Little Traverse Lake
Water Level Investigation

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Goals of the Investigation

- Actions to alleviate high water level conditions
- Obtain data about the creek system
- Determine if the culverts have an impact on current lake levels
- Investigate a reported beaver dam about ¾ of a mile downstream of CR 669
- Analyze possible methods of lowering lake levels

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Methods

- Field survey using GPS equipment
- Stream velocity measurements

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What are the culvert sizes and the true water surface elevations?

CULVERT LOCATION	SIZE	T/CULVERT U/S	T/CULVERT D/S	W.S.E (4/23/14) U/S	W.S.E (4/23/14) D/S	STREAM GAGE T/GAGE
W. Traverse Lake Road	64x43 Arch	596.49	595.68	595.75	595.46	597.8
CR 669	71x47 Arch	594.56	592.88	594.78	594.55	596.7
Lake Michigan Road	64x43 Arch	585.68	585.36	583.80	583.27	
	42" Dia	585.32	585.12	583.80	583.27	
Lake Michigan				578.0		
	All elevations are in feet; NAVD88 Datum					

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Are the water surface gauges on the same datum (do they correspond to each other)?

- No, the gauge adjustments are:
  - Add 0.8' to the gauge at WTL
  - Add 0.7' to the gauge at CR 669

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What is the location, size, and water level of the beaver dam downstream of CR 669?

- Water level drop
  - 7”

Second Beaver Dam

- Discovered in June
- Water level drop: approx. 4 feet

What is the "normal" flow rate range through Shalda Creek?

- About 18.4 cfs "dry weather" flow
- Cubic feet per second (cfs) = 450 gpm

Little Traverse Lake Water Balance	Rate of Flow	Percent of Total
Streams In:	15.3 cfs	71 %
Precipitation:	2.8 cfs	13 %
Ground Water In:	3.4 cfs	16 %
Total In:	21.5 cfs	100 %
Streams Out:	18.4 cfs	86 %
Evaporation Out:	2.8 cfs	13 %
Groundwater Out:	0.3 cfs	1 %
Total Out:	21.5 cfs	100 %

From " A study of Development and Water Quality within the Little Traverse Lake and Lime Lake Watersheds" – 1994, by U of M

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What is the range of flow rate during storm events?

- From Michigan Department of Environmental Quality

	Total Drainage Area (Sq. Miles)	Cont. Drainage Area (Sq. Miles)	Flow (cfs) at Frequency			
			50% (2yr)	10% (10yr)	2% (50yr)	1%(100yr)
West Traverse Lake Road	18.7	15.8	20	120	350	500
CR 669	19.2	16.3	20	120	350	500
West Lake Michigan Road	36	30.9	320	550	750	800
Rainfall Depth by Frequency (in)			2.4	3.25	4.2	4.67

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What is the range of flow rate during storm events?

- Spring, 2014 approx. 70 cfs

May 7, 2014 Velocity Measurements - Flow Calculations

			T/CULVERT		WSE (5/7/14)		FLOW AREA (SFT)		MEASURED VEL. (FT/S)		FLOW (CFS)	
CULVERT LOCATION	SIZE	AREA (SFT)	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S
W. Traverse Lake Road	64x43 Arch	15.08	596.49	595.68	595.7	595.45	12.34	14.6	5.9	6.6	72.8	96.4
CR 669	71x47 Arch	18.18	594.56	592.88	594.72	594.48	18.18	18.18	3.3	6.5	60.0	118.2
Lake Michigan Road	64x43 Arch	15.08	585.68	585.36	583.43	583.19	6.07	6.52	10.0	8.5	60.7	55.4
	42" Dia	9.62	585.32	585.12	583.57	583.29	4.81	4.51	6.0	7.0	28.9	31.6

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Rainfall and Water Level Gauge Readings

- 2013 and 2014 lowest water level was about 595.2.
- In April, 2014, a rainfall event of 1.64" raised the water level from 595.3 to 595.8.
- Shoreline erosion damage occurs at 595.2
- Crawl space flooding at 595.65.

