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This Subsection contains information withheld under 10 CFR 2.390(a)(3)

2.4.1 Hydrologic Description

2.4.1.1 Site and Facilities

The site location is identified in Figure 2.4.1-2. Access to the site is via highway, Tennessee State Highway (TN) 58 and TN 95, rail to Oak Ridge Reservation, and barge or boat on the Clinch River arm of Watts Bar Reservoir. The relationship of the plant area to the surrounding topography is shown in Figure 2.4.1-3. For flood protection of the plant and its safety-related systems and equipment, the plant facilities, including any entry point to below grade structures, will be located above the maximum postulated flood level.

The CRN Site is to be graded such that runoff is directed away from buildings to the extent possible and to the Clinch River arm of Watts Bar Reservoir. An evaluation of a representative site grading plan demonstrates acceptable runoff characteristics. The actual site grading plan will be based on selection of a technology and the associated site layout plan will be developed at combined license application (COLA).

The Circulating Water System and the cooling towers obtain their source water from the Clinch River arm of Watts Bar Reservoir. Figure 2.4.11-2 shows the intake location at Clinch River Mile (CRM) 17.9 on the Clinch River arm of Watts Bar Reservoir. The City of Oak Ridge Department of Public Works would provide potable and wastewater services to the CRN Site. (Reference 2.4.1-6) Closed cooling systems would supply the internal plant reservoirs. The river would not supply any safety related systems. The outfall location at CRM 15.5, also shown in Figure 2.4.11-2, is approximately 2.4 river miles downstream to ensure there would be no recirculation.

2.4.1.2 Hydrosphere

2.4.1.2.1 Surface Water

Site Location

The CRN Site is located on the north bank of the Clinch River in the upper reach of Watts Bar Reservoir between CRM 19 and CRM 14.5 (Reference 2.4.1-1). The drainage area at CRM 16.0 is 3382 sq mi. The nearest facility downstream of the CRN Site with a surface water withdrawal registration with the State of Tennessee is the Oak Ridge Bear Creek Plant, located downstream of the CRN Site as shown on Table 2.4.1-1 and Figure 2.4.1-1 (Location No. 45). This plant is also known as the City of Oak Ridge's West End Water Treatment Plant (WTP) and the K-25 Water Treatment Plant. The Oak Ridge Bear Creek Plant ceased water production on September 30, 2014, and Oak Ridge Utilities which now owns the facility has no plans to resume production at the site. Surface water supplies withdrawn from the 350 mi stretch of the Clinch River between the headwaters near Tazewell, Virginia and the confluence with the Tennessee River at CRM 0 and Tennessee River Mile (TRM) 567.8 are shown in Figure 2.4.1-1 and listed in Table 2.4.1-1. (Reference 2.4.1-6)

The Clinch River originates in Tazewell County, Virginia, about 175 mi northeast of the CRN Site (Reference 2.4.1-2). From its headwaters, the Clinch River flows approximately 350 river miles in a southwesterly direction to its confluence with the Tennessee River at TRM 567.8, near Kingston, Tennessee (Reference 2.4.1-3). Except for its northwestern edge, the river basin above the site is in the Appalachian Valley physiographic sub-region. Comparatively narrow parallel ridges and somewhat broader intervening valleys, which lie in a northeast-southwest direction, characterize this area. The Cumberland Mountains, which range up to approximately

4200 ft in elevation, form the northwestern boundary of the basin. The southeastern boundary follows Clinch Mountain and Black Oak Ridge with elevations ranging up to approximately 4700 ft (Reference 2.4.1-2). The slope of the Clinch River from Norris Dam at CRM 79.8 to CRM 7.0 averages about 1.5 ft per river mile (Reference 2.4.1-2).

Tributaries

The principal tributary of the Clinch River is the Powell River which parallels the Clinch River to the northeast. The Powell River enters the Clinch River at CRM 88.8. Drainage area of the Powell River at its mouth is 938 sq mi. (Reference 2.4.1-3) The second largest tributary of the Clinch River is the Emory River which enters the Clinch River from the north at CRM 4.4 and has a drainage area of 865 sq mi. There are seven Clinch River tributaries with drainage areas greater than 5 sq mi upstream of CRN and downstream of Norris Dam. They are Pawpaw Creek, Whiteoak Creek, Beaver Creek, Bullrun Creek, Hinds Creek, Cane Creek and Coal Creek at CRM 19.1, 20.8, 39.6, 46.7, 65.8, 71.3 and 75, respectively. Downstream, Poplar Creek at CRM 12 is the only Clinch River tributary with a greater than five square miles drainage area (Reference 2.4.1-3).

