

# UNDERSTANDING LITTLE TRAVERSE LAKE WATERSHED RESPONSES TO RAIN EVENTS

Fall 2024 – Spring 2025

Fall 2025 – Winter 2026



*February 2026*

## **UNDERSTANDING LITTLE TRAVERSE LAKE WATERSHED RESPONSES TO RAIN EVENTS Fall 2024 – Spring 2025**

### ***Executive Summary***

This report analyzes hydrologic data collected within the Little Traverse Lake (LTL) watershed in Cleveland Township, Leelanau County, Michigan, focusing on how the system responded to rainfall between late summer 2024 and spring 2025, and the impact of a beaver dam located in Shalda Creek downstream of CR 669. Automated water-level sensors monitored four key locations: Lime Lake outlet (Shetland Creek), LTL at Traverse Lake Road (TLR) culvert (TLR Lake Inlet), Shalda Creek at the TLR culvert (TLR Stream Outlet), and Shalda Creek at the CR 669 bridge. Lime Lake drains into Shetland Creek through an open stream outlet with a minimal rock dam at the bottom. Little Traverse Lake drains into Shalda Creek through a 64x43" culvert. Shalda Creek passes under a 30' span bridge at CR 669 / Bohemian Road.

The central finding is that beaver dams in Shalda Creek significantly altered watershed dynamics, elevating upstream water levels, reducing stream flow, and restricting post-rainfall drainage. While rainfall events caused similar short-term water level increases across all monitored locations, watershed behavior diverged afterward depending on whether beaver dams were present.

When no dams were present, water levels across Lime Lake, LTL, and Shalda Creek rose during rain events and then declined in parallel as the system drained normally, regardless of the presence of structures (rock dam, culvert, bridge) or no structures (Shalda Creek). However, during Fall 2024 through early Spring 2025, a beaver dam downstream of CR 669 caused Shalda Creek levels to remain abnormally elevated after fall rains. Unlike Lime Lake, which declined after rainfall, Shalda Creek and LTL failed to recede during winter and between spring rain events. This resulted in what is metaphorically described as a "filling the bathtub" effect, where the watershed remained near capacity prior to major spring storms. As Shalda Creek levels were elevated, LTL levels were also elevated with LTL level dependent on Shalda Creek level at TLR Stream Outlet. A decline in the LTL level followed the decline in the Shalda Creek level. The LTL level cannot decrease below the Shalda Creek level at TLR Stream Outlet.

In late March 2025, multiple rain events occurred while the downstream beaver dam was still in place. With the watershed already elevated and drainage restricted, Little Traverse Lake overflowed its shoreline, causing property flooding, compromising residential structures, infrastructure risk at the CR 669 bridge, shoreline erosion, high groundwater saturation, negative impacts to tree roots, and septic system stress. The dam was removed on March 30, 2025, only after flooding had occurred.

Data show that dam removal produced an immediate drop in Shalda Creek water levels (approximately 3 inches in less than six hours), followed by staged watershed recovery:

1. Phase 1 – Plateau: Shalda Creek and LTL levels temporarily stabilized as saturated ground and standing water continued feeding the stream. Lake outflow = watershed inflow during this phase.
2. Phase 2 – Steady decline: Shalda Creek and LTL levels began falling in parallel as watershed drainage resumed. LTL levels dropped faster than watershed inflow, which included the clearance of water from Lime Lake flowing down Shetland Creek into LTL.
3. Phase 3 – Accelerated clearance: Stream levels dropped rapidly, allowing LTL to decline below winter plateau levels.

Measured clearance rates showed that, after dam removal, LTL drained at rates equal to or greater than Lime Lake despite additional inflows—demonstrating that the TLR culvert and Shalda Creek channel are capable of

handling substantial volumes when unobstructed. Flow measurements indicated a six-fold increase in stream velocity at CR 669 following dam removal while flow rates increased 30% at TLR culvert following removal of dam downstream from CR 669. Beaver dams elevated Shalda Creek at the TLR Stream Outlet and thereby reduced the culvert inlet-outlet differential as compared to the absence of beaver dams at the same water level, thereby reducing the culvert hydraulic pressure dynamics resulting in slower flow rates and a lower volume of water flowing per second.

The report compares Spring 2025 flooding to similar flood events in Fall 2012-2014 and Fall 2020, both of which also coincided with significant beaver dams that were removed only after flooding occurred. Historical engineering analysis (Gosling Czubak 2020) similarly documented an increase in water levels prior to significant rain events with the presence of beaver dams and sharp water-level drops following dam removal.

The overarching conclusion is that beaver dams materially restrict Shalda Creek flow, elevate upstream water levels, reduce watershed drainage capacity, reduce stream flow rates, and increase flood risk during major rainfall events. The data suggest that proactive dam maintenance prior to fall and spring rain seasons could preserve watershed capacity (helping to ensure the “bathtub” is kept as empty as possible) and potentially mitigate future flooding events by ensuring the watershed has greater capacity to absorb rain events.

After 10 years of collecting water level data and including professional analysis by the engineering firm Gosling Czubak, it is time to establish a longer-term policy regarding beaver dam maintenance that allows proactive removal *before* reaching high water levels rather than a reactionary response *after* flooding has occurred. Gosling Czubak has previously recommended in December 2020:

- 1) Allow Little Traverse Lake Property Owners Association to maintain the section of Shalda Creek between LTL and CR669 free of dam obstructions at all times.*
- 2) Monitor water level elevations at the County Road 669 crossing. If water levels at this culvert rise above 594.0, allow beaver dams downstream to “Fishcamp” to be cleared.*
- 3) Consider a partnership with a local conservation organization to relocate nuisance beaver that may be encountered between Little Traverse Lake and Fishcamp and investigate natural deterrent measures that could be used in this area.*
- 4) Allow creek maintenance and restoration at inactive and problem dam locations between Little Traverse Lake and Fishcamp.*

The report closes by warning that new dams identified in Fall 2025–Winter 2026 may recreate similar elevated conditions heading into snowmelt and spring rains if not addressed.

*David Skjaerlund, PhD*

### **WATERSHED CHANGES Fall 2025 – Winter 2026**

This report includes a supplemental March 2026 update attached at the end regarding Fall 2025-Winter 2026 watershed changes and the influence of two beaver dams in Shalda Creek that were identified during Fall 2025. Water levels continued to rise during the winter after fall rains. Dams were pulled on March 14, 2026 just hours before a 24” snow storm.

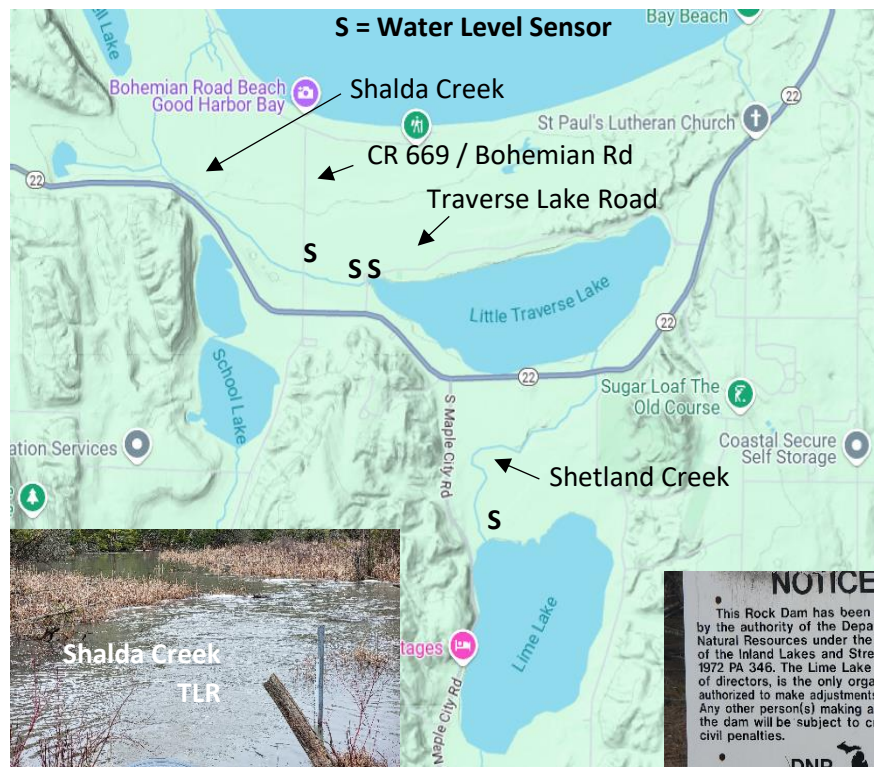
## UNDERSTANDING LITTLE TRAVERSE LAKE WATERSHED RESPONSES TO RAIN EVENTS Fall 2024 – Spring 2025

This paper explores the relationship of watershed responses when beaver dams are present and the contribution to high level flooding events observed at Little Traverse Lake (LTL). This is a compilation, documentation and summary of water level data at four locations within the Little Traverse Lake (LTL) watershed collected by Little Traverse Lake Association (LTLA): 1) *Lime Lake* outlet at the northwest corner flowing into Shetland Creek, 2) LTL outlet at Traverse Lake Road (TLR) *Lake Inlet* side of TLR culvert at the northwest corner of LTL flowing into Shalda Creek, 3) Shalda Creek at *TLR Stream Outlet* side of TLR culvert, and 4) Shalda Creek at the Bohemian Road / *CR 669 Bridge* crossing. Data is taken using automated sensors at the four locations and data is uploaded online in real time. These data graphs and narrative have been prepared by David Skjaerlund PhD, a member of the LTL community, using Lake Man software. Water level data can be accessed at <https://littletraverselake.org/lake-levels> and is available in real time.

### AN OVERVIEW OF LITTLE TRAVERSE LAKE WATERSHED

Little Traverse Lake is a 640 acre lake in Cleveland Township, Leelanau County. The lake is fed by the inflowing Shetland Creek, which is the outlet for 670 acre Lime Lake, and small streams from the Bufka Farm wetlands and Swanson Preserve wetlands on the eastern end as well as other tributaries. In addition, water drains from surrounding sandy hillsides and pushes water into the water table and underground springs also feed the lake as well. Little Traverse Lake is predominantly drained by evaporation and through the outlet feeding Shalda Creek that flows to Lake Michigan.

Lime Lake has a minimal rock “dam” (approximately 8” high, 20’ wide) at the outlet feeding Shetland Creek. Existing culvert across TLR is a 64x43” arch and is structurally sound. TLR Lake Inlet side has 10” air gap from top at high levels (at 595.0 TLR Lake Inlet), dirt on the bottom, and approximately 3’ water in culvert at high levels. Culvert is tilted downward with TLR Stream Outlet side having a 4” airgap at high levels (595.0 TLR Lake Inlet) and dirt on the bottom. The previous CR 669 culvert was replaced with a 30’ wide span bridge during summer 2020.



**NOTICE**

This Rock Dam has been constructed by the authority of the Department of Natural Resources under the provisions of the Inland Lakes and Stream Act, 1972 PA 346. The Lime Lake Association of directors, is the only organization authorized to make adjustments on this dam. Any other person(s) making adjustments of the dam will be subject to criminal and/or civil penalties.

**DNR**



## BEAVER DAM ACTIVITY IN SHALDA CREEK

Construction of debris dams by beavers in Shalda Creek has taken place for many decades. And there have been decades of beaver dam removal by Little Traverse Lake residents, often with help by NPS in the past, as water becomes elevated and water flow in Shalda Creek becomes restricted. After major flooding events in 2012-14, LTLA has manually recorded regular water level measurements after gauges were installed early 2014 and automated water level sensors installed October 2020. Beaver dam presence and subsequent removal have been documented during this time to study the impact on water level changes. The extensive data collection has been thoroughly reviewed, analyzed, and interpreted by the engineering firm Gosling Czubak. Several reports by Gosling Czubak were prepared during 2014-2020 and are available at <https://littletraverselake.org/lake-levels>. Gosling Czubak recommended in the December 15, 2020 report<sup>1</sup> that decision makers and stakeholders establish a beaver dam maintenance policy. As of February 2026, NPS has not yet provided any clarification on a longer term Shalda Creek maintenance / dam removal policy despite requests by Little Traverse Lake watershed stakeholders (Cleveland Township, LCRC, LTLA).

A beaver dam was constructed in Shalda Creek downstream of 669 Bridge during September 2024, at which time Cleveland Township, Leelanau County Road Commission (LCRC), and National Park Service (NPS) were notified by members of the LTL community requesting permission for removal. The dam remained in existence and grew in size between fall 2024 and spring 2025, with additional requests by LTL residents to remove. Water levels reached the bottom of CR 669 Bridge during Spring 2025. Abnormally high water levels were experienced in late March (595.0 TLR Lake Inlet) when a large rain event increased water levels even further and water flowed over LTL banks and into property along the shore, resulting in various undesirable consequences of the resulting flooding. The beaver dam remained in place until it was removed March 30, 2025, following permission by NPS.

### DAM DOWNSTREAM (WEST) OF CR 669 Bridge

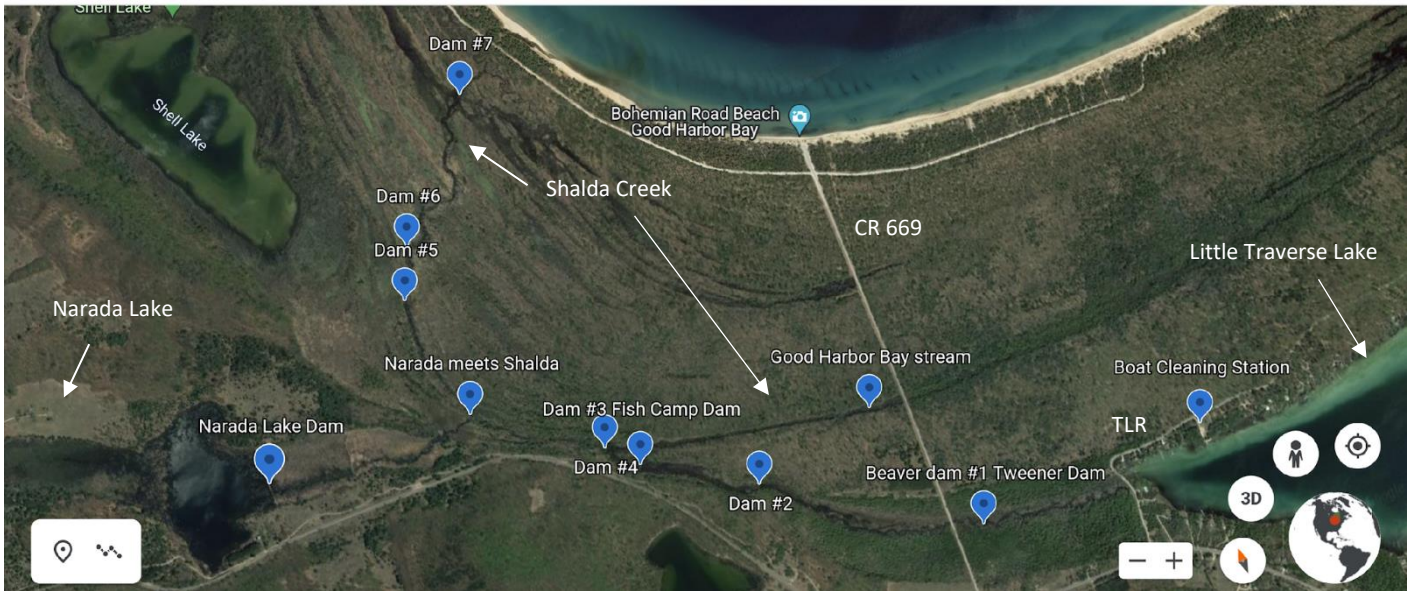


Extreme flooding within the LTL watershed, where shoreline banks overflowed and property was under water, Fall 2012-2014, Fall 2020, and Spring 2025. On all these occasions, large beaver dams in Shalda Creek were present and had elevated water levels prior to a large rainfall event. On these occasions, beaver dams were removed only *after* flooding had occurred, rather than in advance of the rainfall events. This paper is to provide an understanding of the watershed responses that occurred over time between Fall 2024 and Spring 2025.

The abnormally high water levels created negative consequences: 1) water levels rose above the bottom of CR 669 Bridge potentially compromising the road infrastructure and accumulating debris; 2) LTL shoreline property underwater; 3) residential structures impacted by flooding; 4) septic fields challenged by high water levels, potentially impacting water quality; 5) accelerated shoreline erosion and instability/suffocation of tree root structure; and 6) elevated water tables making it difficult for the watershed to absorb additional rainfall events.

<sup>1</sup> Gosling Czubak Engineering Sciences. 2020. Report of Shalda Creek Water Level Study 2017- 2020. Submitted to Traverse Lake Property Owners Association. December 15, 2020.

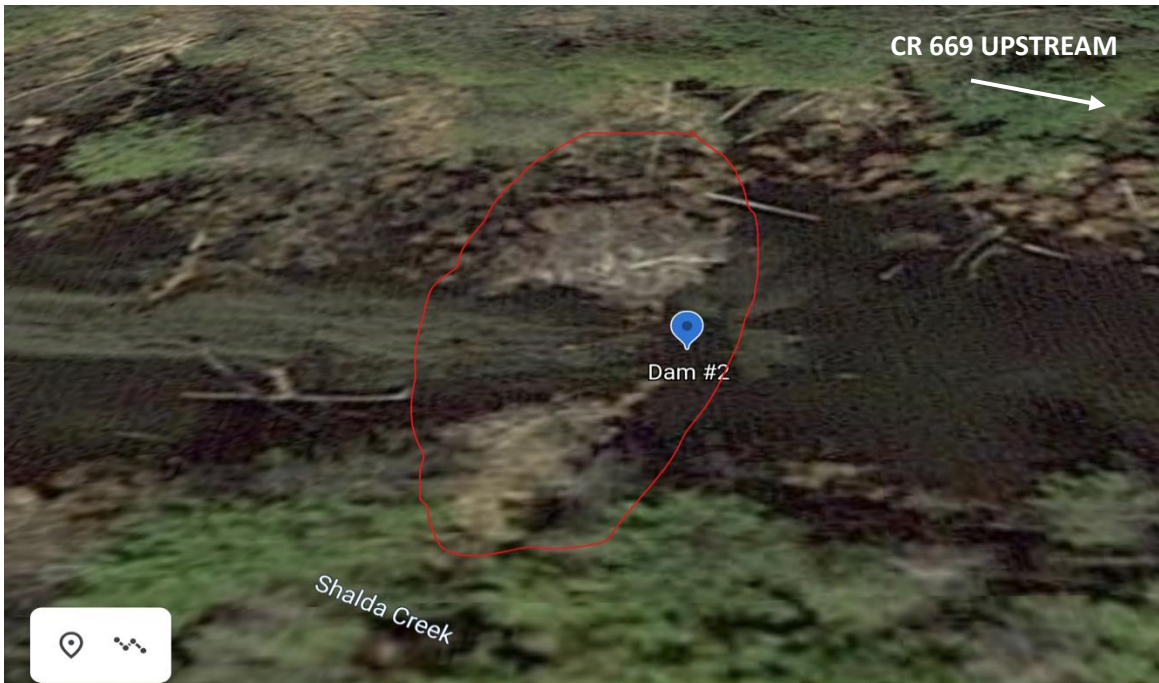
There are several locations where beavers have built dams in Shalda Creek. The locations most critical to LTL watershed is the Tweener Dam (#1), Downstream of CR 669 (#2), and Fish Camp area (#3, #4). When dams are removed at these locations, the tendency is for beavers to attempt to rebuild these locations rather than start in a fresh location. Beavers dams have narrowed the stream channel over the years and have led to accumulation of sediment and debris, visible in aerial photos, and thus altered Shalda Creek stream dynamics over time. Narada Lake was mostly created by a wide beaver dam that accumulated and filled in with sediment, thus leading to Narada Lake as known today. Beaver dams can quickly create watershed saturation upstream due to the shallow and gradual nature of Shalda Creek. Shalda Creek has very little slope, with the 0.43 mile section between TLR and CR 669 dropping only 6.6", representing a 0.024% slope. The 0.71 mile section from CR 669 to Fish Camp dam only has a slope of 0.106%. A slope of 1% is considered adequate for drainage.



