Pensacola Hydroelectric Project
FERC Project No. 1494

Exhibit B
Project Operation and Resource Utilization

Draft License Application

Prepared for

GRDA
Grand River Dam Authority

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APPENDICES

LIST OF ABBREVIATIONS

cfs	cubic feet per second
DO	Dissolved Oxygen
ECC	Energy Control Center
FERC	Federal Energy Regulatory Commission
FPA	Federal Power Act
GRDA	Grand River Dam Authority
Grand Lake	Grand Lake O' the Cherokees
H&H	Hydrologic and Hydraulic
Licensee	Grand River Dam Authority
MW	Megawatts
MWh	Megawatt-hours
NAVD 88	North American Vertical Datum of 1988
NDAA 2020	National Defense Authorization Act for Fiscal Year 2020
NGVD 29	National Geodetic Vertical Datum of 1929
OM	Operations Model
PD	Pensacola Datum
Pensacola Project	Pensacola Hydroelectric Project
Project	Pensacola Hydroelectric Project
SPP	Southwest Power Pool
STID	Supporting Technical Information Document
USACE	U.S. Army Corps of Engineers
USGS	United States Geological Survey

1. Project Operation

The Pensacola Hydroelectric Project (Pensacola Project or Project) is owned and operated by the Grand River Dam Authority (GRDA or Licensee). As required by the Commission's regulations, this Exhibit B contains "a statement of project operation and resource utilization" 18 C.F.R. § 4.51(c). GRDA emphasizes, however, that information contained in this Exhibit B regarding anticipated operations under the new license relating to water surface elevations at Grand Lake is being provided for informational purposes only, as section 7612 of the National Defense Authorization Act for Fiscal Year 2020 (NDAA 2020) expressly prohibits the Commission or any other agency from imposing license obligations relating to water surface elevations of the Project's conservation pool (i.e., surface elevations in Grand Lake up to elevation 745 PD), except with regard to the Commission's dam safety regulations. NDAA 2020 section 612 provides, in relevant part:

> A) IN GENERAL.—Except as may be required by the Secretary to carry out responsibilities under section 7 of the Flood Control Act of 1944 (33 U.S.C. 709), the Commission or any other Federal or State agency shall not include in any license for the project any condition or other requirement relating to—
>
> (i) surface elevations of the conservation pool; or
>
> (ii) the flood pool (except to the extent it references flood control requirements prescribed by the Secretary).
>
> (B) EXCEPTION.—Notwithstanding subparagraph (A), the project shall remain subject to the Commission's rules and regulations for project safety and protection of human health.

Although Congress in NDAA 2020 granted GRDA independence in Project operations relative to surface elevations at Grand Lake, GRDA understands the need for the Commission under the National Environmental Policy Act of 1969 to evaluate the effects of its proposed action, i.e., the relicensing of the Project. For purposes of accommodating the Commission's environmental review, GRDA hereby presents its anticipated parameters during the new license term, as follows:

1. GRDA will no longer utilize a rule curve with seasonal target elevations.
2. GRDA will maintain the reservoir between elevations 742 and 745 feet Pensacola Datum (PD)[1] for purposes of normal hydropower operations and until flood control operations are directed by the U.S. Army Corps of Engineers (USACE).
3. GRDA will continue to adhere to the USACE's direction on flood control operations in accordance with the Water Control Manual (USACE, 1992).
4. Hydraulic flow for hydropower operations is anticipated to take place as the first priority for discharge when the USACE is directing operation under its exclusive jurisdiction over Grand Lake for flood control purposes.
5. Instead of managing the Project to target a specified seasonal elevation, GRDA's anticipated operations may fluctuate reservoir levels within the elevational range of 742 and 745 feet PD, for

[1] Unless stated otherwise, all elevations are presented in Pensacola Datum (PD). To convert from PD to the National Geodetic Vertical Datum of 1929 (NGVD29), add 1.07 feet. To convert from NGVD29 to the North American Vertical Datum of 1988 (NAVD88), add 0.33 feet.

purposes of responding to grid demands, market conditions, and the public interest, such as environmental and recreational considerations.

1.1 Neosho (Grand) River Basin Flow Management

The Pensacola Project is located on the Neosho (Grand) River in Craig, Delaware, Mayes, and Ottawa Counties, Oklahoma and consists of Pensacola Dam with a gated main spillway, middle gated spillway, east gated spillway, and powerhouse. Pensacola Dam impounds Grand Lake O' the Cherokees (Grand Lake). The Federal Energy Regulatory Commission (FERC) license number associated with the Pensacola Project is P-1494.

The Pensacola Project serves multiple purposes including hydropower generation, water supply, public recreation, and wildlife enhancement. For purposes of flood control of the overall upper Arkansas River Basin System, the Tulsa USACE office manages an expansive system of eleven large reservoirs. Grand Lake is within this system. Upstream of the Pensacola Project, USACE manages three federal reservoirs – Marion Reservoir, Council Grove, and John Redmond—with a combined storage capacity of approximately 465,000 acre-feet. Downstream of Grand Lake and GRDA's Lake Hudson (Markham Ferry), USACE manages Fort Gibson Reservoir (919,000 acre-feet) on the Grand River prior to its confluence with the Arkansas River. Within this large system, USACE must provide the safe passage of flows to municipalities and lands as far upstream as Emporia, Kansas, and downstream to Muskogee, Oklahoma—and further down the Arkansas River system, including Fort Smith, Russellville, Van Buren, and even Little Rock, Arkansas (GRDA, 2017).

Pensacola, Markham Ferry, and Fort Gibson Reservoirs are regulated as a subsystem of the upper Arkansas River Basin System, with similar percentages of the total flood control storage in each project utilized during periods of high flow. The system is also balanced by percentage of flood control storage utilized during evacuation (USACE, 1992). Under Section 7 of the Flood Control Act of 1944 (CFR, 1944), the USACE has the responsibility to prescribe releases from Pensacola Dam under active or anticipated flood operations (CFR, 1945).

As noted above, Congress in 2019 enacted the NDAA 2020.[2] Importantly, NDAA 2020 includes special legislation applicable only to operations of the Pensacola Project, and it significantly changes the scope of the ongoing relicensing for this Project. Specifically, as explained above, NDAA 2020 expressly forbids the Commission and other agencies from imposing license conditions relating to surface elevations of the conservation pool at Grand Lake.

1.2 Operation of the Pensacola Project

Power generation at the Pensacola Project is coordinated with GRDA's other hydroelectric generating resources at the Markham Ferry and Salina Pumped-Storage Projects; with the fossil fuel generating units at GRDA's Grand River Energy Center (formerly known as the Coal Fired Complex) and Redbud Power Plant; and renewable energy from wind turbines. Power generation at the Project and GRDA's other generating resources is controlled from GRDA's Energy Control Center (ECC), which is located at Kerr Dam. The ECC is continuously staffed. The ECC operators are responsible for operating GRDA's 16

[2] Pub. L. No. 116-92 (2019).

hydroelectric units. The operating condition of all hydroelectric generators, headwater and tailwater levels, and other status information is continuously updated and available to operators from GRDA's supervisory control and data acquisition system. Since 2013, GRDA has participated in the regional power market that is managed by the Southwest Power Pool (SPP), a multistate regional transmission organization. SPP coordinates the generation from all member utilities to supply current electrical demands using the most economical mix of generating resources (GRDA, 2021b).

1.2.1 Reservoir Normal Operations

For the purposes of normal hydropower operations, GRDA anticipates maintaining the reservoir between elevations 742 and 745 feet PD, with reservoir elevations fluctuating within this elevational range for purposes of responding to grid demands, market conditions, and the public interest, such as environmental and recreational considerations. The basic operating goal of the Project is to use any water available within its operating range for electric generation as efficiently as possible.

1.2.2 Reservoir High Flow Operations

As demonstrated by extensive study during this relicensing process, GRDA's normal hydropower Project operations between the elevations of 742 and 745 feet PD do not materially affect water surface elevations, frequency, timing, amplitude, or duration of flooding in the Grand/Neosho watershed upstream of Pensacola Dam. These findings demonstrate the efforts completed under the Storm Adaptive Management Plan (SAMP) required under the current license are unnecessary to address any Project effect. Therefore, GRDA is not proposing to continue the SAMP under the new license. Instead, any questions or concerns related to flood control at Grand Lake should be raised with USACE—the agency designated by Congress for exclusive jurisdiction over flood control at Grand Lake.

Federal law establishes a Congressionally authorized regulatory structure at Grand Lake. Under Section 7 of the Flood Control Act of 1944 (CFR, 1944), for example, Congress conferred upon the USACE the exclusive responsibility to prescribe releases from Pensacola Dam under active or anticipated flood operations (CFR, 1945). The USACE is also responsible for directing spillway releases in accordance with the procedures for system balancing of flood storage outlined in the Arkansas River Basin Water Control Master Manual (USACE, 1992). This exclusive authority is reinforced by Section 7612(c) of the NDAA of Fiscal Year 2020 which states that "The Secretary [of the Army] shall have exclusive jurisdiction and responsibility for management of the flood pool for flood control operations at Grand Lake O' the Cherokees" (NDAA, 2020). Other federal laws, such as Public Law 76-597, 54 Stat. 303 (1940), and Public Law 79-573, 60 Stat. 743 (1946), confirm that Congress has long established that USACE has sole jurisdiction over flood control, while the Commission retains jurisdiction under the FPA within the conservation pool. Even the original license issued by the Federal Power Commission in 1939 recognizes this bifurcated authority.

The flood storage associated with Grand Lake consists of the storage volume available between the approximate reservoir elevation of 745 feet and the elevation of 755 feet PD (USACE, 1992). When reservoir elevations are either above elevation 745 feet PD or projected to rise above 745 feet PD, the USACE directs the water releases from the dam under the terms of Section 7 of the Flood Control Act of 1944. When directed to make lake releases by USACE, GRDA first discharges as

much water as possible through the Project's hydropower units. Once the Project has reached the powerhouse's maximum hydraulic capacity, USACE may direct GRDA to open one or more spillway gates if the reservoir is still rising, but typically not unless the reservoir elevation exceeds, or is projected to exceed 745 feet PD. USACE will then determine if additional gates need to be opened. The target discharge rate at any time is based on the current reservoir elevation, the current estimated inflow to Grand Lake, and the amount of projected flooding downstream in the Grand or Arkansas River basins (GRDA, 2017).