Reservoir Water Flow

Three dams directly control the water surface elevation at the CRN Site: Norris Dam and Melton Hill Dam, located upstream on the Clinch River; and Watts Bar Dam, located downstream at TRM 529.9.

(SRI/CEII) Norris Dam at CRM 79.8, located about 62 mi upstream from the CRN Site, was completed in March 1936. (Reference 2.4.1-2) Norris Dam is a large structure having a maximum height of approximately 265 ft and an overall length of 1570 ft. There are [redacted] ft. The remainder of the dam consists of [redacted] t sections having a combined length of [redacted] ft and [redacted] ft. At a top-of-dam elevation of 1061 ft National Geodetic Vertical Datum of 1929 (NGVD29) Norris Dam is capable of approximately 344,000 cubic feet per second (cfs) of discharge. Norris Dam impounds approximately 2,552,000 acre-feet (ac-ft) of water at the top of gates elevation, 1034 ft NGVD29. Norris Dam provides hydro power production, flood control, navigation benefits, improved dissolved oxygen (DO), and low flow regulation to enhance downstream water quality. (Reference 2.4.1-7)

(SRI/CEII) Melton Hill Dam is located 5.2 mi upstream of the CRN Site at CRM 23.1 and was completed in May 1963. It is a run-of-the-river dam and a smaller structure than Norris Dam. It has a maximum height of only about 84 ft and an overall length of 1020 ft. Melton Hill Dam has [redacted] gates with a combined length of [redacted] ft. The remainder of the dam consists of [redacted] having a combined length of [redacted] ft and concrete lock and powerhouse sections with a combined length of [redacted] ft. At an elevation of 802 ft NGVD29 Melton Hill Dam is capable of approximately 146,000 cfs of discharge. Melton Hill Dam impounds approximately 126,000 ac-ft of water at the top of gates elevation, 796 ft NGVD29. The primary functions of Melton Hill Dam are navigation and power production, with some regulation of low water flows. (Reference 2.4.1-8)

(SRI/CEII) Watts Bar Dam located downstream of the CRN Site was completed in 1942. Although Watts Bar Dam is located over 50 mi downstream of the site, the backwater from the reservoir extends upstream to the Melton Hill Dam tailwater (Reference 2.4.1-2). Watts Bar Dam is a large structure having a maximum height of about 112 ft and a length of approximately 2960 ft. Watts Bar Dam has a spillway consisting of [redacted] ft wide gates for a combined crest length of [redacted] ft. There are [redacted] earthen embankment sections having a combined length of [redacted] ft and concrete powerhouse, lock section and minor ancillary structures with a total length of [redacted] ft. At the Watts

Bar screen house over flow elevation of 767 ft NGVD29, the Watts Bar Dam is capable of approximately 1,144,000 cfs of discharge. Watts Bar Dam impounds approximately 1,175,000 ac-ft of water at the top of gates elevation, 745 ft NGVD29. (Reference 2.4.1-9)

TVA operates its dams and associated features as part of an integrated system. Therefore, in addition to the three dams described above which directly control water surface elevation, nine dams upstream in the Tennessee River system have the potential to influence flood levels at Watts Bar Reservoir and, as a result, at the CRN Site. These are Fort Loudoun Dam on the Tennessee River; Watauga, South Holston, Boone, Fort Patrick Henry, Cherokee, and Douglas Dams above Fort Loudoun; and Fontana and Tellico Dams on the Little Tennessee River. The location of TVA dams and reservoirs with respect to the CRN Site are shown in Figure 2.4.1-5. (Reference 2.4.1-5)

TVA developed historical flow information for the Clinch River in the vicinity of the CRN Site from multiple sets of stream gages. Through 1968, the U.S. Geological Survey maintained stream gages on the Clinch River in the vicinity of the CRN Site, as shown in Table 2.4.1-2. In addition, TVA has operated stream gages in the vicinity of the CRN Site as listed in Table 2.4.1-3.

