REFLECTIONS: Raising the "Barr "for a High Plains Reservoir in Colorado by Steve Lundt, CLM, January, 2009

Descending towards the Denver International Airport, you will notice several cottonwood-rimmed lakes that seem quiet and remote. Barr Lake is the last one visible just before touching down. Instead of heading straight to the popular mountain destinations like most visitors, a short detour north to Barr Lake will reveal a ground-level perspective of a Kansas-like, high plains landscape interrupted by a highly managed, irrigation reservoir.

Barr Lake, Colorado

Barr Lake, like virtually every other lentic system below 7,000 feet in Colorado, is actually a shallow, warm-water reservoir. In addition to cottonwoods near the shore, there is a ring of white mineral deposits along the concrete dam and a sterile, sandy shoreline exposed from the annual 15-foot draw down. Tranquility noticed from the airplane's window is now rattled by the sounds of a busy interstate, 10 coal trains per day lumbering towards Denver, daily changing of canal headgates sending water to various cornfields, and the humming of suburban development that is quickly encroaching the State Park that buffers the reservoir.

Defining History

Barr Lake actually began as an oasis and has been described as an "oasis" on several occasions throughout its 120+ year history. Before the late 1800's, the site was a buffalo wallow, a welcoming site, and a true oasis for the long cattle drives coming up from Texas. By 1885, Oasis Reservoir was built and filled by a 19-mile canal from the South Platte River, quickly becoming an aristocratic get-away for the Denver elite. Soon, the agricultural development of the dry grasslands around Denver provided the economic push to change ownership, and by 1908 Oasis Reservoir was doubled in size and renamed Barr Lake. For the past 100 years, Barr Lake has been owned and operated by an irrigation company for the sole purpose of providing a reliable source of water to the local share-holding farmers. As long as the reservoir was full at the beginning of the summer, all was well.

Water quality issues finally stepped into the picture in the 1960's when Barr Lake was labeled as the nation's largest in-land sewage lagoon (Barr Lake State Parks 2000). The history of water quantity had finally caught up with Barr Lake. After 50 years of receiving raw and partially treated wastewater and urban/industrial runoff from Denver, Barr Lake was void of any dissolved oxygen, even in the canal inlet water. The typical gas releases that come with anoxia impaired the livability of Brighton, Colorado, a small town just 3 miles north of the reservoir. Residents had to keep their windows closed at night thanks to the blanket of decomposing smells that covered the small town.

By 1966, a new central wastewater treatment facility was brought on-line to improve downstream conditions by consolidating the treatment of wastewater and adding secondary treatment. The new wastewater treatment plant was built further downstream, which placed the new outfalls below Barr Lake's diversion point. (This is where the uniqueness of the dry Southwest challenges a lake professional's beliefs). The owners of Barr Lake, instead of being ecstatic that the location of the wastewater treatment facility was downstream from their diversion, sued to claim their right to the wastewater effluent that used to flow by gravity into Barr Lake. After a complex lawsuit and agreement with water and wastewater utilities, effluent pumps were installed at the new regional wastewater treatment facility so that secondary effluent could be pumped uphill to Barr Lake by the request of the reservoir owners. What's ironic is that this occurred at the exact same time as the infamous wastewater diversion case that involved diverting wastewater away from Lake Washington (Washington). Two completely opposite lake management decisions, Barr Lake's driven by water quantity while Lake Washington's was driven by water quality.

In Lake Washington's case, the diversion of wastewater away from the lake prevented degradation. For Barr Lake, the diversion of wastewater to a reservoir allowed for restoration. The improvement from primary to secondary wastewater treatment and less dependence on wastewater inflows changed Barr Lake from a dead, sewage lagoon to an oasis again, providing a thriving wildlife refuge for some 350 different bird species that have been observed using the reservoir. Barr Lake became a state park in 1976. In just 12 years, Barr Lake's water quality condition experienced a dramatic improvement.

The next major management change occurred when municipalities started eyeing Barr Lake as a secondary drinking water source, another oasis for their thirsty costumers. Those who were relying on deep aquifers had to quickly find new, long range sources for drinking water because the water table quickly dropped. Barr Lake is now a source of drinking water and has been heavily monitored and managed since the early 1990's.

