

November 20, 2011

Lake Isabella Property Owners Association
1096 Queensway
Lake Isabella, MI 48893

RE: Gate Inlet Trash Rack / Drawdown of Lake Isabella

As requested, we have reviewed the hand sketched and proposed repair description provided by Gerace Construction and have provided a Professional Engineer's seal on these documents. The hand sketch and description are of a trash rack system that is installed on the upstream (west) end of a 60" diameter intake pipe. This pipe is approximately 60 feet in length and connects to a 10' x 4' sluice gate forebay located south of and immediately adjacent to the principal spillway. The north wall of this forebay has a 4' x 4' opening and 1' diameter coldwater draw which are controlled by a 4' x 4' sluice gate and a 1' x 1' sluice gate, respectively. Please refer to attached Gerace Construction sketch and relevant plan sheets from the 1967 construction plans.

These sluice gates and the associated inlet pipe are the only means to draw the lake level below the fixed crest elevation of the principal spillway. The association has a permit to draw the lake down approximately 4' below this fixed crest elevation. Prior to commencing this drawdown it was determined necessary to install a trash screen at the upstream end of the 60" CMP intake pipe. The attached Gerace sketch and proposed repair description summarize this trash screen design.

Trash Screen Drawings Structural/ Design Review

We do not have any specific concerns related to the design or structural integrity of the trash rack system. It has been designed with adequate steel cross section and to allow for relatively easy removal of the trash screen bars by a diver if deemed necessary. The trash screen as shown on the sketch should serve its intended purpose and should not cause any harm provided it is monitored and maintained free of debris while the sluice gate is operated.

Operation of Sluice Gate with Trash Screen in Place

There are operational concerns and risks related with the opening of the sluice gates with the new trash rack in place. A typical trash rack is designed for maximum screen velocities of 2 feet per second in a system where it cannot be easily accessed or maintained and 5 feet per second where access is easier and the screen can be readily cleaned off.

The reason for these maximum screen velocities are to minimize headloss at the screen which reduces the hydraulic capacity of the drawdown system, prevents debris from being drawn to the screen which accelerates the clogging of the screen, and provides a safety factor if parts of the screen become plugged.

Updated hydraulic calculations have been completed to determine flows, velocities and headlosses through the inlet pipe and trash rack under various gate open positions (please refer to the attached hydraulic calculations). With the sluice gates fully open the trash screen will see screen velocities exceeding 10 feet per second. These calculations were completed assuming the trash rack was clear of debris. As debris collects on the trash rack the screen velocities will continue to increase causing greater loading of the screen and inlet pipe and causing greater headlosses at the inlet.

These design guidelines are for systems that operate on a regular basis or are used for emergency purposes. Since the gate will be operated for short periods of time and it will be monitored an exception from these guidelines can be considered. However, the need to monitor and maintain the screen will be very important.

A worst case scenario is the screen becomes fully plugged causing a hydraulic loading of the intake pipe and the pipe runs dry or partially dry. At summer water levels this would be equivalent to approximately 700 psf of hydraulic loading on the pipe. The culvert could potentially fail under these load conditions if it is not in good condition. Additionally, a buoyant force would be exerted on the pipe. If the pipe were allowed to run completely or near empty a buoyant force of approximately 1,200 lbs per running foot would be exerted on the pipe making it possible for the pipe to “float” causing potential damage to the pipe.

Operation, Monitoring and Maintenance during the Lake Drawdown

We understand the targeted drawdown duration is two weeks, the MDEQ permit requires this rate occur at no greater than 6 inches per day, and that the lake starts the refilling process no later than March 1st. We are concerned about the gate being open for extended periods of time, since monitoring of the inlet system is very important with the trash rack in place.

We recommend the inlet system be monitored, at a minimum, on a daily basis. To determine if the trash rack system is starting to accumulate debris the observer should monitor the water surface within the sluice gate forebay. This water surface can be monitored for changes in elevation as well as compared to the water surface of the lake. There will be a difference in the lake and forebay water surface elevations due to headloss from the trash rack and inlet pipe system. As flows increase due to the gate opening this difference will become greater (please refer to attached hydraulic calculations).

Additionally, as debris accumulates on the grate there will also be an increase in the difference between the water surface elevations. If the water surface elevations within the forebay continues to increase over time with the gate being held in a relatively fixed position it will be a good indicator that debris is collecting on the trash rack. At no time should the water surface within the forebay be allowed to drop below the top of the 60” CMP inlet pipe.

Finally, maintaining the level at the desired elevation of approximately 891’ will also require continuous monitoring to ensure debris is not collecting on the rack, but also to simply maintain the lake level. As inflows continuously vary into the lake the sluice gate will need to be adjusted up and down to account for these changes and maintain the desired lake level.

It may be necessary, at times, to close the gate and perform a dive inspection or inspection from the water surface to determine if any debris has collected on the inlet. A diver may be necessary to clean the trash rack system if adequate drawdown flows cannot be maintained.

Anticipated Drawdown Duration

Since the duration of the drawdown increases the risk of debris collecting on the trash screen we have performed some calculations to roughly estimate how long it may take to draw down the lake. We have estimated the outflows and the drawdown time based on the sluice gate being open 25%, 50%, 75% and 100%. The assumptions used in the hydraulic calculations are a best case scenario with no debris assumed to be present on the trash rack.

Using the lake volume rating curves from the 1967 construction plans and the 1979 USACE Report the estimated water volume to be drawn down from 895' to 891' is approximately 2,600 Acre-Feet. This volume was used in estimating the drawdown time.

The inflows into the lake were obtained or estimated using the MDEQ's low flow database. Actual real time flows were also obtained from USGS gauge at Mount Pleasant and adjusting these flowrate based on a Drainage Area Ratio. Please refer to the attached hydraulic calculations, estimated drawdown time calculations, and printouts from the MDEQ's low flow database and USGS gauge station for the Chippewa River.

A best case scenario would be historical drought flows (95% exceedance) for the month of December were occurring at Lake Isabella. These historical inflows are approximately 77 cfs. Under these conditions the lake could be drawn down as quickly as 10 days with the gate fully open or up to 22 days with the gate open at 25%.

However, average low flow conditions at Lake Isabella for December (50% exceedance) are approximately 130 cfs. The current flow at the USGS gauge in Mount Pleasant is approximately 264 cfs. With a Drainage Area Ratio applied for the contributing area at Lake Isabella the flow rate into the impoundment is estimated to be approximately 130 cfs. Based on this inflow rate it would take approximately 17 days to lower the lake with the gate in a fully open position and approximately 30 days to lower the lake with the gate 75% open. A drawdown of the lake would likely not be possible in a reasonable time period if the gate was opened to 50% or less for these inflow conditions.

These drawdown estimates are based on best case assumptions for hydraulic conditions and coefficients, assume a runoff generating rainfall event does not occur during this period, and the trash rack is free of debris. Therefore, these can be considered minimum draw down durations for this time of year under the current inflow conditions.

Though it would not be desirable to the lake association the best months for performing a drawdown based on hydrologic conditions would be in July, August, and September. The average flows (50% exceedance) are 83, 75 and 86 cfs, respectively for this period.