Since the completion of Melton Hill Dam in 1963, the daily average flow rate is about 4800 cfs at the CRN Site. There has been an average of about 13 days per year during which there were no releases from the dam. However, since 1990 there has been an average of only 0.5 days per year during which there were no releases from the dam. The longest period of no release from the dam occurred in February and March 1966 when there was no flow below the dam for 29 consecutive days.

TVA completed a comprehensive Reservoir Operations Study (ROS) in 2004 to determine whether changes in the operation of the Tennessee River system would produce greater overall public value for the people of the Tennessee Valley. The preferred alternative implemented in the spring of 2004 resulted in: (1) changes in minimum flow requirements for system operating objectives, (2) establishment of reservoir balancing guides for each tributary storage reservoir to ensure that proportional water releases for downstream system needs are drawn from the tributary reservoirs equitably, (3) scheduled recreational releases at five additional tributary projects, subject to flood control operations or extreme drought conditions (4) establishment of weekly average flow requirements for different periods of the year at Chickamauga and (5) application of other requirements as defined in the Final Programmatic ROS Environmental Impact Statement. As a result of the implementation of the ROS in 2004, historical flow data from Melton Hill Dam are presented for the period 2004 – 2013 only. (Reference 2.4.1-5) Monthly average discharges from Melton Hill Dam for the period 2004 – 2013 are shown in Table 2.4.1-4.

Reservoir Water Levels

Since completion of the Watts Bar Dam in 1942, TVA has regulated water levels on the Watts Bar Reservoir as a part of the integrated operation of the river system. Reservoir operating guidelines establish pool level parameters for daily operation. Figure 2.4.1-6 Sheet 1 of 11 is the seasonal operating curve for Watts Bar Reservoir which reflects target water surface elevations for each month of the year. Reservoir operations may temporarily deviate from normal operating guides to meet navigation, flood-control, critical power production situations or other requirements. Since 1942, the minimum elevation of Watts Bar Reservoir headwater was 733.7 ft NGVD29 and occurred on March 20, 1945. The maximum elevation was 747.4 ft NGVD29 and occurred on May 7, 2003. Since 1999, the minimum elevation of Watts Bar Reservoir at the Melton Hill tailwater was 735.0 ft NGVD29 and occurred both on January 9, 2002 and December 15, 2005. The maximum recorded Melton Hill tailwater elevation of 765.1 ft NGVD29 occurred on April 2, 2000.

2.4.1.2.2 Groundwater

Subsection 2.4.12 contains a detailed description of the hydrogeologic conditions at and in the vicinity of the CRN Site and includes the regional and local groundwater resources that could be affected by the construction and operation of SMRs at the CRN Site. The regional and site-specific data on the physical and hydrologic characterization of these groundwater resources are summarized in order to provide the basic data for an evaluation of impacts on the aquifers in the area.

Subsection 2.4.12.2.1.2 provides information regarding current groundwater users and identifies:

- Community water systems, which serve the same people year-round (e.g., homes)
- Non-transient non-community water systems, which serve the same people but not year-round (e.g., schools that have their own water supply)
- Transient non-community water systems, which do not consistently serve the same people (e.g., rest stops, campgrounds)

In addition, Subsection 2.4.12.2.1.2 includes information pertaining to individual wells in the vicinity of the CRN Site obtained from the Tennessee Department of Environment and Conservation, Division of Water Resources, Drinking Water Unit.

2.4.1.3 References

2.4.1-1. Tennessee Valley Authority (TVA), *Final Environmental Impact Statement, Watts Bar Reservoir Land Management Plan, Loudon, Meigs, Rhea, and Roane Counties, Tennessee*, Panel 4 map, F9, February 2009.

2.4.1-2. TVA, *Clinch Breeder Reactor Project PSAR*, Book 255-10.0 CRBR-General, 1973.

2.4.1-3. TVA, Division of Water Control Planning, Hydraulic Data Branch, *Drainage Areas for Streams in Tennessee River Basin*, Knoxville, Tennessee, Report No. 0-5829-R-2, March 1970.

