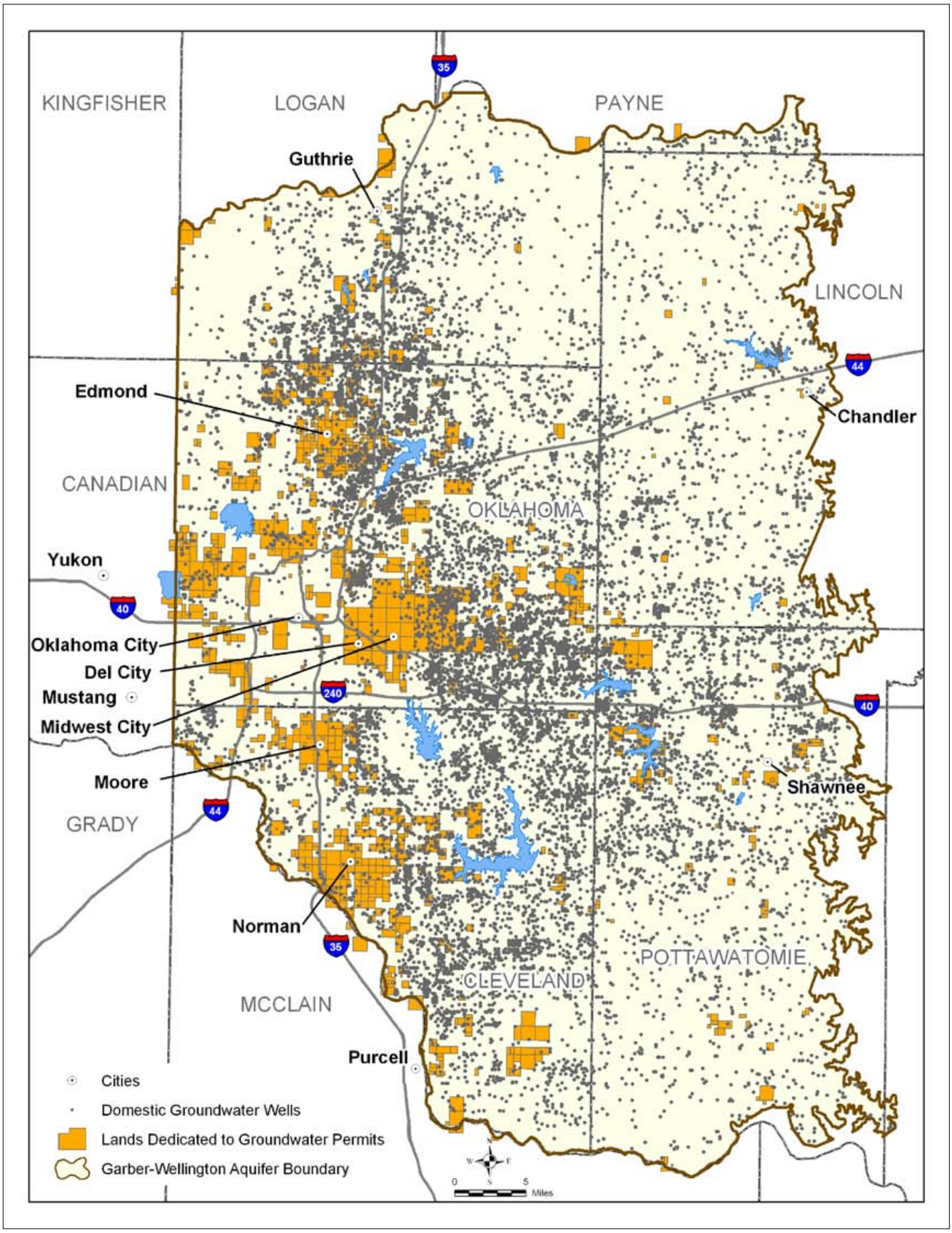
OWRB Garber-Wellington Aquifer & Arcadia Lake Tour

Arcadia Lake & Vicinity
Edmond, Oklahoma



October 12, 2010

Site #2 - Arcadia Lake Project Office

Turn right out of the Best Western parking lot and drive east on 2nd Street. Drive about 4 miles to the intersection of Douglas Boulevard. Continue on 2nd Street about ¼ of a mile, and then turn right (south) on the road to the Arcadia Lake Project Office. Park in the parking lot. If the lot is full, you may park in the gravel lot in back or along the road, providing you leave room for traffic. As you face the office, walk to the right and follow the paved walk that goes to the overlook. We will take a dirt trail to the lakeshore.

Garber Sandstone Sedimentation & Water Quality Monitoring

Neil Suneson, with the OGS, and Stan Paxton will discuss how the rocks and sedimentary features provide important clues to the nature of the environments in which the Garber sediments were deposited. In addition, OWRB Water Quality Division staff will discuss the monitoring at Arcadia Lake and demonstrate sampling techniques.

