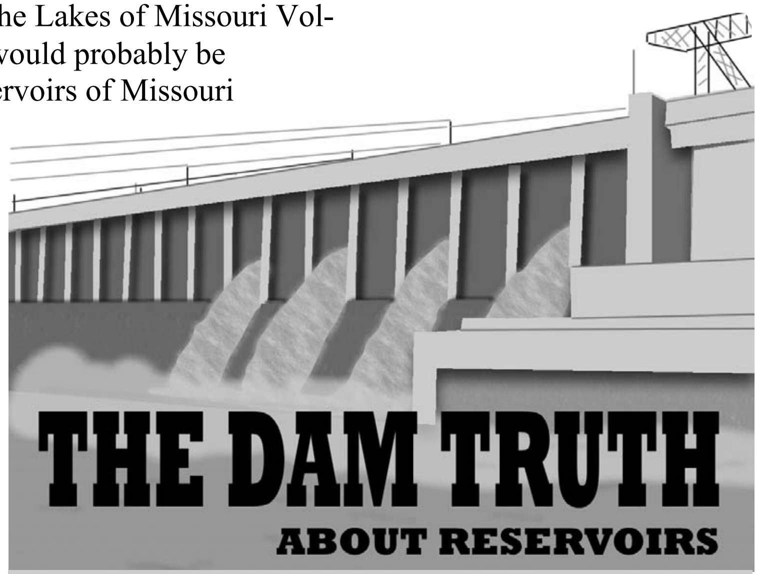
NEWSLETTER FOR THE LAKES OF MISSOURI VOLUNTEER PROGRAM

The Water Line

Volume 7 **Number 1** **Winter 2003**

Our program is called the Lakes of Missouri Volunteer Program, though it would probably be more aptly titled "The Reservoirs of Missouri Volunteer Program". Except for a single oxbow lake, Creve Coeur in St. Louis, all of the water bodies ever sampled for the LMVP have been man-made reservoirs. For this reason, it seems appropriate that we discuss what it means to be a reservoir.



Bagnell Dam in Osage Beach, Missouri is a Gravity Dam

Reservoirs are constructed to address one or more needs such as drinking water supply, irrigation, recreation, flood control, power generation, or navigation. There are 2 broad categories of reservoirs, the valley reservoir and the off-river storage reservoir. The valley reservoir is most common in Missouri. To create a valley reservoir, a dam is constructed perpendicular to a river and the river subsequently pools up behind the dam. The off-river storage reservoir is created near a river and water is diverted to it via gravity or by pumping. Delaney Lake in Mississippi County is an example.

To construct a reservoir, there are 4 basic dam types:

Arch dams are made out of concrete in an arch shape, with the convex side facing upstream. Arch dams can be much thinner than other types of dams, because they incorporate the inherent strength of the arch shape in their design. This type of dam requires very solid rock and for that reason is reserved for narrow, steep sided valleys. An example is the Hoover Dam on the Colorado River.

Buttress dams are made out of concrete (or masonry) and are triangular in cross section. This type of dam is strengthened by regularly spaced supports, or buttresses, along the downstream side of the dam. The supports help to counter the pressure of the water against the dam wall. An example is Powersite Dam at Lake Taneycomo.

Gravity dams are also made of concrete (or masonry). They are essentially giant blocks that use their weight to hold back the water. Gravity dams need to be built on a solid foundation of rock. An example of this type is Bagnell Dam at Lake of the Ozarks.

Embankment dams are constructed of rock or earth. They may have either a central core or a cover layer of impenetrable material, usually clay or concrete. Embankment dams are suitable for areas with wide valleys and may be built on softer soils. An example is Clarence Cannon Dam on Mark Twain Lake.

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LAKES OF MISSOURI VOLUNTEER PROGRAM

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The Dam Truth cont. from pg. 1

According to UN data, there were 800,000 dams worldwide in 1997. Around 25% of the water that previously flowed to the oceans is impounded in reservoirs. These dams are more concentrated in the temperate and sub-tropical latitudes. Most of the 1,700 or so new *large* dams under construction are in developing countries.