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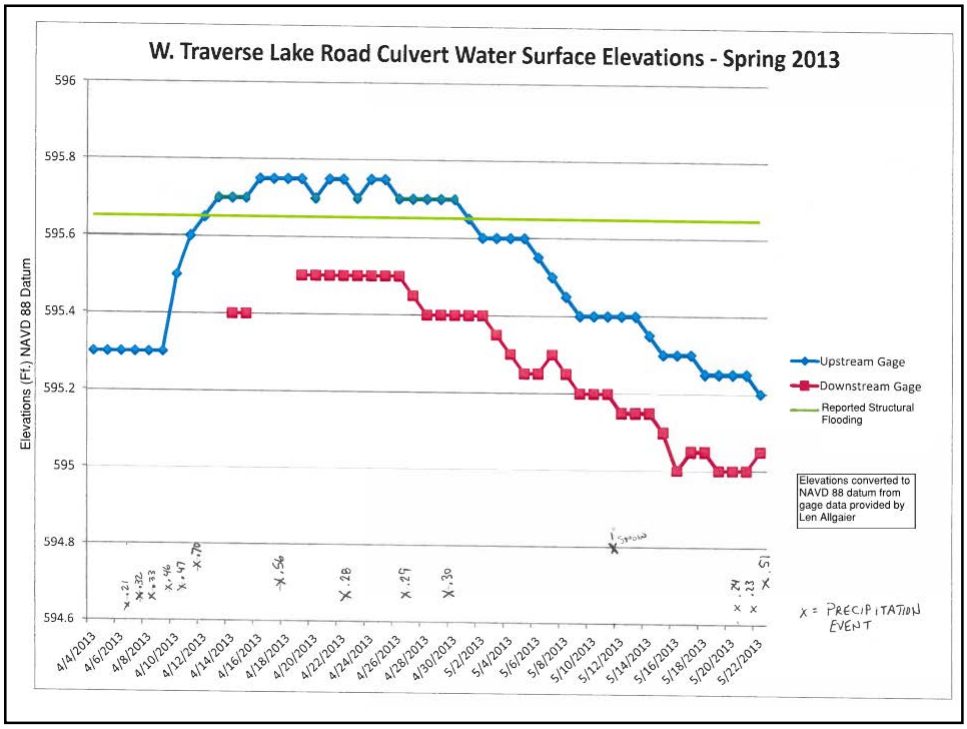
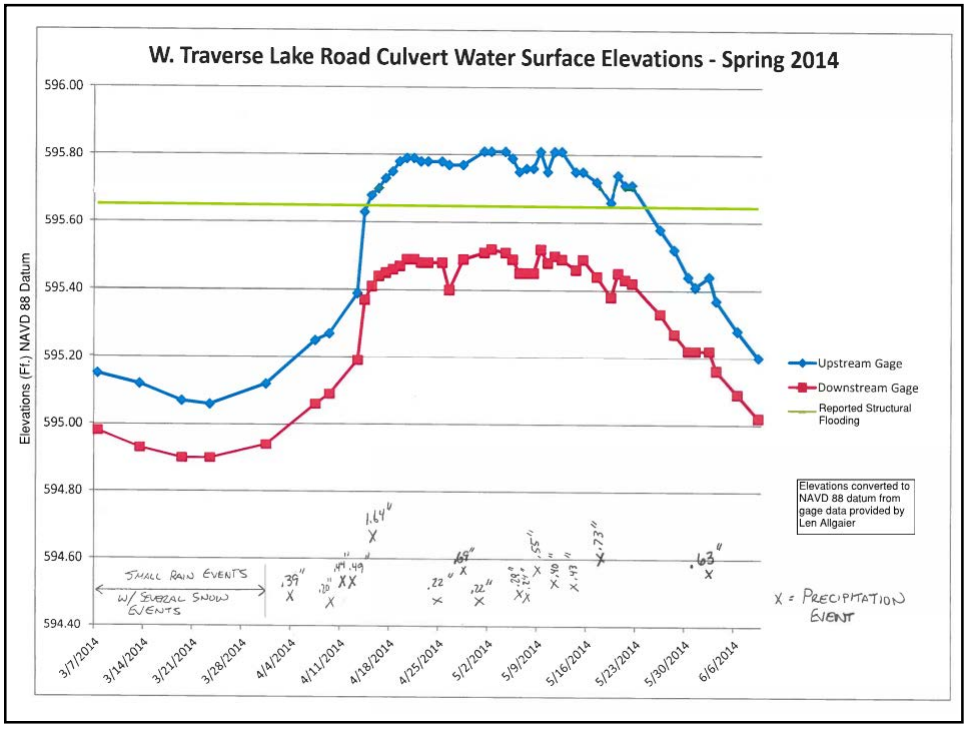