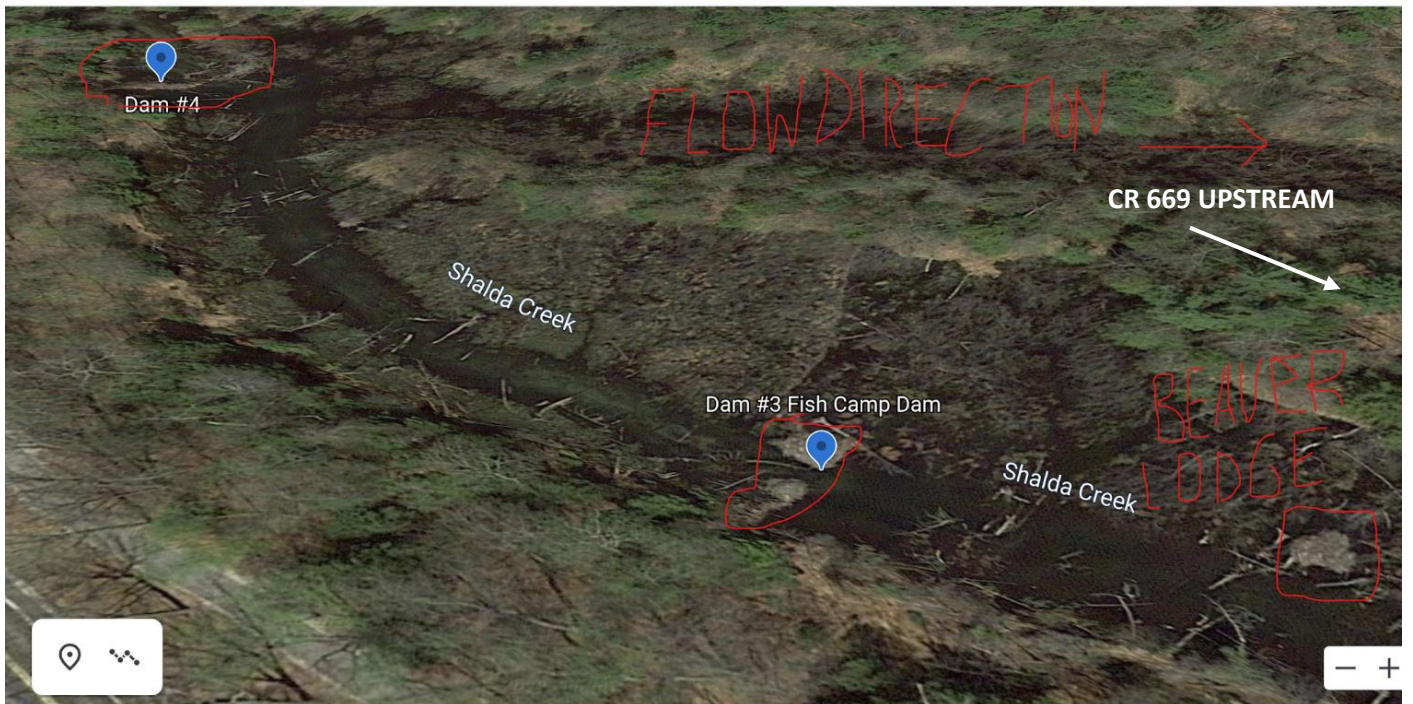
Beaver dam #1 is known as "Tweener Dam" located 1,823 ft (one third of a mile) downstream from CR 669. It can be reached via kayak from TRL In this picture, the dam has been torn out with 12' high stacks of sticks on each side following decades of dam removal. Notice the light-colored sediment that has accumulated upstream of the dam and also downstream. This dam has been documented to have a significant and direct impact on Shalda Creek levels at TLR Stream Outlet and on lake levels.



Beaver dam #2 is less than half a mile downstream of 669. In this picture, the dam has been torn out. Notice sediment downstream with water depth only a foot in that section. The width of cleared dam is narrower than stream channel width, with high stacks of sticks from numerous dam tear outs. This dam was rebuilt late summer 2024 and was cleared out March 30, 2025.



Beaver dam #3 is known as "Fish Camp Dam" as there was a cabin there many years ago. It is accessible walking from M-22 and is visible from the Heritage Trail. The stream width is only four feet at the cleared dam creating a stream choke point with high piles of sticks from dam removal over the years. Note the sediment and debris buildup downstream. Shalda Creek downstream of dam #4 is not navigable with a kayak due to extensive tree blowdown, debris buildup, older beaver dams that have collected sediment. A hike along the stream is very difficult.



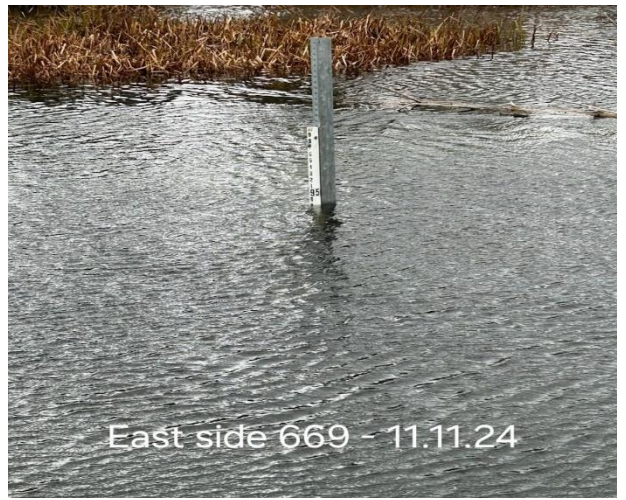
## WATER LEVELS AT CR 669 BRIDGE



A 30' span bridge has no flow restrictions with over a third of the span having zero flow (see subsequent flow data). Shalda Creek should be flowing downward and unrestricted to Lake Michigan. Yet, when beaver dams are present, flow is restricted and water levels increase upstream due to the blockage.

9/16/2025 Low water levels; No beaver dams present; 12" air gap underneath CR 669 Bridge; 593.95 on measuring stick; surrounding area dry.

11/11/2024 Beaver dam present September 2024; elevated water levels Fall 2024 – 594.8 on measuring stick; only 2.5" air gap underneath CR 669 Bridge; NPS permission to remove beaver dam not given.



3/29/2025 Beaver dams present spring 2025, increased in size; water levels elevated with additional rainfall events; no air gap underneath CR 669 Bridge, accumulating debris; standing water in surrounding watershed; 594.95 on measuring stick. This is a second time a beaver dam downstream CR 669 has elevated water levels above the bottom of CR 669 Bridge.



4/2/2025 Beaver dam removed noon 3/30/2025 following NPS permission. 594.75 on measuring stick at 4 pm; 2.5" airgap underneath CR 669 Bridge.



4/9/2025 594.6 on measuring stick, 4.0" air gap underneath CR 669 Bridge.



5/4/2025 Dam downstream CR 669 removed March 30, 2025; Water levels drop to 594.25; 9" air gap underneath CR 669 Bridge



When water levels exceed the bottom of the bridge, infrastructure can start to be impacted. Ground saturation behind the box culvert and road bed can be impacted over time with water saturation. The bridge can then start accumulating stream debris. Erosion of banks can take place. CR 669 Bridge span was engineered to be above water.



### WATER LEVELS AT TRAVERSE LAKE ROAD CULVERT

3/29/2025 – TLR Lake  
Inlet: 594.76 on the  
measuring stick. TLR  
Stream Outlet: 594.53  
on measuring stick,  
water 5" from top of  
culvert. Water in  
residential yards.

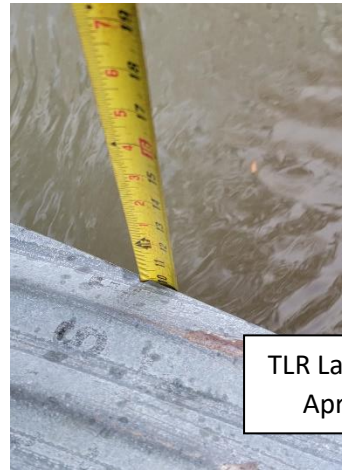




TLR Stream Outlet Side  
April 2, 2025

High water levels on April 2, 2025. TLR outlet side; 4" below top of culvert; 594.6 on measuring stick

High water levels on April 2, 2025. TLR Inlet side; 10" below top of culvert; 595.1 on measuring stick. Extensive flooding of residential yards and structures.



TLR Lake Inlet Side  
April 2, 2025



4/9/2025 Water levels continue to drop a week later. TLR Lake Inlet side level was 594.85 on measuring stick with water 12" from top of culvert. TLR Stream Outlet side level was on 94.45 measuring stick with water 6" from top of culvert. Water still standing in residential yards.



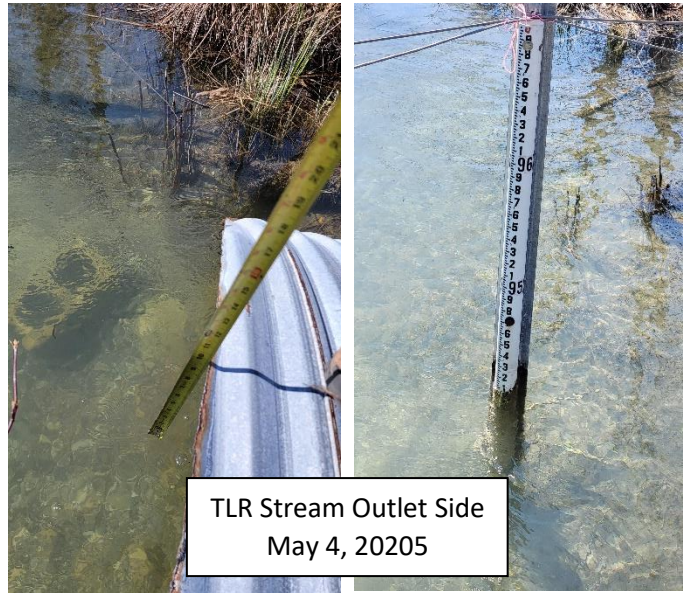
TLR Lake Inlet Side  
April 9, 2025



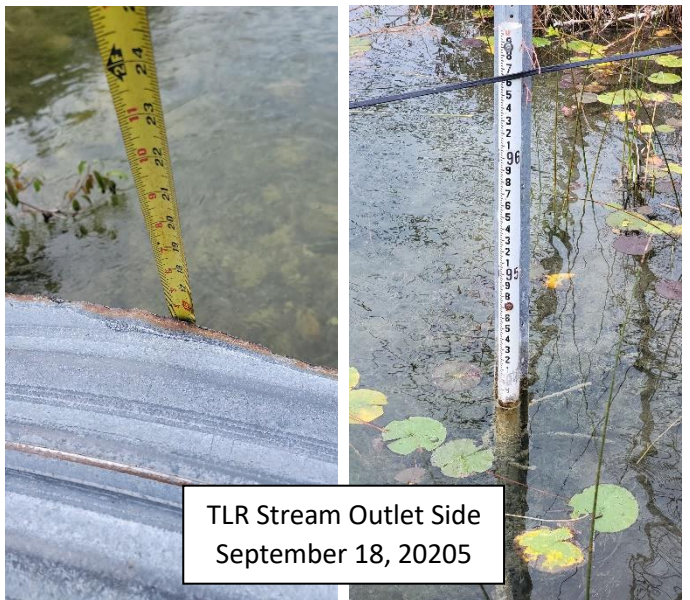
TLR Stream Outlet Side  
April 9, 2025



5/4/2025 Water levels returned to more normal levels a month later. TLR Lake Inlet side level was 594.3 on measuring stick with water 18" from top of culvert. TLR Stream Outlet side level was on 593.9 measuring stick with water 10" from top of culvert.



During lower summer levels on September 18, 2025, TLR Lake Inlet side level was 593.85 on measuring stick with water 24" from top of culvert. TLR Stream Outlet side level was on 593.4 measuring stick with water 15" from top of culvert.



## LITTLE TRAVERSE LAKE PROPERTY IMPACTS

The high water levels during Spring 2025 caused water to overflow the banks of Little Traverse Lake. Highest water levels were observed April 2, 2025 after the rain ceased. The impact of flooding and high water levels include:

- Flooding of adjacent property with water standing in yards;
- Residential structures with standing water, including entering structures;
- Water entering foundational crawl spaces;
- High water table potentially compromised older septic fields and leaching into lake;
- Root structures of trees saturated, suffocating root structure and has a tendency to blow over with high winds;
- Shoreline erosion.

Homeowners have taken measures to minimize the impact of high water but when water breaches the shoreline of the lake, those measures become inadequate and result in negative and costly consequences.

Yards had significant water on March 31 with LTL lake levels at 594.76. Flood waters were observed on April 2 with LTL lake levels reaching 595.1. Water was still standing in yards with LTL lake levels at 594.85 on April 9. At that level, water has been known to infiltrate some residential crawl spaces. Concerns about shoreline breaching, especially during high winds and significant wave activity, and elevated water tables begin when LTL levels reach 594.5.

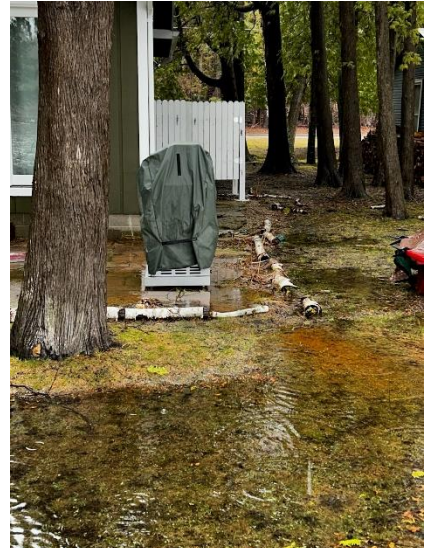


March 31, 2025





April 2, 2025





April 2, 2025



April 9, 2025



May 4, 2025





April 2, 2025



April 9, 2025



May 4, 2025

Relative comparison: April 2 – water overflowing shoreline bank; April 9 – 4" below shoreline bank; May 4 – 9" below shoreline bank; September 16 – 16" below shoreline bank



## A GRAPHIC UNDERSTANDING OF WATERSHED RESPONSES WITH 669 BEAVER DAM SEPTEMBER 2024 – APRIL 2025

An understanding of various watershed responses can be gained by looking at the automated data collected at various points in the watershed:

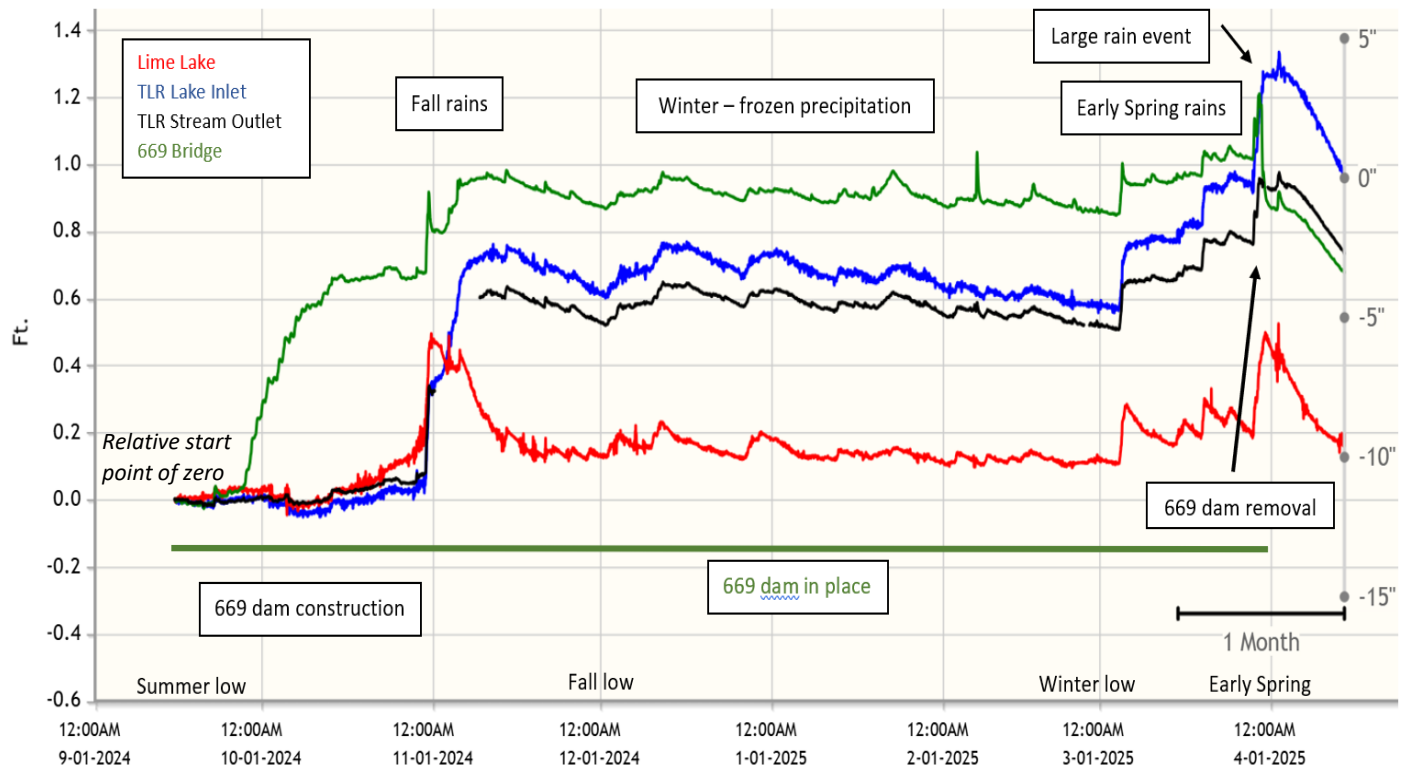
1. Lime Lake – Lime Lake has essentially an unobstructed outlet with a minimal layer of rocks at the transition into Shetland Creek which drains Lime Lake into LTL.
2. Little Traverse Lake – LTL levels are monitored at the lake inlet side of TLR culvert. LTL drains through a 36” culvert into Shalda Creek which then flows to Lake Michigan.
3. Shalda Creek – Shalda Creek is measured at two locations: CR 669 30’ span bridge and at the stream outlet side of TLR culvert. Water flows freely from the west side of TLR to CR 669 along the natural stream of flow.

Automated water level data at four locations helps provide an understanding of watershed changes and the relationship to one another. In addition, flow measurements were collected at three locations under CR 669 Bridge and at both sides of TLR culvert over several months, capturing flow rate changes relative to changes in water levels.

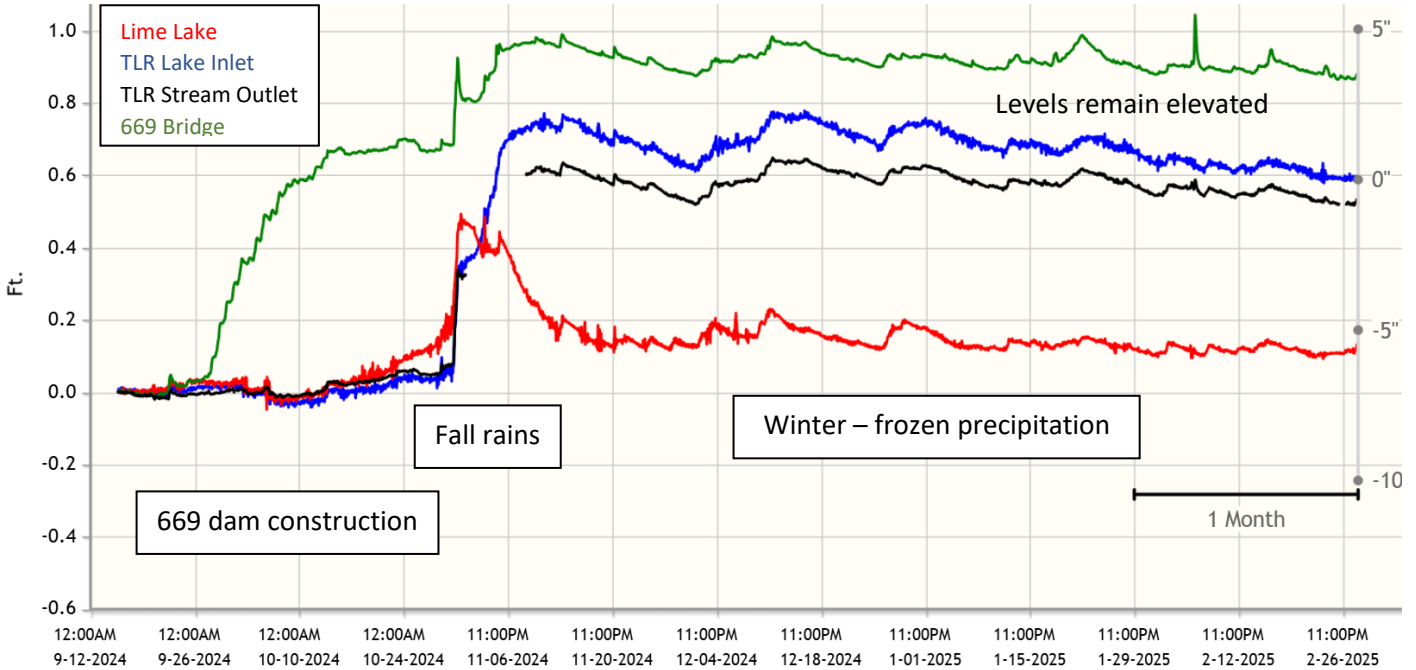
Documentation of the presence or absence of beaver dams is essential in evaluating and analyzing water level data as the presence of beavers has been shown by Gosling Czubak to change flow rates as well as elevate water levels. Beaver dams usually are constructed at the same locations between TLR and CR 669 (aka the tweener dam), downstream of CR 669, and near the old Fish Camp further downstream of CR 669. Interpreting water level data without the understanding of the status of beaver dams can sometimes be misleading.