Dry Climate

Water quantity has almost always trumped water quality in the Southwest because of the climate and the lack of precipitation. East of the Rockies, Colorado is considered semi-arid. Denver's typical annual precipitation is 14 inches, right in the middle of the semi-arid range of 10-20 inches per year (Smith 1996). Severe droughts, flash floods, and unpredictable precipitation patterns are common around Barr Lake. If the availability and quantity of water were similar to the Pacific Northwest or other wetter locations, then Barr Lake would probably have better water quality and would not be so dependent on treated effluent as a source of inflow.

The Value of More Water

Scarcity of any commodity means elevated prices. What is an acre-foot of water worth in the Southwest compared to the Northeast? How valuable is an "oasis" to the thirsty people of Colorado, especially those newer communities facing rapid growth? The trend for the high plains irrigation reservoirs in eastern Colorado is to sell the agricultural water rights to municipalities for drinking

water. Several irrigation reservoirs are now used strictly for domestic water supply use. Along with the water comes very important senior appropriation dates that can guarantee a city water during the driest summers.

The price of water in a reservoir like Barr Lake can range anywhere between $10,000 to $25,000 per acre-foot. At the high end of that range in value, Barr Lake could be worth close to $750 million at full-pool. The future can only mean higher prices for water; higher demand for both quantity and quality. The Denver area is almost in a constant state of water shortage - the demand is always greater than the supply. All of the water in the South Platte River has been appropriated. Recently, it seems each month's rain totals are below the norm, and it is estimated that another 2.0 million people will be moving to the Denver area by 2035 (DRCOG 2008). The pristine Rocky Mountain water was claimed long ago thanks to perspicacious municipalities (Denver Water) and industries (Coors Brewery). Now it is time to get creative with western water laws to keep up with the demand.

The Cost of Cleaner Water

Barr Lake is a great example to show how much people are willing to spend in semi-arid climates to find new sources of drinking water. The reservoir water is ideal for watering crops, with plenty of nutrients to help fertilize the land. In 2004, domestic water supply use was added to Barr Lake. Drinking water standards are considerably more stringent than those allowed for irrigation only.

Barr Lake has been exceeding the state's pH standard of 6.5-9.0 and is currently on Colorado's 303(d) list. This listing triggered the formation of a watershed association in 2004 to help write and implement a pH TMDL for Barr Lake. The TMDL and the implementation plan will include a long-term monitoring program, potentially half a billion dollars spent on building tertiary treatment systems for up to nine wastewater treatment facilities upstream, an annual commitment by several key stakeholders to participate in the planning stages, and changing of social norms for the 2.5 million people who live in the Denver metropolitan area. Half of Colorado's population lives within the Barr Lake watershed, just 850 square miles.

The cost to improve water quality conditions in Barr Lake will be just as staggering as the $25,000 per acre-foot water price. Rate payers will have to share the burden of tertiary upgrades with higher utility bills, residents will have to pay higher stormwater bills to help build pollution reduction facilities throughout the watershed, and cost monitoring is anticipated to cost $250,000 annually that the public will have to share.

Water Runs Uphill

A positive side to the lack of water is that it fosters creativity when it comes to water resource management. Re-use of wastewater, water rights exchanges, flow monitoring, water conservation, and an overall higher appreciation of water are a way of life in Colorado because of the lack of precipitation. Not a drop of water that comes out of the sky goes unused, and the water is typically used multiple times by pushing it uphill.

Effluent Pumps: The only two sources of water for Barr Lake are the South Platte River and Metro Wastewater Reclamation District. The owners of Barr Lake have control over the effluent pumps that deliver about 10%-20% of the total water to Barr Lake. Metro Wastewater Reclamation District has no control over where the water goes and owns no water rights.

