MEMORANDUM

To:	Erik Larson, Commissioner-Secretary, Lake Virginia Management District	
From:	Mike Rogney, P.E.	
Date:	December 29, 2023	Project No.: 37-0145.00
Re:	Lake Virginia Dam Project (Field File 56.35, KSN 829) – Sauk County, WI	

Project Background

The Lake Virginia Dam is owned and operated by the Lake Virginia Management District (Lake District) and is located in Section 08, Township 12 North, Range 05 West, Town of Excelsior, Sauk County, Wisconsin. The dam is classified as a large, low hazard dam by the Wisconsin Department of Natural Resources (WDNR). The Lake District reached out to Ayres to discuss concerns and potential repairs related to leakage occurring at the pre-cast concrete whistle tube riser and through the stop logs.

The following is a report, based on a targeted field inspection of the principal spillway structure, completed by Ayres on December 15, 2023. The intent of the report is to summarize and describe the inspection findings and provide recommendations on repair options. Upon approval from the Lake District, the report will be submitted to the WDNR for review and concurrence. Once a concurrence and repair directive are obtained, the Lake District may consider pursuing funding from the WDNR's Municipal Dam Grant program. The application deadline is March 1, 2024.

Historical Inspections, Construction, & Repairs

The Lake Virginia Dam was originally approved by the WDNR on October 6, 1969, and constructed in the early 1970's. In 2003, a plan approval was issued to the Lake District by WDNR for repair and reconstruction, which mainly consisted of replacing the original corrugated metal principal spillway with reinforced concrete. In 2014, an effort to seal ongoing leakage occurring around and through the stop logs within the principal spillway was completed, which was noted by WDNR as completion of seepage repairs. The most recent repair was conducted in 2015, which included temporarily removing the top two pre-cast riser pipe sections, removal of a concrete baffle within the second riser section, as well as replacement of the stop log channels and stop logs with stainless steel channels and white oak stop logs. Based on the information from a September 29, 2015, email, from Alieus Engineering to WDNR, the drawdown gate (alfalfa valve) was also tested and found to be functioning properly.

Inspection & Observations

Ayres was joined by two Lake District members during the targeted field inspection on December 15, 2023. The inspection primarily focused on the leakage occurring within the principal spillway whistletube riser, however a visual observation of the downstream outlet and toe drains was also completed. Attached to this report are photos from the December 15, 2023, inspection.

Principal Spillway Whistletube Riser

Based on visual observation, there is leakage occurring at the joint between the second and third pre-cast riser pipe sections as well as the bottom-most stop log. Most of the leakage occurring during the December 15, 2023, site visit was observed on the right side of the riser (referenced from right to left

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while looking downstream) at the joint near the bottom of the right stainless-steel stop log channel. Previous video submitted to Ayres by the Lake District also demonstrated leakage occurring at the same joint between the second and third riser sections. However, the video also demonstrated leakage occurring through the joint on the downstream end (by the grab bars). The water level in the impoundment was likely higher during the previously submitted video than it was during the December 15, 2023 inspection, which was approximately 2-ft. below the top of the stop logs on the upstream side.

Although the leakage during the December 15, 2023 site visit was primarily occurring at the right side of the whistletube riser, since leakage was also occurring on the downstream side by the grab bars in the previously submitted video, it is likely that water is infiltrating from outside of the pre-cast whistletube riser pipe and not just internally around the stop log channels along the joint. This may be due to a high phreatic water surface through the dam embankment.

Concrete Outlet & Toe Drains

A visual observation of the downstream outlet pipe and toe drains was also completed on December 15, 2023. There are three 6-inch toe drain outlet pipes located at the downstream plunge pool area. Two of which are the original corrugated metal pipe (CMP) drains, while the third is a plastic corrugated pipe, which may have been installed as part of the 2003 repair/reconstruction.