Reservoirs vs. Lakes

<u>Physical Differences</u>

Though they seem similar to one another, reservoirs and lakes are different in a number of ways. One way to differentiate them is by their shape when viewed from above. Reservoirs usually have a dendritic appearance, thin at the upper stretches and thicker toward the dam. This is a result of the water backing up into the feeding streams as the reservoir filled in. Natural lakes, on the other hand, are usually much more rounded, due to the processes that form them (glacial, volcanic, tectonic).

Reservoirs are deeper at the dam and become shallower at the upper end. The deepest part of a natural lake is generally at the center.

<u>Differences in Water Quality</u>

Reservoirs usually have greater inputs of pollutants than natural lakes. This is primarily due to the greater volume of water flowing into reservoirs than lakes. However, this greater inflow also means that water must be flowing *out* of the reservoir at a faster rate. The amount of time a waterbody holds a particular unit of water is called its residence or retention time. Among Missouri reservoirs, retention times vary considerably. For example, Taneycomo water is replaced every 3 days on average, while Stockton Lake water sticks around for 1.2 years. The great Lake Superior, a natural lake, has a retention time of 500 years.

The water quality in natural lakes tends to improve toward the center of the lake. In reservoirs, water quality improves longitudinally, toward the dam. For reservoirs, this is largely due to the deposition of sediments and other materials as the water velocity decreases.

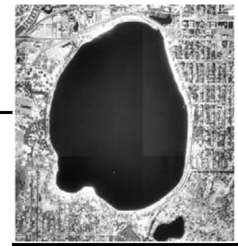
What happens downstream of a dam in another thing to consider. Typically the water coming out of the dam has lower concentrations of nutrients and sediments than the stream . In some cases, though, reservoir managers may choose to pull water through the dam from near the bottom of the lake. This is called selective withdrawal. Deep, *hypolimnetic* (see page 5 of the Spring 2002 Waterline) water is colder, has higher concentrations of nutrients and less oxygen than the surface water. Sending this water downstream can have significant effects on the physical, chemical and biological characteristics of the stream.

When several reservoirs occur on the same river, the first reservoir often has higher concentrations of nutrients and suspended sediments. An example of this is the Jackson County lakes, Jacomo, Blue Springs and Prairie Lee. See the figure below.

I hope this helps in your understanding of reservoirs. I apologize in advance, but I'm going to continue calling our reservoirs "lakes". The RMVP just doesn't have the same ring to it.

Tony Thorpe

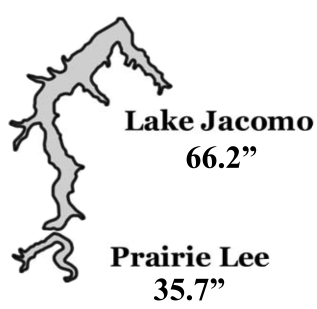
Right:
Lake Calhoun, near Minneapolis, MN is a natural lake.



Left:
Table Rock Lake, in SW Missouri is a man-made reservoir.

Note the contrasting shapes of these two waterbodies. The man-made reservoir has a dendritic shape, while the natural lake has a round shape. *The pictures are not to scale.*

Secchi Values at 2 Jackson County Reservoirs



These reservoirs are located on the East Fork of the Little Blue River in Jackson County. The numbers represent the average 1999 Secchi transparency values in inches. Prairie Lee catches much of the sediment that would otherwise flow into Lake Jacomo.

Secchi transparency is measure of water clarity. Higher numbers indicate clearer water.

It may seem that once the sampling is over, the work is done. At LMVP headquarters, though, our work has just begun.

Lindsay, the Lab Technician, takes filters out of the drying oven. Next step is to weigh the filters, then to cook them at 500° C (932° F).

