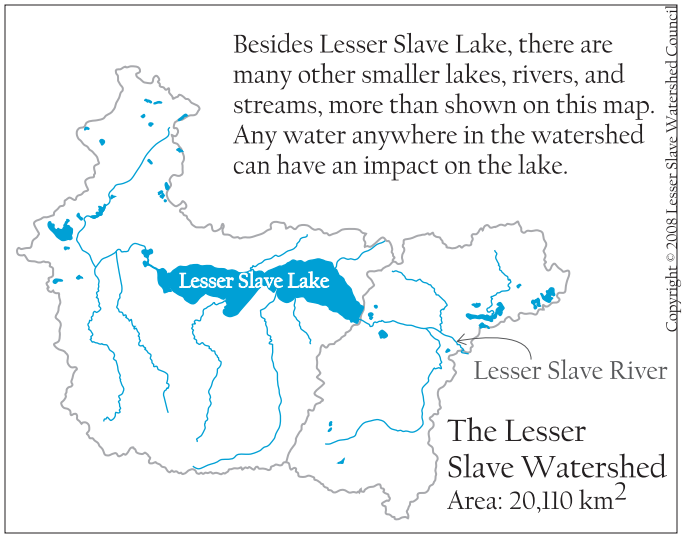
LSWC Fact Sheet:
Hydrology and Water Management

Hydrology Defined

Hydrology is the study of water: it's flows and volumes. When looking at the hydrology of a lake or a river, a hydrologist will be finding out: how much water is flowing in, how much water is flowing out, and how the water levels change. Water management can be complicated but at the bottom of it is the delicate balancing act of trying to make sure there is always enough water, not too much and not too little. This fact sheet looks at the basic hydrology of Lesser Slave Lake and the Lesser Slave River and some of the water management issues that local residents and regulators deal with.

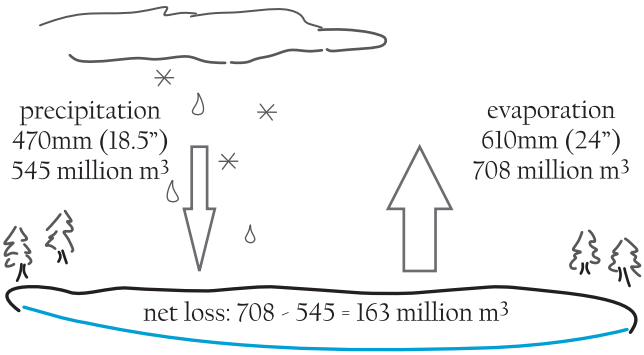


Hydrology of Lesser Slave Lake

Looking at a lake, it's easy to imagine that the water stays put. In fact, nothing can be farther from the truth. Water is constantly moving in and out of Lesser Slave Lake. A drop of water stays in the lake (on average) 9.5 years. In other words, after 9.5 years all the water that was in the lake has moved on and has been replaced by new water that came in by rain or by one of the creeks or rivers that flow into the lake.

A Note About Numbers

All the numbers in this fact sheet are annual averages. Of course some years are wet years, and some years are dry years but by using numbers recorded from weather stations and river gauges over the last 50 or 60 years, we have a pretty good idea of what usually happens.



Evaporation and Precipitation

There's more evaporation than precipitation each year. If direct precipitation was Lesser Slave Lake's only source of water, the lake would be completely dry in about 24 years. Luckily, most of the lake's water comes in as runoff from the watershed by

Inflow and Outflow

There are 5 major rivers that bring water into Lesser Slave Lake. Only the Lesser Slave River flows out. The South Heart comes from northwest

of the lake and is joined by the East Prairie River and the West Prairie River. The Swan River and Driftpile River come down from the south (Figure 1).