This analysis begins with an overview of water level changes from late summer 2024 through spring 2025. Key weather aspects include fall winters, winter snows and freeze, and then followed by spring melt and rain. During the winter, there is usually little additional precipitation (other than snow) being added to the frozen lake while drainage of lake and stream continues. The two key rain seasons are fall and spring, with the addition of winter snow melt.

**OVERVIEW DATA REFERENCE GRAPH – 669 Dam Construction and Removal – Fall 2024 to Spring 2025**



**SUMMER LOW – FALL RAINS -WINTER (WITH 669 DAM IN PLACE)**



Downstream 669 beaver dam construction rapidly elevated the Shalda Creek level at CR 669. Fall rains elevated water levels at all points of measurement. After fall rains slowed, Lime Lake decreased. However, Shalda Creek, at both 669 Bridge and LTL Stream Outlet, and LTL Lake Inlet did not decrease after fall rains. From 9/15/2024 to 12/1/2024, Shalda Creek at CR 669 Bridge increased 10.32 inches due to the presence of a downstream beaver dam. Shalda Creek at TLR Stream Outlet increased 6” due to water levels backing upstream in Shalda Creek while Traverse Lake increased 7.2”. Meanwhile, Lime Lake only increased 1.44”.

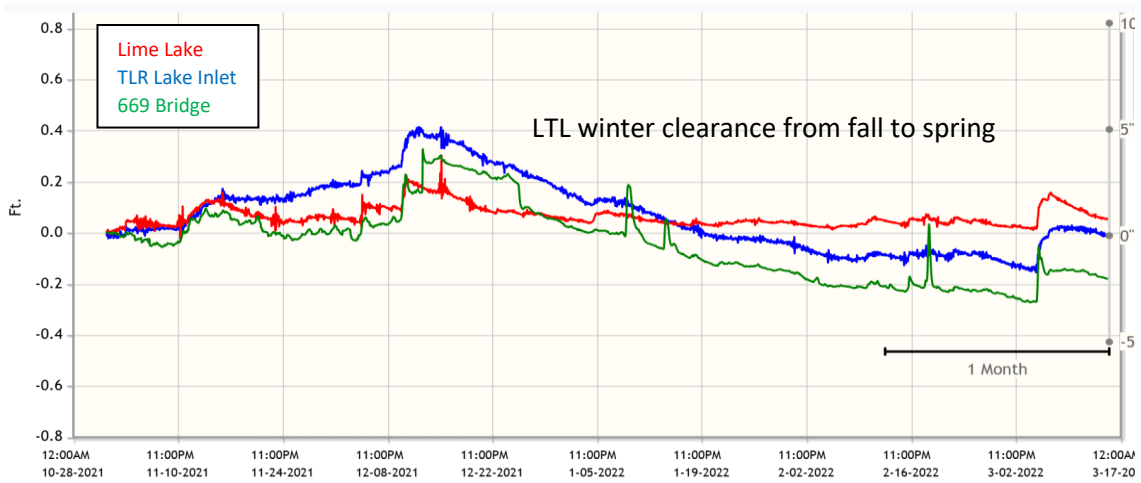
During the winter from 12/1/2024 to 3/1/2025, levels at all four locations remain essentially the same. However, levels for Shalda Creek, both at CR 669 Bridge and TLR Stream Outlet, and LTL Lake Inlet were significantly elevated in comparison to summer low on 9/15/2024 due to the presence of beaver dam restricting normal stream flow. In comparison, Lime Lake had decreased after fall rains allowing winter level to be only 1.2” higher than summer low.

**Key Watershed Benchmarks**

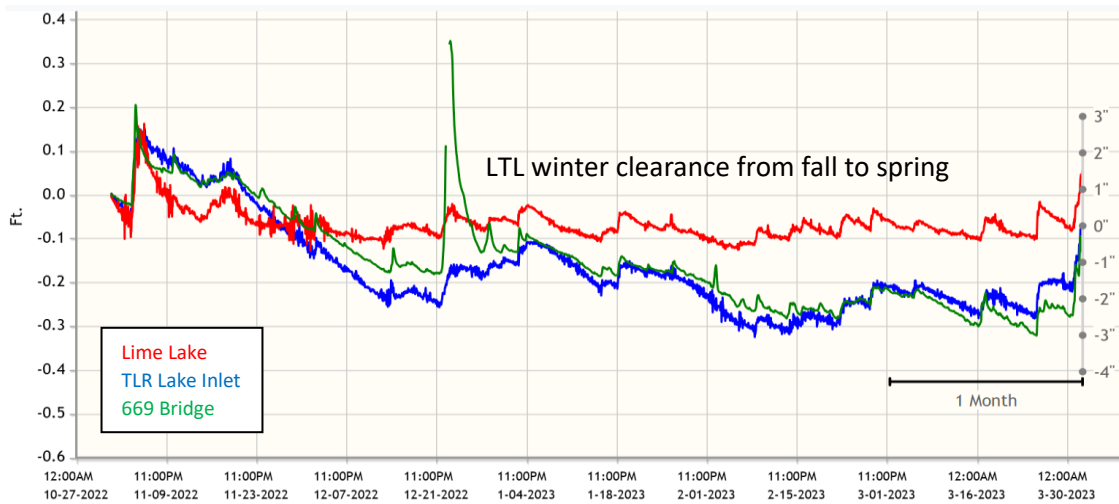
	During presence of 669 dam		
Date	9/15/2024 0:00	12/1/2024 0:00	3/1/2025 0:00
Comment	Summer low	Post fall rain	Winter low
<b>Lime Lake</b>	617.58	617.7	617.68
<i>Difference from previous</i>		0.12	-0.02
<i>Difference (inches)</i>		1.44	-0.24
<b>TLR Lake Inlet</b>	593.7	594.3	594.3
<i>Difference from previous (ft)</i>		0.6	0
<i>Difference (inches)</i>		7.2	0
<b>TLR Stream Outlet</b>	593.7	594.2	594.2
<i>Difference from previous</i>		0.5	0
<i>Difference (inches)</i>		6	0
<b>669 Bridge</b>	593.86	594.72	594.72
<i>Difference from previous</i>		0.86	0
<i>Difference (inches)</i>		10.32	0

With the presence of a beaver dam, the water level responses at 669 Bridge, LTL Stream Outlet and LTL Lake Inlet responses are nontypical. Shalda Creek should be clearing water and levels dropping after fall rains, followed by LTL levels declining. Compare the 2024-2025 response below to three years without beaver dams being present.

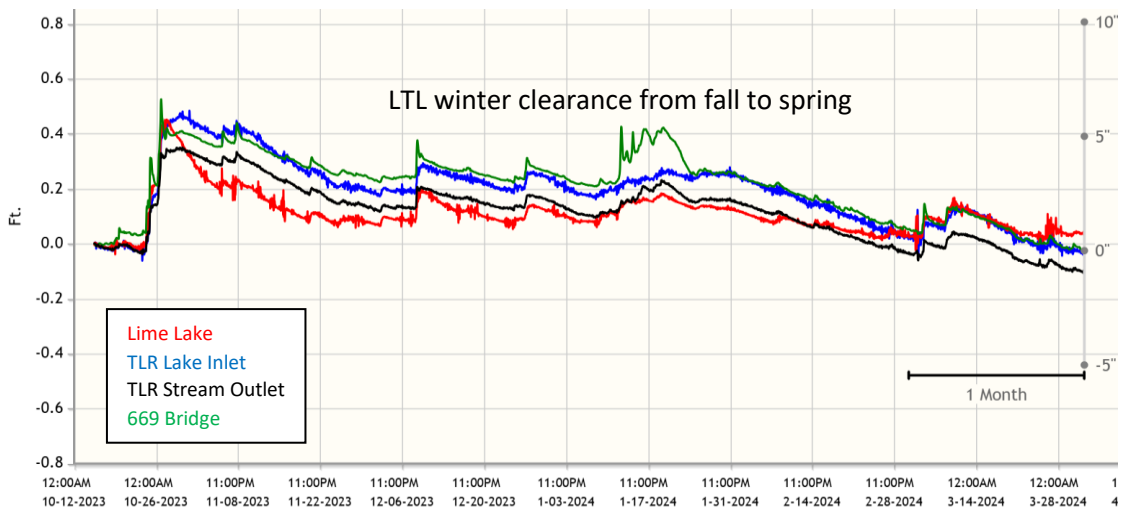
**Winter 2022 – no dams present**



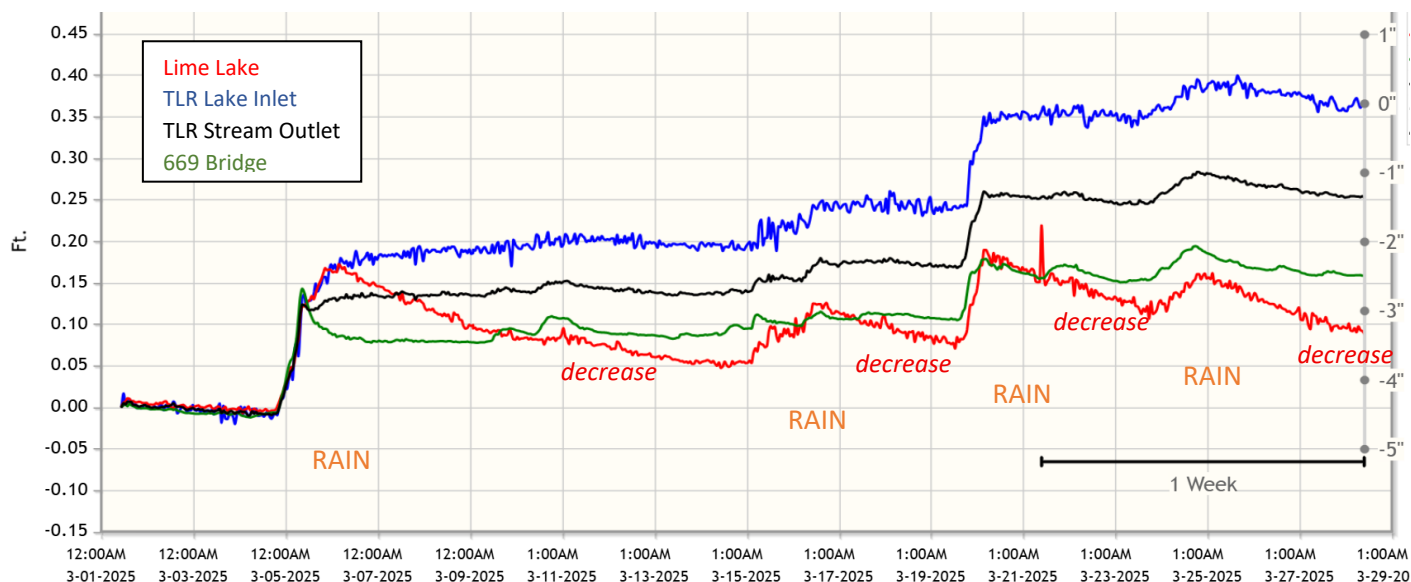
**Winter 2023 – no dams present**



**Winter 2024 – no dams present**



### WINTER – EARLY SPRING RAINS (WITH 669 DAM IN PLACE)



Four rain events occurred during March 2025. During each rain event, all four measurement locations in the watershed responded very similarly. Shalda Creek, at both CR 669 and TLR Stream Outlet, LTL and Lime Lake all increased based on the amount of rain. This similar increase after a rain event is independent of whether Lime Lake outlet has no structure (low rock dam), LTL outlet has a culvert, Shalda Creek has a normal stream flow downstream or Shalda Creek has a 30' span bridge. When it rains, the watershed levels go up.

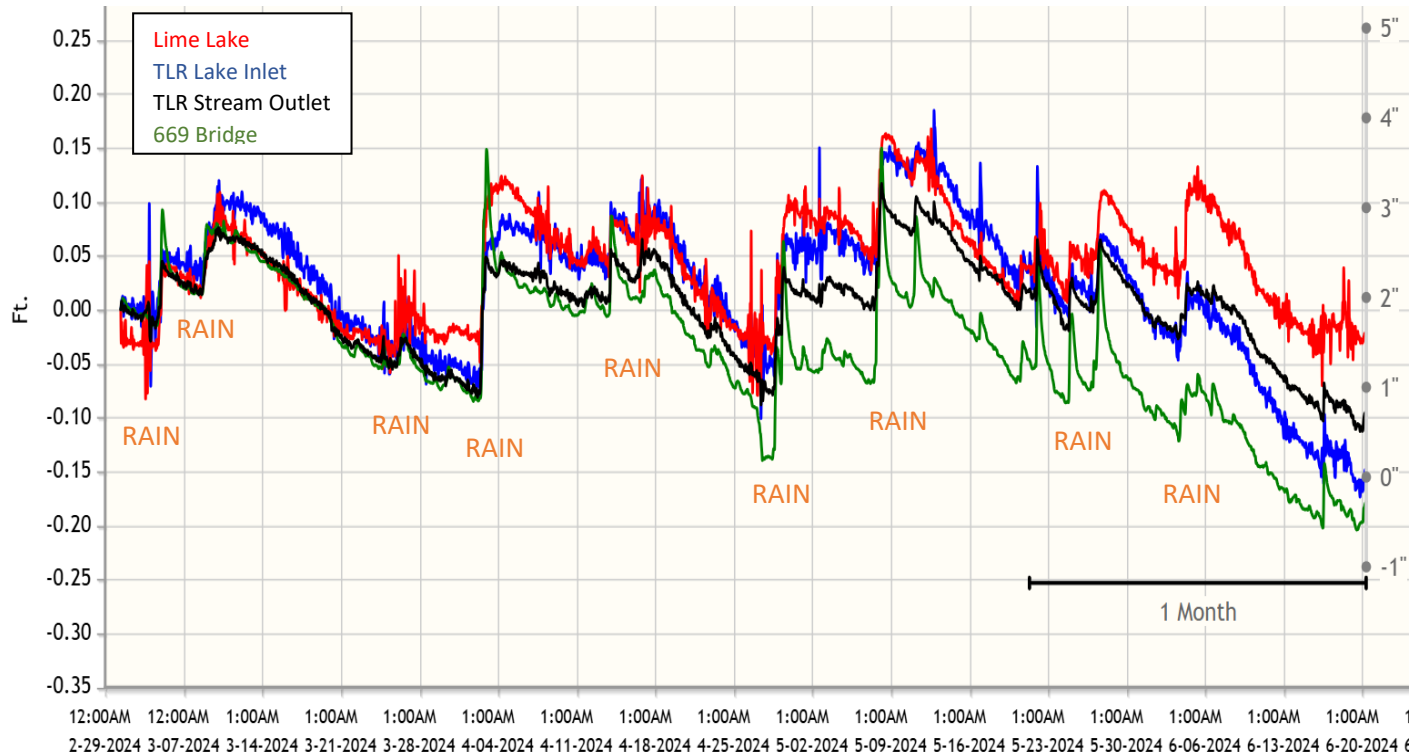
However, the response after a rain event end is considerably different. Lime Lake levels decrease after each rain event as water is cleared. However, Shalda Creek, at both CR 669 and TLR Stream Outlet, and LTL do not decrease due to the presence of beaver dam restricting flow and beavers adding to the size of dam. This is a non-typical response. Usually, water levels decrease similarly across the watershed after a rain event. As a result, during the rainy season from 3/1/2025 to 3/29/2025, Lime Lake increased 1.08" while LTL increased 4.2", Shalda Creek at TLR Stream Outlet increased 3.12", and Shalda Creek at CR 669 Bridge increased 1.92". Keep in mind that Shalda Creek normally has nothing to restrict flow, except in this case is now impeded with a beaver dam.

LTL water levels are now becoming high, with the TLR culvert differential (the difference between lake inlet and stream outlet) changing. This will be a topic of discussion later on in relation to culvert dynamics. It is important to notice that Shalda Creek levels at TLR Stream Outlet are not decreasing after rain events, which has nothing to do with culvert structure upstream. If Shalda Creek elevates at TLR Stream Outlet due to a beaver dam restricting flow, it will be a significant factor contributing to LTL rising, regardless of what outlet structure is present at TLR.

Date	3/1/2025 0.00	3/29/2025 0.00
<b>Lime Lake</b>	617.68	617.77
<i>Difference from previous</i>		0.09
<i>Difference (inches)</i>		1.08
<b>TLR Lake Inlet</b>	594.3	594.65
<i>Difference from previous (ft)</i>		0.35
<i>Difference (inches)</i>		4.2
<b>TLR Stream Outlet</b>	594.2	594.26
<i>Difference from previous</i>		0.26
<i>Difference (inches)</i>		3.12
<b>669 Bridge</b>	594.72	594.88
<i>Difference from previous</i>		0.16
<i>Difference (inches)</i>		1.92

It is helpful to understand what a typical response to rain events looks like across the watershed when there are no beaver dams present. The following examples shows that water levels increase at all four locations in the watershed during a rain event and then water levels decrease at all four locations after the rain event ends. Generally, the watershed responses to rain events are similar at all locations and tend to parallel each other: all locations increase according to the size of the rain event and all locations have reduction in water levels after the rain even ends.

**TYPICAL WATERSHED RESPONSES TO RAIN EVENTS – WITH NO DAMS**

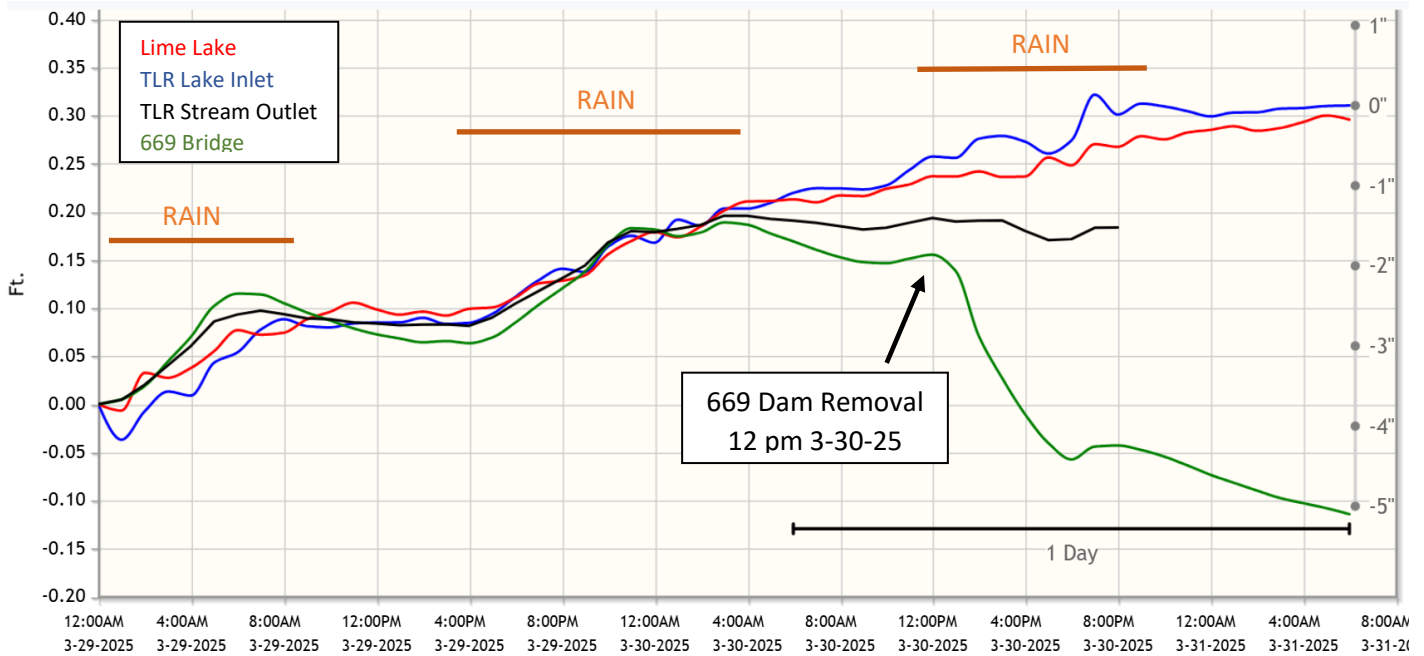


By the end of March 2025, LTL levels were high. Shalda Creek levels had been elevated in the fall due to the beaver dam with water only 2.5” from the bottom of the CR 669 Bridge on 11.11.2024. Beaver dams restrict water flow and elevate water levels upstream, even with a 30’ span bridge. Shalda Creek levels were also elevated at the TLR Stream Outlet. Little Traverse Lake increased as a result. If Shalda Creek rises, then LTL cannot decrease levels beyond that limiting factor. None of the Shalda Creek locations or LTL declined during winter and did not decline after rain events – both non-typical responses compared to what is observed with no beaver dams present. The LTL bathtub kept filling up with the drain being plugged downstream. Water pushed into the watershed and also elevated the water table. Typically, there would be more bathtub capacity to absorb spring rains with lower lake levels, lower water tables, and surrounding area with no standing water. But the bathtub was almost full after fall rains, winter snow melt, and early spring rains – with not enough water being drained out during that time. If the watershed can respond after fall and spring rain events, the bathtub can be empty enough to have capacity to absorb additional rain events. Even then, mother nature rules and when it rains, the watershed levels will go up everywhere, regardless of presence, absence or type of stream or outlet structures.