W. Traverse Lake Road Culvert Water Surface Elevations - Spring 2013
Elevations (Ft.) NAVD 88 Datum
596
595.8
595.6
595.4
595.2
595
594.8
594.6
4/4/2013
4/6/2013
4/8/2013
4/10/2013
4/12/2013
4/14/2013
4/16/2013
4/18/2013
4/20/2013
4/22/2013
4/24/2013
4/26/2013
4/28/2013
4/30/2013
5/2/2013
5/4/2013
5/6/2013
5/8/2013
5/10/2013
5/12/2013
5/14/2013
5/16/2013
5/18/2013
5/20/2013
5/22/2013
Upstream Gage
Downstream Gage
Reported Structural Flooding
Elevations converted to NAVD 88 datum from gage data provided by Len Allgaier
X = PRECIPITATION EVENT


W. Traverse Lake Road Culvert Water Surface Elevations - Spring 2014
Elevations (Ft.) NAVD 88 Datum
596.00
595.80
595.60
595.40
595.20
595.00
594.80
594.60
594.40
3/7/2014
3/14/2014
3/21/2014
3/28/2014
4/4/2014
4/11/2014
4/18/2014
4/25/2014
5/2/2014
5/9/2014
5/16/2014
5/23/2014
5/30/2014
6/6/2014
SMALL RAIN EVENTS W/ SEVERAL SNOW EVENTS
Upstream Gage
Downstream Gage
Reported Structural Flooding
Elevations converted to NAVD 88 datum from gage data provided by Len Allgaier
X = PRECIPITATION EVENT