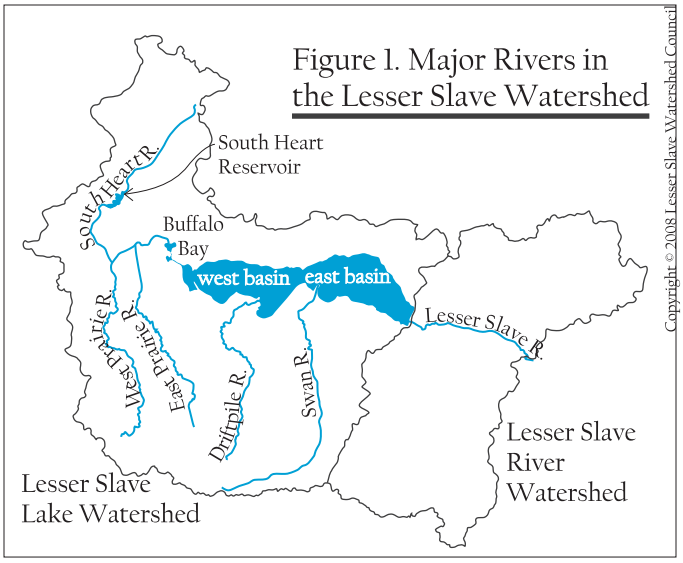


Figure 1. Major Rivers in the Lesser Slave Watershed

Rivers from the Swan Hills, south of the lake, contribute most of the runoff (Figure 2). The Swan and Driftpile rivers combined cover only 22% of the drainage area but contribute 40% of the total water runoff volume. In contrast, 17% of the lake's total drainage basin is upstream of the South Heart Reservoir but the area only contributes 7% of the total runoff. Some people have suggested that we can use the reservoir to help reduce flooding on the lake. Unfortunately, compared to the other rivers that carry water into the lake, the amount of water released from the reservoir is insignificant and has little impact on lake levels.