After Shalda Creek and LTL levels increased and were high by the end of March, a large rain event then happened that caused the bathtub to overflow. The watershed received several inches of rain over the course of a couple days raising the water level at all four monitoring locations.

Finally, NPS gave the permission to remove the beaver dam *after* significant flooding had occurred. The dam was removed at noon on March 30, 2025 followed by additional rain that afternoon.

## LARGE RAINFALL EVENT AND 669 DAM REMOVAL



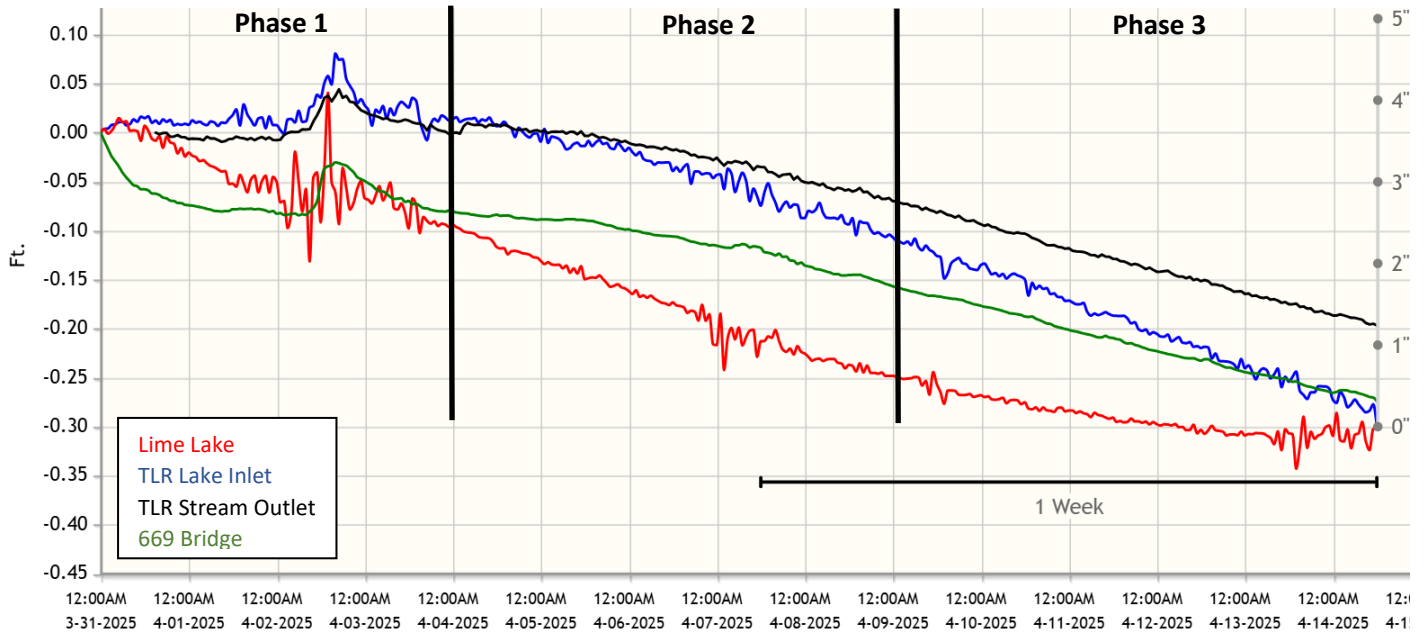
During first part of rain window, Lime Lake, TLR Lake Inlet, TLR Stream Outlet and 669 Bridge all increased similarly. The dam was pulled just before the start of the third rain window. Lime Lake and TLR Lake Inlet increased similarly. However, Shalda Creek at 669 Bridge experienced an initial rapid drop in water levels as the dam downstream was pulled with a rush of water flushing downstream draining Shalda Creek channel – dropping 3” in less than 6 hours. As a result of Shalda Creek emptying out downstream, Shalda Creek at TLR Stream Outlet no longer increased similarly to Lime Lake or LTL with continued rainfall as water was being drawn downstream after the dam removal. During the three rain periods between 12 am 3/29/2025 and 6 am 3/31/2025, Lime Lake had increased 3.48”, LTL increased 3.96” while Shalda Creek at TLR Stream Outlet increased only 1.68” with beaver dam removal allowing water to be cleared from the stream channel. Shalda Creek levels at CR 669 Bridge decreased 1.68”.

Date	3/29/2025 0.00	3/31/2025 6.00
<b>Lime Lake</b>	617.77	618.06
<i>Difference from previous</i>		0.29
<i>Difference (inches)</i>		3.48
<b>TLR Lake Inlet</b>	594.65	594.98
<i>Difference from previous (ft)</i>		0.33
<i>Difference (inches)</i>		3.96
<b>TLR Stream Outlet</b>	594.26	594.6
<i>Difference from previous</i>		0.14
<i>Difference (inches)</i>		1.68
<b>669 Bridge</b>	594.88	594.74
<i>Difference from previous</i>		-0.14
<i>Difference (inches)</i>		-1.68

It’s not possible to go back to see what would have happened if the beaver dam would have been removed months before water was already being elevated. The rain event would still have increased water levels across the watershed. Likely the watershed bathtub would have lower, allowing it to absorb a large rain event without flooding. When there is 3” of rain, water levels will increase 3” or more with runoff pushing water into the watershed lakes and streams. That will happen regardless of whether there is a low rock dam at the outlet (Lime Lake), a culvert at

the outlet (LTL), no structure in place (Shalda Creek at TLR Stream Outlet), or a 30' span bridge (Shalda Creek at CR 669). The impact of a beaver dam is upon clearance rates following a rain event. If the stream flow is restricted and water levels elevated due to a beaver dam, then the capacity to clear water after a rain event will be affected. Let's proceed with understanding what happened to water levels in the watershed after beaver dam removal and the end of the rain event.

### WATERSHED RESPONSES AFTER 669 DAM REMOVAL AND RAIN ENDS



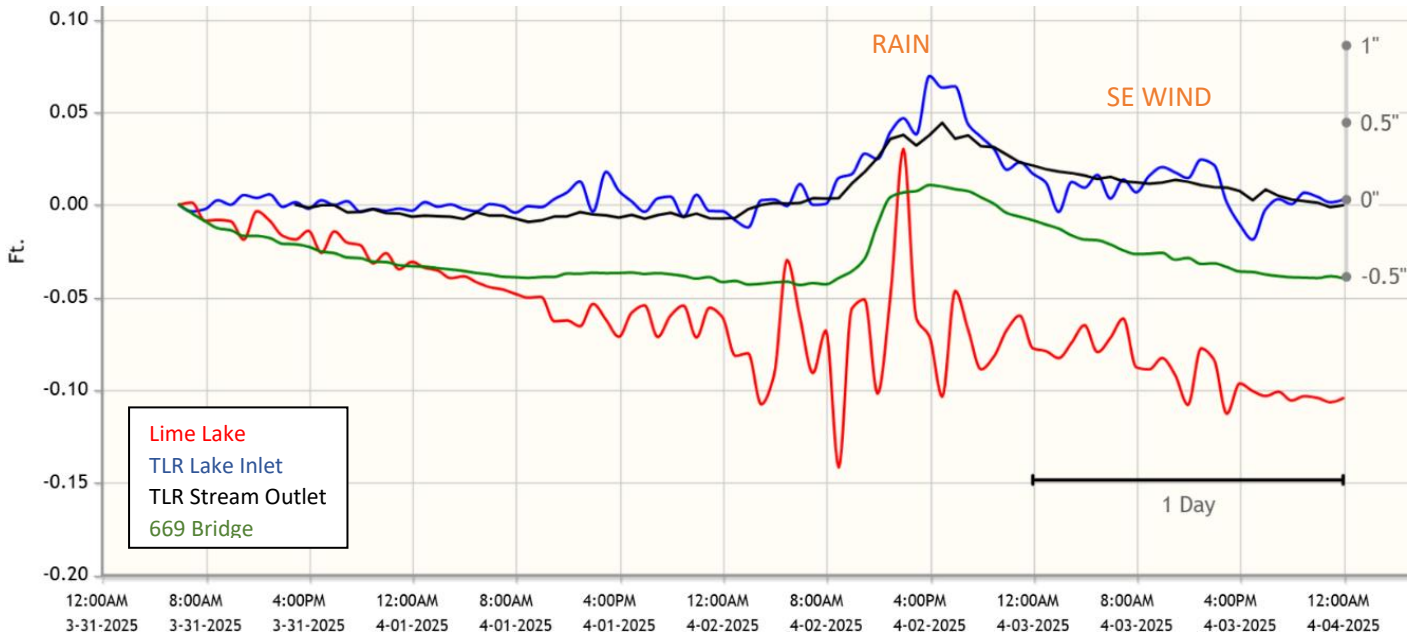
Following the removal of 669 dam (which led to an initial rapid drop of water levels as the stream channel cleared) and the end of rain events, three distinct phases occurred thereafter and have different clearance rates based on the various clearance phases happening in the watershed.

Date	3/31/2025 6.00	4/4/2025 0.00	4/13/2025 18.00
<b>Lime Lake</b>	618.06	617.96	617.74
<i>Difference from previous</i>		-0.1	-0.22
<i>Difference (inches)</i>		-1.2	-2.64
<b>TLR Lake Inlet</b>	594.98	594.98	594.7
<i>Difference from previous (ft)</i>		0	-0.28
<i>Difference (inches)</i>		0	-3.36
<b>TLR Stream Outlet</b>	594.6	594.6	584.2
<i>Difference from previous</i>		0	-0.4
<i>Difference (inches)</i>		0	-4.8
<b>669 Bridge</b>	594.74	594.74	594.54
<i>Difference from previous</i>		0	-0.2
<i>Difference (inches)</i>		0	-2.4

It is important to note that rain continued the afternoon of March 31. Dam was removed at noon on March 31.

Three different phases are expounded upon in the next three graphs.

**PHASE 1 - IMMEDIATE PLATEAU PERIOD AFTER 669 DAM REMOVAL AND RAIN ENDS**



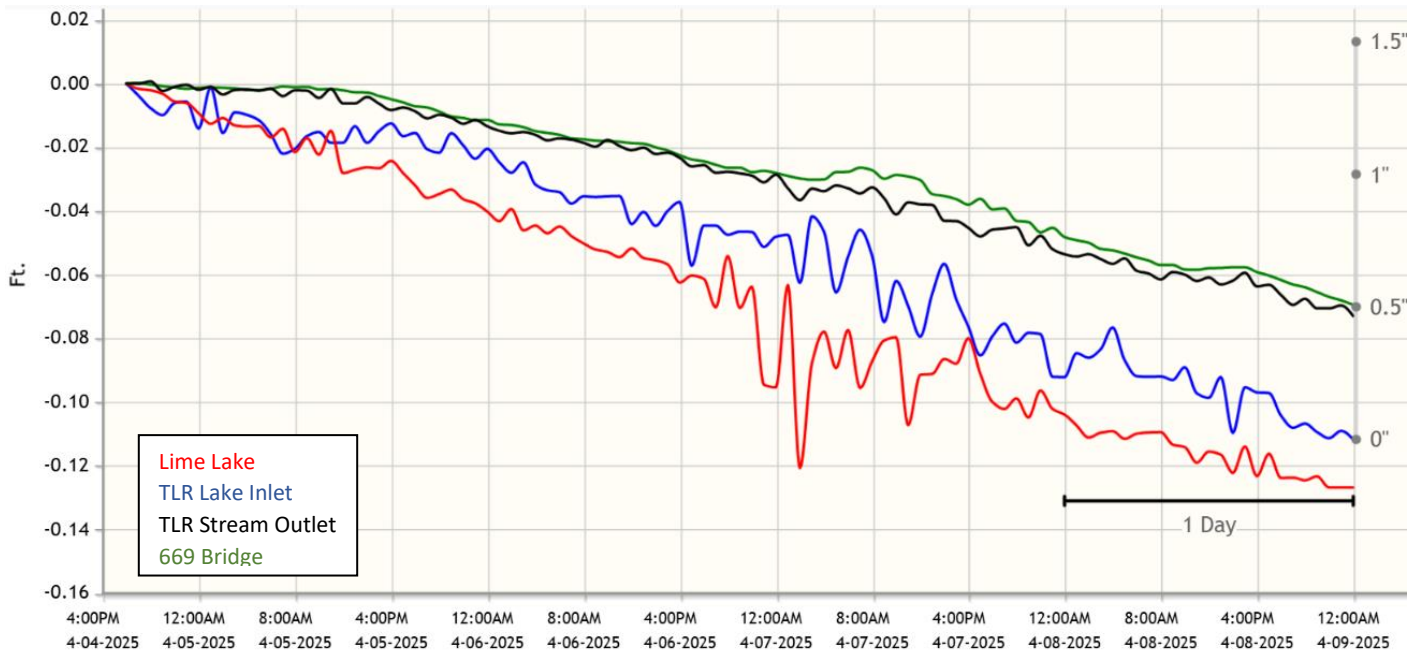
Lime Lake begins to decrease after rain ends and continues a steady decline, clearing water out of the lake through Shetland Creek outlet. In Phase 1, 669 Bridge, TLR Stream Outlet, TLR Lake Inlet all plateau and flatline in clearance response. Shalda Creek, at both CR 669 Bridge and at TLR Stream Outlet, does not decrease further after the initial rapid drop after dam removal. This is due to the time it takes for water to be cleared out of the Shalda Creek watershed. Before rain event occurred, there was standing water far beyond Shalda Creek banks as water levels were elevated due to the beaver dam in place. This condition existed since Fall causing water table to rise and the surrounding ground to be saturated. This standing water and ground saturation continued to add to the volume of water entering Shalda Creek channel, let alone the volume of water coming from LTL. It takes time to clear that much water from the surrounding watershed. As a result, Shalda creek does not rapidly decline during Phase 1.



LTL levels cannot decrease until Shalda Creek decreases. LTL levels are determined by Shalda Creek levels and there is a parallel response seen. When Shalda Creek clears out and levels drop, then LTL levels can decrease. LTL is dependent on TLR Stream Outlet levels. After the rain ends, LTL levels do not continue to increase. Lime Lake is draining into LTL along with other tributaries. The surrounding higher watershed is pushing water into LTL through runoff and through the ground water. Properties are saturated and ground water levels are high. LTL inflow rates and volumes are high. Even with all this water flowing into LTL, lake levels do not continue to increase. During this time, culvert outflow = watershed inflow.

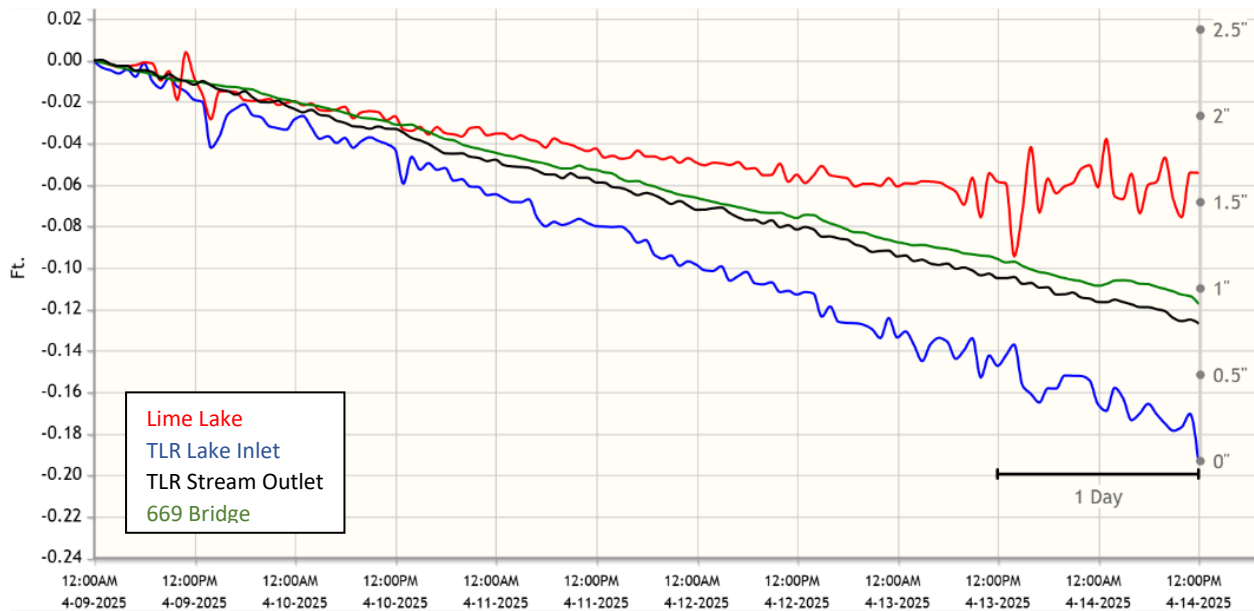


### PHASE 2 – SUBSEQUENT WATERSHED CLEARANCE



Lime Lake continues its steady decline. As water is cleared out of the immediate Shalda Creek watershed, Shalda Creek levels at 669 Bridge and at TLR Stream Outlet begin to decrease similarly and in a parallel fashion. A steady decline in Shalda Creek levels is observed while it is clearing water from LTL as well as still draining the surrounding watershed. As a result, LTL levels begin to decline. The rate of decline in lake levels for LTL (with an outlet culvert) is similar to Lime Lake (with a stream outlet), with parallel responses. TLR culvert is now clearing both watershed inflow and beginning to drop LTL levels itself and clearing the water out from the surrounding flooded watershed. Flow rates are now clearing all the watershed inflow into LTL and removing water from the 640 acre lake itself, even at higher levels. During this time, culvert outflow is significantly greater than watershed inflow.

### PHASE 3 – ACCELERATED WATERSHED CLEARANCE

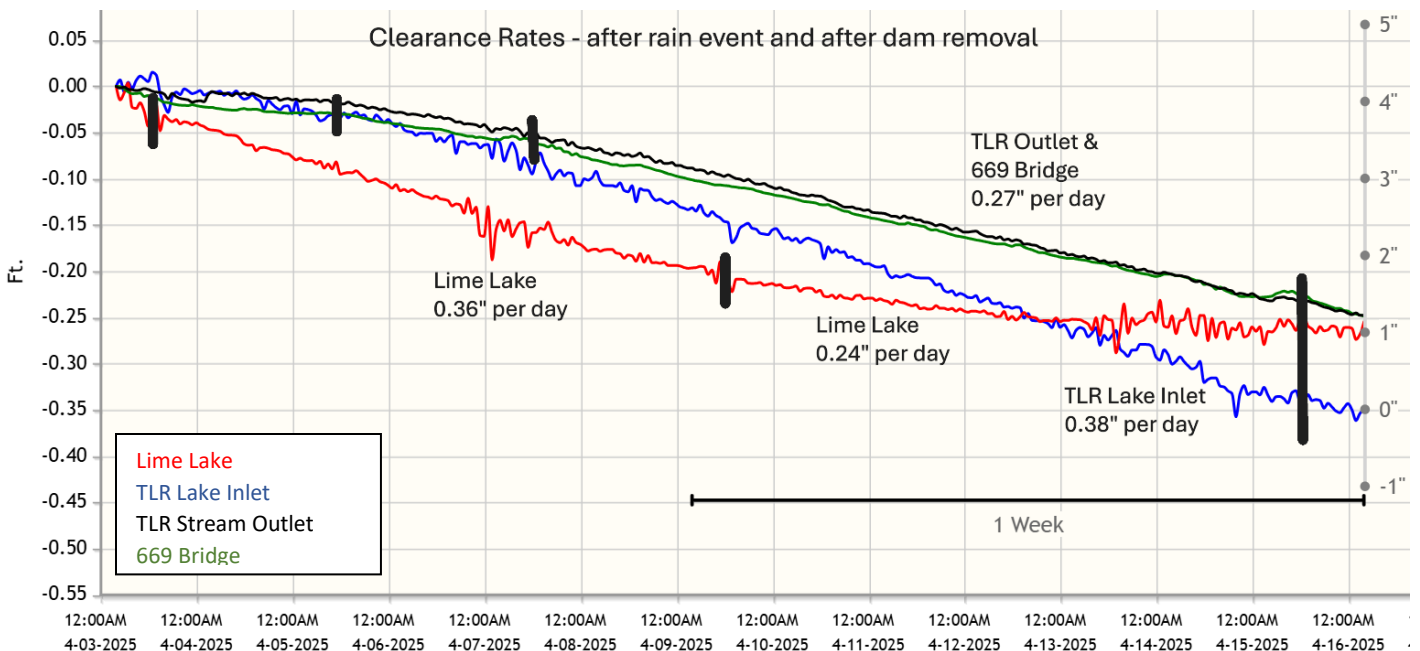


Lime Lake clearance rates begins to slow and plateau as levels approach rock dam control. Lime Lake has responded to the rain event. Shalda Creek and LTL is still responding to months of elevated water levels. Shalda Creek levels, at both the TLR Stream Outlet and 669 Bridge, begin to decline at a more rapid rate and in a similar response that parallels each other. During this time, Shalda Creek watershed has cleared out significant water from the surrounding creek area. Fourteen days after beaver dam removal, Shalda Creek water levels at CR 669 Bridge is 2' lower than the winter plateau and levels at TRL Stream Outlet are equal to winter lows, having cleared out spring rain events. TLR Lake Inlet continues to decrease and clearance rates increase as Shalda Creek levels decrease and also as watershed inflow slows. TLR Lake Inlet is dependent and correlated to Shalda Creek levels at TLR Stream Outlet. Lake levels cannot be lowered below TLR Stream Outlet levels. Decline in Shalda Creek levels lead a decline in LTL levels, although in normal circumstances they often parallel in response.