Shalda Creek Water Surface Slope

- Upstream sections are 2 to 7 times shallower than down stream sections

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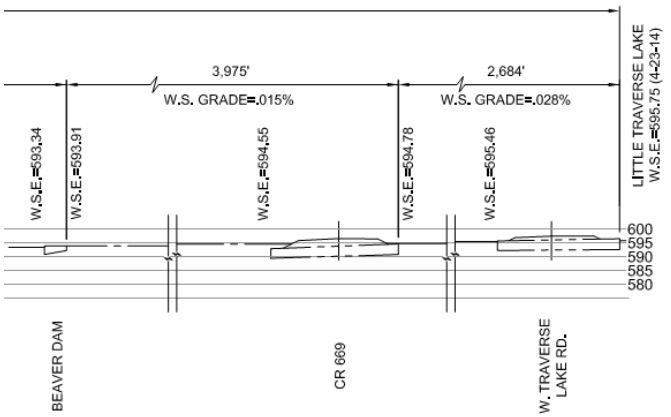
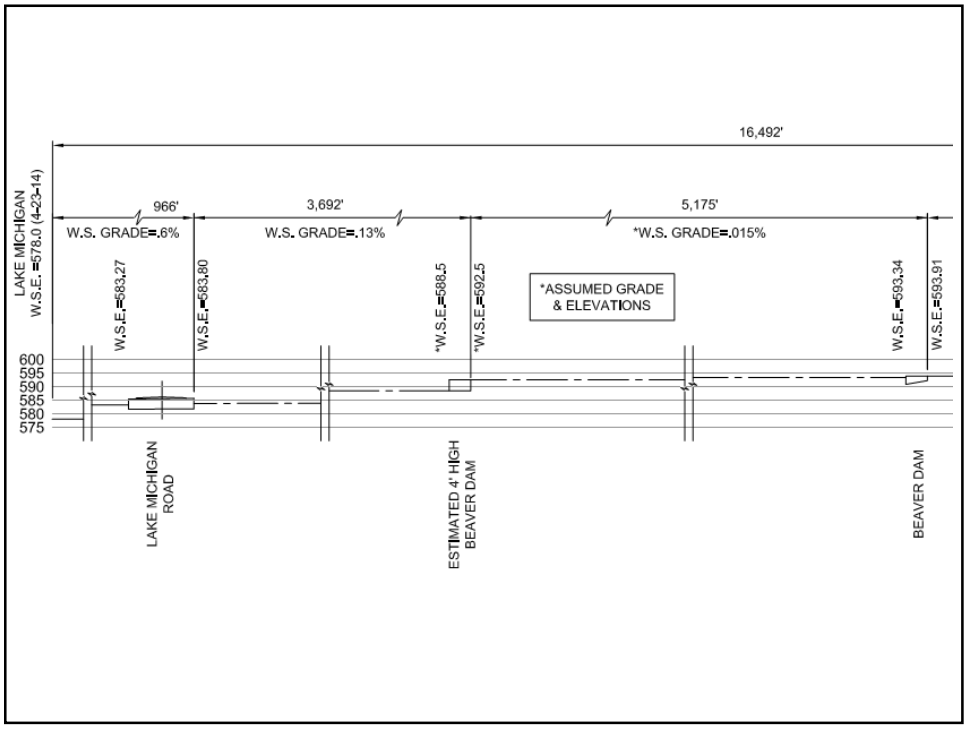
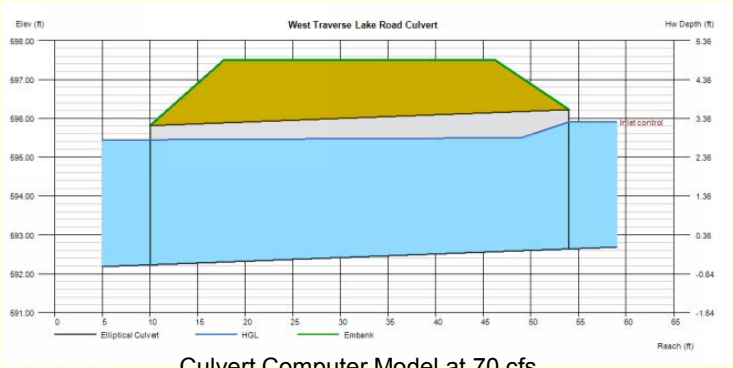




Do the calculated water surface levels at the culverts match real world observations?

- Yes



Culvert Computer Model at 70 cfs

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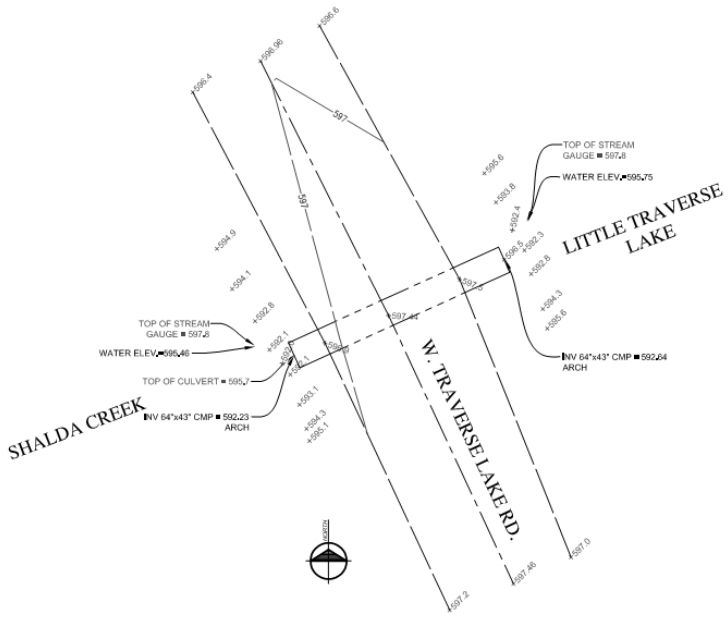
Does the culvert at Traverse Lake Road impede creek flow or impact Little Traverse Lake levels?