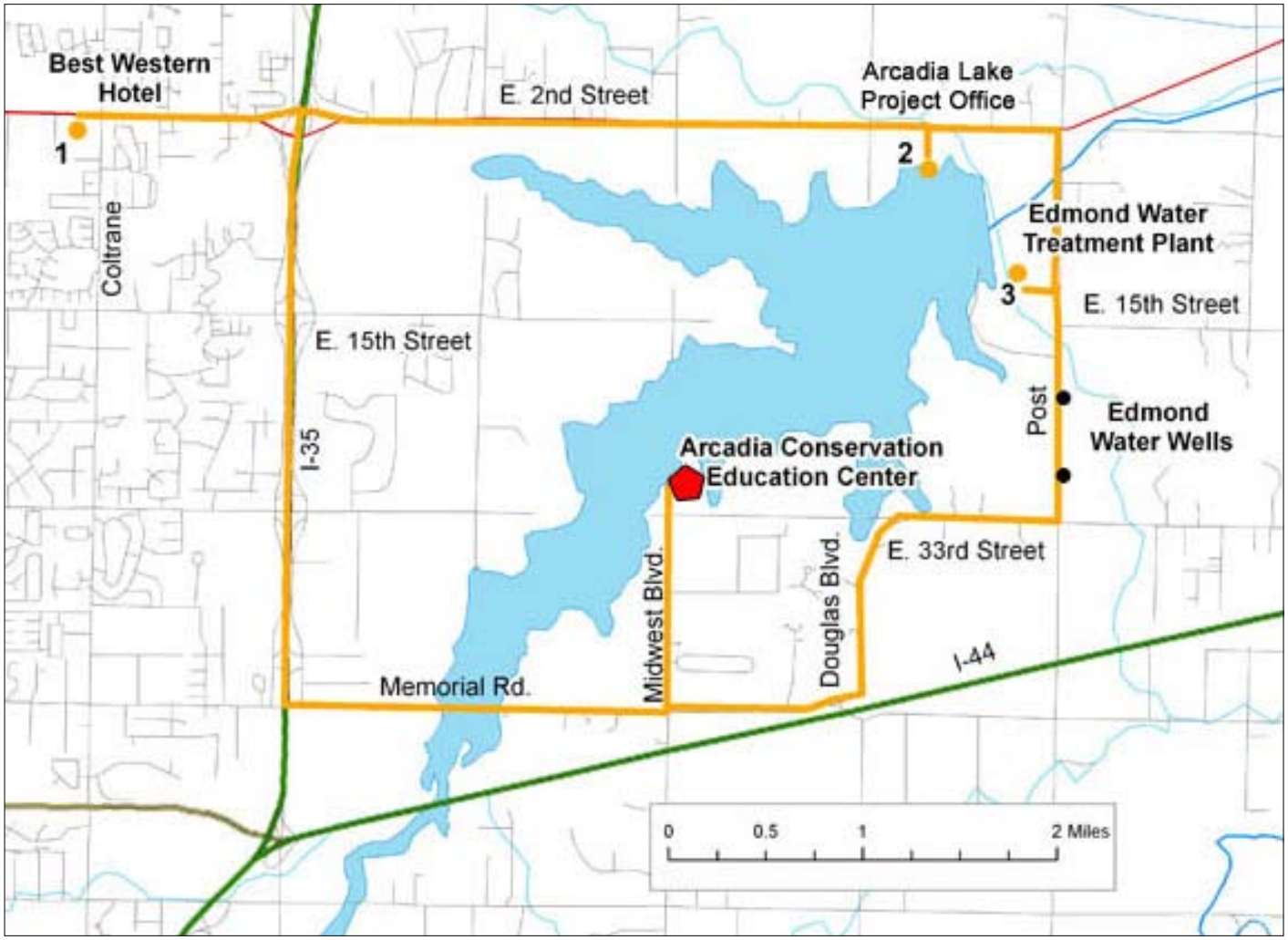
Rock outcrops along the lakeshore reveal evidence of what this part of Oklahoma was like about 260 million years ago during the Permian Period. The rocks exposed along the shores of Arcadia Lake are in the lower part of the Garber Sandstone. Most of the rocks that make up this geologic unit are sandstone, conglomerate, siltstone, and mudstone. These sedimentary rocks exhibit many features, such as cross bedding, ripple marks, mud cracks, calcite nodules, and insect tracks and trails. For more information on the geology of Arcadia Lake, see "Geology of Arcadia Lake Parks-An Introduction and Field-Trip Guide", Oklahoma Geological Survey Information Series 7, by Aaron Siemers, Thomas Stanley, and Neil Suneson, 2000.

Dr. Neil Suneson is a geologist with the Oklahoma Geological Survey, where he has worked since 1986. In addition, Neil serves as an adjunct professor at the University of Oklahoma. Previously, he served as a development geologist with Chevron, USA, and as a geologist with the U.S. Geological Survey. Neil has authored or co-authored more than 25 geologic maps and at least 100 papers and books focusing on the Ouachita Mountains, Oklahoma City metro area, and northwest Oklahoma. Neil possesses a broad knowledge of Oklahoma geology and exhibits an intense research and public-service interest in the geologic issues facing the state. He is co-author of the OGS publication "Geology of Arcadia Lake Parks: An Introduction and Field-Trip Guide." Neil served on the technical peer review team of the Arbuckle-Simpson Hydrology Study, and is currently on the study team for the Garber-Wellington Water Management Study.