Operators in the ECC are contacted by USACE personnel when gate operations are required. When USACE directs GRDA to release water from Grand Lake, the staff at Pensacola Dam decides which specific gate or gates to open. The opening order of these gates is rotated so each gate is opened about the same number of times. However, a general exception to this rule is that GRDA avoids opening the outside gates on all three spillways, when possible, to help limit bank erosion in the discharge channels downstream of the spillways (GRDA, 2021b).

1.2.3 Reservoir Low Flow Operations

GRDA's anticipated operations are not based on a targeted seasonal rule curve. As a result, GRDA will not be implementing a Drought Adaptive Management Plan under its anticipated operations because it is no longer necessary to maintain targeted minimums. GRDA anticipates maintaining required dissolved oxygen (DO) concentrations downstream of the Pensacola Project and Markham Ferry Projects during drought conditions while still maintaining reservoir elevations at the Markham Ferry Project sufficient to operate the Salina Pumped Storage Project, as well as meeting water supply needs (FERC, 2017).

2. Generating Characteristics and Flow Data

2.1 Average Annual Generation

The Pensacola Project has a generating capacity of 105.176 megawatts (MW). The Operations Model (OM) developed as part of the Hydrologic and Hydraulic (H&H) study (Mead & Hunt, 2022), was used to compute average annual generation for the baseline operations, which reflects the seasonal midnight rule curve that was in place prior to the 2015 license amendment. The operations model was used to compute average annual generation for the baseline condition in order to have a reasonable comparison to anticipated operations also computed by the Operations Model. The average annual generation computed for the baseline operations is 397,734 megawatt-hours (MWh).

Based on anticipated operations for the Project simulated using the Operations Model, the anticipated annual generation for the new license term is 425,911 MWh.

2.2 Plant Factor

The following equation is used to determine the average annual plant factor:

Average Annual Plant Factor = (Average Annual Output) ÷ (Nameplate Capacity × 8,760 hours/year)

According to GRDA's generation records for the 10-year period spanning January 2012 through December 2021, the Pensacola Project had a gross average annual energy production (output) of 444,855 MWh per year and an annual plant factor of 0.482 based on its current FERC authorized capacity of 105.176 MW.

To provide a proper comparison of the estimated change in project generation, the OM estimates an average annual generation under the baseline operation of 397,734 MWh (see Section 2.1) with a plant factor of 0.432 based on the FERC authorized capacity of 105.176 MW, and an average annual generation under the anticipated operation of 425,911 MWh with a plant factor of 0.462.

2.3 River Flow Characteristics

Inflow to the Pensacola Project comes from three rivers which are tributaries to Grand Lake: the Neosho River, Spring River, and Elk River. Flow data for each river is recorded by U.S. Geological Survey (USGS) surface water gaging stations Nos. 07185000, 07188000, and 07189000 respectively. Drainage areas at the USGS stream gages are 5,926, 2,516, and 851 square miles respectively (USGS, 2022a), (USGS, 2022b), (USGS, 2022c). The drainage area at Pensacola Dam is 10,345 square miles (USGS, 2022d). Mean daily flow data was retrieved for the period of record from January 1,1965 to December 31, 2021 for each river and the flows were combined to determine the total tributary flows and adjusted for the drainage area at the Project. Daily mean flows were obtained only for dates after January 1, 1965, to account for completion of the upstream John Redmond Reservoir in 1964.

2.3.1 Mean Monthly Flow

The mean monthly flows at Pensacola Dam are shown below in **Table 2.3.1-1**.

Table 2.3.1-1: Mean Monthly Flows

Month	Mean Monthly Flow (cfs)
January	5,077
February	6,079
March	10,009
April	10,897
May	13,783
June	11,980
July	6,904
August	3,386
September	4,197
October	5,051
November	6,438
December	5,611

Sources: USGS Gaging Station Nos. 07185000, 07188000, 07189000

2.3.2 Flow Duration Curves

Flow duration data shows the percentage of time a given flow is equaled or exceeded. Monthly flow-duration curves and the annual exceedance table are based on data collected for the period of record from January 1965 to December 2021 and are included in **Appendix B-1**.

2.3.3 Discharge Variation

Pensacola Dam discharge variations are shown below in **Table 2.3.3-1**. Discharge variations are based on the USGS data collected for the period of record from January 1965 to December 2021.

Table 2.3.3-1: Variation in Discharge

Flow Statistic	Flow Statistic Value (cfs)	Date(s)
Annual mean	7,452	1965-2021
Highest annual mean	17,555	2019
Lowest annual mean	1,553	2006
Highest daily mean	281,300	Sep. 26, 1993
Lowest daily mean	129	Aug. 2, 2012
10-percent exceedance	19,180	--
50-percent exceedance	3,338	--
90-percent exceedance	586	--

Sources: USGS Gaging Station Nos. 07185000, 07188000, 07189000, and 07190000

2.4 Dependable Capacity

Dependable capacity refers to the power the Pensacola Project is guaranteed to produce during future hours of peak demand under adverse flow conditions. The hydraulic capacity for the Pensacola Project's six turbine-generator units and the house unit is 15,090 cfs and the installed capacity is 105.176 MW. The dependable capacity has been assumed to be 105.176 MW.

2.5 Area Capacity Curves

Appendix B-2 presents area capacity and storage capacity curves for the Pensacola Project obtained from the 2019 bathymetric survey of Grand Lake performed by USGS (Hunter, Trevisan, Villa, & Smith, 2020). The reservoir encompasses 41,581 acres with a gross storage capacity of 1,307,289 acre-feet at a reservoir elevation of 742 feet PD (the bottom of the anticipated operating range). At a reservoir elevation of 745 feet PD, the reservoir encompasses 45,056 acres with a gross storage capacity of 1,437,348 acre-feet. The useable storage capacity of the Pensacola Project within the range of 742 and 745 feet PD is therefore 130,059 acre-feet.

2.6 Plant Estimated Hydraulic Capacity

The maximum hydraulic capacity is 15,090 cfs at a net head of 125 feet. The minimum hydraulic capacity limited by cavitation is 2,005 cfs at a net head of 95 feet (Mead & Hunt, 2022).

2.7 Tailwater Rating Curve

The Pensacola Project discharges into the Neosho River immediately downstream of the powerhouse. Under normal operating conditions, the tailrace elevation varies in direct response to the operation of the Pensacola Project. The tailwater rating curve for the Project is included as **Appendix B-3**. The tailwater elevations indicated by the curve are only valid for the tailrace channel below the Pensacola Powerhouse. Also, this curve should be applied only for conditions when the reservoir elevation of downstream Lake Hudson is near normal (elevation 619.0 feet NGVD). The Lake Hudson reservoir elevation can have a significant impact on tailwater elevations at Pensacola Project (GRDA, 2021b).

2.8 Plant Capability Versus Head

For normal hydropower operations at the Pensacola Project, the reservoir elevation is anticipated to fluctuate between 742 and 745 feet PD. The head available for power generation is dependent on tailwater elevations. The turbine-generator units are rated for a nominal head of 117.5 feet. Plant capability based on maximum generator output at various head elevations for the Pensacola Project were derived from inputs used for the Operations Model developed as part of the H&H study (Mead & Hunt, 2022). The plant capability curve for the Pensacola Project is presented as **Appendix B-4**.

3. Utilization of Public Power

Power generated at the Pensacola Project is sold to three customer classes: municipalities, electric cooperatives, and industries. GRDA customers include 15 Oklahoma public power municipalities, resident industries in the MidAmerica Industrial Park, Western Farmers Electric Cooperative, and other customers across a four-state region (GRDA, n.d.).

4. Proposed Future Development

GRDA is not proposing any new development or any expansion of any land or water rights as a consequence of this application.

5. Works Cited

CFR. (1944). *Regulations for use of storage waters.* 33 U.S. Code § 709.

CFR. (1945). *Pensacola Dam and Reservoir, Grand (Neosho) River, Okla.* 33 CFR § 208.25.

FERC. (2009). *Order Amending Licesnse by Revising Annual Charges.*

FERC. (2017). *Order Amending License and Dismissing Application for Temporary Variance.*

GRDA. (2017). *Pensacola Hydroelectric Project, FERC No. 1494 Pre-Application Document.*

GRDA. (2021a, December 29). Pensacola Hydroelectric Project (FERC Project No. 1494-438); Response to Comments on Intitial Study Report, Notice of Technical Meeting, and Request for Privileged Treatment of Cultural Resources Information.

GRDA. (2021b). *Supporting Technical Information Document - Revision 3.*

GRDA. (n.d.). *Electricity*. Retrieved October 24, 2022, from GRDA: https://grda.com/electricity/

Hunter, S. L., Trevisan, A. R., Villa, J., & Smith, K. A. (2020). *Bathymetric Map,Surface Area, and Capacity of Grand Lake O' the Cherokees, Northeastern Oklahoma, 2019.* Denver: USGS.

Mead & Hunt. (2022). *Hydrologic and Hydraulic Modeling: Operations Model.*

NDAA. (2020). *S. 1790 National Defense Authorization Act for Fiscal Year 2020.* Public Law No. 116-92.