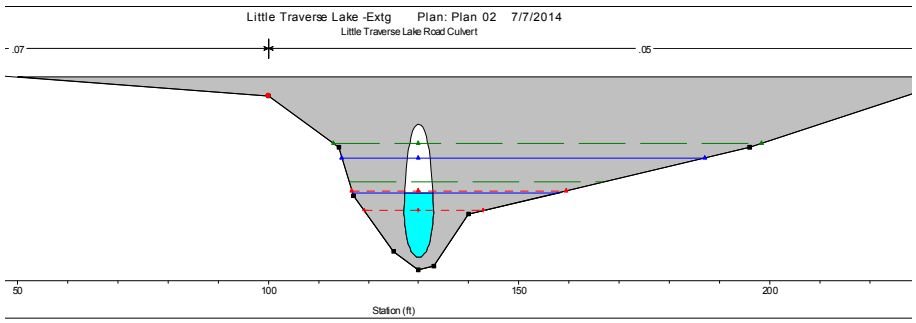
- Yes
- Outlet control capacity approx. 60 cfs

Upstream

Downstream



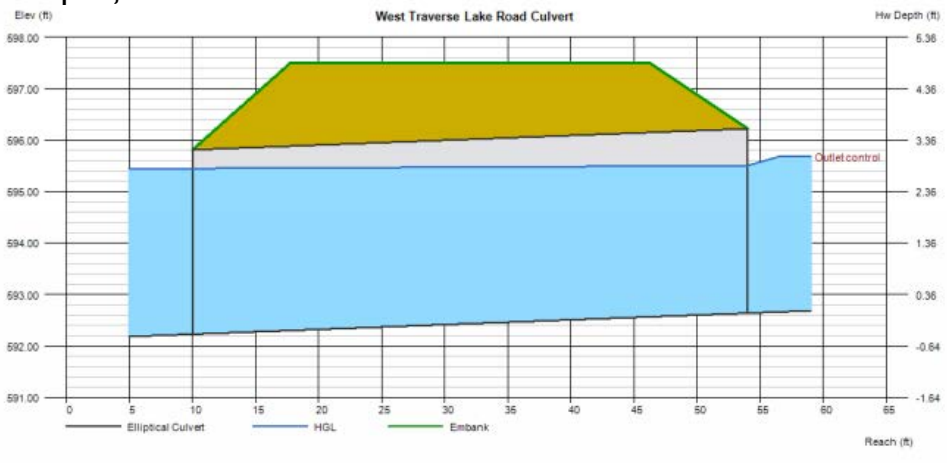
W. TRAVERSE LAKE RD. CULVERT PLAN VIEW



Traverse Lake Rd. Culvert – Computer Model Cross Section

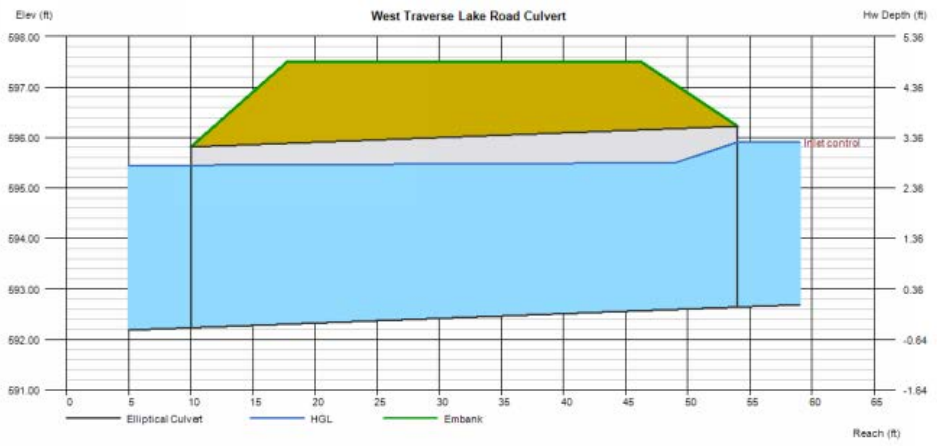
Traverse Lake Road Culvert

- April, 2014. Culvert under outlet control at 40 cfs



Traverse Lake Road Culvert

- April, 2014. Culvert under inlet control at 70 cfs

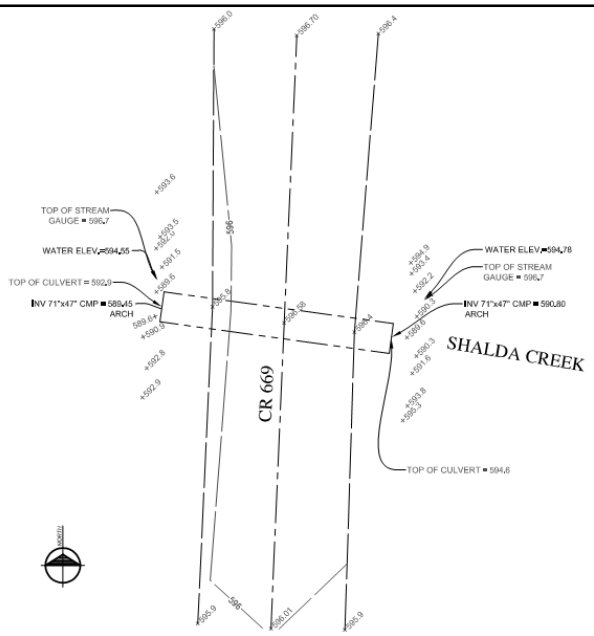


Does the culvert at County Road 669 impede creek flow or impact Little Traverse Lake levels?

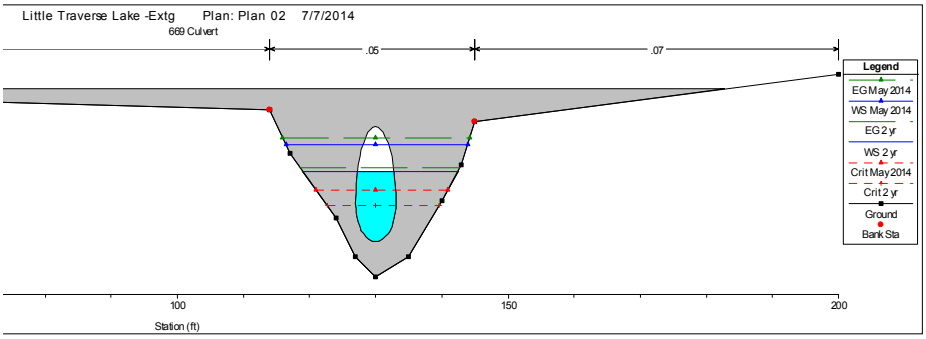
- Yes
- High tailwater condition capacity 120 cfs

Upstream