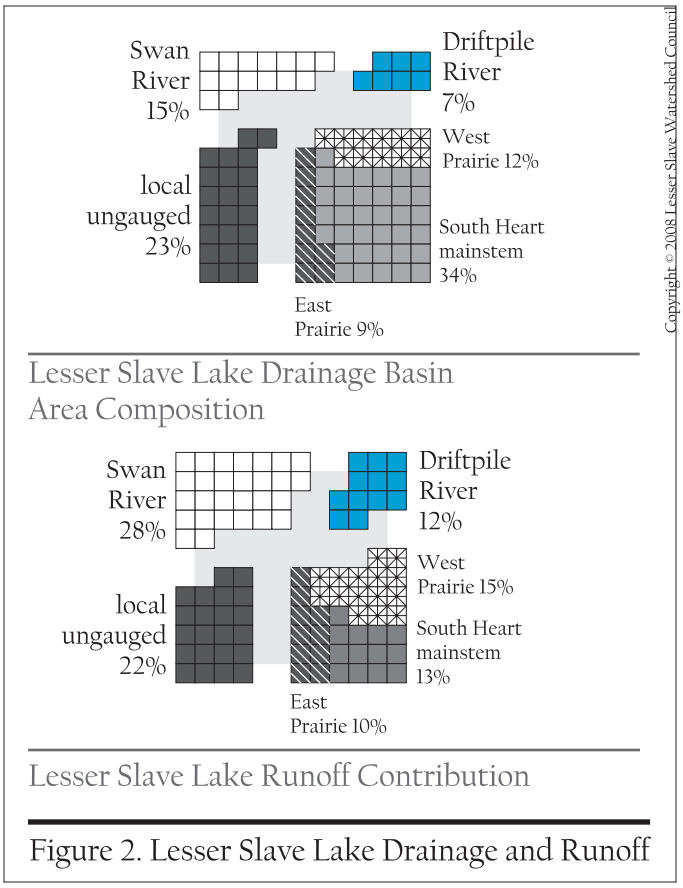


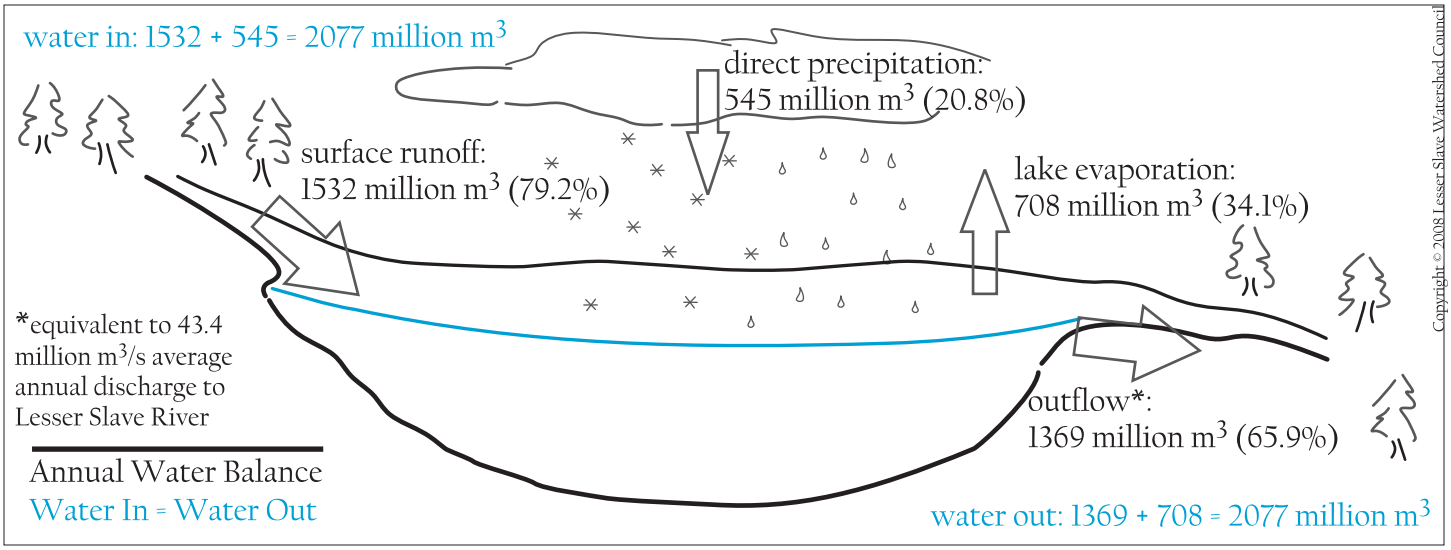
Figure 2. Lesser Slave Lake Drainage and Runoff

A Large Watershed

Lesser Slave Lake has a large watershed; each km^2 of lake surface is fed by about 11 km^2 of catchment basin. This means a few things:

The Good

- The lake is very sustainable, resistant to long term climate changes (dry or wet periods).



- Water levels vary from year to year but usually stay above the level needed for water to flow down the Lesser Slave River, which is good news for anyone who uses the river for their water supply.
- Really dry years mean less flow in the Lesser Slave River rather than a huge drop in lake levels.

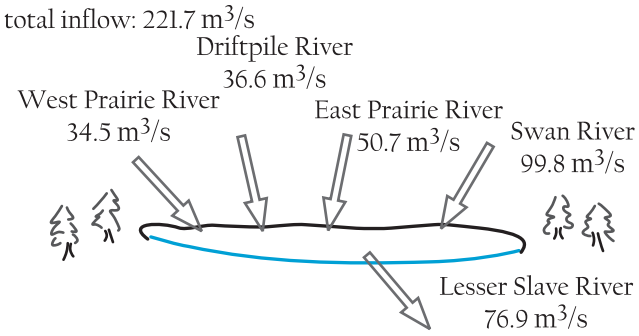
The Bad

- Lake levels can rise very rapidly during extreme runoff events.

Why Does the Lake Flood?

The Lesser Slave River isn't very good at moving water efficiently. The beginning of the river is very winding with a low gradient (it isn't very steep). This slows the water down and stops large volumes of water from moving quickly downstream. Instead, any extra water is stored in the lake and then released gradually over the following months.

An example of a flood scenario is shown in Figure 3. In July 1983, water flowed into the lake at a rate of 221.7 m^3/s, and only flowed out at a rate of 76.9 m^3/s. All the extra water had to go somewhere and so it was stored in the lake. This forced the lake level to rise.
In the next month, August, the inflow drops off dramatically, by about 80%, but the outflow in the Lesser Slave River actually increases slightly for August and September. It stays relatively high until mid-winter as all the water from the July rains is gradually released down river.