Gosling Czubak have extensively documented the impact of beaver dams on Shalda Creek levels. There are numerous documented instances in their reports of beaver dam removal and the resulting decline in Shalda Creek levels. That is common sense. Beaver dams do restrict stream flow with buildup of debris. Beaver dams do elevate stream levels as the dams are built larger and higher, and water does back up behind the dam. Shalda Creek stream dynamics are critical to the clearance of water from LTL. Water cannot be cleared from LTL if Shalda Creek has restricted flow or is elevated at TLR Stream Outlet. Flow rates through the culvert decrease (will be discussed subsequently) and water levels cannot drop below Shalda Creek. A dam between TLR and CR 669 has the biggest impact. It has been shown numerous times that LTL levels can drop 6-9" very quickly after a dam is removed. This dam downstream of CR 669 led to elevated water levels in Shalda Creek not only at CR 669 30' span bridge but also at TLR Stream Outlet.

### CLEARANCE RATES WITHIN THE WATERSHED

Clearance rates are helpful in understanding the volume of water that is removed per day after a rain event. The volume of water through an outlet is best determined by monitoring flow rates at the outlet and volume can be determine by outlet size (see subsequent discussion). The volume of water being cleared from a body of water includes the watershed inflow into the lake as well as the water being cleared from the body of water itself. Water levels can help provide a rough indication of clearance rates across the various body of waters and is helpful comparatively, although not a determination of actual flow rates through an outlet. It can also provide an understanding of how long it may take to see a decline in water levels.

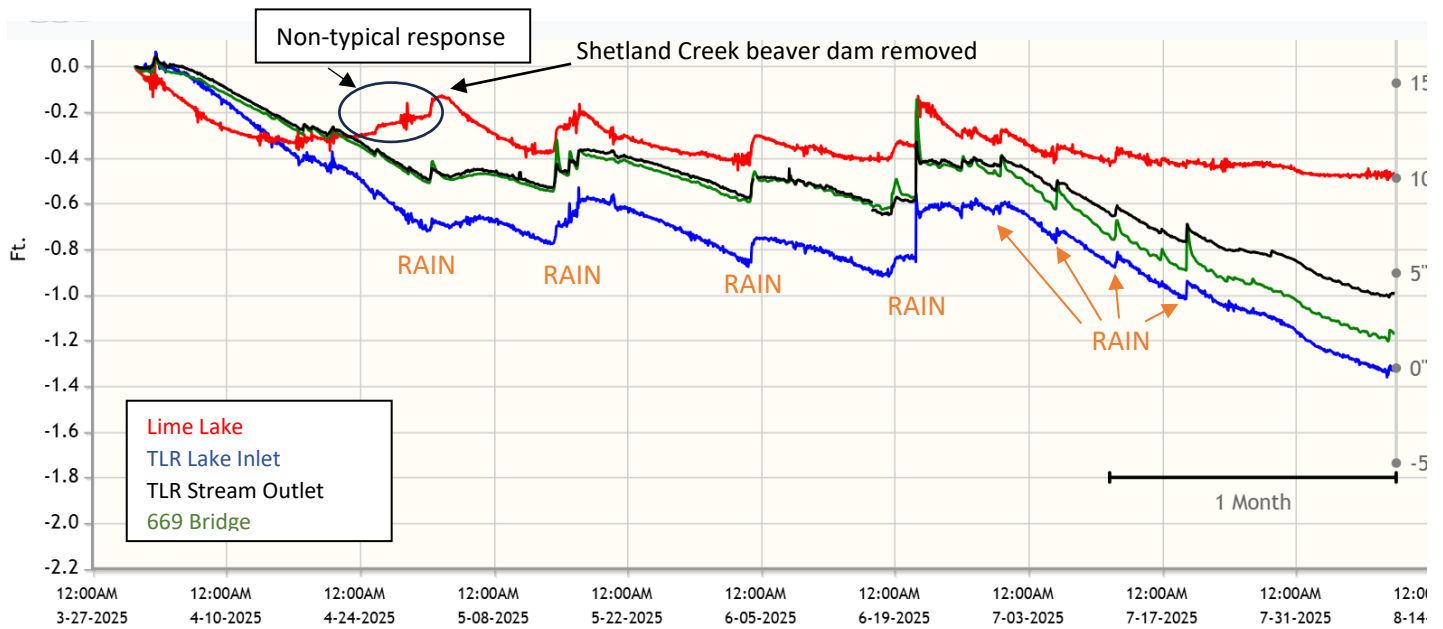


Lime Lake initially saw a clearance rate of 0.36" per day, followed by a slower 0.24" per day, before then reaching a plateau created by the shallow rock dam as the lake reaches a state of equilibrium. Lime Lake is 670 acre lake, similar in size as the 640 acre LTL. At a rate of 0.36" per day, Lime Lake decrease represents about 6,549,545 gallons per day removed from the surface volume of the lake (one acre foot of water equals approximately 325,851 gallons or 43,560 cubic feet; 1" acre of water equals approximately 27,154 gallons or 3,639 cubic feet).

After the Shalda Creek watershed was cleared of initial high water, Shalda Creek declined at a consistent 0.27' per day at both CR 669 Bridge and at TLR Stream Outlet, with a parallel response being observed.

Following the initial Shalda Creek watershed clearance, LTL saw a steady decline of 0.38" per day, representing roughly 6,603,852 gallons of water removed from the surface volume of the 640 acre lake every day. LTL clearance rate was equal to or greater than Lime Lake clearance rates, even with Lime Lake's water flowing into LTL along with other tributaries and the surrounding hillside. So the actual volume of water flowing through LTL outlet is much greater than just a surface volume calculation. Nonetheless, the amount of water flowing through the TLR culvert is significantly more than the volume of water being removed from Lime Lake with an open low rock dam at the stream outlet. The clearance rates of LTL are greater than the watershed inflow into the lake, lowering the lake level 1" in less than 3 days at these high water levels.

### WATERSHED CHANGES SPRING TO SUMMER 2025



Following the removal of beaver dam and clearance of spring rainfall events, water levels retreated to normal levels and the watershed responses became typical once again, with water levels increasing similarly during rain event followed by decrease. Lime Lake plateaus due to the shallow low rock dam which maintains a consistent water level throughout the summer. LTL continues to decrease to lower levels as Shalda Creek levels decrease as well.

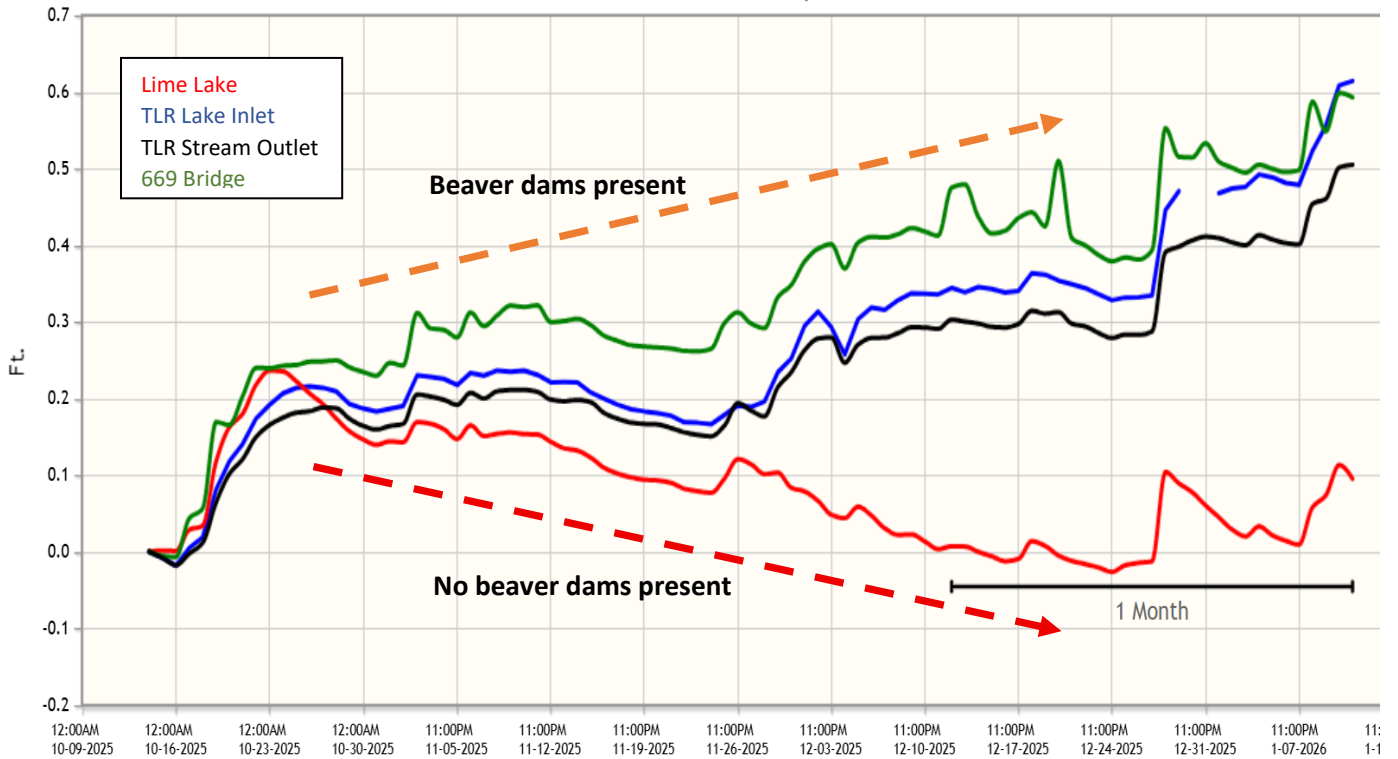
Monitoring water level helps identify nontypical patterns. When Shalda Creek begins to rise in a nontypical fashion compared to LTL or Lime Lake, it's likely there is beaver activity. After noticing that Lime Lake was increasing in a nontypical fashion during the end of April 2025, Shetland Creek was inspected for beaver dams. A beaver dam was identified to be restricting flow and backing up water levels. After removal of beaver dam, Lime Lake returned to its typical response to watershed rain events. It is another example of the impact of beaver dams on lake levels.

## DE JA VU DURING FALL 2025 – WINTER 2026?

During routine scouting of Shalda Creek early Fall 2025, two dams were located: A tweener dam between TLR and CR 669 and a dam downstream of CR 669 Bridge. Cleveland Township notified NPS but permission was not granted to remove before the winter snowstorms. Once again, clearing of fall rain events has not happened in Shalda Creek and LTL with levels continuing to increase. As of late February, LTL levels are 594.36, only a few inches from when high water levels begin to create problems for riparian owners. And winter snow melt or spring rains have not yet occurred. With substantial winter snows and potential spring rains, will history repeat itself?



### WATER LEVEL CHANGES FALL 2025 – WINTER 2026



## HISTORICAL SIMILIARITIES

There are two other instances where water overflowed LTL banks and created flooding – Fall 2012-2014 and Fall 2020. Both of those had beaver dams in Shalda Creek that impacted watershed dynamics, elevating water levels, prior to extensive and large rain events. In both instances, the beaver dams were removed after flooding had already occurred. Post-reactive dam removal after flooding occurs is helpful but doesn’t work to potentially prevent reaching flood levels by keeping water levels lower prior to a significant rain event. When Shalda Creek is clear of dams headed into the fall and spring rains, flood stage has not been reached even with significant rain events.

During 2012-2014 a large beaver dam, combined with several smaller dams, was constructed at Fish Camp area and existed for a long period of time with no permission to remove dams. This dam was massive; nearly hundred feet in width and backed up water more than 4’ high. A huge area of standing water existed all the way to CR 669. Ground was saturated with standing water and water table elevated. Then came fall rains with several large rain events that pushed LTL over its shoreline causing flooding. The huge dam was removed after high levels occurred.

The culvert at CR 669 was replaced with a 30’ span bridge in summer of 2020. Leading up to Fall 2020, dams existed between TLR and CR 669 as well as downstream of CR 669. Water levels increased in Shalda Creek and LTL leading up to a 3” rain event that caused significant flooding, at which time the dams were removed. Significant damage occurred including trees blowing over after saturation of root structures during high winds. Gosling Czubak in their December 15, 2020 report (pages 21-23) summarized the 2020 event as follows:

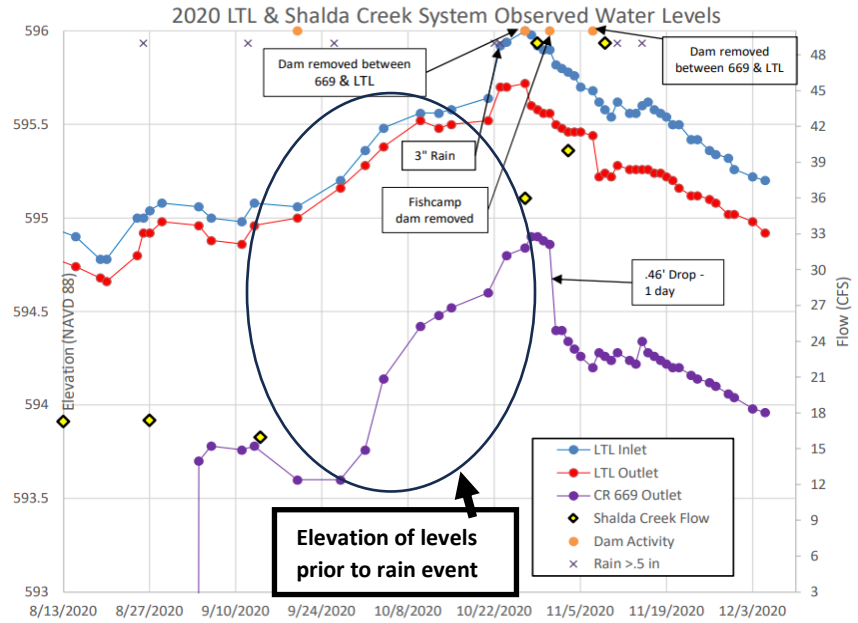
*The low water elevation of 594.78 was measured for the year on August 20, 2020. This was .32 feet (3.8 inches) more than the 2018 level of 594.46 measured on August 19, 2018. Precipitation for August and September 2020 was below normal for both months and the water levels at Little Traverse Lake were fairly consistent just above 595 from late August until September 20, 2020 when the presence of dams both at “Fishcamp” and between CR669 and Traverse Lake Road are noted. **With below average precipitation for August and September, further water level decline at Little Traverse Lake through the dry period would have been expected. The presence of both dams at “Fishcamp” and between CR669 and Traverse Lake Road coupled with the above average October precipitation drastically impacted water levels and caused them to reach a high of 596.0 on October 27, 2020. It is also noted that a high-water level of 594.9 at the new CR669 culvert was observed on this date and was above the top of the new concrete culvert opening of 594.8.***

*The National Park Service allowed an emergency removal of the dam between CR669 and Little Traverse Lake on October 27, 2020. A removal of the Fishcamp dam was authorized on October 31, 2020. Prior to and following these removals Gosling Czubak measured flow through the culvert at Little Traverse Lake. Flow was estimated by measuring velocity from the time for an apple to pass through the culvert and flow area from the water level readings. The flow estimations from several dates and locations within the system are summarized in Table 3 below.*

FLOW (CFS)	10/27/20	10/29/20	11/3/20	11/9/2	<b>Dam removal 10/27 36% greater flow rates</b>
W Traverse Lake Road	36	49	40	49	
M-22/ Shetland Creek	36	33	29		

*Figure 15 below shows an enlarged graph of the 2020 data from mid-August. Following removal of the dam between CR669 and LTL water levels dropped .1 ft at the LTL inlet, .16 ft at the outlet, and rose .06 feet at CR699. Once the downstream Fishcamp dam was removed, the system could “drain” and the water level at CR669 dropped .46 feet (5.5 inches) in one day. The dam between LTL and CR669 had been significantly rebuilt and was removed again on November 7, 2020. The LTL outlet quickly dropped .22 feet (2.64 inches) followed by a steady drop in the LTL water levels. The LTL outlet drop following this event was twice as much than the first removal event on October 27 due to the fish camp dam removal and lowering levels at CR669.*

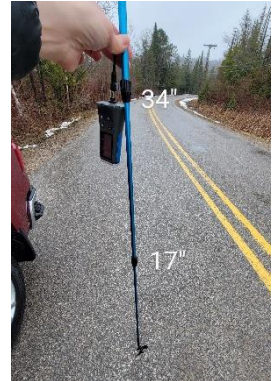
# Remembering Fall 2020 Flooding



**Dams removed only AFTER flooding. What if beaver dams had not elevated levels leading up to 3" rainfall event?**

## UNDERSTANDING STREAM FLOW CHARACTERISTICS

In an effort to understand the impact of watershed changes on flow rates, flow rates were measured using a JDC Electronics Flowwatch Flowmeter with fluid impeller ( <https://www.forestry-suppliers.com/p/94356/65971/flowwatch-flowmeter/anemometer> ) with accuracy  $\pm 2\%$  fluid speed, capable of measuring fluid speed 0.2 to 40 mph, and resolution 0.2 mph. Measurements were taken (by LTL resident Jerry Leanderson) at both the inlet and outlet of TLR culvert and at both the upstream and downstream side of CR 669 Bridge. In addition, measurements were taken in the top half of the water depth as well as the bottom half of the water depth. At CR 669, measurements were taken at the southern third section of the bridge, the middle third section of the bridge, and the northern third section of the bridge. Manual readings of the measuring sticks in the water were recorded. A laser level was used at TLR culvert to verify the consistency of the measuring sticks to actual differences in inlet and outlet levels (within 0.25") to make sure they had not been altered. Twenty-five data sets were taken between March 28, 2025 and September 18, 2025 in order to capture the full range of water levels from high to low (16 measurements per data set, 25 different days, 400 total flow measurements taken). Two data sets were collected on March 28 & 29 prior to dam removal, one data set during dam removal with one set 4 hours after dam removal on March 30, and the rest thereafter. Raw data available upon request; a summary is included in Appendix 1.



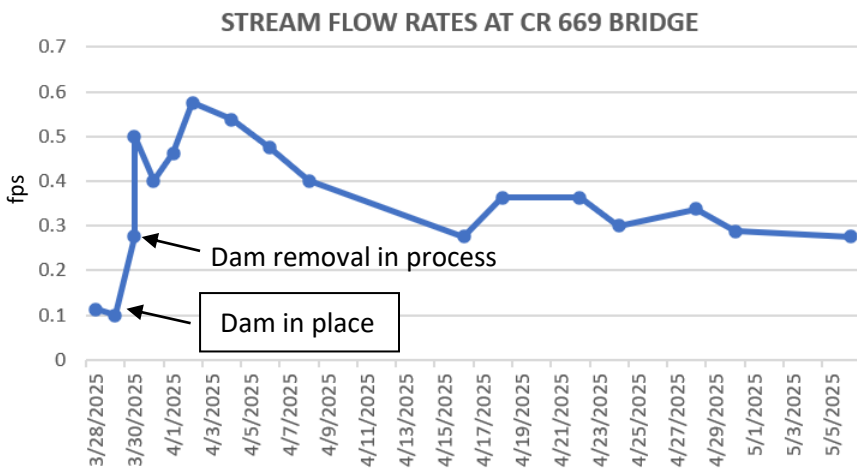
*Location specific observations from the data sets at CR 669 Bridge:* Readings at the upper and lower water depths are essentially the same over the 25 data sets. The southern one-third of the 30' bridge span has essentially zero flow (readings zero) at both the upstream side and the downstream side, even at high water levels and during the period after dam removal. Readings at the middle section and the northern section are closer, with the northern section having 14% higher flow rates than the middle section on the upstream side (middle and northern outlet readings more similar on the downstream side) over all 25 data sets. The stream has a slight curve heading into the bridge span pushing water to the north. The water has carved out a deeper channel in the northern one third of the bridge span. The upstream side has 36% higher flow rates than the downstream side over all 25 data sets. Water freely enters bridge and then gets more evenly mixed as it leaves the bridge span downstream with a deep channel cut as well headed back towards middle of stream. On the downstream side, the middle section had 8% higher flow rates than the northern section over all 25 data sets. Not all of the 30' bridge span capacity is being used, with the highest volume of water utilizing the northern one-third section (with deeper channel cut) and the southern one-third third section not used at all. For data analysis over time, an average of the four readings on the upstream side were used (upper and lower depth readings at middle one third section, upper and lower readings at northern one third section) combined with the four readings on the downstream side (upper and lower depth readings at middle one third section, upper and lower readings at northern one third section), resulting in an average of eight readings.

