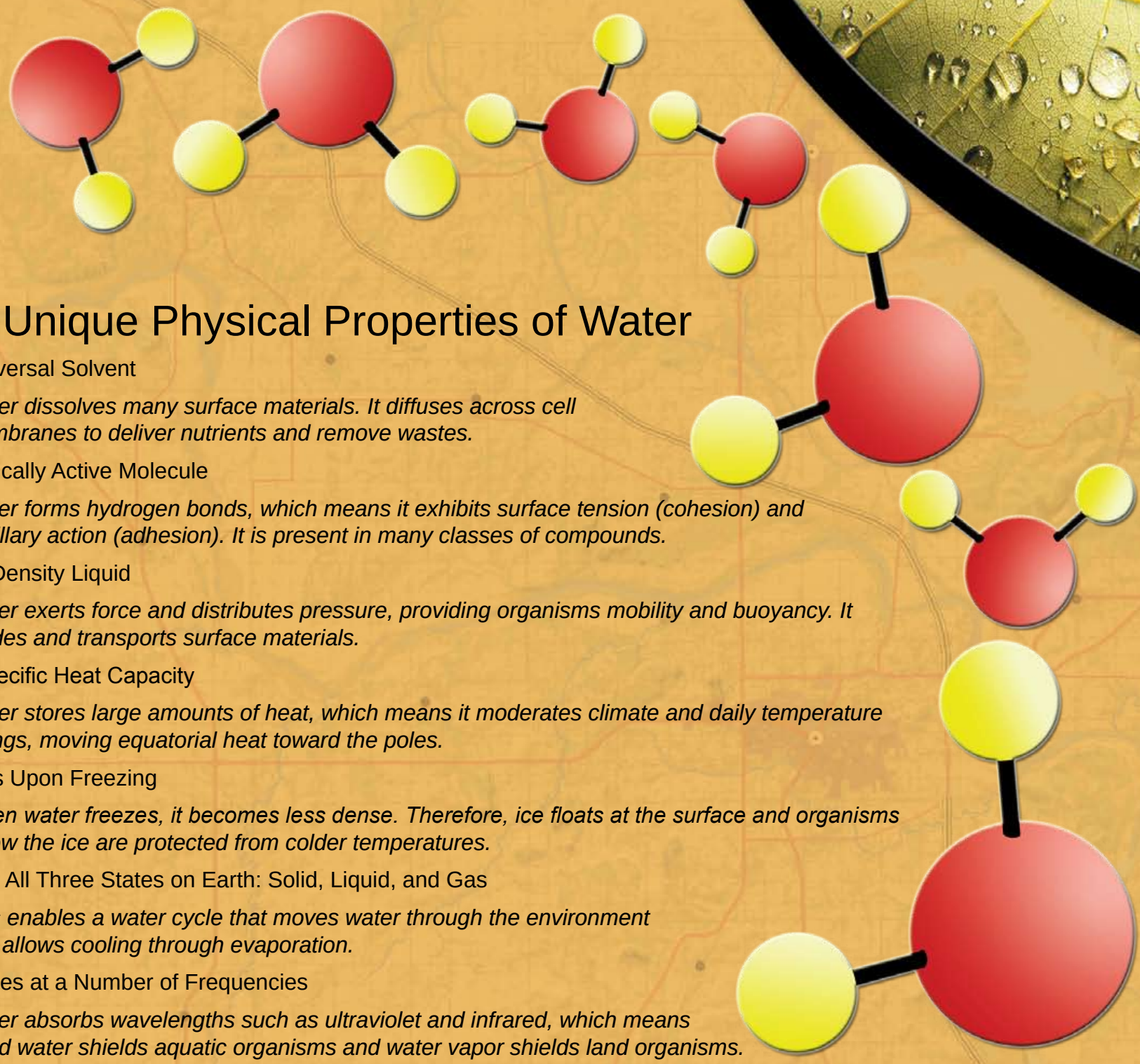
The agency was recognized for maximizing federal and state funding for the Oklahoma Comprehensive Water Plan, while working with the Oklahoma Water Resources Research Institute (OWRRI) to involve the public in the planning process through local and regional input meetings held throughout the state.

For more information on the OCWP, visit the OWRB's website at www.owrb.ok.gov. For questions and comments concerning policy development and public meetings, contact the OWRRI at 405-744-9994, by e-mail at waterplan@okstate.edu, or go to http://okwaterplan.info.

The *2009 OCWP Status Report* was published by the Oklahoma Water Resources Board as authorized by Duane A. Smith, Executive Director. One thousand copies have been printed by University Printing Services at an approximate cost of $____ each. Copies have been deposited at the Publications Clearinghouse of the Oklahoma Department of Libraries.

Oklahoma Water Resources Board

Oklahoma Water Resources Board Members and the water use interests they represent. Seated (left to right): Jack Keeley (municipal), Chairman Mark Nichols (irrigation), Rudy Herrmann (industry), & Lonnie Farmer (Rural Residential). Standing: OWRB Executive Director Duane Smith, Ed Fite (recreation), Linda Lambert (industry), Richard Sevenoaks (municipal), Ford Drummond (agriculture), Kenny Knowles (soil conservation), and Executive Secretary Mary Schooley.



The Unique Physical Properties of Water

The Universal Solvent

Water dissolves many surface materials. It diffuses across cell membranes to deliver nutrients and remove wastes.

A Chemically Active Molecule

Water forms hydrogen bonds, which means it exhibits surface tension (cohesion) and capillary action (adhesion). It is present in many classes of compounds.

A High-Density Liquid

Water exerts force and distributes pressure, providing organisms mobility and buoyancy. It erodes and transports surface materials.

High Specific Heat Capacity

Water stores large amounts of heat, which means it moderates climate and daily temperature swings, moving equatorial heat toward the poles.

Expands Upon Freezing

When water freezes, it becomes less dense. Therefore, ice floats at the surface and organisms below the ice are protected from colder temperatures.

Exists in All Three States on Earth: Solid, Liquid, and Gas

This enables a water cycle that moves water through the environment and allows cooling through evaporation.

Resonates at a Number of Frequencies

Water absorbs wavelengths such as ultraviolet and infrared, which means liquid water shields aquatic organisms and water vapor shields land organisms.

Contains Hydrogen and Oxygen

Water is a possible fuel source for Earth-returning missions to space.

Source: www.nasa.gov