Downstream



CO. RD. 669 CULVERT PLAN VIEW



CR 669 Culvert – Computer Model Cross Section

What is the size and capacity of the culvert on West Lake Michigan Road?

- Two culverts
- Inlet control capacity of 140 cfs

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If the culvert(s) were removed or increased in size, how would lake levels change?

- At 70 cfs
- Tailwater condition from April, 2014
- Removing culverts could lower lake levels up to 0.6 feet (595.3)
  - Erosion damage at 595.2
  - Crawl space flooding at 595.65

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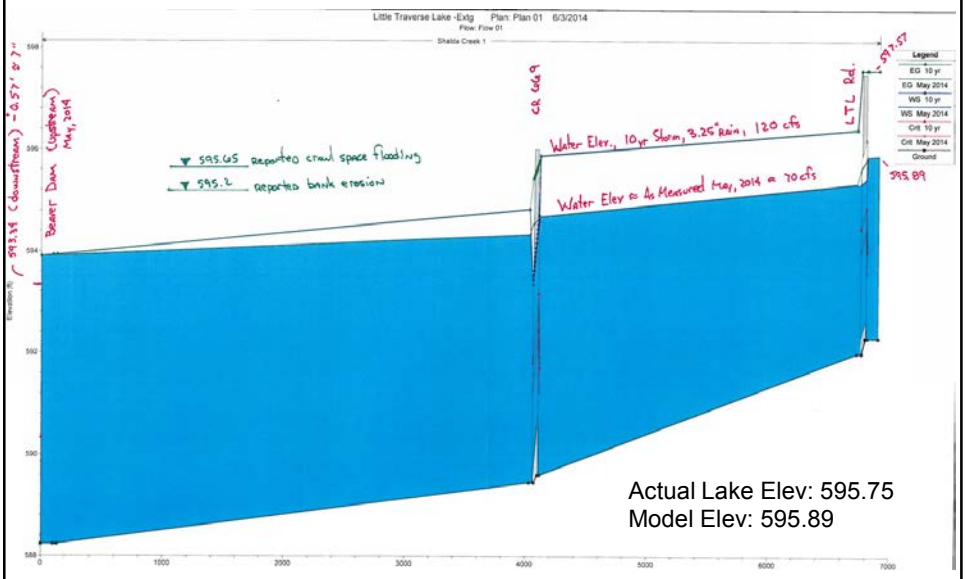
Shalda Creek Profile – Existing Conditions - April, 2014