Re-use: In Colorado, 80% of the precipitation lands on the west side of the Continental Divide, while about 80% of the people and water use occurs on the east side where most Coloradans live. Trans-Continental water, west slope water pumped uphill through massive tunnels to the east slope, can be

used to extinction. Many Front Range municipalities have built re-use treatment plants connected to the end of a wastewater treatment facility to provide non-potable water for irrigating public parks and golf courses. Since wastewater treatment facilities are always downstream, it requires a complex pumping and distribution system to get re-use water back uphill to be used.

Water Exchanges: Some of the water that gets to Barr Lake actually comes from downstream water users that have sold their water rights to upstream cities. This kind of transfer of a water right not only moves water uphill but it does so without even using a pump. For example, a municipality that needs to store more drinking water in Barr Lake can buy a farm that is a county or two downstream that has a senior agricultural water right. Once the water exchange has been approved, the municipality can change that water right to drinking water and move the point of diversion upstream to Barr Lake with the understanding that the land where the old ranch was will dry up completely.

Side Bank or Sand Filtration: Municipalities that are drawing their drinking water from effluent-dominated rivers and reservoirs are using the sandy loams to pull their water up through the alluvial aquifer. The ground is one big sand filtration system removing particulates and organic matter from the water. After the pumped, shallow groundwater is pulled out of the ground, it is usually sent back upstream to a drinking water treatment plant to be polished and sent back out for drinking water. The cycle of water starts all over again.

If a person could track the movement of each water molecule, there would be definite patterns of spiraling and grand circulations around the Denver area going from drinking water to wastewater and then back to drinking water. At a given location along the South Platte River, it looks like water is flowing nicely downhill but with a closer look, the water (that should have gone to the Pacific Ocean) is just heading to another pump to be sent back uphill.

Reservoir/Watershed Management Challenges

Along with the challenges to find water to put into Barr Lake, the other struggle is to determine what water quality is appropriate for the designated uses in Barr Lake. Clearly a wallow was appropriate in the 1800's, but how should a shallow, irrigation reservoir turned drinking water reservoir downstream of 2.5 million people look? The past 100 years was a struggle for quantity, and the next 100 years will be a struggle for both quantity and quality.

Barr Lake's 303(d) listing for pH directly relates to the usual cultural eutrophication process that chokes so many of our world's lakes and reservoirs. On average, 200,000 pounds of total phosphorus is loaded to Barr Lake each year, usually when the reservoir refills each winter (Boyer 2008). By 2010, there will be state-wide nutrient criteria applied to Colorado water bodies. For so many years, quantity has been the focus for reservoir management decisions at Barr Lake, sometimes helping water quality. Now, with the management swing from agriculture to water supply use, water quality and water quantity decisions are dipolar. It is important to make sure that water quality conditions and regulations do not change Barr Lake from an oasis into a mirage.

Summary

The lack of precipitation has been the driving force behind Barr Lake's existence, while at the same time the steady presence of water in Barr Lake has made it an oasis for hundreds of years. There has always been just enough water to meet the needs; a wallow for the buffalo, a small reservoir for the Denver elite, a fluctuating irrigation reservoir for farmers, and now a reliable drinking water reservoir for expanding communities. Groundwater, rain, snowmelt, stormwater, and wastewater effluent have supported Barr Lake and its users for the past 120 years. The next challenge is to make sure the quality of water is appropriate to protect the uses for the future.

Oasis has two definitions that both apply to this reservoir: *1) a fertile spot in a desert, made so by the presence of water, and 2) A situation preserved from surrounding unpleasantness; a refuge* (American Heritage Dictionary 2008). Barr Lake clearly satisfies the first definition historically. It is the second definition that may be more appropriate for the future of Barr Lake. Barr Lake is a refuge for water managers trying to provide more drinking water in an unpleasant situation – too little water and too much phosphorus.

References

Smith, R.L. 1996. *Ecology and Field Biology, 5th Edition*
Barr Lake State Park, 2000. *A Land in Transition, The History of Barr Lake*
DRCOG 2008. *Metro Vision 2035 Plan*
"oasis." *The American Heritage® Dictionary of the English Language, Fourth Edition*. Houghton Mifflin Company, 2004. 14 Oct. 2008. <Dictionary.com
Boyer, J.M. 2008. *Barr Lake Reservoir Assessment*. AMEC, Inc.