Here's a look at what goes on

In the LAB

Total Suspended Solids

Travis, the Senior Research Technician, enters his data. We record values to 0.1 mg. That's just 3.5 millionths of an ounce! Note the look of intense concentration. Data entry is a very important part of this job.

At most LMVP sample sites, volunteers collect and filter water to measure inorganic suspended solids (suspended sediment). For this test, a volume of water is pulled through a glass fiber filter using a vacuum pump. The filter strains tiny particles from the water in much the same way a colander strains pasta. Afterwards, the filter is carefully folded to make sure all of the particles remain on the filter, placed in a protective filter "house" and then frozen.

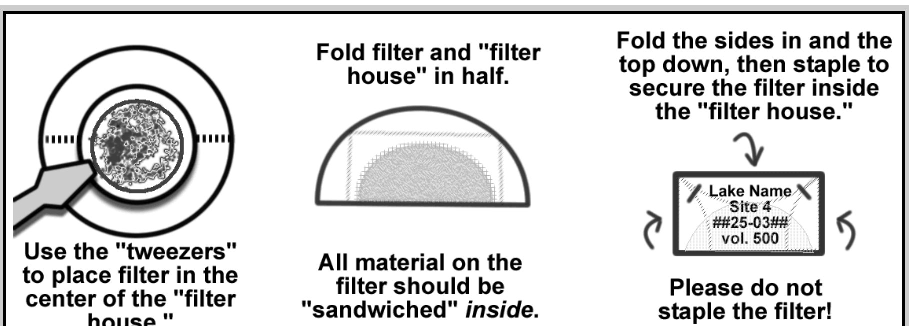
When we conduct the analyses for inorganic suspended solids, the first step is to dry the filter to remove any remaining water. To accomplish this, the filters are heated to 105° C (221° F). Then the filters are weighed. After being weighed, the filters are cooked at an extremely high temperature (500° C or 932° F). At such a high temperature, any organic bits are burned away, leaving only inorganic compounds behind. The organic bits on the filters often spark and flash as we put the filters in the oven! The filters are weighed again after cooking for 20 minutes.

Here is where it can get really complicated. We now have to compare the weight of the filters *after* cooking to the weight we recorded *before* we gave the filters to the volunteers. It is the only way we can determine the weight of the substances on the filter. *This means that we have to identify every single filter by the number written on the paper filter "house"*.

This is easily accomplished if a volunteer is only sampling one site. However, when a volunteer samples multiple sites there is often some confusion. What usually happens is that a filter intended for one site will be used at another. As long as the change is recorded on both the filter "house" and the data sheet, and we can still read the original number, there is no problem. It can be very confusing, though, if the volunteer isn't aware of the change, or a well-intentioned volunteer scratches out the old site number and writes the new one in. It takes much work, but these issues can usually be resolved through deductive reasoning.

After we have identified the filters, we are ready to enter the data into our database. From here we can make those nifty graphs you see in the data report each year!

Tony Thorpe



At left are the procedures for processing your TSS filters.

Important things to remember:

1. **Don't touch the filter with your bare hands**
2. **Don't alter the number on the filter**
3. **Be sure to record the filter number, the site number (if applicable), and volume of water filtered on the data sheet**

The Influence of Freshwater on the World Climate

You probably know that the world's oceans contribute significantly to the global climate. Water circulation in the North Atlantic is driven by small differences in water density. These density differences depend on a balance between water temperature and the salinity fluctuations that arise from small freshwater inputs; i.e. precipitation and river run-off. The circulation process itself is known as *thermohaline circulation*, or *ocean overturn*.

Here's how it works:
The warm, salty, surface waters of the Gulf Stream move up the eastern coast of North America and then east to the European coast. From here, the heat absorbed by the water at the equator is released and carried into Europe by westerly onshore winds. As the surface water cools, it becomes denser and sinks to a depth of about 1 mile, traveling back across the Atlantic and then southward toward the equator again. The climates of Europe and North America rely heavily on the heat released from the Gulf Stream.