*Location specific observations from the data sets at the TLR culvert:* Readings at the upper and lower water depths are essentially the same over the 25 data sets. Readings on the outlet side were 10% higher than the readings on the inlet side over the 25 data sets. The flow of water coming of the culvert is more concentrated and turbulent at the center of the outlet side than the water being pulled in on the inlet side. For data analysis over time, an average of the two readings taken on the inlet side were used (upper and lower readings), combined with the two readings on the outlet side (upper and lower depth readings), resulting in an average of four readings.

*Comparisons of culvert versus bridge span:* Over all 25 data sets, flow readings at TLR culvert were 8 times greater than those taken at CR 669 Bridge. Even though the 64x43" TLR culvert is much smaller than the 30' span CR 669 Bridge, water flow rates are significantly higher, pushing high volumes of water through. Based on the average decrease in LTL water levels of 0.38' per day observed during April 2025, that decline in surface water across the 640 acre lake represents roughly 6,603,852 gallons per day, or roughly 76 gallons per seconds (11.5 cubic feet). The actual clearance volume is much greater when taking into consideration of also removing water volumes contributed

by inflows such as Shetland Creek draining Lime Lake, other tributaries, and ground water influx. During higher clearance rates for the 670 acre Lime Lake during April 2025 at a rate of 0.36" per day, the Lime Lake decrease represents the removal of about 6,549,545 gallons per day, or roughly 76 gallons per second (11.5 cubic feet) Based on measured flow rates of 3 fps and a culvert cross section with water 3' in depth and culvert width of 5' (actual water cross sectional area likely closer to 10 sq ft), clearance volume would be 45 cfs.

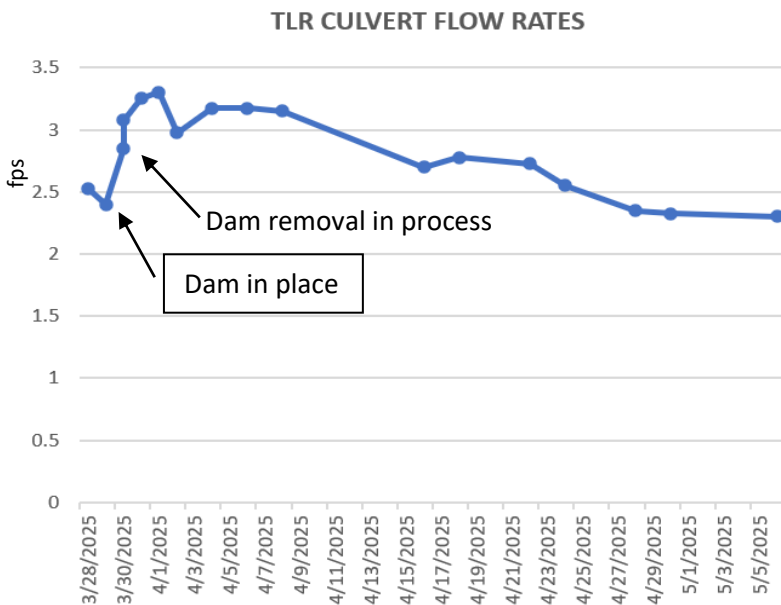
*Impact of dam removal on flow rates at CR 669:* As seen in the water level data graphs, a rapid decline in water levels were observed in Shalda Creek at CR 669 following the removal of the downstream 669 dam. It would be expected to observe an increase in flow rates as well. Flow rates in Shalda Creek at CR 669 Bridge increased from 0.1 cfs when the dam was in place to as high as 0.6 fps after dam removal, a six fold increase in flow rates. Flow rates a month later at the beginning of May were 0.3 fps, three times higher than prior to dam removal when water levels were abnormally high. Even the summer flow rates, when water levels are low, are 50% higher than flow rates when the dam was in place.



Additional Flow Rates (FPS)

5/16/2025	0.2875
5/22/2025	0.3375
6/3/2025	0.225
6/4/2025	0.2625
6/16/2025	0.2
8/4/2025	0.1625
9/18/2025	0.1875

*Impact of dam removal on flow rates at TLR:* Flow rates following downstream 669 dam removal increased 30%, from roughly 2.5 fps to 3.2 fps. Removal of a dam downstream of CR 669 does impact flow rates at TLR culvert.



Additional Flow Rates (FPS)

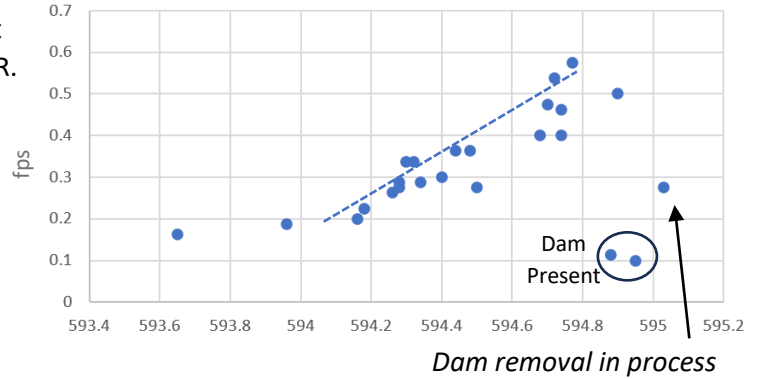
5/16/2025	2.475
5/22/2025	2.275
6/3/2025	2.15
6/4/2025	2.1
6/16/2025	1.9
8/4/2025	1.575
9/18/2025	1.625

3' high water x 5' culvert width = 15 sq ft  
3 fps = 45 cfs

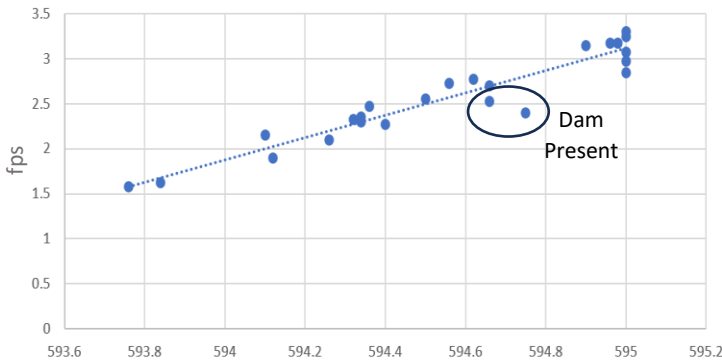
Actual flow rate less based on area of water which is less based on water level and dirt fill  
Inlet: Top of culvert to dirt bottom 28.5"  
Outlet: Top of culvert to dirt bottom 33"  
Culvert size 64x43

**Correlation of flow rates and water levels:** Flow rates (fps) are dependent on water levels and it is important to understand the correlation to water levels. Flow rates at CR 669 are less linear in correlation than flow rates at TLR. Flow rates during presence of downstream dam are significantly nontypical. The flow rates at TLR culvert are similarly correlated to either lake inlet levels or stream outlet levels. Lake levels are dependent on Shalda Creek levels on the outlet side and cannot be lowered more than the creek level. When beaver dams elevate Shalda Creek levels, flow rates decrease.

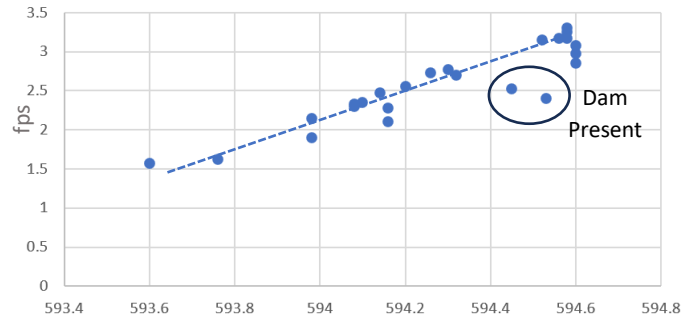
**CORRELATION OF CR 669 BRIDGE FLOW RATES TO SHALDA CREEK LEVELS**



**CORRELATION OF TLR CULVERT FLOW RATE TO INLET LAKE LEVEL**

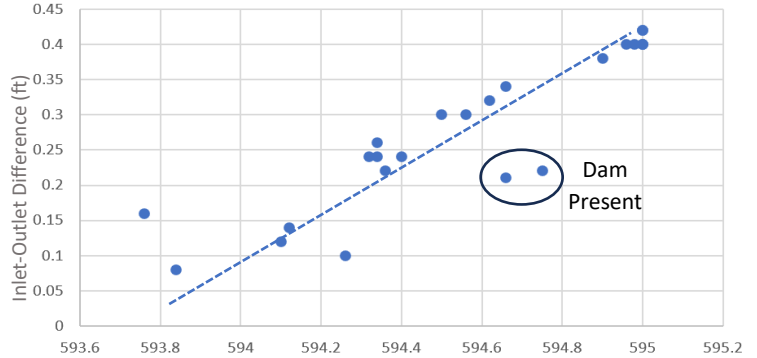


**CORRELATION OF TLR CULVERT FLOW RATES TO STREAM OUTLET LEVELS**



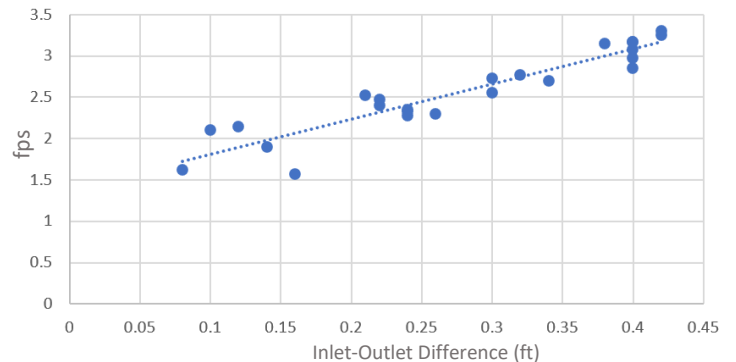
Water levels on the lake inlet side of TLR culvert are mostly higher than water levels at the stream inlet side. The difference is correlated to lake water levels – the higher the lake the level, the greater the culvert inlet-outlet differential. A greater data set is presented on the following page, including a comparison of whether a beaver dam is present or not. A beaver dam downstream of CR 669 can impact the culvert inlet-outlet differential by raising the Shalda Creek side of TLR culvert.

**TLR CULVERT INLET-OUTLET DIFFERENTIAL CORRELATION TO INLET LAKE LEVELS**



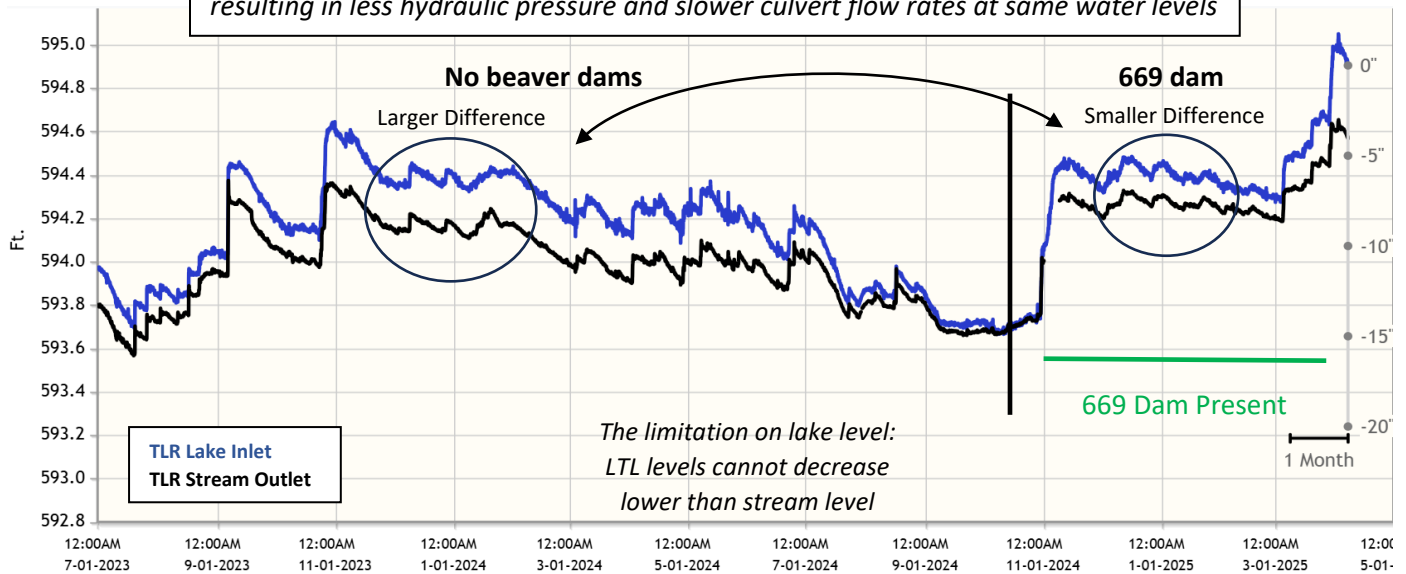
The inlet-outlet differences create a hydraulic pressure that increases as water levels increase. The result is that flow rates increase as well. Flow rates are correlated in a linear fashion to the culvert differential. As water levels increase, flow rates increase pushing a greater volume of water through. As water levels increase, the area of culvert capacity utilized by water flow also increases, creating a greater cubic feet per second flow. When the inlet-culvert differential is lower during the presence of a beaver dam downstream, culvert performance is reduced.

**CORRELATION OF FLOW RATES TO CULVERT INLET-OUTLET DIFFERENTIAL**



## TLR CULVERT LAKE INLET – STREAM OUTLET LEVELS during beaver dam absence or presence

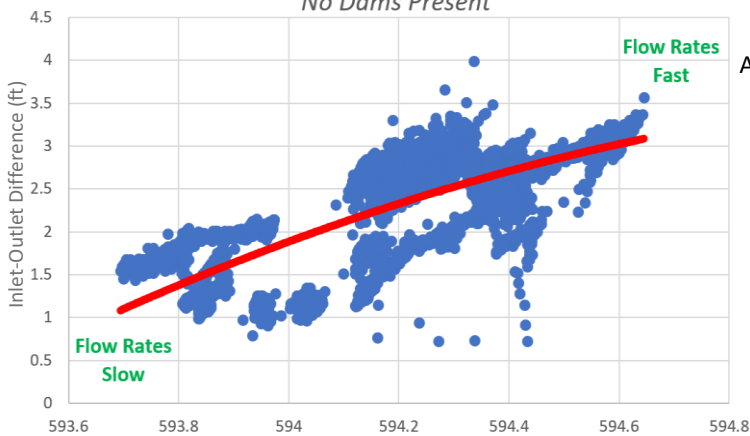
*Inlet – Outlet difference is less with presence of beaver dams at same water levels, resulting in less hydraulic pressure and slower culvert flow rates at same water levels*



### Culvert Difference Inlet-Outlet vs LTL Lake Levels

7-1-23 to 6-7-24

No Dams Present



● 595.0  
Apr 25

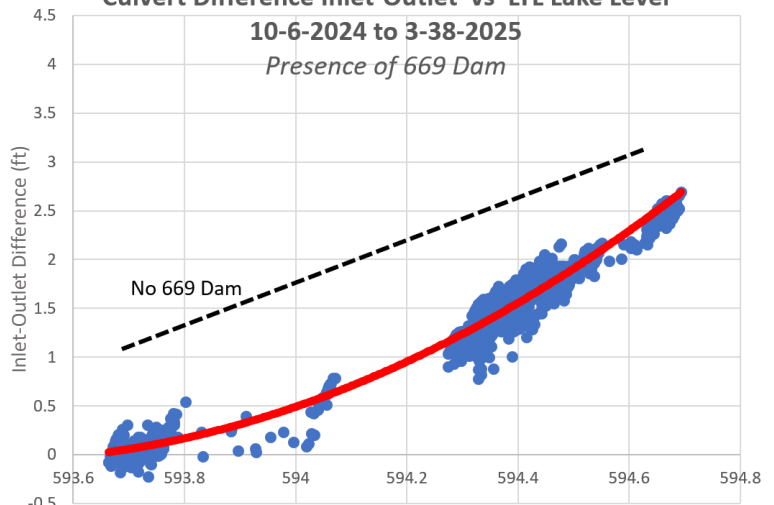
As water levels increase, the differential between TLR Lake Inlet and Stream Outlet increases. The difference usually ranges from 1" at lower levels to 3.5" at higher levels. On 4/1/2025, the differential was 5.0" with rain increase on inlet side and simultaneous dam removal on outlet side. The inlet-outlet differential creates hydraulic pressure, forcing a higher rate of flow through the culvert, thus increasing the volume of water flowing through culvert. If there was no culvert, water levels would be equal to the Shalda Creek level on the Stream Outlet side. Note the parallel response pattern over time between lake inlet and stream outlet levels.

The difference between inlet and outlet levels is smaller when beaver dams are present, which elevate Shalda Creek levels at TLR Stream Outlet. This smaller differential creates less hydraulic pressure, which can then reduce flow rates and the volume of water. In addition, beaver dams restrict flow of water in the stream creating slower flow rates as well. Thus, beaver dams have a significant impact on culvert dynamics and associated flow capacity. The best scenario is to ensure lake levels can be as low as possible leading to smaller inlet-outlet differences as a preventative action, not a post-reactive response to high water levels.

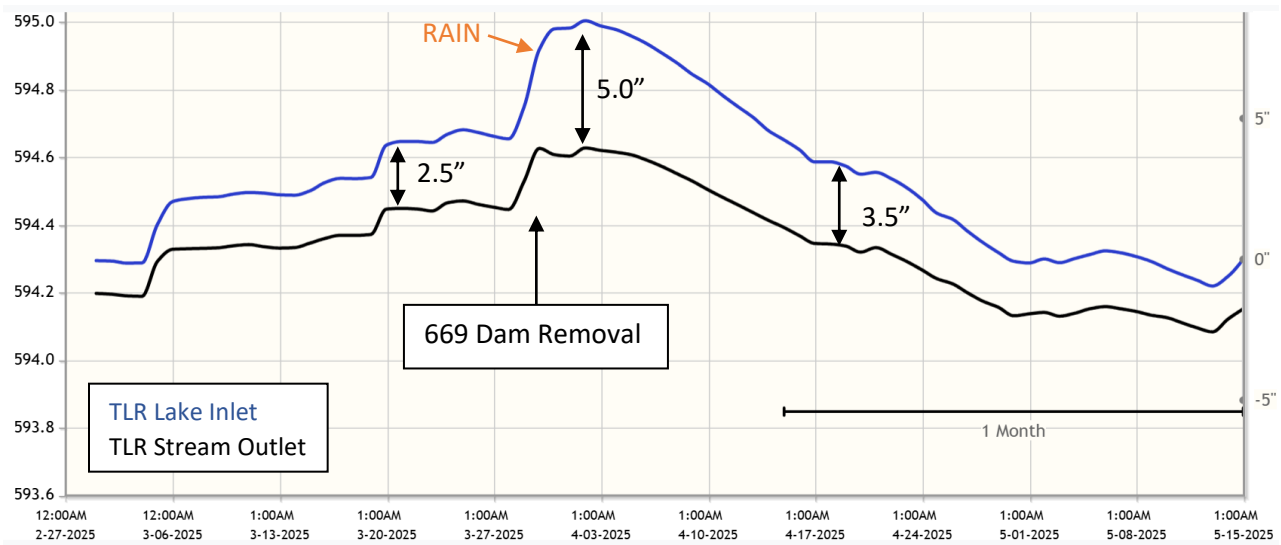
### Culvert Difference Inlet-Outlet vs LTL Lake Level

10-6-2024 to 3-38-2025

Presence of 669 Dam



## IMPACT OF DAM REMOVAL ON INLET – OUTLET CULVERT DIFFERENTIAL



The inlet-outlet culvert differential increased after dam removal when compared at similar water levels (e.g. 2.5” vs 3.5”). The differential increased rapidly immediately after dam removal as water was pulled downstream as the Shalda Creek channel was emptied of excess water. With a drop in Shalda Creek levels at the TLR Stream Outlet side, combined with rain event increase of levels on the TLR Lake Inlet side, the culvert differential increased to 5” at the peak. Flow rates were also at peak rates during this time. It is also clear that a dam downstream from CR 669 had impacted Shalda Creek levels all the way upstream to TLR. There is a lag time after dam removal for the differential to return to more normal differences simply due to size of water bodies. Shalda Creek can clear more quickly than a 640 acre lake draining into a 20’ stream. The greater the culvert differential, the greater the hydraulic pressure, the greater the flow rate, and thus a larger volume of water being cleared per second. Beaver dams elevate stream outlet levels, reducing the culvert differential and thus negatively impacting culvert performance with reduced flow rates.