If the culvert(s) were removed or increased in size, how would lake levels change?

- water level in June, 2014
- 595.35
- Tailwater condition reduced at beaver dam
- Estimated flow 15- 30 cfs
- Removing culverts could lower lake levels up to 0.3 feet (595.05)

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Does the beaver dam impact lake levels?

- Yes, depending on flow
- Low flow
  - beaver dam creates a high tailwater
  - Removal would lower lake levels
- High flow
  - Inlet control, so less impact from beaver dam removal
  - Lower tailwater could reduce duration of high lake levels
- Dam removal doesn't always translate upstream

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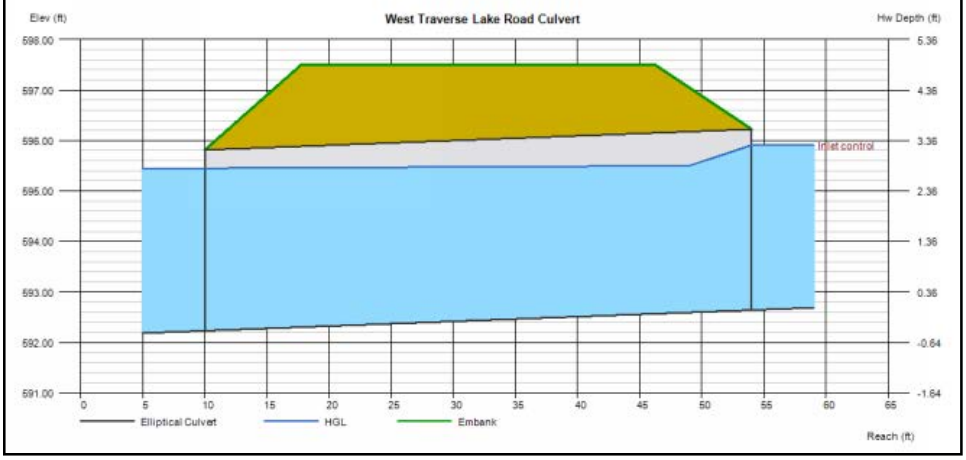
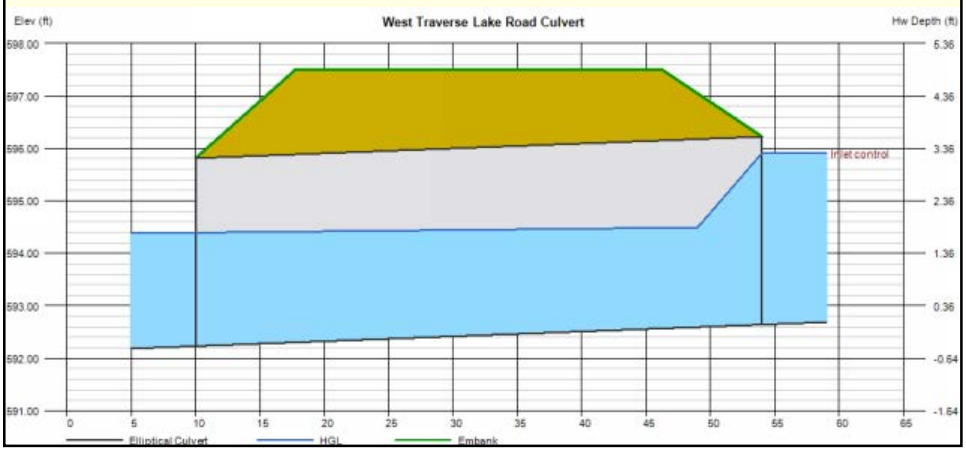
Traverse Lake Road Culvert