2.4.1-4. TVA, *Stream Gages in the Tennessee River Basin*, October 1970.

2.4.1-5. TVA, *Reservoir Operations Study – Final Programmatic EIS*, 2004.

2.4.1-6. TVA, *Clinch River Small Modular Reactor Site, Regional Surface Water Use Study*, Public Version, Rev. 2, April 24, 2015.

2.4.1-7. TVA River Operations, *TVA Water Control Project Manual (Blue Book) for Norris Dam*, July 1998.

2.4.1-8. TVA River Operations, *TVA Water Control Project Manual (Blue Book) for Melton Hill Dam*, December 1999.

2.4.1-9. TVA River Operations, *TVA Water Control Project Manual (Blue Book) for Watts Bar Dam*, August 1999.

2.4.1-10. TVA, Watts Bar Updated Final Safety Analysis Report, through Amendment 114, Figure 2.4-3 (Sheets 2–12), October 15, 2015.

Table 2.4.1-1 (Sheet 1 of 2)
Water Supply Withdrawals in the Clinch River Basin

	Name	Type of Withdrawal	Source
1	Kingston Fossil Plant	Thermoelectric	Watts Bar Reservoir
2	Oak Ridge Dept of Public Works, Clinch River Plant	Public Supply	Clinch River
3	Oak Ridge Country Club	Irrigation	Stream Or We
4	Greater Tazewell Regional Water Treatment Plant	Public Supply	Cox's Branch Reservoir
5	Greater Tazewell Regional Water Treatment Plant	Public Supply	Clinch River
6	Greater Tazewell Regional Water Treatment Plant	Public Supply	Lake Whitten
7	Pounding Mill Quarry Corp, Pounding Mill Plant	Mining	Clinch River
8	Tazewell County Public Service Authority, Claypool Hill Water Treatment Plant	Public Supply	Little River
9	Town of Richlands, Richlands Water Treatment Plant	Public Supply	Clinch River
10	Knox Creek Coal Corp, Coal Creek No. 3 Preparation Plant	Mining	Coal Creek Above Red Ash
11	Knox Creek Coal Corp, Coal Creek No. 3 Preparation Plant	Mining	Jamison Creek
12	Town of Lebanon, Lebanon Water Treatment Plant	Public Supply	Big Cedar Creek
13	Clinchfield Coal Co, Moss No. 2 Preparation Plant	Mining	Hurricane Fork
14	Dickenson-Russell Coal Co LLC, Moss No. 3 Preparation Plant	Mining	Chaney Creek
15	American Electric Power Co, Clinch River Power Plant	Thermoelectric	Clinch River
16	Lake Bonaventure Country Club	Irrigation	Lake Bonaventure
17	Town of St. Paul, St. Paul Water Treatment Plant	Public Supply	Clinch River
18	Wise County Regional Water Treatment Plant	Public Supply	Clinch River
19	Coeburn Water Treatment Plant	Public Supply	Tom's Creek Reservoir
20	Fisheries Division of the Virginia Department of Game and Inland Fisheries-Marion Fish Cultural Station	Industrial	Corder and Ramey Branch
21	Wise Water Treatment Plant	Public Supply	Wise Reservoir
22	Wise Water Treatment Plant	Public Supply	Bear Creek
23	Gate City Water Treatment Plant	Public Supply	Big Moccasin Creek
24	Paramount Coal Co Virginia LLC, Ramsey Preparation Plant	Mining	Guest River
25	Big Stone Gap Water Treatment Plant	Public Supply	South Fork Powell River
26	Appalachia Water Treatment Plant	Public Supply	Appalachia Reservoir
27	Duffield Water Treatment Plant	Public Supply	Spurlock Branch
28	Duffield Water Treatment Plant	Public Supply	North Fork Clinch River
29	Pennington Gap Water Treatment Plant	Public Supply	Powell River
30	Sneedville Utility District, Water Plant	Public Supply	Brier Creek Tributary
31	Claiborne County Utility District, Water Plant	Public Supply	Water Plant
32	Arthur-Shawnee Utility District, Filter Plant	Public Supply	Powell River
33	La Follette Water Dept, Norris Lake Plant	Public Supply	Norris Lake
34	Rexnord Corporation Link-Belt Bearing	Industrial	Clinch River
35	Clinton Utilities Board, Clinch River Plant	Public Supply	Clinch River