Data for the South Heart River is unavailable, as there wasn't a monitoring station installed in 1983. We also don't have data for any of the smaller streams that account for 22% of the inflow to Lesser Slave Lake. Even ignoring those rivers that we don't have data for, there is still almost three times as much water flowing into the lake as there is flowing out..

Figure 3. July 1983: Extreme Runoff Event

The Lesser Slave Lake Regulation Project

The provincial government completed the lake regulation project in 1983 to reduce flooding problems around the lake. The main cause of flooding is how slow the Lesser Slave River is at moving water downstream. To help the water flow more efficiently, a series of 8 cut-offs were built to straighten the river (Figure 4). Water can flow faster down the straightened, steeper river and this helps move water out of the lake and down the river more quickly, helping to reduce flooding.

Figure 4. Lesser Slave River Cutoffs

A fixed crest weir was also installed at the start of the Lesser Slave River. A weir looks a bit like a dam but is built so the water always flows across the top of it. Some weirs have a movable top so the height can be adjusted but the one on the Lesser Slave River is a fixed crest weir which means the height can't be adjusted. The weir helps prevent low lake levels by slowing water down as water levels drop. During a major flood, the water levels are so high that the weir becomes insignificant (Figure 5, next page).

So Are the Weir and Cutoffs Working?

The short answer is: yes. A report written in 1993 about the status of the project and an update issued

This image shows average flow over the weir in June 2004: the weir is visible but water has no trouble flowing over it.

The lesser Slave River showing low flow, January 2000. Siphons were put in place to ensure continuous water flow.

Figure 5. The Weir on Lesser Slave River

in 2000 concluded that:

- High flood events don't happen as often, and when they do, they're not as bad. (large volumes of water still flow into the lake but now the Lesser Slave River is better at moving it out so high water levels in the lake don't get quite so high.)
- Low water levels don't go as low as they would without the project
- Average lake water levels are about 0.3 m lower.
- Lake levels still fluctuate but not to the extremes they used to. Before there was a 3.5 m difference between the highest levels and the lowest levels, now there is only a 2.7 m difference.

Hydrologists have used computer modeling to simulate regulated and non-regulated lake levels. They calculated what levels would have been like if the weir was built in 1917 and what they would be like today if it was never built at all. Figure 6 shows a section of the graph. The complete graph is available online in the reports.

You can see that high and low water events still happen because of the nature of the watershed, but the regulation project does help minimize them.