Garber-Wellington Aquifer & Arcadia Lake Tour

Length: 19 miles
Time: 3 hours
Itinerary:

Start	Noon	Arcadia Conservation Education Center
Site 1	12:25	Best Western Hotel - Garber Sandstone Outcrop
Site 2	1:10	Arcadia Lake Project Office - Geology and BUMP Sampling
Site 3	2:10	Edmond Water Treatment Plant - Edmond Water Supply & Treatment
End	3:00	Arcadia Conservation Education Center



About Arcadia Lake

A relatively young body of water, Arcadia Lake was constructed in 1987 through a cooperative effort between the City of Edmond and the U.S. Army Corps of Engineers. In addition to serving as a vital water supply source for Edmond residents, the lake serves as flood control for the Deep Fork River Basin, provides recreational and educational opportunities, and provides vital habitat for fish and wildlife.

Arcadia Lake Pertinent Data

- Built: 1986 (Corps of Engineers)
- Stream: Deep Fork River
- Purposes: Flood Control, Water Supply, Recreation
- Water Supply Storage: 23,090 acre-feet
- Water Supply Yield: 12,320 acre-feet
- Normal Pool Elevation: 1,006 feet
- Normal Pool Area: 1,677 acres
- Normal Pool Capacity 29,544 acre-feet
- Shoreline: 26 miles

Site #1 - Best Western Hotel

From the Arcadia Conservation Education Center, drive south on Midwest Boulevard, and then west on Memorial Rd. to Interstate-35. Drive 3 miles north to East 2nd Street (State Highway 66). Turn left on 2nd Street, drive 1 mile through the intersection of Coltrane, and then continue on 2nd Street about 1 block to the Best Western Hotel (on left). Park in the parking lot behind the hotel.

Garber Sandstone Outcrop

Stan Paxton, with the U.S. Geological Survey, will discuss how we can apply information obtained at surface outcrops to interpretation of subsurface data.

A thick sandstone channel system in the Garber Sandstone is exposed in the road cut behind the parking lot. USGS staff and geology students from the University of Tulsa and Oklahoma State University studied this outcrop in May 2010. The research team used a handheld instrument to measure natural, low-level gamma radiation emitted by the Garber Sandstone. The gamma-ray data will be used to correlate the properties of the Garber-Wellington aquifer into a series of cross sections and maps made from geophysical logs of water wells located throughout central Oklahoma. The cross sections and maps help the study team better define the three-dimensional distribution of the hydrologic properties of the Garber-Wellington aquifer.

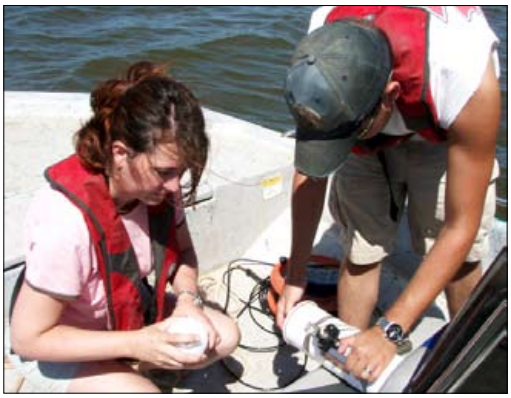
Water Quality in the Garber-Wellington Aquifer

Water from the Garber-Wellington aquifer is normally suitable for public water supply, but in some areas natural concentrations of arsenic, chromium, uranium, and selenium exceed drinking water standards. As a result of new federal drinking water standards for arsenic, several municipal well fields were forced to close or severely curtail water production from water wells that had unacceptable high levels of arsenic. Another natural impairment to water quality is salinity, which increases with depth in the aquifer. Saline water is encountered as shallow as 100 feet in some portions of the Garber-Wellington aquifer. Human-induced activities have also impaired water quality. In some areas, such as the Thunderhead Hills addition in Edmond, salt-water contamination from past oil-field activity has impaired the use of domestic wells.

Dr. Stanley Paxton is Studies Chief at the U.S. Geological Survey Oklahoma Water Science Center. Stan worked from 1982-1999 with ExxonMobil's exploration research lab, where he specialized in the properties of sedimentary rocks in basins. From 1999-2006, Stan served as a faculty member at the Boone-Pickens School of Geology at Oklahoma State University. Stan has a passion for Oklahoma geology, and particularly the Garber-Wellington aquifer. While teaching at OSU, he oversaw five masters students with theses related to the Garber-Wellington aquifer. Currently, Stan is on the study team for the Garber-Wellington Water Management Study.

Beneficial Use Monitoring Program (BUMP) Lake Sampling

Lake Arcadia is one of the 130 lakes monitored through the Beneficial Use Monitoring Program. Five sample locations represent various zones of the lake. At each location, staff collect samples for a broad suite of parameters, acquire a vertical profile of the water column, and record information about current conditions at the site.