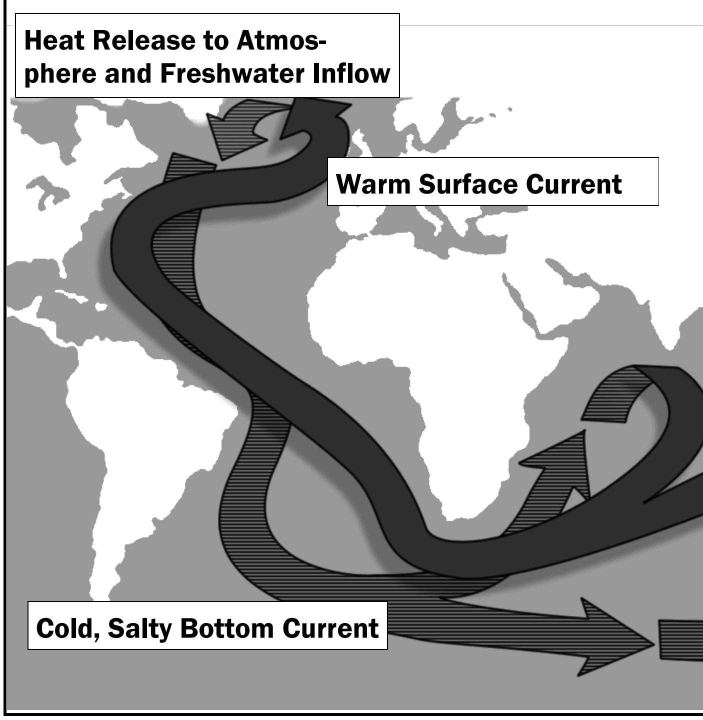
New Revelations:
Over the past 30 years, the North Atlantic has been receiving huge inflows of cold freshwater. There is mounting evidence that the resulting cool-down of the North Atlantic could give rise to a mini ice age. Scientists cannot say without a doubt that these huge inflows come from the glaciers melting in the Arctic, but they are certainly the prime suspect.

The new mass of relatively fresh water sits on top of the ocean's saltier water like a thermal blanket. This may cause a weakening or even halting water circulation. As glaciers continue to melt and precipitation in higher latitudes increases, greater inflows of cold freshwater are going to rapidly drop salinity and temperatures of the North Atlantic and adjoining seas.

This could have a profound effect. The deepwater current that twists and swirls through *all* the world's oceans is driven primarily by the circulation of the North Atlantic. If the North Atlantic circulation pattern were altered, average temperatures over much of the U.S. could drop by 5 degrees Fahrenheit and by as much as 10 degrees Fahrenheit in northern Europe and northern Asia. Strangely enough, global warming could lead to localized cooling.

Travis Hill

Atlantic Ocean Circulation Patterns



For more information:
http://www.discover.com/sept_02/featice.html
http://www.enviroliteracy.org/article.php/545.html
http://www.whoi.edu/home/about/whatsnew_abruptclimate.html

Look for the LMVP at the 2003 Missouri Natural Resources Conference in Osage Beach

The conference takes place from January 29th to the 31st. Tony and Dan will have a booth set up with the purpose of spreading the good word about the program.

For more information about the Missouri Natural Resources Conference, visit their website at: http://www.mnrc.org/

Coliforms are a sub-group of bacteria that are often mentioned in reference to water quality. There are numerous bacteria that fall under the coliform heading, which leads to some confusion when discussing bacteria types and numbers. What follows is a short discussion on coliforms, how the different types relate to each other, and water quality standards.

<u>Total Coliform</u>

A total coliform test measures just that, all coliform bacteria. There are numerous coliform species which occur naturally in the environment. Most are considered harmless, however some of the bacteria *are* harmful and indicate fecal contamination.