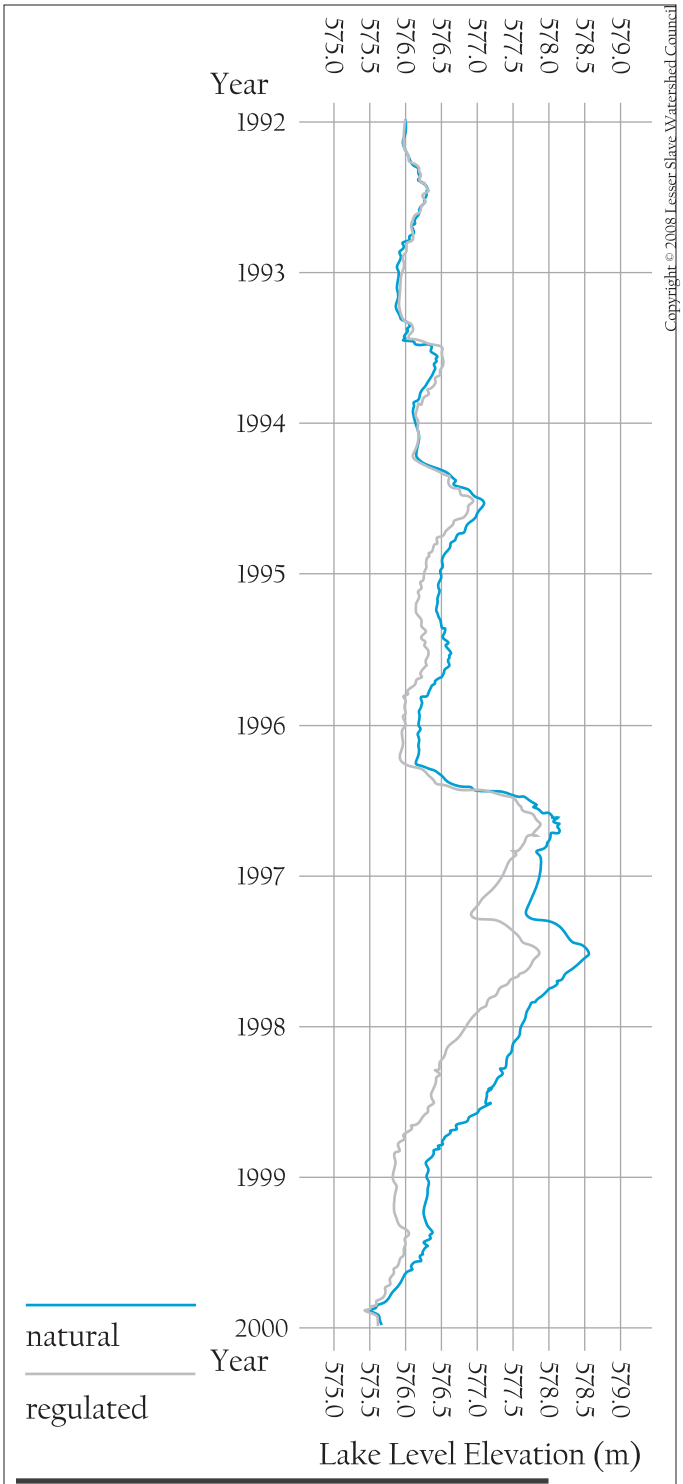


Figure 6. Natural vs. Regulated Scenarios

An Adjustable Weir?

Some people think that building a movable crest weir so we could adjust the height would help reduce flooding even more. It might help give us more control but the weir mostly just helps reduce low water events. A movable crest weir could

create problems of its own. Who will decide what the lake levels should be? Who will take responsibility if they guess wrong and there is flooding? Who wants to pay for maintenance and repairs if there is vandalism or other damage?

Make the weir taller.

Problem: If we make the weir taller, we raise lake levels. The problem is we can't know if the next year will be a wet year or a dry year. If it's a dry year, great, the stored water will keep lake levels from dropping too low. If it's a wet year, though, we're in trouble. The water will have nowhere to go and an even more extreme flood will result.
A higher weir could also be a problem for the Lesser Slave River. In the winter of 1999, lake levels dropped low enough that water temporarily stopped flowing into the river. Siphons were installed to move water over the weir until spring when water levels recovered but no studies were done to understand what happened to the fish and other aquatic life when the river almost dried up.

Make the weir lower.

Problem: It kind of makes sense that if the lake levels are too high, we just need to lower the weir and all the extra water will flow out. The problem is that when lake levels are that high the water is so deep that the weir is basically a little bump on the bottom of the river. The reason the water can't flow out any faster is because of the basic nature of the Lesser Slave River—the fact that it isn't very steep and that it is very curving and winding.

How the Fish Feel About All of This

In general, people like things to be predictable. Floods and droughts are disruptions that are hard for us to deal with. We forget that the lake and river have been experiencing these natural cycles for hundreds of years. Many plants and animals need the occasional flood. The ecosystem has adapted to take advantage of it. If people manage to eliminate this natural variability, we may find ourselves with a lake we don't recognize anymore. Fluctuations in water levels prevent beaches from being completely overgrown with plants. Flood years have been linked to successful years for spawning and growth of young fish-of-the-year for northern pike and walleye, giving us healthy fish populations. It is the changing water levels of Lesser Slave Lake that has created the lake we enjoy today.

Water management on a lake like Lesser Slave Lake is a balancing act. Many different groups of people are interested in how the lake levels are managed and sometimes these interests conflict. We also face the need to maintain a healthy ecosystem and protect nature. Understanding the hydrology behind the many issues residents and regulators face can help us make informed and realistic decisions, to successfully walk that delicate balance.

References

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This fact sheet about hydrology in the Lesser Slave Watershed is one of a series of informational brochures about the Lesser Slave Watershed produced by the Lesser Slave Watershed Council.

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