Table 2.4.1-1 (Sheet 2 of 2)
Water Supply Withdrawals in the Clinch River Basin

	Name	Type of Withdrawal	Source
36	North Anderson County Utility District, Water Plant	Public Supply	Clinch River
37	Hallsdale Powell Utility District, Bull Run Creek Embayment	Public Supply	Melton Hill Reservoir
38	West Knox Utility District, Melton Hill/Old/Daugherty	Public Supply	Melton Hill Old
39	Bull Run Fossil Plant	Thermoelectric	Clinch River
40	Anderson County Utility Board, Filter Plant	Public Supply	Clinch River
41	Centennial Golf Course	Irrigation	Clinch River
42	Caryville-Jacksboro Utility District, Cove Lake Plant	Public Supply	Cove Lake
43	West Knox Utility District, Melton HIll /New/Williams	Public Supply	Melton Hill New
44	West Knox Utility District, Melton HIll /New/Williams	Public Supply	Melton Hill New
45	Oak Ridge Bear Creek Plant	Industrial	Clinch River
46	Cumberland Utility District, Little Emory River Plant	Public Supply	Little Emory
47	Lakeside Golf Course	Irrigation	Smith Creek
48	Kingston Water System, TN River/Watts Bar	Public Supply	Watts Bar Reservoir
49	Plateau Utility District, Crooked Fork Creek Plant	Public Supply	Crooked Fork Creek
50	Harriman Utility Board, Emory River Plant	Public Supply	Emory River
51	Crab Orchard Utility District[(a)]	Public Supply	Otter Creek Impoundment
52	Bear Trace at Cumberland Mountain State Park[(a)]	Irrigation	Irrigation Pump
53	Deer Creek Golf Club[(a)]	Irrigation	Genesis Pond
54	Crossville Water Dept[(a)]	Public Supply	Lake Holiday
55	River Run Golf Club[(a)]	Irrigation	Little Obed Creek
56	Crossville Water Dept[(a)]	Public Supply	Meadow Park Lake
57	Paramont Coal Co Virginia, Deep Mine 35	Mining	Chaney Creek
58	Big Stone Gap Water Treatment Plant	Public Supply	Powell River-Emergency Withdrawal

(a) Downstream of the Clinch River Nuclear Site

Source: Reference 2.4.1-7

Table 2.4.1-2
U.S. Geological Survey Historically Maintained Stream Gages on the Clinch River

Stream Gage Location	River Mile	Period of Record
Near Wheat	14.4 14.4	1936–1941 1967–1968
Below Melton Hill Dam	23.1	1962–1964
Near Scarboro	39.0	1941–1962
Near Kingston	1.3	1897–1934
Kingston Steam Plant	2.6	1951–1956
Near Lake City	75.9	1927–1945

Notes:

Historic discharge data for the above-listed gages are incorporated into a single USGS gage with identification number 03538150 and can be retrieved via web address http://waterdata.usgs.gov/tn/nwis/

Reference 2.4.1-2

Table 2.4.1-3
TVA Stream Gages in the Vicinity of the Clinch River Nuclear Site

Station Name	River Mile	Period of Record
Kingston[(a)]	TRM 568.1	1941–
Below Melton Hill Dam Tailwater	CRM 23.1	1961–
Melton Hill Dam Headwater	CRM 23.1	1963–
Clinton[(b)]	CRM 58.8	1965–
Norris Dam	CRM 78.8	1937–

(a) Recent data can be obtained for the Kingston gage by accessing gage identification number KGTT1 at web address http://www.nws.noaa.gov/oh/hads/
(b) The Clinch River gage near Clinton was out of service for an unknown time period. Recent data can be obtained for the Clinton gage by accessing gage identification number CCLT1 at web address http://www.nws.noaa.gov/oh/hads/