Total coliform bacteria testing is used to screen water quality because the bacteria are easy to culture in a lab setting. The non-fecal types of bacteria tend to survive longer in the environment than the those associated with fecal material. This means the window of opportunity for finding coliform bacteria in a water sample is longer than if just fecal coliform were being tested. Total coliform numbers have been used as an indicator of potentially harmful bacteria as well as other pathogenic organisms.

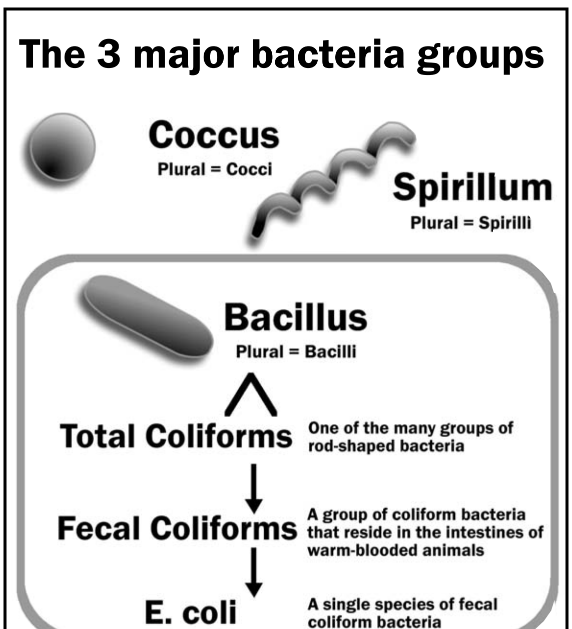
Total coliform testing is very useful when monitoring drinking water, as the presence of any of these bacteria would suggest a problem with water treatment. Use of total coliform monitoring for swimming areas has mixed value. On one hand, high total coliform numbers would suggest a potential problem even if the more harmful bacteria were not present at the actual time of sampling. The down side to using total coliform is that you may find that the bacteria are always present, and concern over water contact might be overrated.

<u>Fecal Coliform</u>

This is a sub-group of bacteria under the total coliform grouping. These bacteria are found in the guts of warm blooded animals (humans, livestock, pets, waterfowl, etc). Presence of these bacteria indicate a fecal contamination of the water. These bacteria can cause diarrhea, stomach cramps, and nausea. Non-fecal bacteria are not measured with this test.

Monitoring fecal coliform bacteria gives you an exact number of potentially harmful bacteria in the water (as opposed to an indicator of possible presence). The drawback to monitoring just fecal coliform is that these bacteria are relatively short-lived in the environment. A low reading may not give you a good indication of what was present the day before.

In Missouri, the acceptable level for fecal coliform is less than 200 cells (colony forming units) per 100 mL of water. If a reading is equal to or higher than this, the water is deemed unsafe for full body contact.



The major groups of bacteria are defined by shape. Coliform bacteria fall in the bacillus, or rod-shaped, group.

<u>E.coli</u>

Escherichia coli is a specific bacteria that falls under the fecal coliform heading. There are many strains of this one type of bacteria and most are harmless. There is one strain, E. coli 0157: H7, that produces a powerful toxin and can lead to serious illness.

Monitoring for this specific bacteria is probably not the best approach for determining if waters are safe for full-contact recreation as the monitoring is too specific and may overlook other harmful types of bacteria.

Dan Obrecht

A World of Water

A recent issue of <u>National Geographic</u> contained an article entitled "Water Pressure" which dealt with water as a limited resource on Earth. The idea of water being limited seems hard to fathom for many of us. What follows is a conversation that I had with myself on the subject:

I've seen satellite photos of the Earth, the majority of the photo is blue with water. So how can there be any shortage?

Yes, the Earth is covered with a lot of water, about 70% of its surface is water. If you add up all of the water on Earth you would find that there is 326 million cubic miles (give or take a few gallons) of water on this planet.

That's a lot of H_2O! So what is the problem?

A full 97% of that water is found in the oceans. This water is too saline to be used for drinking, irrigation, or even industry. Desalinization is currently too expensive to be a large scale answer to any water shortages we may face.