USACE. (1992). *Pensacola Reservoir Water Control Manual-Appendix E, Part I of III to the Water Control Manual for the Arkansas River System.*

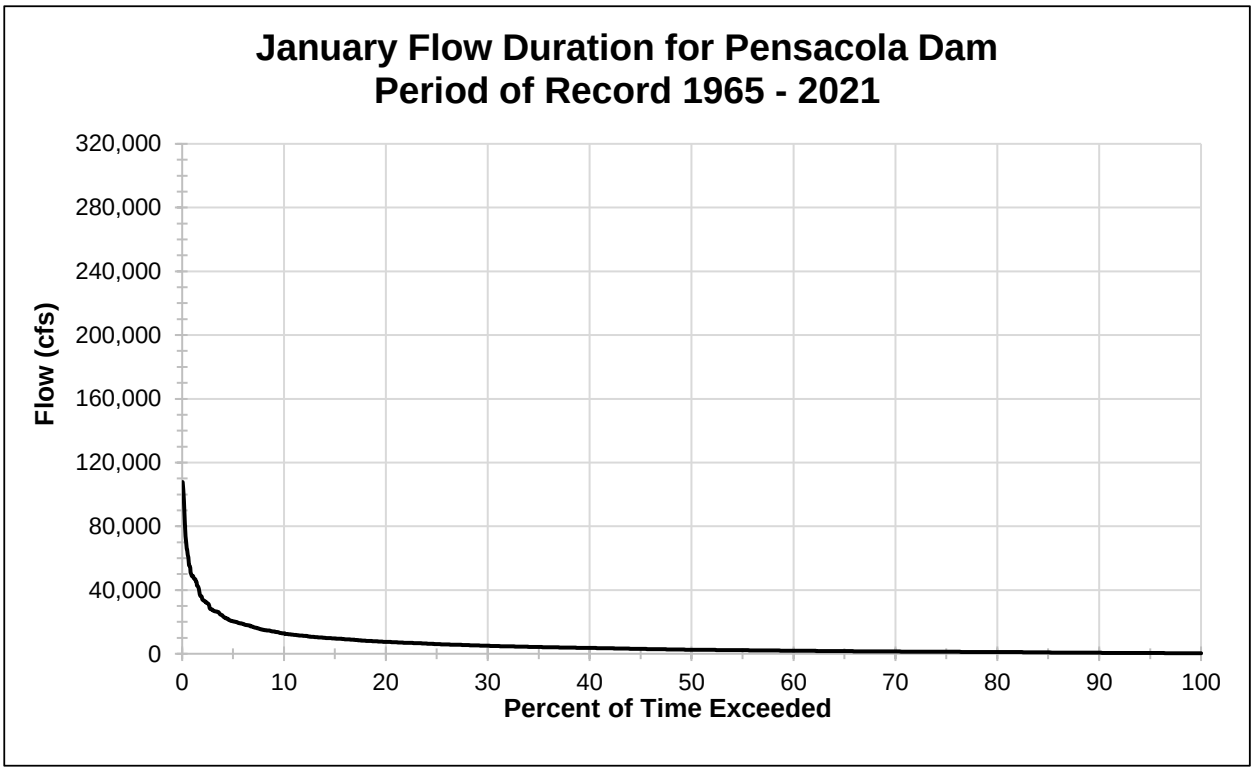
USGS. (2022a, September). *USGS 07185000 Neosho River near Commerce, OK*. Retrieved from National Water Information System: https://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=07185000

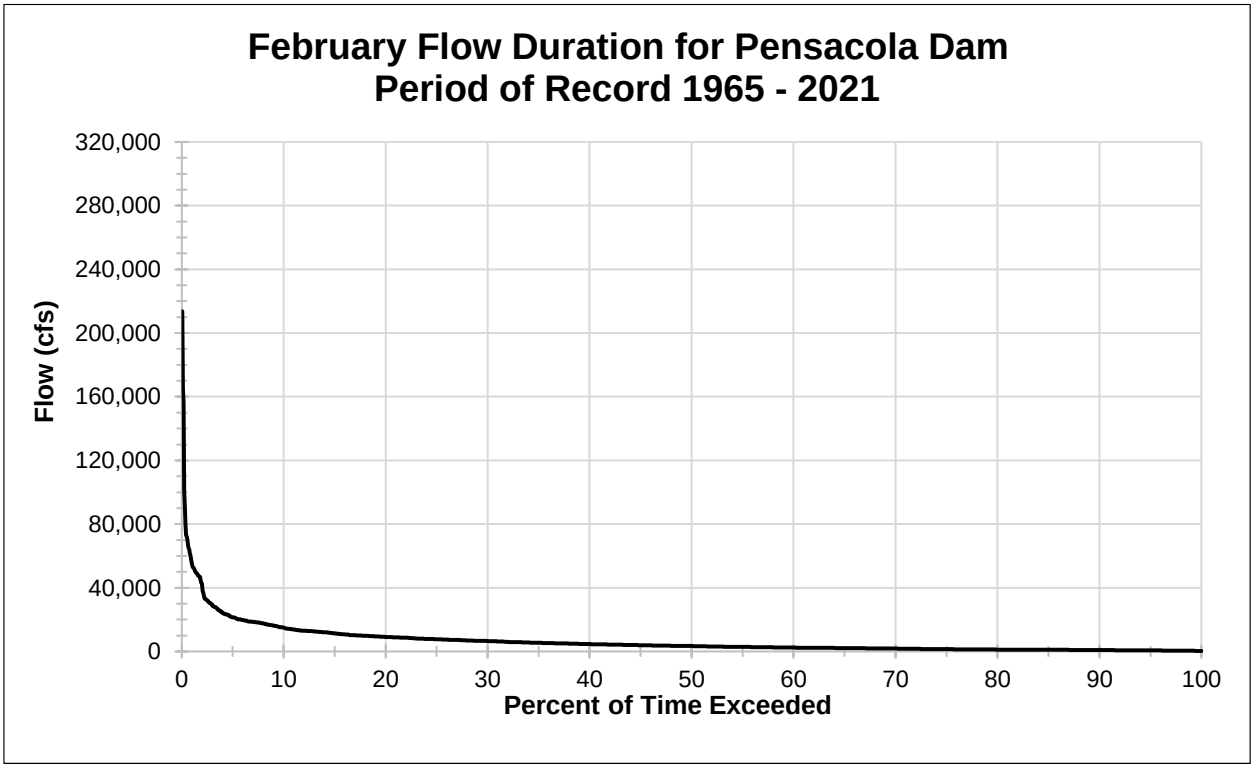
USGS. (2022b, September). *USGS 07188000 Spring River near Quapaw, OK*. Retrieved from National Water Information System: https://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=07188000

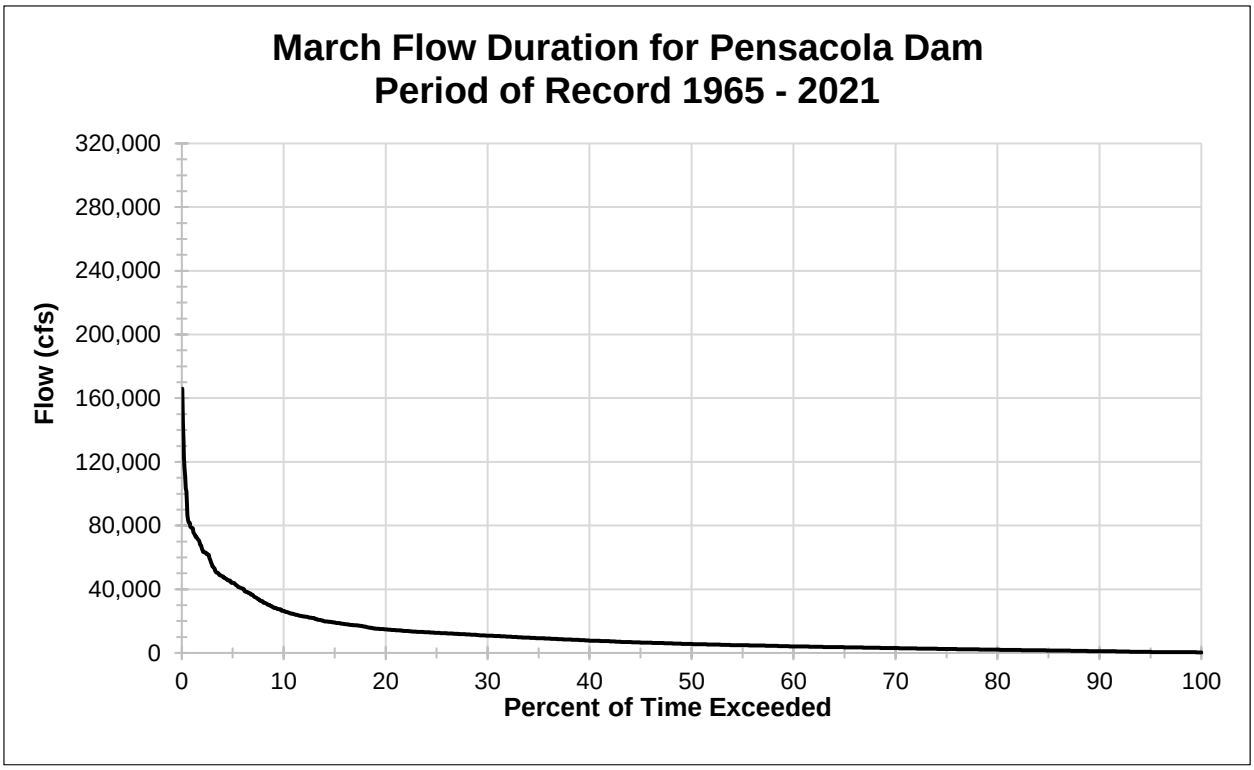
USGS. (2022c, September). *USGS 07189000 Elk River near Tiff City, MO*. Retrieved from National Water Information System: https://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=07189000