Arcadia

Sample Period	Times Visited	Sampling Sites
October 2006 - August 2007	4	5

General

Location	Oklahoma County	Click map for site data
Impoundment	1986	
Area	1,820 acres	
Capacity	27,520 acre-feet	
Purposes	Water Supply, Flood Control, Recreation	

Click Site Names for Available Data

Parameters

	Parameter (Descriptions)	Result	Notes/Comments
	Average Turbidity	42 NTU	30% of values > OWQS of 25 NTU
	Average True Color	53 units	10% of values > OWQS of 70
	Average Secchi Disk Depth	67 cm	
	Water Clarity Rating	average	
	Trophic State Index	58	
	Trophic Class	eutrophic	
Profile	Salinity	0.10 – 0.20 ppt	
Profile	Specific Conductivity	209.7 - 422 µS/cm	
Profile	pH	7.32 - 8.47 pH units	Neutral to slightly alkaline
Profile	Oxidation-Reduction Potential	148 to 415 mV	
Profile	Dissolved Oxygen	Up to 38% of water column < 2 mg/L in August	
Nutrients	Surface Total Nitrogen	0.75 mg/L to 1.85 mg/L	
Nutrients	Surface Total Phosphorus	0.025 mg/L to 0.231 mg/L	
Nutrients	Nitrogen to Phosphorus Ratio	15:1	Phosphorus limited

Beneficial Uses

Click to learn more about Beneficial Uses	Turbidity	pH	Dissolved Oxygen	Metals	TSI	True Color	Sulfates	Chlorides	Total Dissolved Solids	Enterro. & E. coli	Chlor-a
Fish & Wildlife Propagation	NS	S	S	S							
Aesthetics					S	S					
Agriculture							S	S	S		
Primary Body Contact Recreation										NEI	
Public & Private Water Supply											NS