Flow volume (cfs=fps x culvert area, less than 15 ft<sup>2</sup>) measured at the TLR culvert was below 45 cfs in March 2025 and March 2026 during high water levels. Gosling Czubak (2020 report, page 16) references 60 cfs as the threshold where the culvert begins to be a limiting factor:

*Previous analysis provided by Gosling Czubak identified the Traverse Lake Road culvert operates under inlet control with flows above 60 cfs. The BCD data indicates flows in both Shetland and Shalda Creeks well below 60 cfs such that the Traverse Lake Culvert was not operating under inlet control. This is significant and indicates that downstream conditions such as a beaver dam are affecting water levels as opposed to the culvert being under inlet control conditions.*

### HISTORIC WATER LEVEL COMPARISONS

Little Traverse Lake residents have been monitoring water levels for many decades. Regular and frequent manual readings were taken since 2014 when measuring sticks were installed by surveyors. Automated sensors were installed Fall 2020. From 1984 - 2000, local resident Roger Favorite recorded water levels by measuring the distance from the top of TLR culvert (lake side) to the water level in the culvert. Dave Spathelf would measure a secure rod off his retaining wall. It is not known if the culvert has sunk lower since Roger Favorite’s readings (which would make those readings lower than today’s comparison) but a comparison can be made by translating the data into current levels. Some of Roger Favorite’s readings have been passed on in various correspondence and a few of those are noted here.

Highest water level	October 2, 1984	16"	594.47	
Lowest water level	July 4, 1988	32.75"	593.12	
Most recent levels	March 7, 2000	23.25"	593.79	
	June 28, 2000	28.75"	593.45	
	August 11, 2000	31.25"	593.25	
Proposed ideal range		22"-25"	593.7-593.9	
Measured levels 2025	April 2, 2025	10'	595.1	
	April 9, 2025	12"	594.85	
	May 4, 2025	18"	594.3	
	September 18, 2025	24"	593.85	considered "low"

Again, it is likely there has been some settling of the culvert over time. Water levels are considered low today when in the range 593.6-593.8 which was considered the proposed ideal range observed before 2000. It would be unusual today to have water levels at 593.8 in March. It would appear that normal range of water levels observed today could be 4-6" higher than that observed 25-35 years ago. The increase in water level norms is due to a buildup in Shalda Creek with debris, beaver dams, and sediment in gradual stream slope areas over the past decades that has raised Shalda Creek levels at TLR Stream Outlet.

#### SUMMARY OF KEY OBSERVATIONS

- When it rains, the levels at all four locations in the watershed increase in a similar fashion, regardless of structures present or type of structures (culvert, bridge, or no structure).
- The beaver dam downstream of CR 669 elevated water levels in Shalda Creek at CR 669 Bridge and at TLR Stream Outlet side of TLR culvert, and thus increased water levels in LTL – even prior to spring rain events. The increase in water levels was nontypical to normal patterns and as observed for Lime Lake.
- The beaver dam downstream of CR 699 lowered the TLR culvert inlet-outlet differential and thus decreased culvert performance.
- The flow rates at both CR 669 Bridge and TLR culvert were reduced in comparison to an unrestricted stream with flow rates drastically increasing after removal of beaver dam.
- Beaver dam removal after flooding is helpful for helping with the clearance of water after a large rain event. However, removal of a beaver dam before flooding occurs is even more critical and important. Stream flow can be maximized as well as clearing water from all locations in the watershed after rain event. As a result, the bathtub (LTL) can be as low as possible allowing there to be a capacity to absorb additional rain events. When beaver dams elevate the water levels in Shalda Creek, and LTL subsequently, the watershed becomes saturated and it becomes difficult to absorb rain events. Then, not only does lake water need to be cleared but also water in the surrounding watershed and saturated water tables.
- Dams need regular maintenance before fall and spring rains, *before* high water levels result and *before* flooding results.

## KEY CONSIDERATIONS FOR BEAVER DAM REMOVAL

Having automated data collection at the four locations is imperative. The cost of this and the monitoring of data has been borne by Little Traverse Lake Association (LTLA) members, initially recording physical readings at each location and recently using automated sensors. Data has been collected for over a decade, with extensive professional analysis done by Gosling Czubak, the cost of which has been borne by LTLA. Usually non-typical watershed responses can be observed in the automated data readings (when one location response is no longer parallel or consistent with weather related activity). Physical dam scouting of Shalda Creek is done when red flags of concern are noted in the automated data and is also done leading up to fall and spring rain seasons as well as during those seasons. The cost of scouting is borne by LTLA. Having access to satellite cameras at the dam locations would be helpful.

It is difficult work to remove a beaver dam, the cost of which has been borne by LTLA. The longer time goes on, the larger the dam is built and more intricate. If left in place, the debris begins to collect sediment. If never removed, the dam turns into a berm similar to what has created Narada Lake. It is not prudent to let beaver dams exist for long periods of time. With regular dam maintenance, experience has shown that beavers will locate elsewhere and the dams often are not rebuilt.

Beaver dams not only restrict stream flow but they restrict fish movement in the stream, blocking access and movement. This is a significant fishery impact as streams connect Lake Michigan and LTL. In the past, salmon were known to reach LTL.



It is dangerous for individuals to remove dams when the weather is cold, water levels are high, or during winter with potential ice. Removing dams before the rainy season is prudent and easier.

Not allowing beaver dam maintenance is not a prudent option. Gosling Czubak commented on this in the December 15, 2020 report (page 25):

*While not the focus of this report, discussions are merited in regard to long term impact of any policy that does not allow dam modification downstream of CR669. Dams have been built further downstream of fishcamp which impounded over three feet of water as was seen back in 2014. If no maintenance or beaver management is allowed, it is feared that existing dams could continue to grow, could fill with silt, and create long term challenges for the creek to effectively transport drainage from the watershed. A buildup of debris from dams already exists and constricts the stream meriting channel width restoration. The impact to property has been experienced and could be even more significant over time without a long-term management policy partnership with Little Traverse Lake riparian owners.*

If beaver dams from TLR to Fish Camp were left unchecked over decades, this flat portion of the Shalda Creek would drastically alter the Little Traverse Lake watershed and stream dynamics. There was period of several years leading when beaver dam scouting and maintenance did not occur. As a result a large dam (4' high and very wide) was constructed at Fish Camp and created "Shalda Lake" that backed up standing water from Fish Camp upstream to CR 669 as well as the construction of three other dams. The saturated Shalda Creek watershed and LTL watershed experience significant flooding in Fall of 2012-2014 when multiple significant rain events occurred.

There are two examples of the long term impacts of beaver dam construction that continues unchecked: the formation of Narada Lake and currently the dam activity in the Port Oneida area which has overtaken and engulfed Kelderhouse Road. Shalda Creek downstream of Fish Camp to Lake Michigan has not historically been kept clear and

as a result, the creek has several beaver dams and significant blow down of trees into and over the creek. Shalda Creek is only navigable by kayak from TLR to Fish Camp. It is a difficult walk from there to Lake Michigan with all the debris. This photo shows an example of the tree debris downstream of Fish Camp.



These photos taken June 2014 show the accumulation of debris that exists between Fish Camp and Lake Michigan. Shalda Creek has lots of beaver dam activity as well as tree blow down as trees die out with saturated water tables.





This beaver dam near the Fish Camp area was present June 2014 and finally removed October 2014 as part of the Gosling Czubak study. It is an example of how larger beaver dams can become over time if not maintained. The dams then collect sediment and if left untouched, will drastically alter the ecosystem with standing water upstream that then chokes off trees and creates a saturated and elevated watershed that has little capacity to absorb seasonal rain events, especially if significant. This process created Narada Lake is underway at Kelderhouse Road in Port Oneida.



## LONG HISTORY OF BEAVER DAM REMOVAL

Monitoring Shalda Creek from TLR to Fish Camp for beaver dams and subsequent removal of beaver dams when found has been considered normal practices for over 50 years. Some remember generations who had cleared beaver dams going back to 1969. Beaver dam maintenance has been essential over the years to help keep this portion of Shalda Creek free of restrictions, clear of debris, and to maximize stream flow, especially with the gradual slope of Shalda creek in this area.

In the past, the National Park Service and Little Traverse Lake residents worked side by side in beaver dam maintenance. The minutes of the November 11, 1998 meeting of Little Traverse Lake Property Owners Association Board of Directors included this reference:

*Tom VanZoeren, NPS, spoke regarding beaver habitat, environmental concerns and control. Summary of the discussion: the NPS recognizes the possibility for damage to the environment outside of the park boundary that may be caused by animals within the park and have a responsibility to help avoid problems. The Park will review the possibility of a winter burn of debris piles from the dams. The Lake Association will continue to monitor the lake level and beaver activity and report to the NPS.*

A Fall 1994 newsletter of the Little Traverse Lake Property Owners Association stated:

*The lake reached a level in September that was several inches above and recent recordings. A brief search disclosed that those busy beavers had built another dam in Shalda Creek. After discussion with Ivan Miller, National Lakeshore Superintendent, and Tom VanZoeren, Park Ranger, we agreed to help breach the dam. Roger Favorite and Bob Kraemer got together with Tom and removed the dam. Within three days, the lake level had dropped over four inches, to its normal range for this time of year.*

### Lake Level

The lake reached a level in September that was several inches above any recent recordings. A brief search disclosed that those busy federal beavers had built another dam in Shalda Creek. After discussion with **Ivan Miller**, National Lakeshore Superintendent, and **Tom VanZoeren**, Park Ranger, we agreed to help breach the dam. **Roger Favorite** and **Bob Kraemer** got together with Tom and removed the dam. Within three days, the lake level had dropped over four inches, to its normal range for this time of year.



Mother Nature's furry architects may try to rebuild, and since they do most of the work at night, they may be difficult to discourage. We will have to be equally persistent.

## ESTABLISHING A STANDING POLICY ON DAM REMOVAL

After collecting data for more than ten years, extensively analyzing that data, and documenting experiences with numerous beaver dams being built and removed, it is time to establish a clear policy on dam removal for the sake of stakeholders and decision makers. The status quo on seeking permission to remove dams is not working.

Gosling Czubak, after reviewing and analyzing years work of data, made these conclusions in their final December 15, 2020 report (page 24):

- 1) Dams between LTL and CR669 can significantly reduce creek flow rates, reducing the ability of LTL to drain naturally. Removal of the dams has shown increased downstream flow rates.*
- 2) Dams between Little Traverse Lake and CR669 can lead to increasing water levels at LTL leading up to dam removal in comparison to decreasing levels at CR669 during the same time.*
- 3) Little Traverse Lake water levels have shown rapid and significant water level decline following removal of dams between LTL and CR669.*
- 4) When no dams are present between LTL and CR669, water levels at LTL normally decrease following seasonal high-water levels in the early spring season even with continued rainfall.*

5) Dam activity between LTL and CR669 can restrict flow more and have a greater impact on LTL water levels than culvert restrictions.

6) Allowing LTL water levels to naturally decrease without beaver dam obstructions is important to provide buffer capacity in the lake going into the higher rainfall fall season.

7) Significant dam activity downstream of CR669 during high water levels can elevate water levels at CR669, including increasing water levels above the top of the recently installed larger culvert. This new culvert reduced culvert restrictions to non-detectable levels under normal conditions. Removal of larger downstream dams showed water levels at CR669 greatly improved with large drops.

8) Dam activity, if significant during high water levels, can reduce the creek flow at CR669 and LTL, thus affecting the ability of LTL to naturally drain.

In the same December 15, 2020 report, Gosling Czubak made these recommendations:

1) Allow Little Traverse Lake Property Owners Association to maintain the section of Shalda Creek between LTL and CR669 free of dam obstructions at all times.

2) Monitor water level elevations at the County Road 669 crossing. If water levels at this culvert rise above 594.0, allow beaver dams downstream to "Fishcamp" to be cleared.

3) Consider a partnership with a local conservation organization to relocate nuisance beaver that may be encountered between Little Traverse Lake and Fishcamp and investigate natural deterrent measures that could be used in this area.

4) Allow creek maintenance and restoration at inactive and problem dam locations between Little Traverse Lake and Fishcamp.

The time for establishing a clear dam maintenance policy is more critical than ever, especially more than five years after that independent professional recommendation was made based on engineering analysis. Waiting to remove beaver dams until high water levels or flood levels are reached has proven to be damaging and detrimental to the health of LTL watershed and also to the riparian owners. Timely removal of beaver dams between LTL and as far downstream from CR Bridge as Fish Camp represents a prudent approach to Spring flood prevention on LTL. The goal is to reach a win:win in which the environmental benefits of beavers is balanced with the protection of lake resident's interests that lie outside the Sleeping Bear Dunes National Lakeshore.

*Flash back photos of flooding November 18, 2013*



## APPENDIX 1 – FLOW RATE STUDY DATA SUMMARY

*Dam downstream from 669 removed March 30, 2025, 12:00*

Date	Time	669 Bridge Height ft	TLR Inlet Height ft	TLR Outlet Height ft	Differential ft	Difference in	TLR avg flow fps	669 Avg flow fps
3/28/2025	11:00	594.88	594.66	594.45	0.21	2.52	2.525	0.1125
3/29/2025	12:30	594.95	594.75	594.53	0.22	2.64	2.4	0.1
3/30/2025	12:00	595.03	595	594.6	0.4	4.8	2.85	0.275
3/30/2025	15:10	594.9	595	594.6	0.4	4.8	3.075	0.5
3/31/2025	14:15	594.74	595	594.58	0.42	5.04	3.25	0.4
4/1/2025	15:15	594.74	595	594.58	0.42	5.04	3.3	0.4625
4/2/2025	19:00	594.77	595	594.6	0.4	4.8	2.975	0.575
4/4/2025	16:00	594.72	594.98	594.58	0.4	4.8	3.175	0.5375
4/6/2025	11:00	594.7	594.96	594.56	0.4	4.8	3.175	0.475
4/8/2025	15:45	594.68	594.9	594.52	0.38	4.56	3.15	0.4
4/16/2025	17:15	594.5	594.66	594.32	0.34	4.08	2.7	0.275
4/18/2025	14:30	594.48	594.62	594.3	0.32	3.84	2.775	0.3625
4/22/2025	11:00	594.44	594.56	594.26	0.3	3.6	2.725	0.3625
4/24/2025	10:30	594.4	594.5	594.2	0.3	3.6	2.55	0.3
4/28/2025	15:30	594.3	594.34	594.1	0.24	2.88	2.35	0.3375
4/30/2025	16:30	594.28	594.32	594.08	0.24	2.88	2.325	0.2875
5/6/2025	11:00	594.28	594.34	594.08	0.26	3.12	2.3	0.275
5/16/2025	10:00	594.34	594.36	594.14	0.22	2.64	2.475	0.2875
5/22/2025	10:00	594.32	594.4	594.16	0.24	2.88	2.275	0.3375
6/3/2025	15:30	594.18	594.1	593.98	0.12	1.44	2.15	0.225
6/4/2025	15:30	594.26	594.26	594.16	0.1	1.2	2.1	0.2625
6/16/2025	17:00	594.16	594.12	593.98	0.14	1.68	1.9	0.2
8/4/2025	9:30	593.65	593.76	593.6	0.16	1.92	1.575	0.1625
9/18/2025	16:30	593.96	593.84	593.76	0.08	0.96	1.625	0.1875

TLR Culvert Average Flow Rate includes the average of measurements taken at the top half and bottom half of the TLR Lake Inlet and the top half and bottom half of the TLR Stream Outlet (an average of four data measurements)

CR 669 Bridge Average Flow Rate includes the average of measurements taken at the upstream side and downstream side with measurements at the top half and bottom half of the middle third section and the northern third section (an average of eight data measurements). The flow rates at the southern third section were zero.

All height measurements were manual readings of previously installed measuring sticks.

All flow rates were measured using a JDC Electronics Flowwatch Flowmeter with fluid impeller ( <https://www.forestry-suppliers.com/p/94356/65971/flowwatch-flowmeter/anemometer> ) with accuracy +- 2% fluid speed, capable of measuring fluid speed 0.2 to 40 mph, and resolution 0.2 mph.

## WATERSHED CHANGES Fall 2025- Winter 2026

During scouting of Shalda Creek at the end of September 2025, two beaver dams were detected – one between TLR and CR 669 (“Tweener Dam”) and one downstream CR 669 at Fish Camp (“Fish Camp Dam”). The National Park Service (NPS) was notified but permission to remove the beaver dams was not granted during Fall 2025.

FISH CAMP DAM

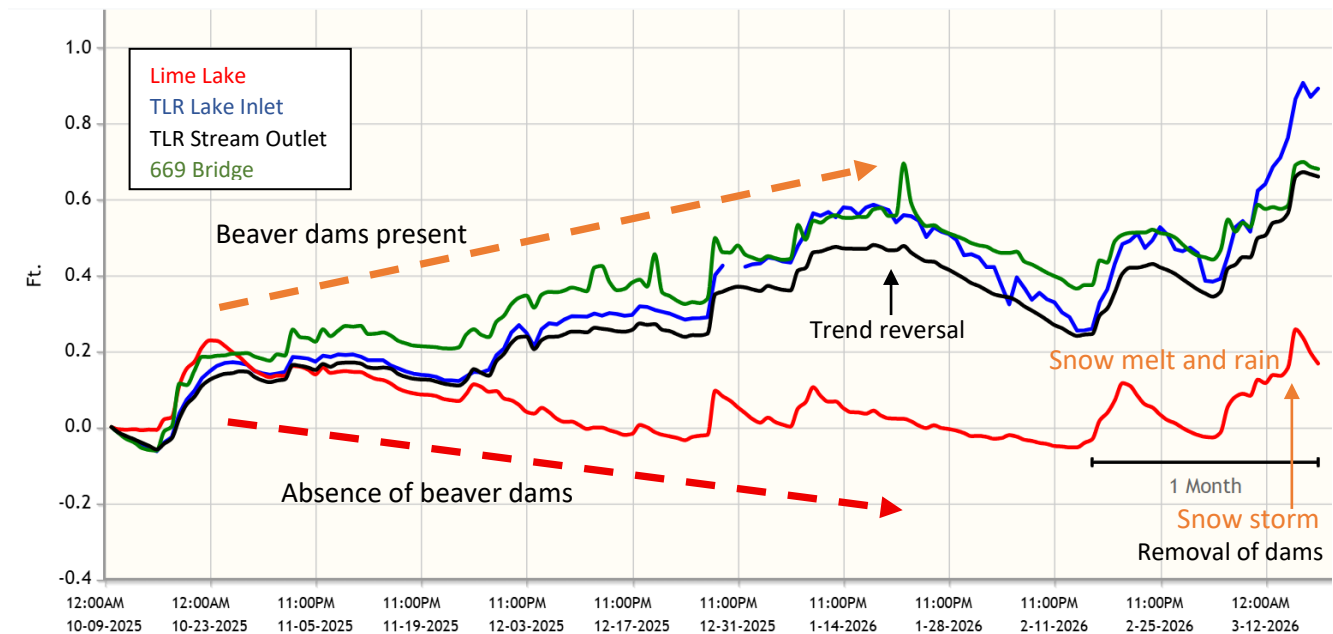


TWEENER DAM



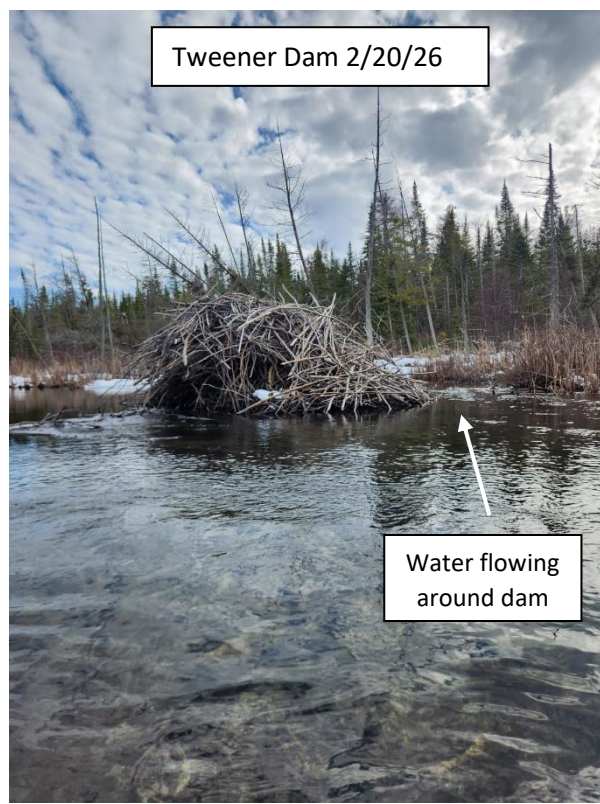
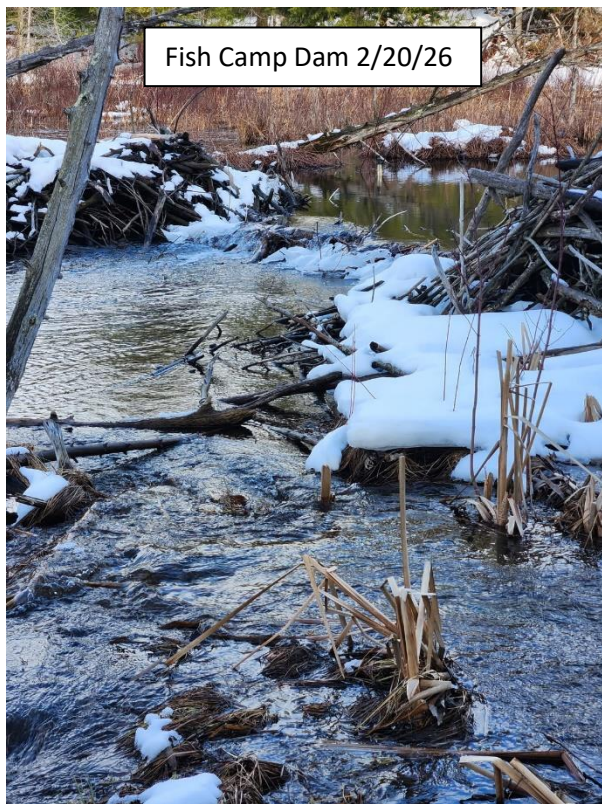
Watershed changes during Fall 2025 – Winter 2026 between Lime Lake and Shalda Creek were different. Lime lake decreased after fall rain events, reaching its low-level plateau established by the small rock dam outlet. Shalda Creek watershed, and thus LTL, continued to increase after fall rain events with the presence of two beaver dams.