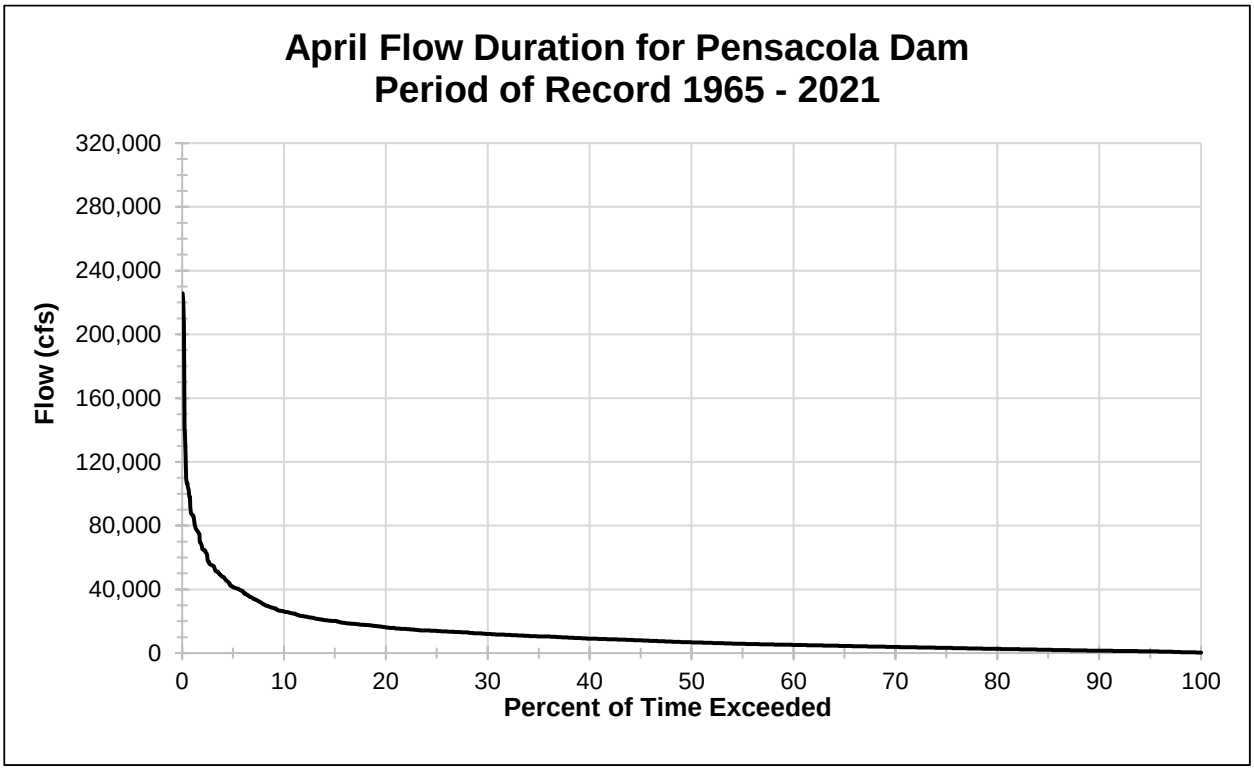
USGS. (2022d, September). *USGS 071890000 Lake O' the Cherokees at Langley, OK*. Retrieved from National Water Information System: https://waterdata.usgs.gov/ok/nwis/inventory/?site_no=07190000&agency_cd=USGS

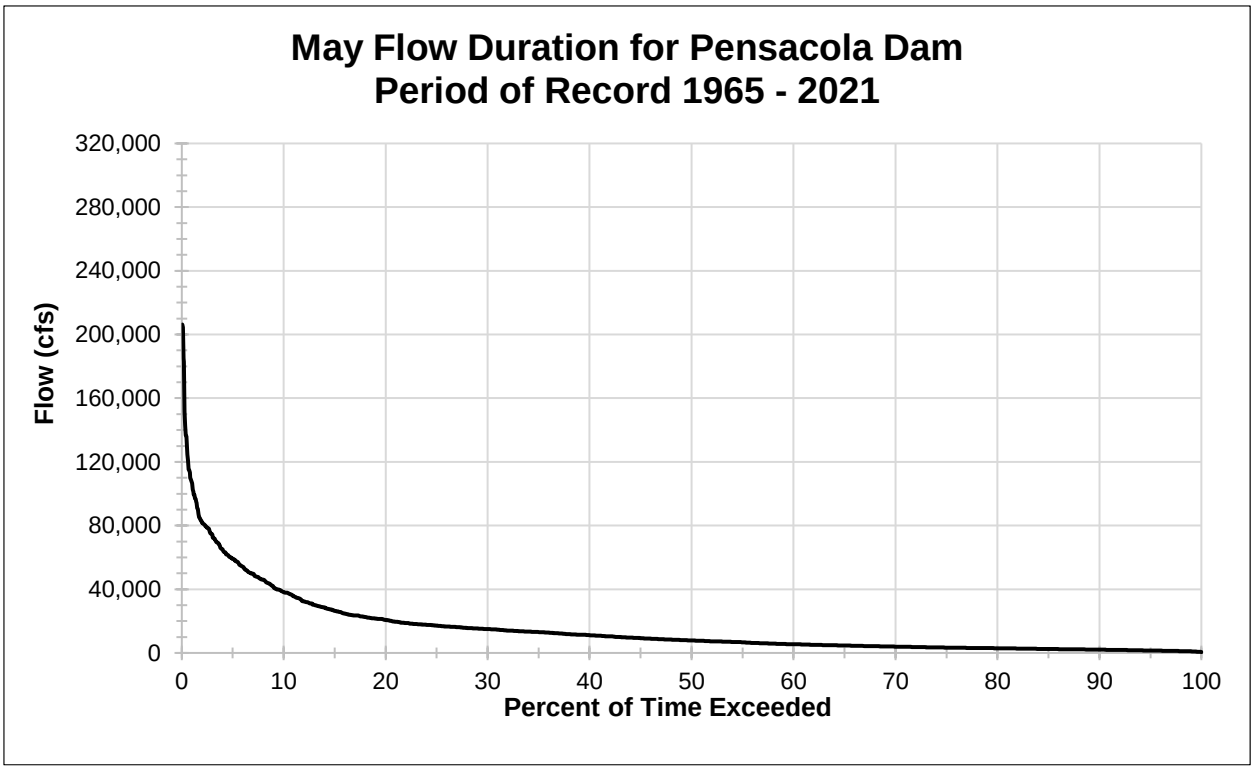
APPENDIX B-1 Flow Duration Curves and Exceedance Table

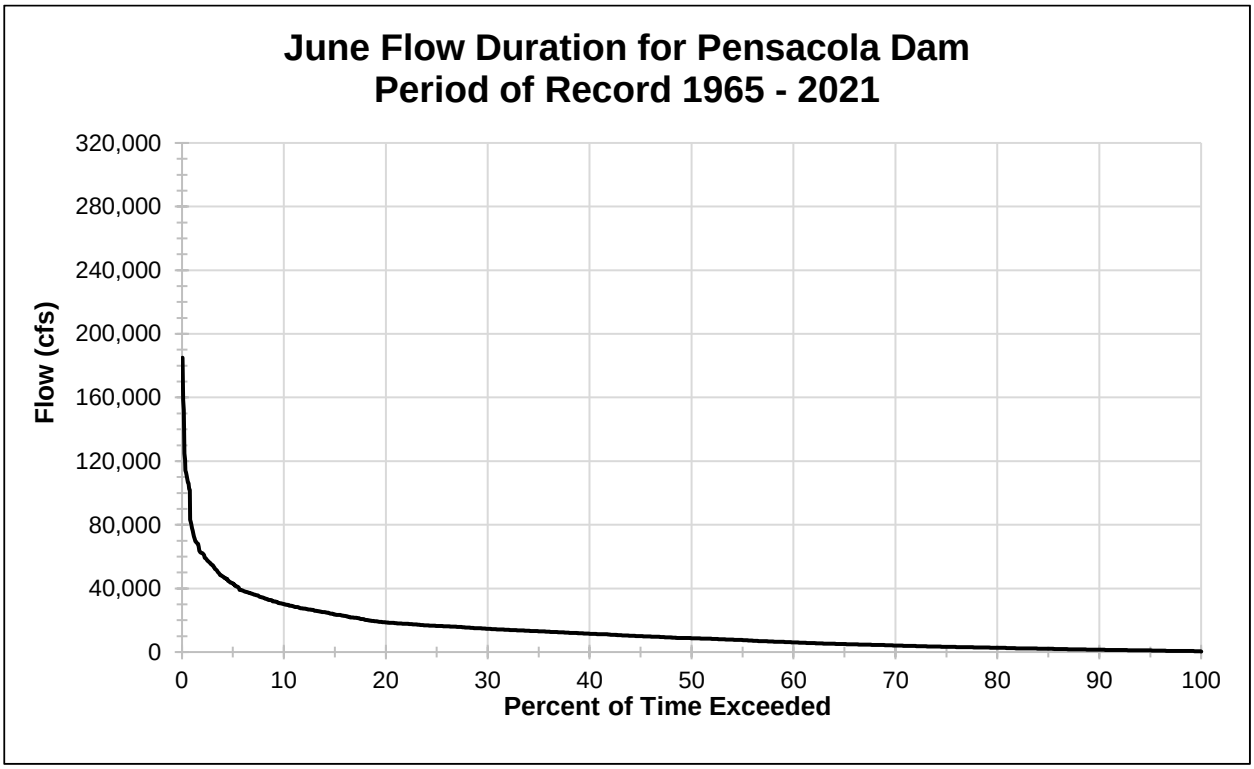

January Flow Duration for Pensacola Dam
Period of Record 1965 - 2021
Flow (cfs)
320,000
280,000
240,000
200,000
160,000
120,000
80,000
40,000
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Exceeded