- April, 2014. Culvert under inlet control at 70 cfs



Traverse Lake Road Culvert

- April, 2014. Low Tailwater & inlet control at 70 cfs



Options

Install additional culverts next to existing culverts (multi-tube)

Advantages	Disadvantages	Impact to Lake Levels	Relative Cost
-Lower cost -No change to low water level - mimics full width flow	-Doesn't dramatically reduce high water -Generally not preferred by MDEQ	0.4 feet lower at 70 cfs	lowest

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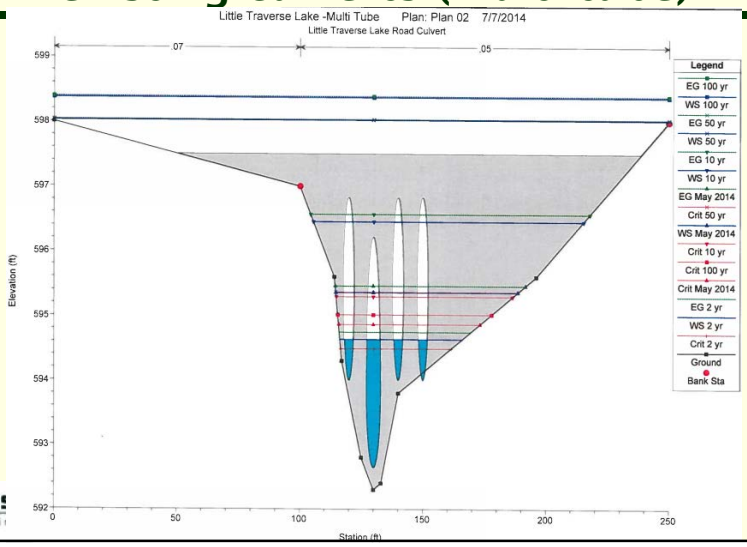
Options

Install additional culverts next to existing culverts (multi-tube)



Options

Remove existing culverts and replace with higher capacity culverts

Advantages	Disadvantages	Impact to Lake Levels	Relative Cost
-Provides less high flow restriction -mimics full width flow - lower cost than bridge	-May lower "normal" lake level - Doesn't dramatically reduce high water	Lower lake levels by less than 0.6 feet	moderate

Options

Remove existing culverts and replace with clear span bridge

Advantages	Disadvantages	Impact to Lake Levels	Relative Cost
-Provides no high flow restriction -Provides full width flow	-May lower "normal" lake level -Doesn't dramatically reduce high water -Lake levels may still be impacted by beaver dams	Lower lake levels by approx. 0.6 feet	highest

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Options

Keep existing culverts but remove all beaver dam restrictions

Advantages	Disadvantages	Impact to Lake Levels	Relative Cost
-Lower cost - Lower lake levels during normal flow	-May lower "normal" lake level - Culverts still impede flow during high flow -Lake levels still impacted by beaver dams in future - Requires regulatory approval from NPS	Likely lower, but total change uncertain under low flow. Under high flow, lower lake level by a negligible amount	low

Options

Replace all culverts with bridges and remove all beaver dam restrictions

Advantages	Disadvantages	Impact to Lake Levels	Relative Cost
-Provides no high flow restriction -Provides full width flow	-May lower "normal" lake level -High water level difficult to predict -Lake levels still impacted by beaver dams in future - Requires regulatory approval from NPS	Greater than 0.5' at 70 cfs, maybe considerably more	Highest

Summary

- Replacing the existing culverts with higher capacity culverts or a clear span bridge may not produce the desired lake level reduction unless it is coupled with some form of beaver dam control.
- Beaver dam control without culvert modifications will continue to produce high lake levels at flows near or above 70 cfs.

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Questions

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