APPENDIX C –
DAM SAFETY

Water Supply Storage Reallocation Study
Beaver Dam

1.0 General. This reallocation study was initiated at the request of three water entities: Benton Washington Regional Public Water Authority; Carroll Boone Water District; and Madison County Rural Water Authority. The total request from the three entities is for an additional 41,960 acre-feet of water supply storage. The plan to meet this request to allocate the requested storage to the entities from the existing conservation pool at Beaver Lake. This will not result in a change to the top of the conservation pool.

2.0 Purpose and Scope. The purpose of this report is to evaluate potential dam safety concerns in regards to the above mentioned request for additional water supply storage. The evaluation is based strictly on static loading; however, historic information on previous assessments will be presented. It is vital to address various aspects of design and performance to assure that the proposed storage re-allocation does not impact the continued safe operation of the dam and does not pose dam safety concerns. This evaluation addresses the following areas of interest.

- Structural Analysis
- Potential Failure Modes from the 2016 Dam Safety Periodic Assessment

3.0 General Project Description. The main components of the project are a concrete gravity dam section, a compacted earthen embankment section, and three (3) earthen dikes, which serve as the main water barriers; a concrete spillway used to provide additional release of water from the dam during major flood events; and a powerhouse. The elevation of the top of the dam and embankments is 1,142 feet. The spillway can pass up to 2.52 million gallons per second (337,000 cubic feet per second) or approximately the volume of 3.82 Olympic size swimming pools each second. The powerhouse contains two generators that each have a 56,000 kilowatt capacity.

General

National Inventory of Dam (NID) ID AR00174
Purpose ..... Flood Risk Management, Water Supply, Hydropower
Counties in Arkansas ..... Carroll, Benton, Washington
Location (River Mile) 609

Historic Inflow Events and Reservoir Elevations

Date	Peak Flow* (cfs)	Date	Elevation (ft-NGVD29)
25 April 2011	181,520	16 Apr 2008	1,132.21
27 Dec 2015	158,424	28 Dec 2015	1,132.04
19 May 2008	157,351	26 Apr 2011	1,131.62
10 April 2008	133,009	24 May 2011	1,131.59
24 May 2011	116,413	22 Dec 1984	1,130.38
24 Apr 2004	115,708	09 April 2002	1,130.37
04 May 1990	87,200*	10 Jun 1974	1,130.13

*Daily Average Inflow

4.0 Structural Stability. A stability analysis was conducted in 2011 due to a foreseen change to the probable maximum flood (PMF) elevation from 1137 ft. to 1139.9 ft. A drilling program was conducted in early 2011 and consisted of nine borings and testing of selected samples. Five borings were made in the inspection gallery through monoliths 17-21 and four borings were conducted downstream of the dam. Core samples from the borings were tested for direct shear at natural fractures and smooth-sawn surfaces. The results of sampling were used to analyze the stability of the dam. During the analysis, overturning stability and bearing capacity were verified, but the focus of the study was sliding stability of the dam. The table below shows the required and calculated safety factors against sliding for the three monoliths evaluated. Also shown are the required and calculated base in compression criteria to check for overturning. All load cases meet criteria for sliding and the overturning stability is confirmed. The PMF in the table below is 1139.9 ft. The PMF as of 2016 is 1144.9 ft., which is 2.9 ft. above the top of the dam. Taking into account the past performance of the dam, the calculated factors of safety, and the conservative nature of the calculations, the dam is considered to be structurally sound against sliding and overturning.

Monolith	Loadcase	SF Criteria	Calculated SF	Overturning Criteria	Base in Compression
12	10-year Flood	1.7	2.32	100%	100%
(nonoverflow)	300-year Flood	1.3	2.26	75%	100%
	OBE	1.7	2.52	75%	100%
	MCE	1.3	2.20	>0%	100%
	PMF	1.1	1.69	>0%	29%
	Historic High	na	2.27	na	100%
22	10-year Flood	1.7	1.97	100%	100%
(overflow)	300-year Flood	1.3	1.91	75%	100%
	OBE	1.7	2.19	75%	100%
	MCE	1.3	1.95	>0%	100%
	PMF	1.1	1.31	>0%	36%
	Historic High	na	1.92	na	100%
24	10-year Flood	1.7	2.88	100%	100%
(nonoverflow)	300-year Flood	1.3	2.85	75%	100%

OBE	1.7	3.20	75%	100%
MCE	1.3	2.77	>0%	100%
PMF	1.1	1.97	>0%	23%
Historic High	na	2.83	na	100%

5.0 Periodic Assessment No. 1 2016, Potential Failure Modes

Four (4) potential failure modes and a major non-breach risk were identified by the periodic assessment (PA) team for consideration. The following risk-driver potential failure modes and non-breach risk were evaluated by the PA team:

- **Inundation of Tainter gate machinery and electrical components prevents operation of gate causing the dam to overtop.**
- **Concentrated leak erosion at concrete dam and earthen embankment interface**
- **Concentrated leak erosion in Dike 3 foundation**
- **Head gate roller chain failure**
- **Non-breach risk associated with the large releases necessary to pass flows from a large rain event**

The risk associated with the head gate roller chain failure was considered to have a low likelihood of occurrence, and is not impacted by pool elevations. The other three risk driver potential failure modes and the non-breach risk are effected by reservoir pool elevations. The periodic assessment team, after considering current pool elevations and current Water Control Manual operations, determined that those three potential failure modes and the non-breach risk have a low likelihood of occurrence as well. This determination was made after a thorough investigation into the construction methods used to construct the dam, and the results of the ongoing instrumentation monitoring of the dam. The District has ongoing monitoring programs in place to monitor all five items listed above.

6.0 Conclusions:

Results from the Stability analysis conducted in 2011 indicate that the dam is structurally sound at current anticipated lake levels. The periodic assessment found 4 risk driving failure modes and a non-breach risk as described above. A permanent increase in pool elevations could significantly increase the likelihood of occurrence for the pool dependent potential failure modes and the non-breach risk. The requested storage re-allocation will not raise the top of the conservation pool and thereby does not create a permanent increase in pool elevations. Therefore, the current request should have no negative effect on the stability, probable failure modes, or non-breach risk of the dam.