S = Fully Supporting
NS = Not Supporting
NEI = Not Enough Information

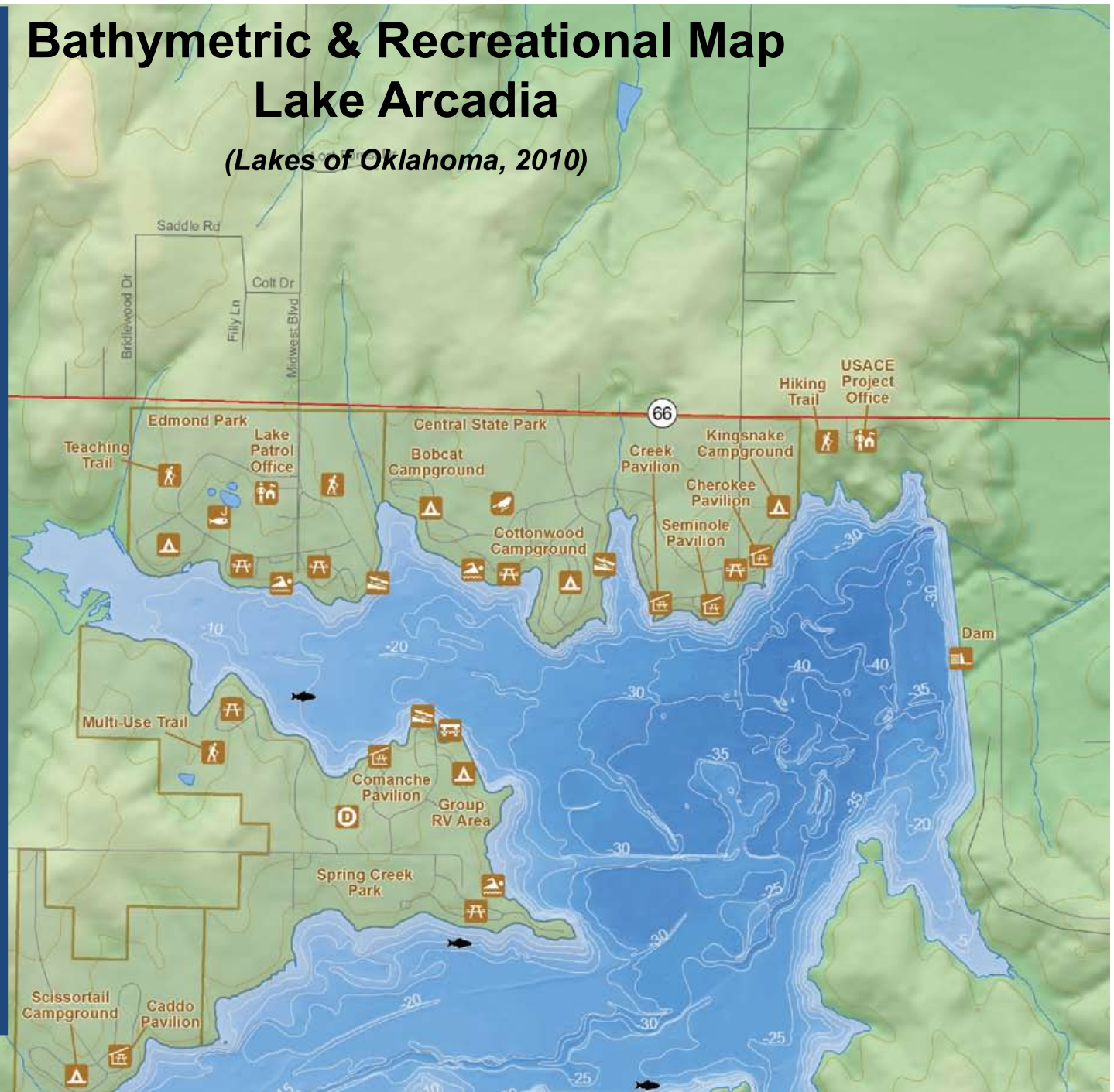
Notes

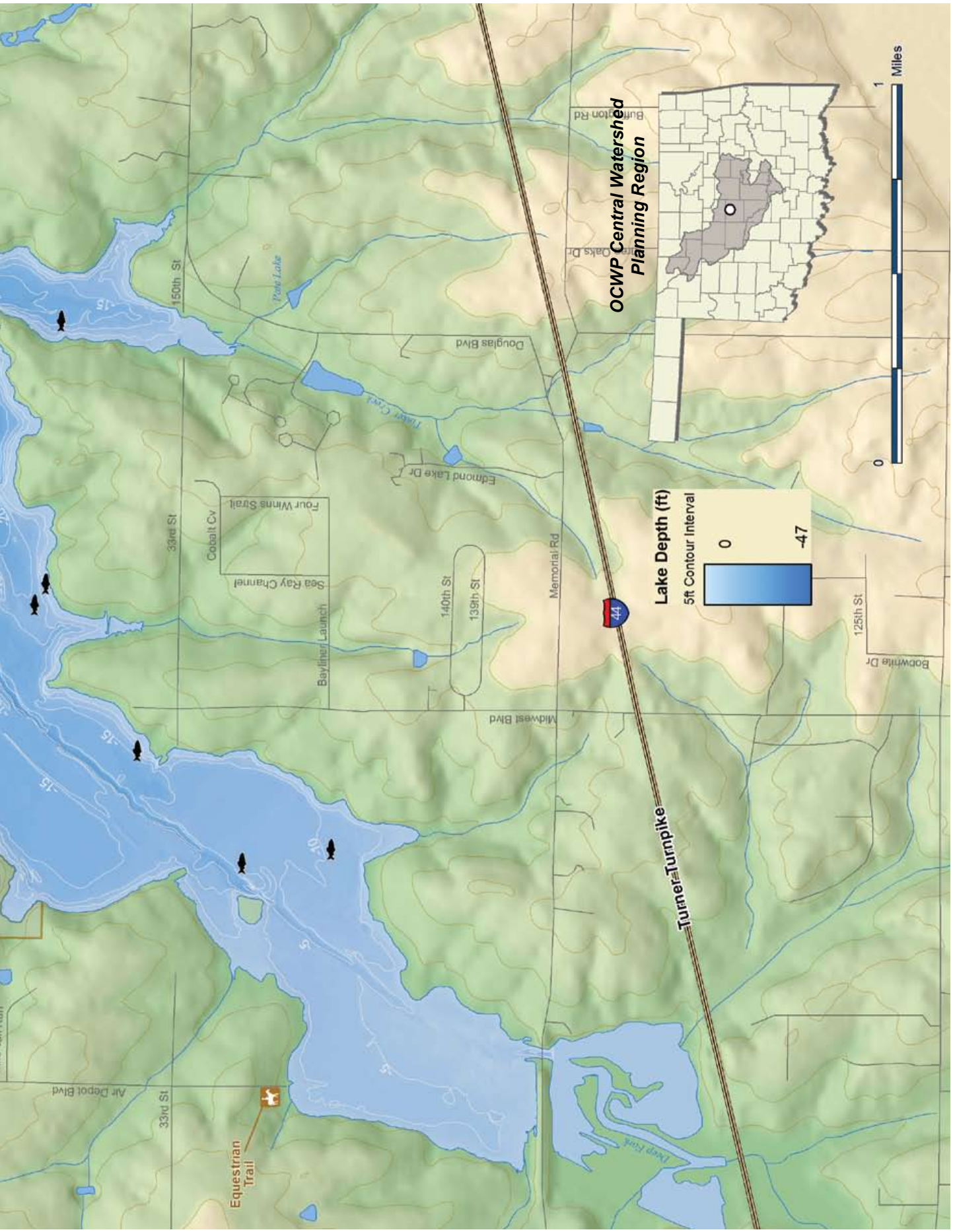
NTU = nephelometric turbidity units
µS/cm = microsiemens per centimeter
E. coli = Escherichia coli
OWQS = Oklahoma Water Quality Standards
mV = millivolts
Chlor-a = Chlorophyll-a
mg/L = milligrams per liter
µS/cm = microsiemens/cm
ppt = parts per thousand
En = Enterococci

Sampling and Assessment by the **Oklahoma Water Resources Board** - 3800 Classen Blvd, Oklahoma City, OK, 73118 - 405/530.8800 - http://www.owrb.ok.gov

Bathymetric Mapping

The OWRB's bathymetric mapping program, which utilizes the agency's GIS and related technology, began in the late 1990s. As of August 2010, the OWRB has completed bathymetric surveys on 37 reservoirs, including Arcadia Lake. The purpose of the program is to provide accurate determinations of the current storage capacities in the state's reservoirs. Obtaining accurate storage volumes is an integral tool used in the management of the state's water supply. For many reservoirs, the only available storage volumes are those that were estimated when the lake was first constructed. Because of sediment deposition that occurs in the reservoir, the volume of the reservoir can be reduced over time.