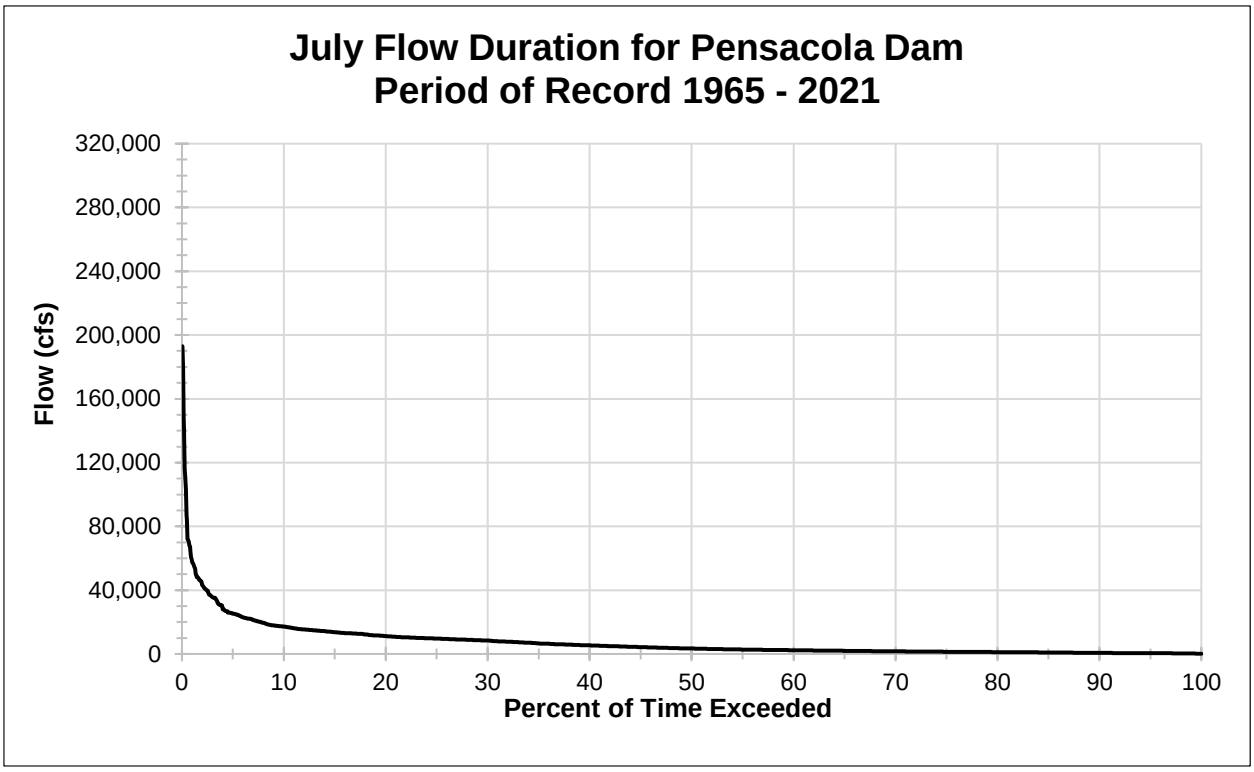

February Flow Duration for Pensacola Dam
Period of Record 1965 - 2021
Flow (cfs)
320,000
280,000
240,000
200,000
160,000
120,000
80,000
40,000
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Exceeded

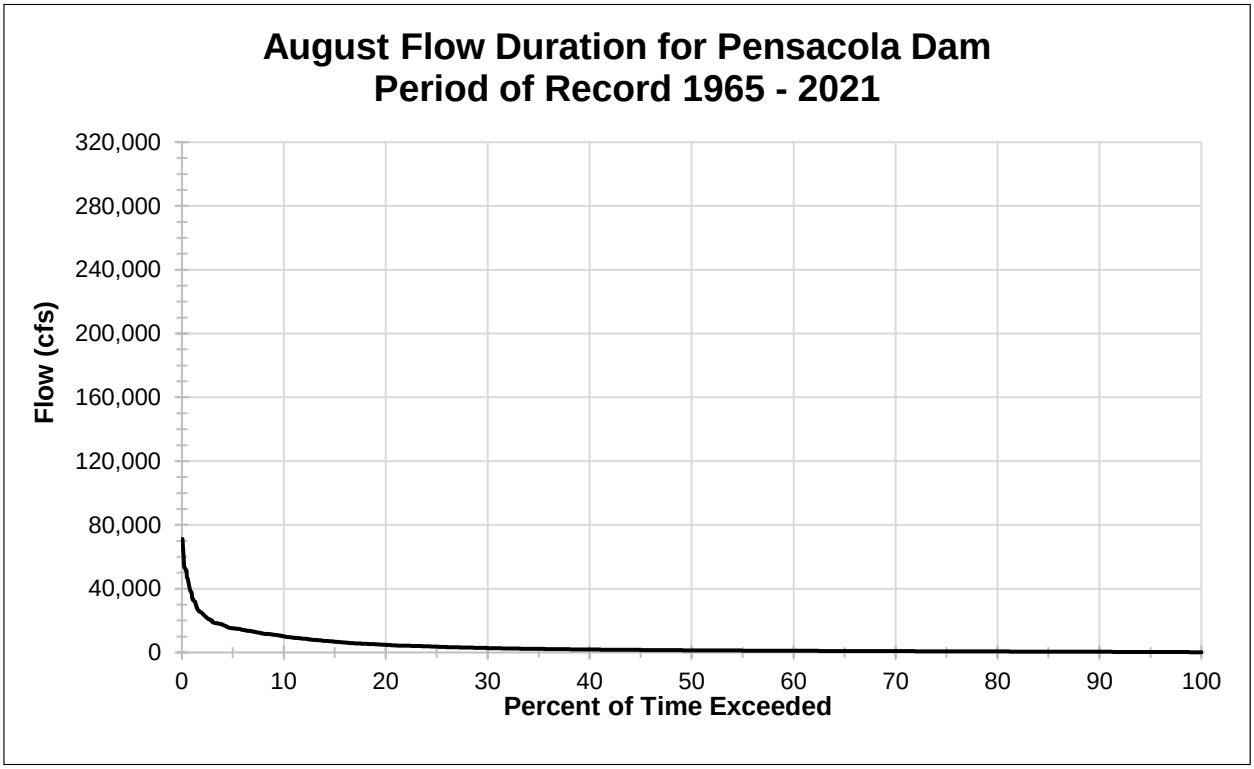

March Flow Duration for Pensacola Dam
Period of Record 1965 - 2021
Flow (cfs)
320,000
280,000
240,000
200,000
160,000
120,000
80,000
40,000
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Exceeded


April Flow Duration for Pensacola Dam
Period of Record 1965 - 2021
Flow (cfs)
320,000
280,000
240,000
200,000
160,000
120,000
80,000
40,000
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Exceeded


May Flow Duration for Pensacola Dam
Period of Record 1965 - 2021
Flow (cfs)
320,000
280,000
240,000
200,000
160,000
120,000
80,000
40,000
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Exceeded


June Flow Duration for Pensacola Dam
Period of Record 1965 - 2021
Flow (cfs)
320,000
280,000
240,000
200,000
160,000
120,000
80,000
40,000
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Exceeded


July Flow Duration for Pensacola Dam
Period of Record 1965 - 2021
Flow (cfs)
320,000
280,000
240,000
200,000
160,000
120,000
80,000
40,000
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Exceeded


August Flow Duration for Pensacola Dam
Period of Record 1965 - 2021
Flow (cfs)
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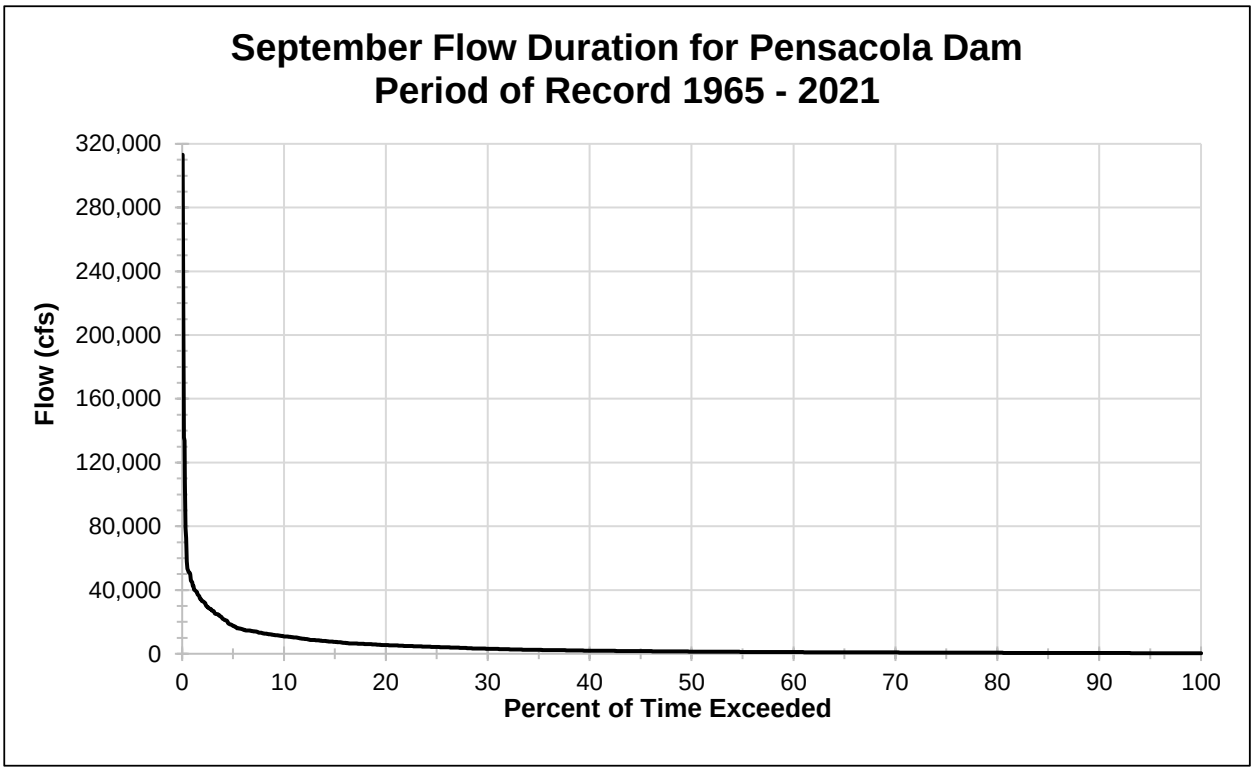
280,000
240,000
200,000
160,000
120,000
80,000
40,000
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Exceeded