Both CMP toe drains were flowing at the time of the inspection, while the plastic pipe was mostly submerged below the tailwater and had little to no water flow. The flow observed in the two CMP drains was generally clear of sediment; however, a significant amount of iron oxidizing bacteria was observed. In general iron oxidizing bacteria is not a concern in relation to the structural integrity of the dam; however, it should be monitored for significant changes or abnormal conditions. A cleanout port for one of the toe drains was also found, but not opened, further up the downstream embankment (right of the 30-inch concrete outlet pipe). Overall, the outlets of the CMP toe drains are in poor condition. The bottoms of both drains have corroded entirely. The toe drains were not televised during the inspection. Therefore, the extent of corrosion up the pipe is not entirely known other than what was visually observed.

In general, the 30-inch reinforced concrete outlet pipe and apron end wall are in good condition. The two tie rods connecting the outlet pipe to the apron endwall are corroded/rusted externally but appear to be functioning. Inside of the outlet, the pipe and end wall appear flush. However, the joint on top is approximately 1.75-inches higher where the outlet pipe connects to the apron end wall section. This may be due to how the pipe sections were cast, or it may have heaved. This should for monitored for any changes.

Dam Repair Recommendations

The following are recommended repairs for the Lake Viriginia Dam, based on the targeted inspection completed on December 15, 2023:

1) Principal Spillway Whistletube Riser Leakage
    a. Repair and seal leakage occurring at all joints and sections within the whistle tube riser.
    b. Replace stop logs channels and stop logs, as needed.

2) Toe Drain Repair
    a. Investigate extent of corrosion and condition of the downstream toe drains. Replace as needed based on further observations and inspection.

Dam Repair Alternatives

Alternative 1: Principal Spillway Repair – Grout Injection & Stop Log Replacement

This approach includes pressure injection of a water-activated grout at all leaking joints and sections within the principal spillway whistletube riser. It also includes replacing the existing stop log channels and stop logs.

- The proposed repair alternative would be completed under normal pool conditions to help identify all leaks and areas within the principal spillway whistletube riser that need to be sealed.
- To complete the grout injection, the water level within the principal spillway whistletube riser would need to be lowered. This may be accomplished by plugging the 36-inch concrete inlet and bypassing minimum flow via pump or siphon.
- Plugging the inlet of the spillway under normal pool conditions would require the use of a qualified diver.
- Excavation of the embankment around the riser would not be required for this alternative.
- In addition to the grout injection and sealing of all joints and sections, Ayres recommends replacement of the existing stop log channels and stop logs, as needed.
    - The existing stop log channels were installed as part of the 2015 repair. The Lake District may want to consider more robust stop log channels with proper seals, such as rubber or neoprene, to assist with ongoing leakage.
    - The bottom-most stop log is leaking and needs replacement. Other stop logs appear in fair condition but may be beneficial to replace all seven stop logs at the same time. Ayres recommends an untreated hard wood species for the stop logs.
- Advantages:
    - A drawdown of the impoundment would not be required.
    - Limits disturbance to the embankment and principal spillway structure.
- Disadvantages:
    - Plugging of the inlet would require a qualified diver, increasing cost. Use of a diver may not be possible and/or unsafe depending on the flow conditions at the inlet.
    - Would require continuous use of a pump or siphon, as needed, to ensure minimum flow is passed at all times and to keep the principal spillway dewatered.
- The estimated cost for this repair option, including engineering is: $91,000.

Alternative 2: Principal Spillway Repair – Excavate & Seal Whistletube Riser Externally & Stop Log Replacement

The second recommended option includes a drawdown of the impoundment to dewater the principal spillway whistletube riser and maintain minimum flow, excavating the embankment adjacent to the riser to seal any leaking areas, and replacing the existing stop logs.

- A drawdown would be completed at a rate of 6-inches per day by removing the stop logs and opening the alfalfa valve at the bottom of the principal spillway riser to lower the impoundment and maintain minimum flow.
- A qualified contractor would strategically excavate the embankment material adjacent to the riser to expose areas that need sealing.
- Ayres recommends that all pre-cast riser sections are removed, reset, and sealed while the lake is drawn down and embankment is excavated.
    - Taking advantage of the draw down and excavation will help minimize future leaking and issues at other joints and sections within the riser.
    - An external, water-tight, joint wrap would be used to seal the joints from the outside of the riser, in addition to the butyl sealant between the pre-cast riser sections.
- Upon placement of the external seal, the embankment will be replaced using lifts and compaction techniques to ensure proper soil strength is achieved.