OCWP Central Watershed Planning Region
Lake Depth (ft)
5ft Contour Interval
0
-47
0
1
Miles
Turner Turnpike
44
Douglas Blvd
Edmond Lake Dr
Memorial Rd
Midwest Blvd
Bayliner Launch
Sea Ray Channel
Four Winns Strait
Cobalt Cv
33rd St
150th St
140th St
139th St
125th St
Bobwhite Dr
Air Depot Blvd
Equestrian Trail
Pete Lake
Deep Fork

Site #3 - Edmond Water Treatment Plant

From the Arcadia Lake Project Office, turn right onto 2nd Street and drive about ¾ miles to Post Road. Turn right (south) onto Post Road and drive about ¾ mile to the treatment plant. Turn right, onto the drive to the plant. Park in the parking lot on the east side, directly in front of the Filter and Operations building.

Edmond Water Supply

Fred Rice, City of Edmond Water Superintendent, will discuss the Edmond water treatment plant, the well field, water supply, and water quality issues.

Water from Arcadia Lake is processed at the Edmond water treatment plant, which is designed to treat 12 million gallons per day. The plant is an advanced water treatment facility that employs seven processes, including ozonation and activated carbon filtration, to purify lake water. Lime softening is also used to reduce hardness and some organics in the finished water. A new state-of-the-art monitoring and control system for the plant and wells allows operators to review real-time data for water quality and volume throughout the system.

The City of Edmond has two primary sources of water: surface water from Arcadia Lake and groundwater from the Garber-Wellington aquifer. In addition, Edmond purchases water from Oklahoma City during periods of high volume demands. In 2009, Edmond used 2.0 billion gallons of Arcadia Lake water, 1.6 billion gallons of groundwater, and 30 million gallons of Oklahoma City water.

The City of Edmond operates and maintains 56 water wells that produce water from the Garber-Wellington aquifer. The wells produce approximately 10 MGD. During the winter off-peak water usage season, the wells produce much of the water used by Edmond residents. Four water wells located east of I-35 were put on line in early 2008. The cost to build these water wells and pipelines was approximately $2 million. The wells can produce over one MGD.

Both well and plant water enter the same distribution system and mix accordingly. The city's west side receives more well water while the east side receives more treatment plant water. Central Edmond receives varying blends of well and plant water.

(Driving back to the Education Center on Post Road, notice two of Edmond's newest water wells.)

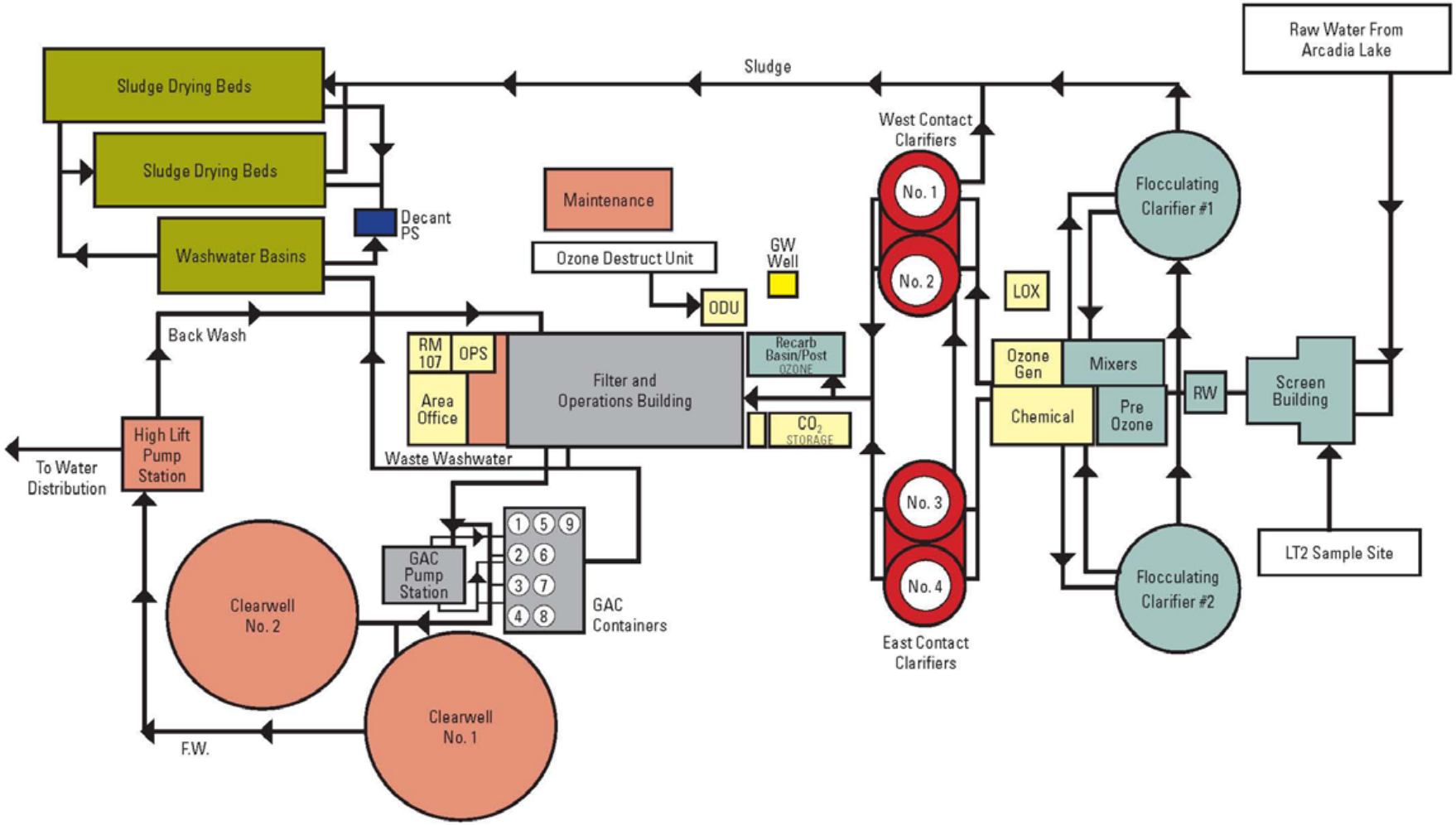
Fred Rice has over 31 years experience in the water and wastewater field. In 2003 he became the Water Resources Superintendent with the City of Edmond, where he manages the operations of the water plant, wastewater plant, water wells, water pumping stations, water towers, water storage tanks and wastewater pumping stations. Since he began working for the city, Water Resources staff has achieved near perfect compliance with all regulatory parameters for drinking water quality and wastewater treatment. Fred has been an active participant with the Oklahoma Comprehensive Water Plan and served as a delegate in the 2010 Water Town Hall.