September Flow Duration for Pensacola Dam
Period of Record 1965 - 2021
Flow (cfs)
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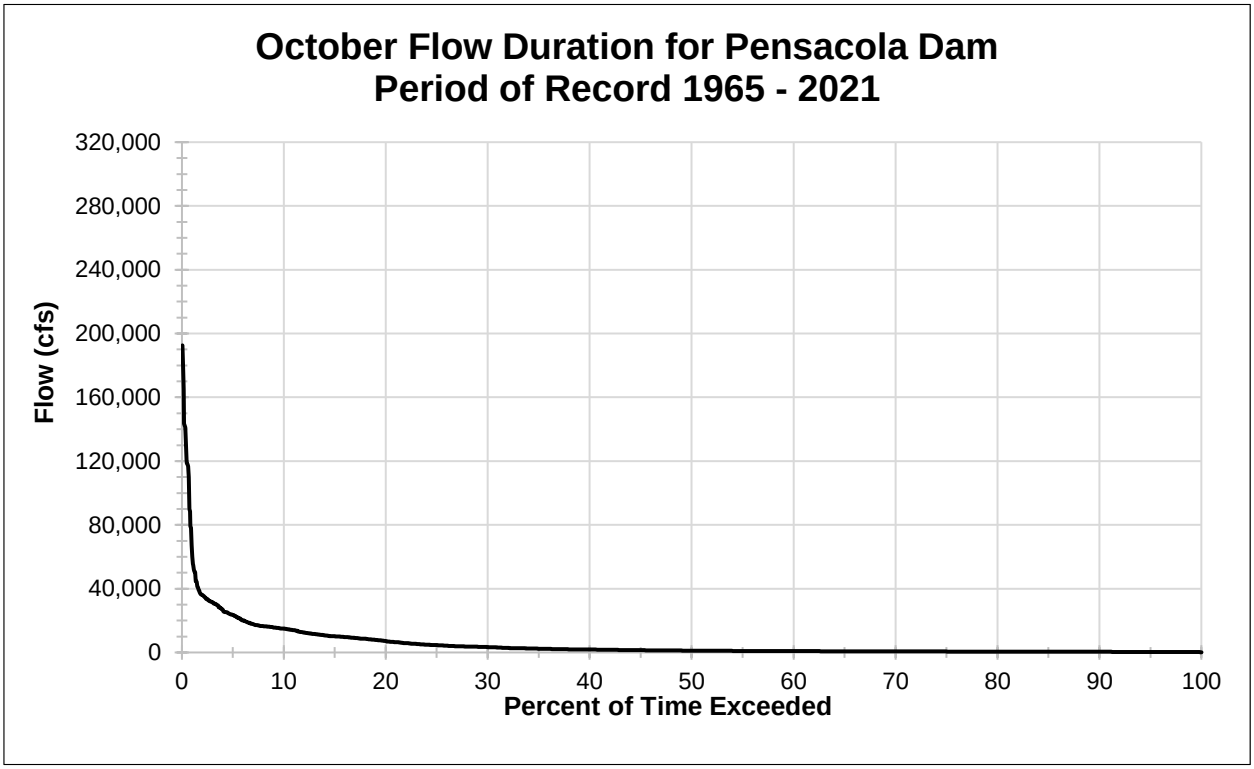
280,000
240,000
200,000
160,000
120,000
80,000
40,000
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Exceeded


October Flow Duration for Pensacola Dam
Period of Record 1965 - 2021
Flow (cfs)
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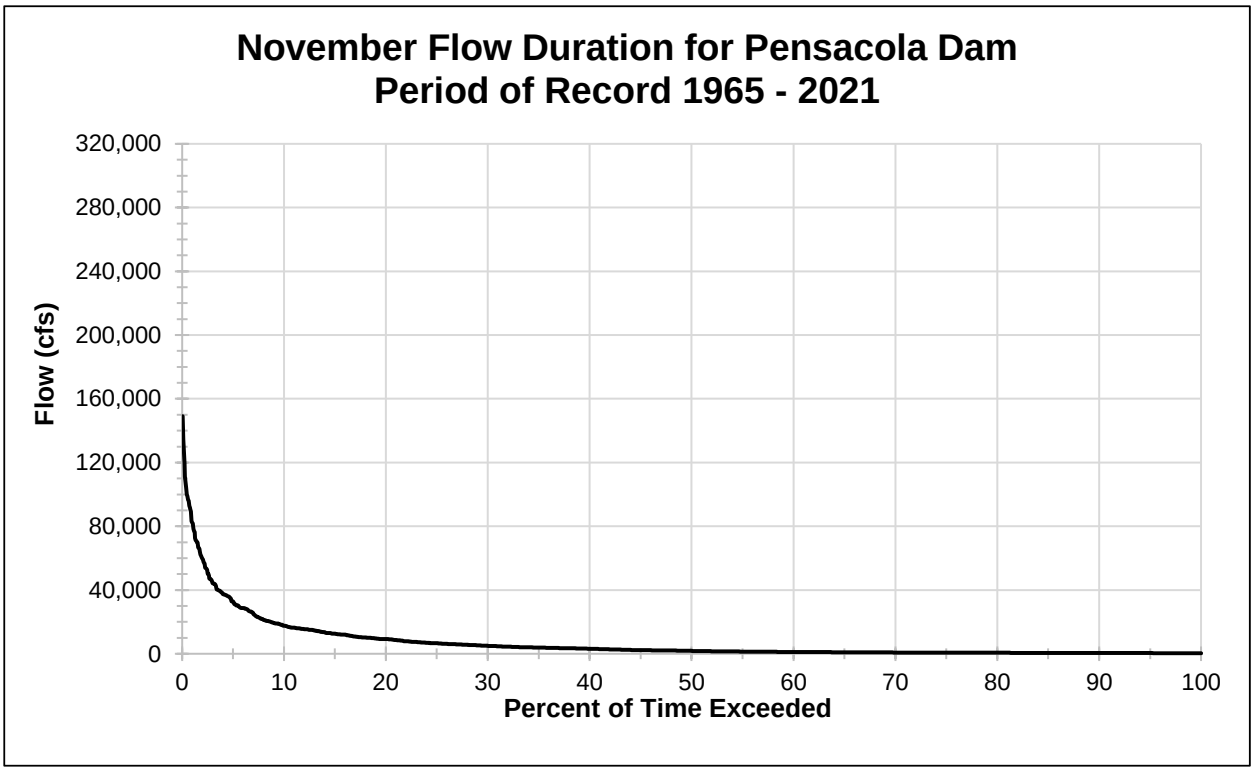
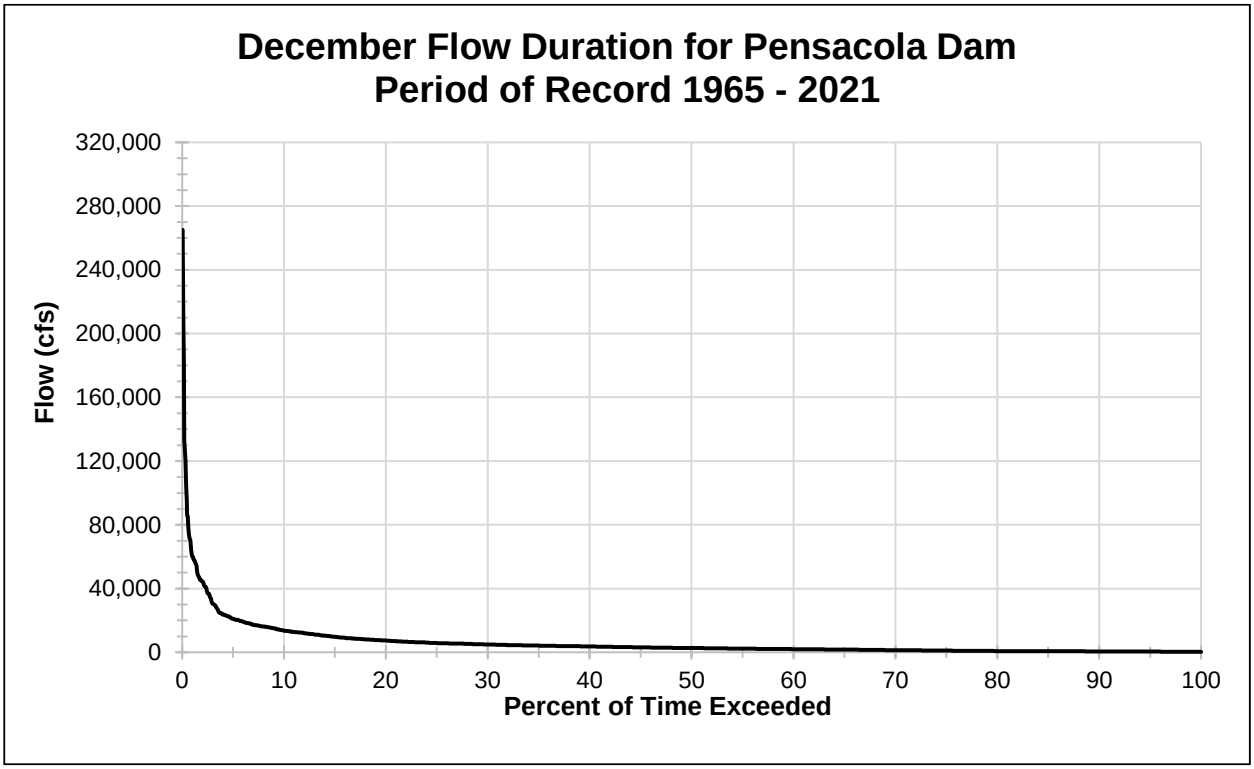
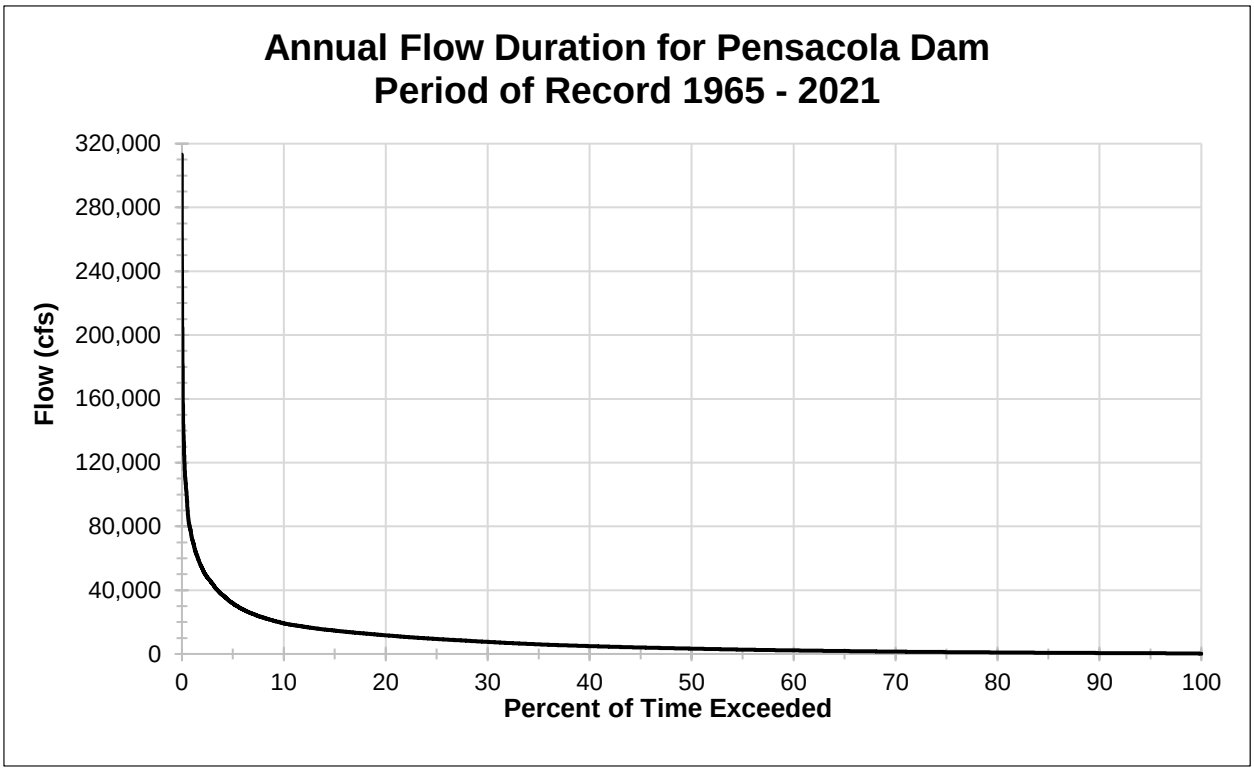
280,000
240,000
200,000
160,000
120,000
80,000
40,000
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Exceeded