- In addition to the external sealing of the joints and sections of the pre-cast riser, Ayres recommends replacement of the existing stop log channels and stop logs, as needed.
    - The existing stop log channels were installed as part of the 2015 repair. The Lake District may want to consider more robust stop log channels with proper seals, such as rubber or neoprene, to assist with ongoing leakage.
    - The bottom-most stop log is leaking and needs replacement. Other stop logs appear in fair condition but may be beneficial to replace all seven stop logs at the same time. Ayres recommends an untreated hard wood species for the stop logs.
- To avoid needing to install an upstream cofferdam, all work would need to be completed in one day during dry weather conditions. The embankment could not be left open and unattended.
- Advantages:
    - A drawdown may save the cost of hiring a diver to plug in the principal spillway inlet.
    - An external wrap-around seal of the principal spillway riser can be installed to protect against further infiltration.
    - More robust repair than joint grouting under full pool.
- Disadvantages:
    - Would require a drawdown of the impoundment and may take a long period of time to refill the impoundment depending on flows.
    - Involves excavation and disturbance of existing embankment materials.
- The estimated cost for this repair option including engineering is: $55,000.

Optional Alternative: Repair Principal Spillway, Investigate Toe Drains & Repair

In addition to repairing the leakage occurring within the principal spillway whistletube riser, Ayres recommends further investigation and repair of the downstream toe drain outlets. As described earlier the bottom of each CMP toe drain outlets have corroded entirely. The internal conditions of the drains were not investigated or televised during the December 15, 2023, inspection. Therefore, it is recommended that the toe drains are televised to investigate the condition and extent of the corrosion. Depending on the extent, sections of the toe drains may need to be excavated and replaced accordingly. If replacement of the toe drains is needed, this would need to be done under drawn down conditions.

Opinion of Probable Cost

Project: Lake Virginia Dam Repair - Option 1
Client: Lake Virginia Management District
Location: Section 08, Township 12 North, Range 05 West, Town of Excelsior, Sauk County, Wisconsin
Project No.: 37-0145.00

References: 1.) *Heavy Construction Cost Data*. RSMeans online database 2023 costs

Item	Description	Quantity	Unit	Unit Price	Total
General					
1	Mobilization	1	LS	4990	$ 4,990.00
Construction Dewatering & Diversion					
1	Principal Spillway Dewatering	1	LS	15,000	$ 15,000.00
2	Flow Bypass	1	EA	25,000	$ 25,000.00
Joint Sealing					
1	Water-activated grout injection	1	LS	6,000	$ 6,000.00
Stop Log Replacement					
1	Stop Log Channels	1	LS	1,200	$ 1,200.00
2	Stop Logs	7	EA	100	$ 700.00
3	Install Channels and Stop Logs	1	LS	2,000	$ 2,000.00
				Subtotal	**$ 54,890.00**
				Engineering	**$ 25,000.00**
				Contingency (20%)	**$ 10,978.00**
				Total	**$ 90,868.00**

Opinion of Probable Cost

Project: Lake Virginia Dam Repair - Alternative 2
Client: Lake Virginia Management District
Location: Section 08, Township 12 North, Range 05 West, Town of Excelsior, Sauk County, Wisconsin
Project No.: 37-0145.00

References:

Item	Description	Quantity	Unit	Unit Price	Total
General					
1	Mobilization	1	LS	2232.47	$ 2,232.47
2	Erosion Control	1	LS	2500	$ 2,500.00
3	Excavation	130	CY	75	$ 9,750.00
4	Embankment Replacement & Compaction	130	CY	5.19	$ 674.70
5	Site Restoration	1	LS	2500	$ 2,500.00
Joint Sealing					
1	External Joint Seals	1	LS	3000	$ 3,000.00
Stop Log Replacement					
1	Stop Log Channels	1	LS	1200	$ 1,200.00
2	Stop Logs	7	EA	100	$ 700.00
3	Install Channels and Stop Logs	1	LS	2000	$ 2,000.00
				Subtotal	**$ 24,557.17**
				Engineering	**$ 25,000.00**
				Contingency (20%)	**$ 4,911.43**
				Total	**$ 54,468.60**