EDMOND WATER RESOURCES

WATER TREATMENT PLANT

City of Edmond, Oklahoma

PWSID# OK1020723



edmond
A GREAT PLACE TO GROW

Garber-Wellington Water Management Study

The Garber-Wellington aquifer, also referred to as the Central Oklahoma aquifer, underlies about 3,000 square miles in central Oklahoma, where the aquifer is used for municipal, industrial, commercial, agricultural, and domestic water supplies. With the exception of Oklahoma City, all the major communities in central Oklahoma rely either solely or partly on groundwater from this aquifer. In addition to municipal water supply, more than 20,000 homeowners use well water for household or yard use. With a population of approximately 1 million, which is expected to increase 30 percent by 2060, sufficient water supply for the future has became a major concern of water planners and managers.

Oklahoma water law requires the OWRB to conduct hydrologic investigations of State aquifers (groundwater basins), and determine the amount of water that may be allocated to permitted water users. At the present time, the maximum annual yield has not been determined for the Garber-Wellington aquifer. Until the determination is made, users are issued a temporary permit for two acre-feet of water per acre per year. Establishing the maximum yield and equal proportionate share of the Garber-Wellington groundwater basin will enable the OWRB to more efficiently manage the resources of the region and provide water users with a set allocation that will sustain long-term water supply.

Oklahoma Comprehensive Water Plan Implementation

The Garber-Wellington Water Management Study, managed by the OWRB, is funded through state monies and federal funds from the U.S. Bureau of Reclamation and U.S. Geological Survey, who also serve as study partners. Also assisting the investigation are the Association of Central Oklahoma Governments, Oklahoma Geological Survey, Tinker Air Force Base, and other state and federal agencies.

Contributing the state's funding share is the Oklahoma Comprehensive Water Plan, consistent with the long-range plan's water supply planning and implementation strategy. From a supply standpoint, the Garber-Wellington study meets OCWP objectives in that subsequent information will enhance long-term certainty and reliability of the resource to central Oklahoma communities and users. While planning for Oklahoma's future supply and demand issues dominated initial efforts, actual implementation of initiatives and projects arising from the OCWP has already begun. In addition to the Garber-Wellington study, the OCWP is sponsoring work to augment supply through identification of sites statewide for potential artificial groundwater recharge and utilize untapped marginal quality water sources to increase existing supplies. The OCWP is also sponsoring bathymetric mapping of important water supply reservoirs (such as Arcadia, Hulah, Wister, and Waurika) to gather important information related to storage capacity and their ability to meet future local water demands.

Oklahoma Comprehensive Water Plan
OCWP

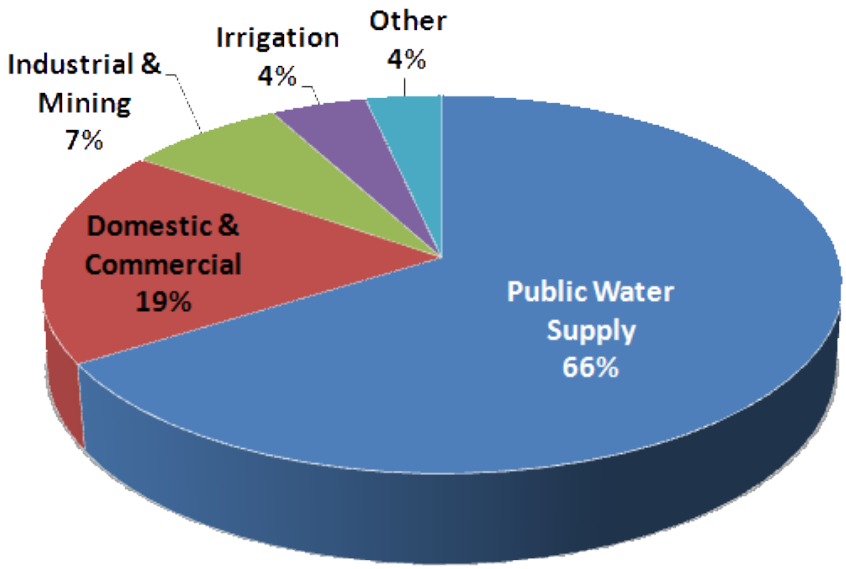
The Oklahoma Water Resources Board (OWRB) initiated the Garber-Wellington Water Management Study in June 2008. The purpose of the study is to conduct an investigation of the geohydrology of the Garber-Wellington aquifer that will provide information to the OWRB, enabling the agency to determine the maximum annual yield of the aquifer. A study team, consisting of geologists and hydrologists with expertise in the Garber-Wellington aquifer, ensures the use of sound science and appropriate methods.