November Flow Duration for Pensacola Dam
Period of Record 1965 - 2021
Flow (cfs)
320,000
280,000
240,000
200,000
160,000
120,000
80,000
40,000
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Exceeded

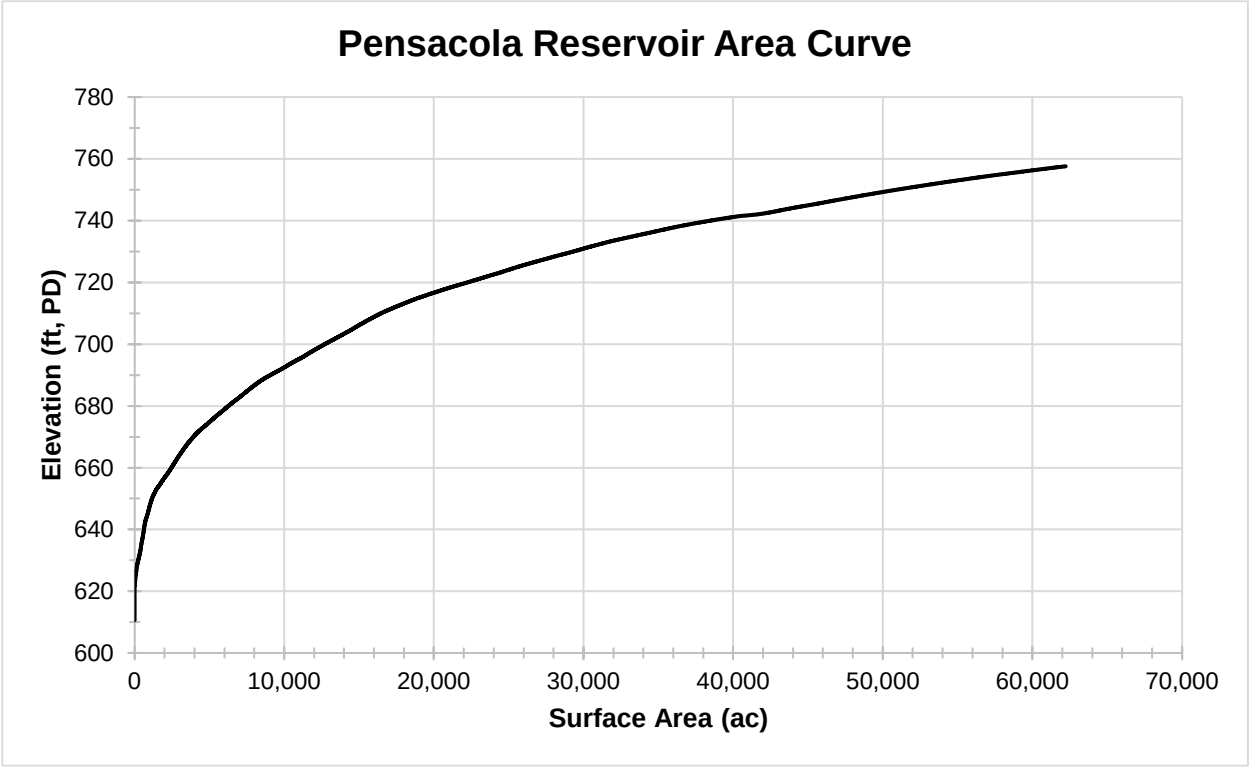

December Flow Duration for Pensacola Dam
Period of Record 1965 - 2021
Flow (cfs)
320,000
280,000
240,000
200,000
160,000
120,000
80,000
40,000
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Exceeded


Annual Flow Duration for Pensacola Dam
Period of Record 1965 - 2021
Flow (cfs)
320,000
280,000
240,000
200,000
160,000
120,000
80,000
40,000
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Exceeded

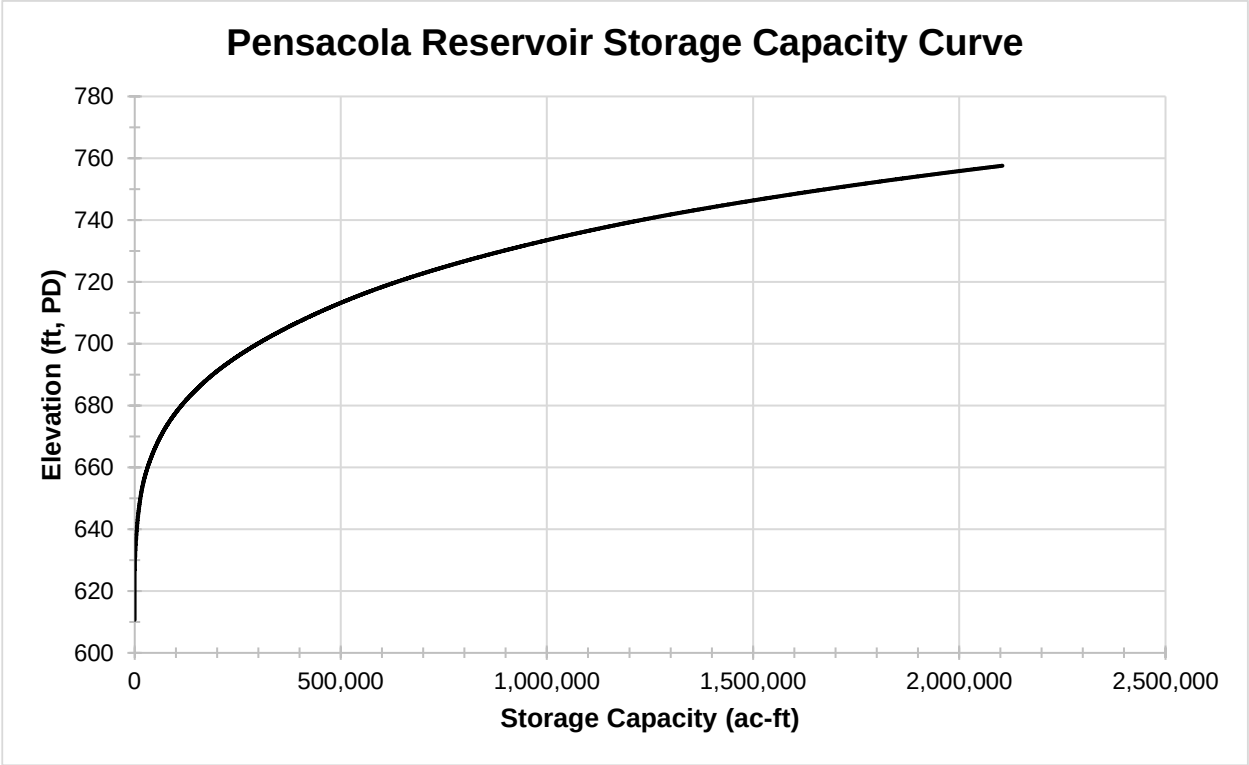
Flow Duration for Pensacola Dam (Period of Record 1965 - 2021)