Hold on! I just did the math. According to your numbers, we have close to 10 million cubic miles of fresh (non-salt) water on the planet. I still don't see how water can be limiting.

Well, out of all of the fresh water on the Earth, over two-thirds is locked up in glaciers and ice caps. When you get down to it, less than one percent of the water on Earth is both fresh and available to use.

Okay, so we only have 3.26 million cubic miles of usable fresh water. I guess you're going to tell me that we are using it up too fast and soon there will be none left.

That isn't quite how it works. You see we don't really use water up as much as recycle it.

Recycle water?

Yes. Haven't you ever heard of the water cycle? It is the process in which water moves around, through and above the Earth. There is constantly water or water vapor moving all around us.

Even in a drought?

The water cycle is a global phenomenon. It may be dry here, but its raining somewhere else. In fact, about 4 trillion gallons of water falls to Earth each day. Most of the 3,100 cubic miles of water in the atmosphere is in the form of vapor. When it falls back to Earth its in the form of rain, snow and ice.

So what happens once it hits Earth?

Generally there are two paths for the water to go. One is to move across the surface, the other is for it to soak into the ground. If the water stays on the surface it will flow until it reaches a lake or the ocean, that is if it doesn't evaporate before it reaches its final destination. If water soaks into the ground it can end up stored there for quite a while, but at some time it will make its way back to the surface.

You mean like through a spring?

Yes, ground water will make its way to the surface through things such as springs, artesian wells and seepages. Ground water can also be pulled up to the surface by humans and through the roots of plants.

Okay, so how does it get back into the atmosphere?

I've already mentioned evaporation. Water that is on the surfaces will evaporate into the atmos-

World of Water continued from page 6

phere. This can be water in a puddle, a pond, a river and the ocean. Approximately 2.5 trillion gallons a day re-enter the atmosphere by way of evaporation. A second way water vapor moves into the atmosphere is through transpiration.

Transper-what?

Transpiration. Plants are constantly pulling water up through their roots and then passing the water out through the leaves where it enters the atmosphere. This process is known as transpiration.

If the amount of water remains the same on Earth, how can it be a limiting resource?

While the total amount of fresh water remains relatively constant across the Earth, the demand doesn't. The global population grows by 219,000 people everyday. All of these people require fresh water. If demand continues to grow we can only expect more shortages of water in the future. It should also be noted that the distribution of water is not even across the globe. Sometimes water is a limited resource because there is not enough of it in a region. The southwest United States is a great example.

How so?

The Colorado River was once mighty enough to carve out the Grand Canyon. It now reaches the ocean as a mere trickle because the water is diverted to quench the thirst of the arid southwest.

We drink all of it?

The Colorado River is a water source for about 25 million people. Another big drain on the river is irrigation. In fact, 70% of the water used globally goes into growing food.

That's a lot of people drinking Colorado River water.

Yes it is. In the U.S. we rely on surface waters (rivers and lakes) for about 80% of our water, with the rest coming from underground. Of course there are some regions where one or the other is the whole source of water.

Columbia Daily Tribune - Saturday, October 19, 2002

I guess we should look at things from a global perspective since the water cycle is such a large scale phenomenon. What is the global outlook?

The United Nations predicts that 2.7 billion people will face a water shortage by the year 2025. Along with water shortages, we have to be concerned with the purity of our water. There are 1.2 billion people in the world that don't have clean drinking water, something we in the United States sometimes take for granted.

Not only is it important to be aware of our water use, and misuse, it is also important to protect what we have. The amount of fresh, clean, accessible water is finite. We need to do everything we can to protect it.

Dan Obrecht

You'll Never Miss the Water
Till the Well Runs Dry

Credited to W.C. Handy—"Father of the Blues"

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In This Issue

Remember to check the "Links" page at www.lmvp.org for websites containing information about the topics in this newsletter.

And, of course, all links mentioned in the articles will be included on the web so you don't have to type them in.

www.lmvp.org