## WATERLEVEL CHANGES Fall 2025- Winter 2026



During fall 2025 and early winter 2026, water levels continued to rise in Shalda Creek at both CR 669 and at TLR Stream Outlet as well as LTL at TLR Lake Inlet, while Lime Lake levels decreased after fall rains. In comparison to water levels on October 17, 2025, Lime Lake levels on February 20, 2025 were 0.4" higher. During this same time period, Shalda Creek levels at CR 669 and LTL levels at TLR Lake Inlet were nearly 7" higher while Shalda Creek levels at TLR Stream Outlet was approximately 5.8" higher on February 20, 2026 as compared to October 17, 2025.

The steady increase in water levels observed in Shalda Creek and LTL was altered around January 20, 2026, when the start of a steady decline in Shalda Creek and LTL levels were observed. There was a two-day surge of water and increase in Shalda Creek levels downstream at CR 669. The trend reversal is evident although the cause is not fully known and is not related to winter precipitation changes at that time. Perhaps there was a breakthrough in combination of snow, ice, and debris blockage. During dam monitoring on February 27, it was noted Shalda Creek had bypassed the Tweener Dam and was flowing over the banks and around the 12' high stack of wood debris from previous dam removals. This has not been historically observed.



Water levels began to increase again in the watershed following snow melt and rain events beginning mid-February. On March 1, 2026, prior to the combination of ongoing snow melt and additional rain during the first part of March, Lime Lake levels were the same as observed on October 17, 2025. However, Shalda Creek and LTL levels on March 1, 2026, were nearly 6" higher than observed on October 17, 2025. The LTL "bathtub" and Shalda Creek watershed was already partially full before another series of precipitation events.

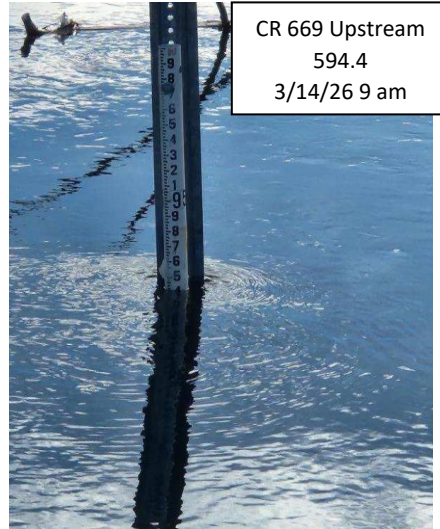
Permission was finally granted by NPS and both dams were removed on Saturday, March 14, 2026 around 11 am. The Fish Camp Dam was holding back approximately 12" of water. The Tweener Dam was about 3-4' high from stream bottom to top. Water levels in LTL were high, measuring 594.55 on the TLR upstream measuring stick and 594.2 on the Shalda Creek side of TLR. The CR 669 level was 594.4 on the measuring stick.



TLR Lake Inlet  
594.55  
3/14/26 9 am



TLR Stream Outlet  
594.2  
3/14/26 9 am



CR 669 Upstream  
594.4  
3/14/26 9 am



Tweener Dam 3/14/26

BEFORE



AFTER



Fish Camp Dam 3/14/26

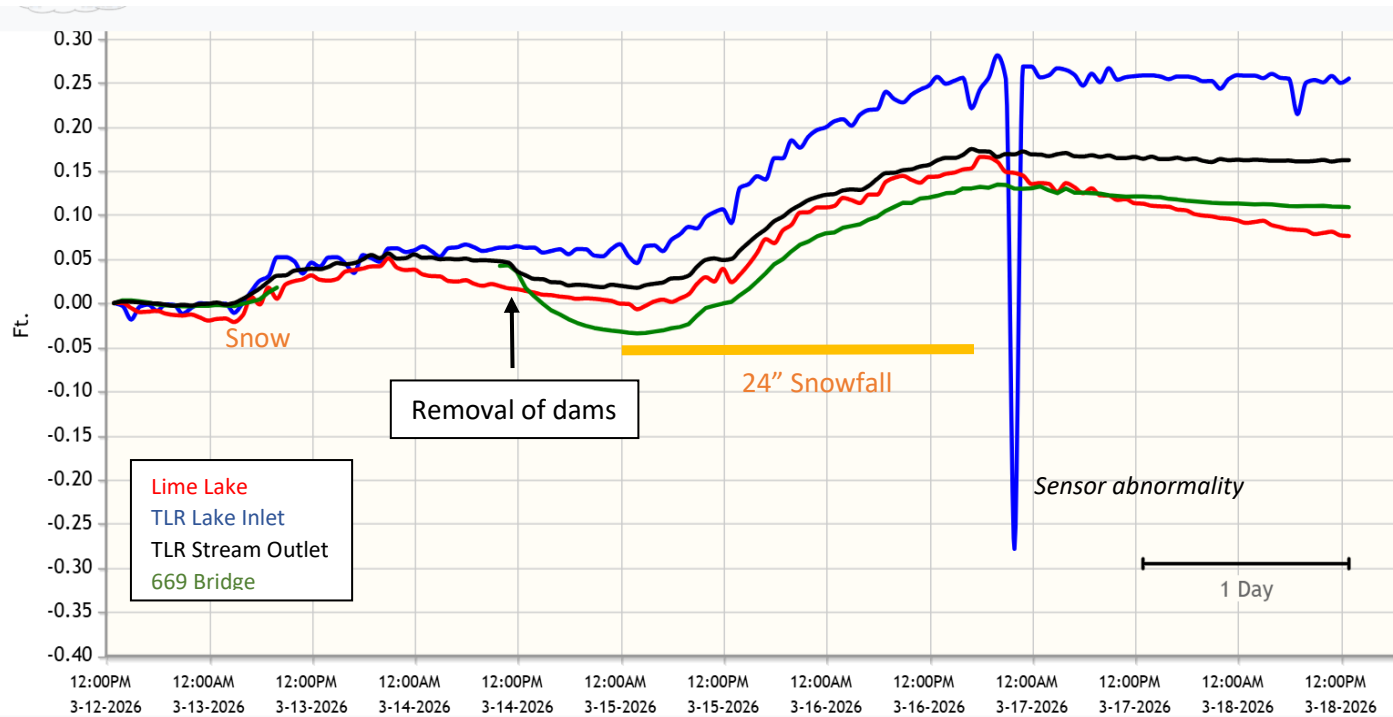
BEFORE



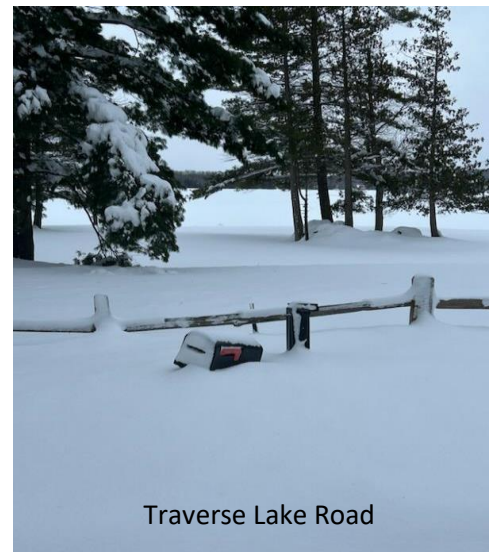
AFTER

Water levels in Shalda Creek began to drop at CR 669 and at TLR Stream Outlet during the hours following removal of both dams as water was cleared from the stream channel. Water levels had decreased 1.0" at CR 669 when a major snowstorm event started that evening.

### WATER LEVEL CHANGES MARCH 2026



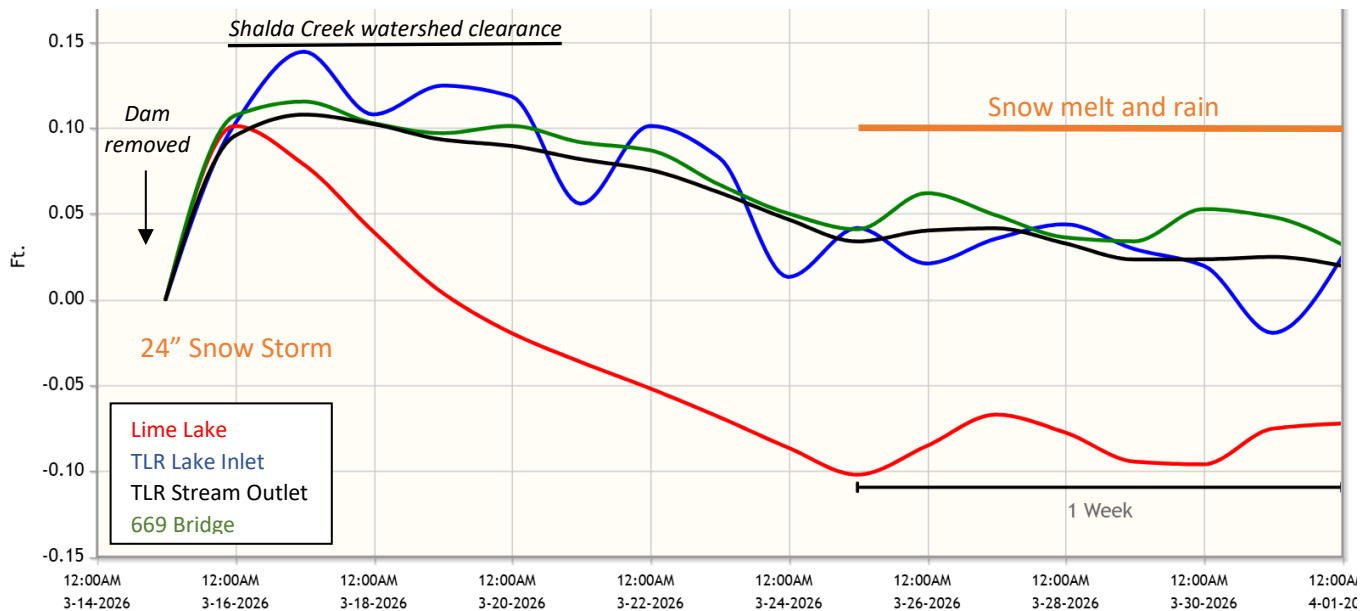
A 48-hour snow event began the evening of March 14, 2026 which led to snow accumulation of more than 24" during the course of the snowstorm (10" snow = 1" water, equivalent to 2.4" rain). Previously, lake ice had melted along the shoreline. The additional snow added to the weight on top of the floating lake ice and to the flowing streams. Water levels at all four measurement points in the watershed increased during this precipitation event, overwhelming any immediate response from beaver dam removal. Water levels, as recorded by the automatic sensors, rose approximately 2.0" at Lime Lake and Shalda Creek (both CR 669 and TLR Stream Outlet) while LTL levels rose 2.2" during the course of the snow storm. It has been observed previously, water levels in the watershed increase similarly during a precipitation event, regardless of the presence / absence of beaver dams or type of structure (culvert, bridge, rock dam, or no structure). LTL levels also cannot decrease lower than Shalda Creek levels as measured at TLR Stream Outlet, which also elevate during rain events. The LTL levels reached 594.8 on the TLR Lake Inlet measuring stick, a level at which water begins to appear in yards of shoreline properties, although not visible with the new snowpack blanketing the area.



When the snowstorm ended, water levels in the watershed immediately plateaued at all four measurement locations. Shalda Creek and LTL maintain steady levels for several days as it cleared out water from the watershed after dam removal before a drop in water levels were observed. Lime Lake began a steady decrease. With snow melt and additional rain, the influx of water slowed the drop in water levels expected. Elevated

water levels in the watershed do remain a concern with the potential for additional spring rains. With water levels rising during the winter in Shalda Creek and LTL watershed, in contrast to Lime Lake levels, there is lots of water to clear out.

### WATER LEVEL CHANGES AFTER DAM REMOVAL



### FLOW RATE CHANGES

Flow rates (fps) were periodically measured before and after dam removal with the help of Doug Verellen, LTL resident. All flow rates were measured using a JDC Electronics Flowwatch Flowmeter with fluid impeller (<https://www.forestry-suppliers.com/p/94356/65971/flowwatch-flowmeter/anemometer>) with accuracy +/-2% fluid speed, capable of measuring fluid speed 0.2 to 40 mph, and resolution 0.2 mph. Flow rate averages were determined in the same manner as previously described (the average of upstream and downstream data points). Flow rates at TLR culvert increased about 20% after dam removal while flow rates at CR 669 bridge increased almost doubled.

Date	TLR Culvert (fps)	Inlet level	CR 669 (fps)	Inlet level
February 25, 2026 2:30 pm	2.05	594.36	0.3	594.3
March 12, 2026 2:45 pm	2.3	594.5	0.35	594.35
March 14, 2026 10:30 am	2.52	594.55	0.4	594.4
<i>Removal of dams March 14, 2026 10:00 am</i>				
March 14, 2026 4:00 pm	2.8	594.5	0.43	594.35
March 17, 2026 9:15 am	2.8	594.8	0.6	594.6
March 18, 2026 1:00 pm	2.9	594.75	0.5	594.6
March 19, 2026 11:45 am	3.15	594.7	0.5	594.5
March 31, 2026 5:30 pm	2.83	594.7	0.58	594.4

## SUMMARY

Beaver dams were removed only AFTER high levels were being observed in LTL and Shalda Creek. Removal of beaver dams did increase stream flow rates at both CR 669 bridge and TLR culvert. If beaver dams had been removed in fall 2025, water levels in the Shalda Creek / LTL watershed should have been lower by the end of January and February as was the case for Lime Lake, creating more capacity to absorb snow melt and spring precipitation events during March. The goal should be to maximize stream flow going into and during the rainy seasons, allowing the “bathtub” to be as low as possible for the watershed to have the capacity to absorb precipitation.

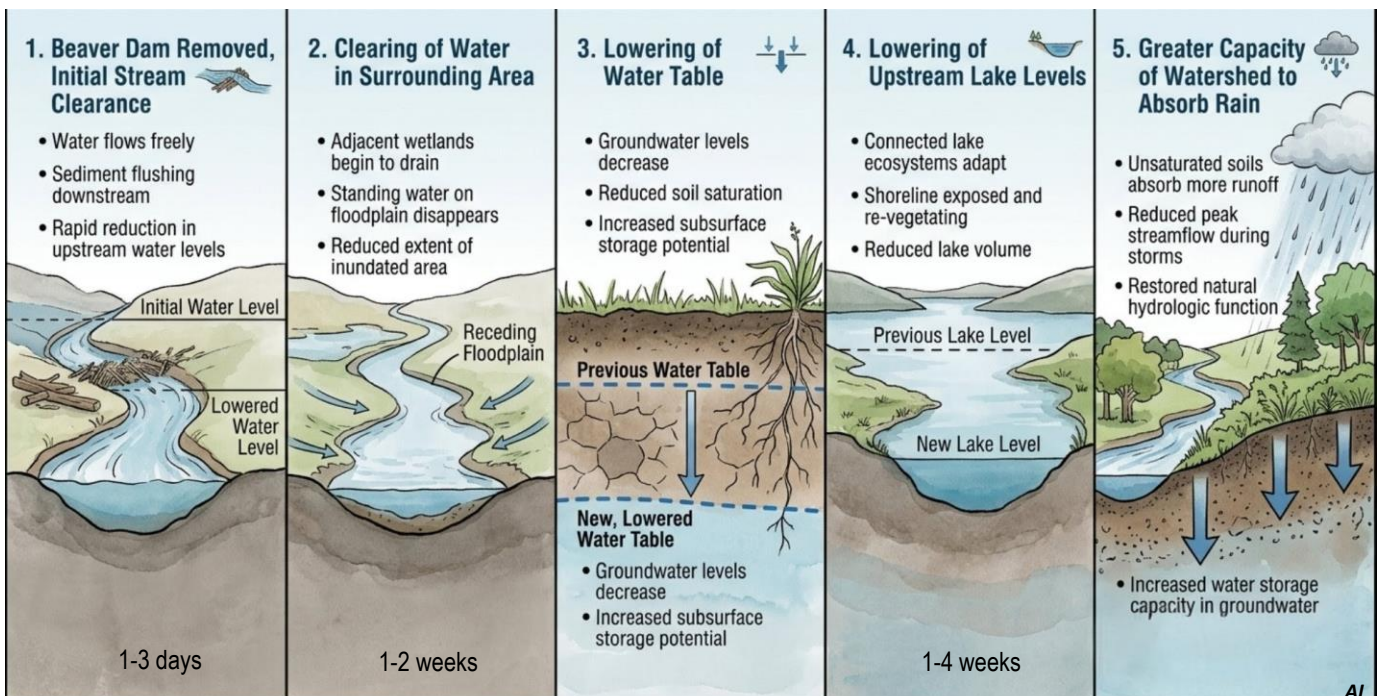
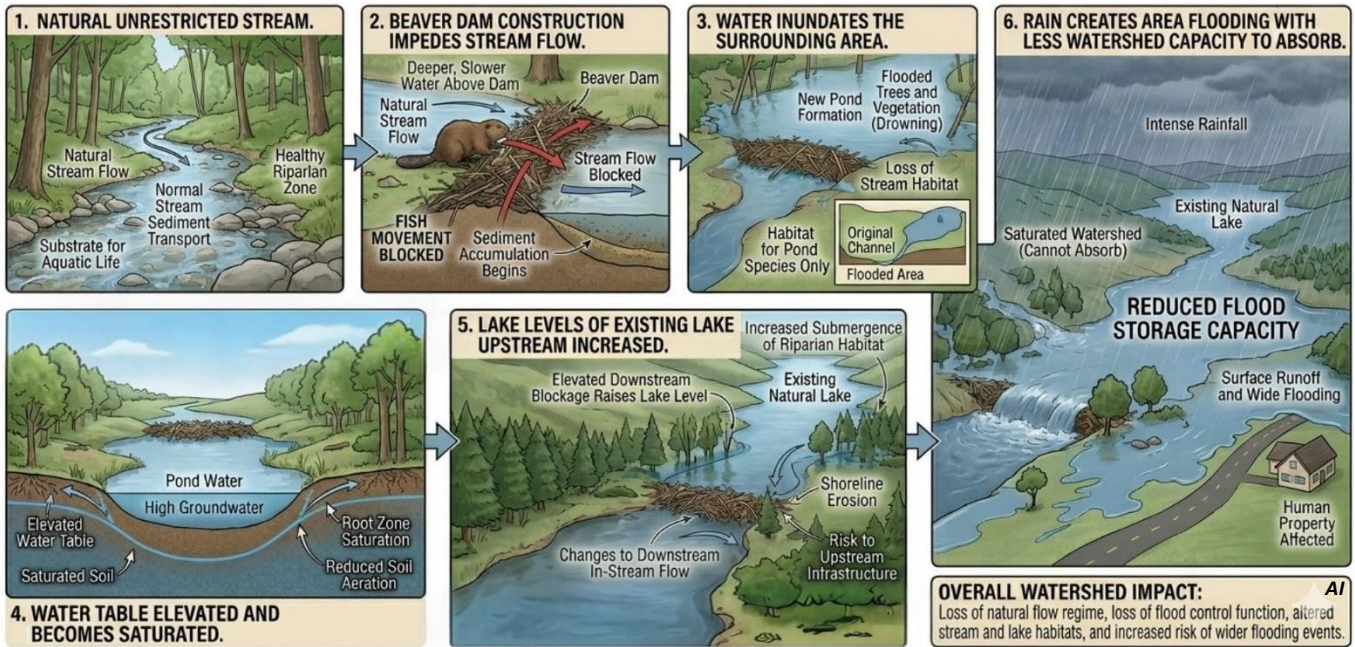
*David Skjaerlund, PhD  
March 2026*

P.S. Perhaps it is time to do a prescribed burn of the large beaver dam debris piles that have been growing in size over the past decades. This would aid in the ease of future beaver dam removal as well as potentially widen the stream at beaver dam pinch points.

*Flash back photo of beaver dam June 2014*



# ILLUSTRATIVE SUMMARY OF LONGER-TERM BEAVER DAMS AND THEIR IMPACTS ON WATERSHED



**THE BENEFICIAL WATERSHED SEQUENCE AFTER BEAVER DAM REMOVAL:** A process of hydrological restoration and increased resiliency