Percent of Time	January	February	March	April	May	June	July	August	September	October	November	December	Annual
95	451	645	611	1,098	1,526	1,005	479	328	360	312	402	425	444
90	604	878	1,098	1,508	2,048	1,449	643	418	441	420	468	573	586
85	852	1,055	1,557	2,027	2,476	2,064	952	511	530	483	535	651	735
80	1,078	1,186	2,010	2,608	2,941	2,683	1,163	621	609	531	612	785	957
75	1,239	1,443	2,479	3,248	3,353	3,324	1,381	718	695	597	702	1,050	1,182
70	1,412	1,799	3,000	3,852	3,953	4,154	1,646	835	803	665	787	1,339	1,462
65	1,638	2,104	3,567	4,474	4,647	4,988	1,971	931	903	741	951	1,677	1,820
60	1,890	2,405	4,149	5,144	5,466	6,078	2,332	1,050	1,021	857	1,144	1,958	2,233
55	2,238	2,829	4,836	5,833	6,708	7,555	2,780	1,190	1,184	967	1,367	2,287	2,713
50	2,535	3,386	5,566	6,738	7,848	8,739	3,419	1,360	1,366	1,154	1,793	2,679	3,338
45	3,039	3,927	6,549	7,993	9,326	9,963	4,291	1,581	1,650	1,426	2,287	3,098	4,060
40	3,656	4,591	7,741	9,050	11,199	11,511	5,371	1,875	1,957	1,826	3,149	3,665	4,911
35	4,215	5,424	9,301	10,486	13,136	13,100	6,624	2,238	2,406	2,366	3,868	4,177	6,012
30	5,021	6,530	10,874	12,043	14,995	14,594	8,385	2,777	3,151	3,357	4,967	4,881	7,581
25	6,036	7,648	12,613	13,937	17,215	16,394	9,679	3,615	4,268	4,584	6,596	5,773	9,381
20	7,470	9,097	14,772	16,097	20,706	18,613	11,236	4,793	5,449	7,169	9,162	7,373	11,662
15	9,551	11,388	19,069	20,093	26,517	23,533	13,641	6,742	7,447	10,152	12,529	9,693	14,673
10	12,746	14,906	26,394	26,194	38,160	30,038	17,196	10,131	10,889	15,017	17,589	13,648	19,180

APPENDIX B-2 Reservoir Area and Storage Capacity Curves

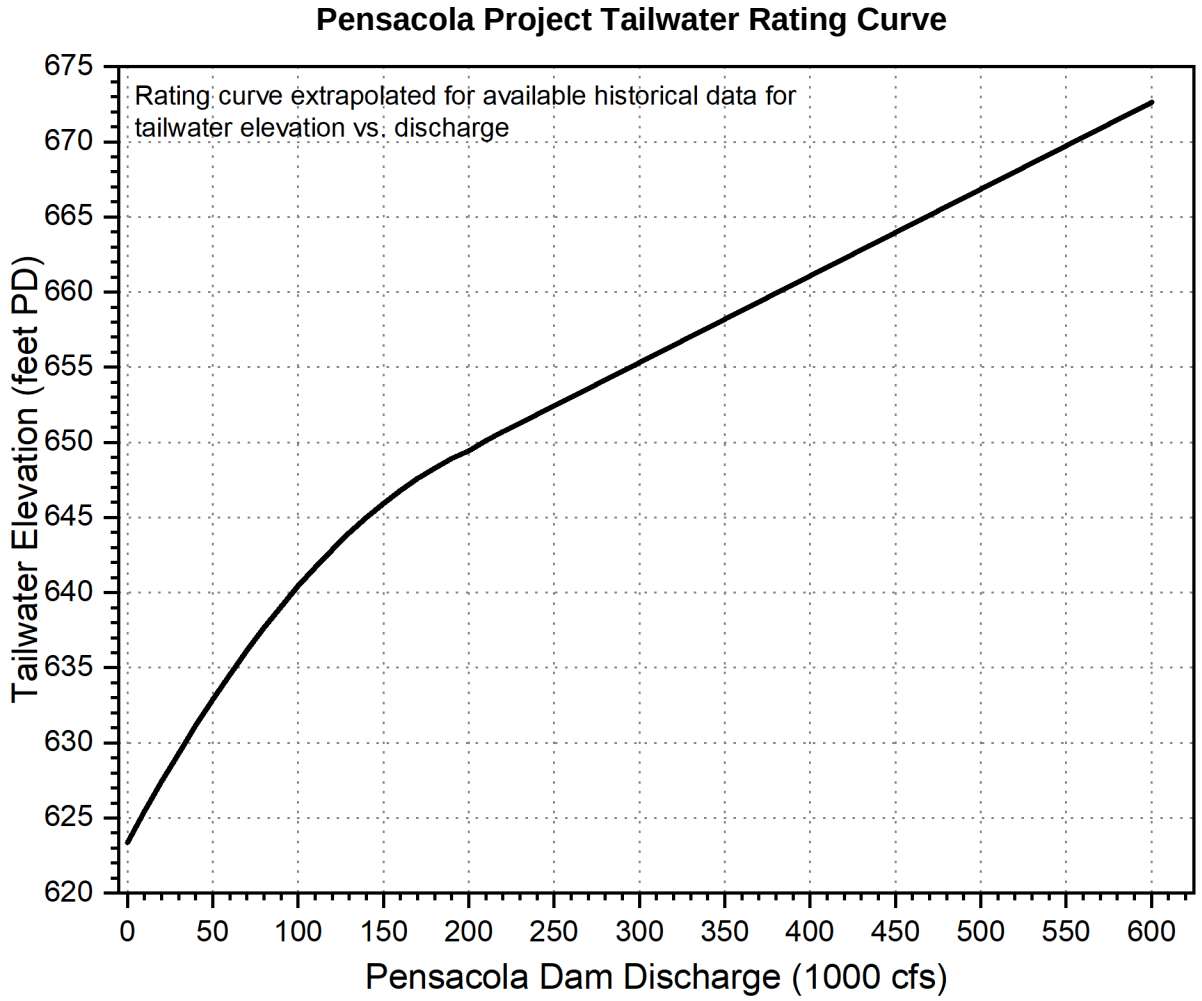


Area capacity curve obtained from the 2019 bathymetric survey of Grand Lake performed by USGS (Hunter, Trevisan, Villa, & Smith, 2020)

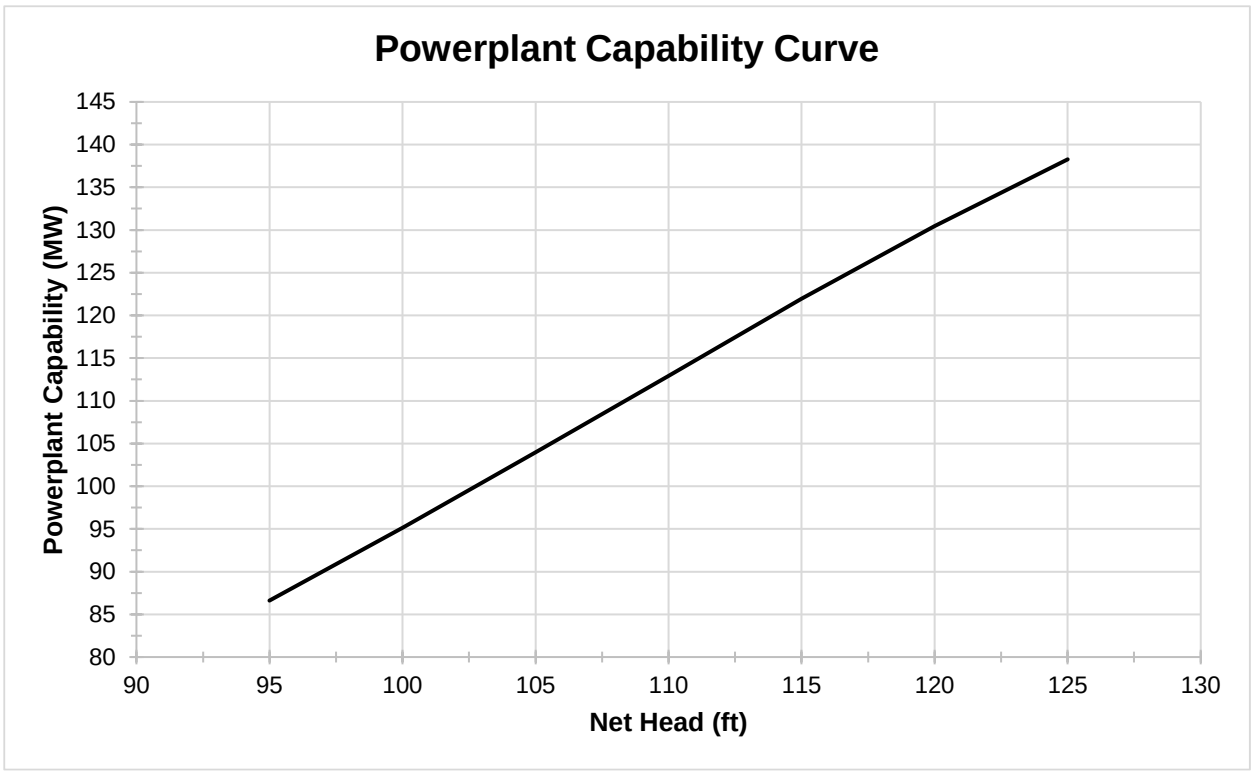


Storage capacity curve obtained from the 2019 bathymetric survey of Grand Lake performed by USGS (Hunter, Trevisan, Villa, & Smith, 2020)

APPENDIX B-3 Tailwater Rating Curve


Pensacola Project Tailwater Rating Curve
Rating curve extrapolated for available historical data for tailwater elevation vs. discharge
Tailwater Elevation (feet PD)
675
670
665
660
655
650
645
640
635
630
625
620
0
50
100
150
200
250
300
350
400
450
500
550
600
Pensacola Dam Discharge (1000 cfs)

APPENDIX B-4 Powerplant Capability Curve


Powerplant Capability Curve
Powerplant Capability (MW)
145
140
135
130
125
120
115
110
105
100
95
90
85
80
90
95
100
105
110
115
120
125
130
Net Head (ft)