The primary objectives of the Garber-Wellington Water Management Study are to:

- Characterize the aquifer in terms of geologic framework, aquifer boundaries, hydraulic properties (hydraulic conductivity, transmissivity, storage coefficient), water levels, groundwater flow, and the water budget.
- Construct a digital, transient groundwater-flow model of the aquifer to be used in evaluating the allocation of water rights and in simulating various water management strategies.

The study is on track to be completed by September 30, 2011. Over the last year, OWRB staff have monitored continuous groundwater levels in 12 observation wells and has compiled and analyzed reported water use from more than 530 permit holders. USGS staff have made considerable progress in developing a three-dimensional representation of the lithologic properties of the aquifer. The focus for the final year of the study will be constructing a digital groundwater-flow model to evaluate the maximum annual yield and predict the impacts of long-term withdrawals on the aquifer.

Garber-Wellington Aquifer Freshwater Withdrawals (2005)



The USGS estimated that 45,000 acre-feet of water (40 million gallons per day) was withdrawn from the Garber-Wellington aquifer in 2005.

Garber-Wellington Geology

The Garber-Wellington aquifer is composed of three geologic units of Permian age: the Garber Sandstone, Wellington Formation, and Chase, Council Grove, and Admire Groups (formerly classified as the Pennsylvanian-age Oscar Group). These units are mainly interbedded sandstone and mudstone, with minor amounts of conglomerate. The strata in these Permian-aged rock units are commonly referred to as "redbeds" because of the pronounced red color from iron oxide coatings on the mineral grain surfaces.

The total thickness of the combined units is from 1,000 to 1,600 feet. Sandstone thickness ranges from less than 50 feet in the Chase, Council Grove, and Admire Groups (CCGA), in the east part of the aquifer, to more than 600 feet in the Garber Sandstone, in the west-central part of the aquifer. The aquifer can be divided into a clay-rich part (less than 40 percent sandstone) in the east, dominantly in the CCGA, and a sand-rich part (greater than 40 percent sandstone) in the west.

Most of the usable groundwater is in the Garber Sandstone and the Wellington Formation. Wells completed in the aquifer can yield as much as 600 gallons per minute (gpm), but generally yield from 200 to 400 gpm. Most domestic, stock, and irrigation wells in the aquifer draw water from less than 300 feet below land surface, whereas most public-supply wells produce water from depths greater than 300 feet.

OWRB Loan Program

To date, the OWRB's Financial Assistance Program has provided five loans to the City of Edmond to fund more than $25.7 million in various drinking water projects. These loans through the Drinking Water State Revolving Fund, a cooperative program between the OWRB and Oklahoma Department of Environmental Quality, have saved approximately $7.7 million in interest costs to the City.

Through its five loan and grant programs, the OWRB has provided more than $2.3 billion in water and wastewater improvements throughout Oklahoma.

Oklahoma Water Resources Board Funding				
Edmond Public Works Authority				
Funding	Closing Date	Amount	Interest Rate Savings	Project Description
DWSRF Loan	August 2005	$3,726,484	$1,117,945	Proceeds used to refinance Edmond's OWRB Interim Construction Drinking Water SRF Promissory Note (2002), originally incurred to fund water treatment plant improvements to address an ODEQ Consent Order, other plant needs, construction design and management.
DWSRF Loan	February 2005	$7,620,000	$2,286,000	Proceeds used to make improvements to Edmond's water system as part of the 2020 Master Water Plan Improvements, including a new water storage and pumping complex with two one million gallon storage tanks, two 3,000 gallon per minute pumps, two 5,500 gpm pumps, 6 miles of 24-inch transmission lines, 4 miles of 24-inch distribution lines, 4.5 miles of 36-inch transmission line, and related appurtenances.
DWSRF Loan	June 2005	$7,597,844	$2,279,353	
DWSRF Loan	November 2005	$3,068,246	$920,474	
DWSRF Loan	August 2005	$3,713,142	$1,113,943	
	TOTALS	$25,725,716	$7,717,715	

Acknowledgements

The OWRB thanks the many individuals and organizations that contributed to this field trip. In particular, we thank the City of Edmond, Best Western Edmond Inn and Suites, and the Oklahoma Department of Wildlife and Conservation for their assistance and access to their property.