Source: Reference 2.4.1-4

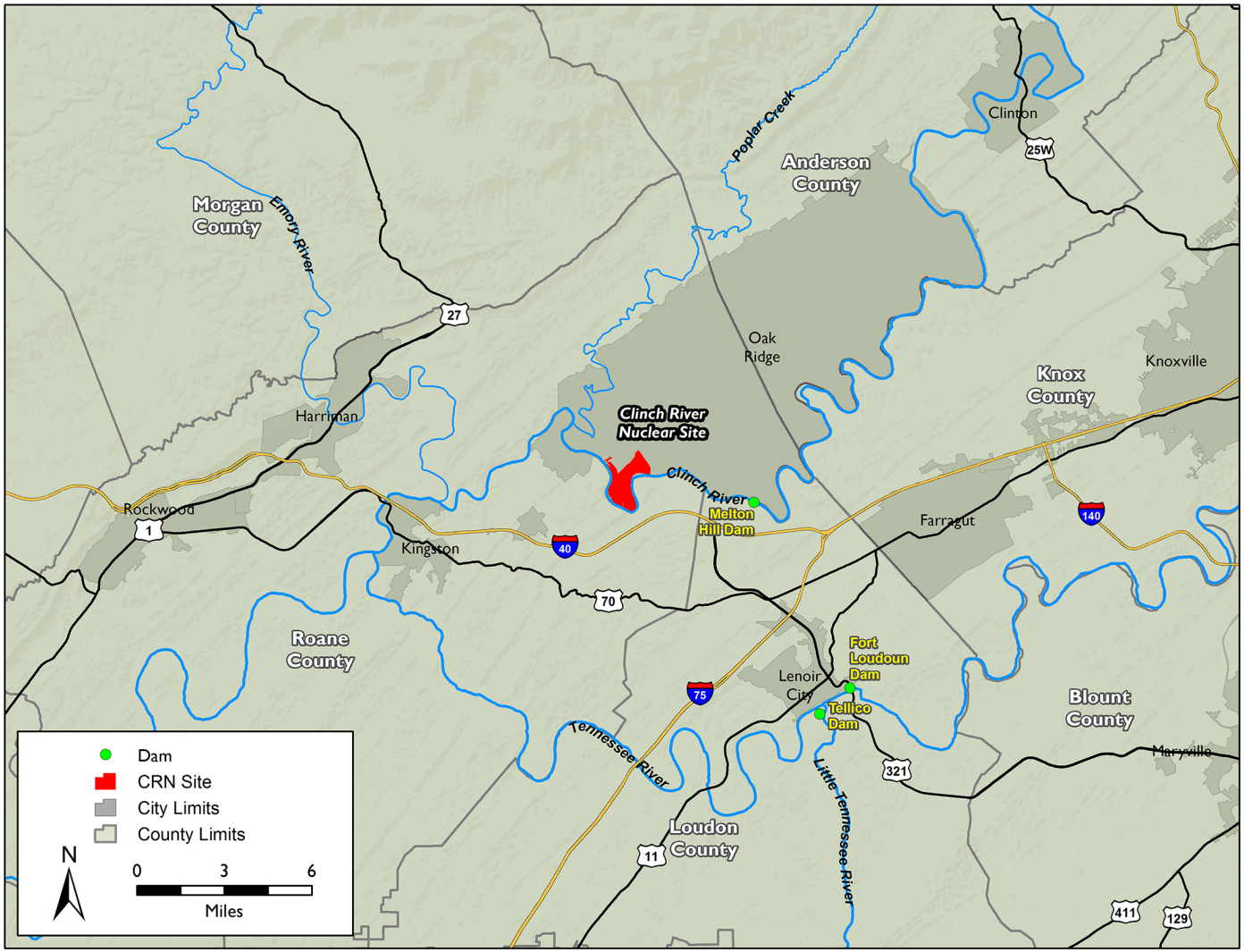
Table 2.4.1-4
Monthly Average Discharges from Melton Hill Dam (2004–2013)

	Monthly Average Discharge (cubic feet per second)									
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
January	8860	9150	2910	6070	1090	8370	10,300	5010	8690	10,800
February	7240	6390	2930	2170	1510	5170	13,000	3600	8830	14,500
March	4380	4360	1910	1640	1880	3880	2320	14,800	10,800	5490
April	1510	3350	2240	1850	1520	1840	1050	7540	1210	4000
May	1560	4900	3030	1710	1260	7340	2540	6400	1310	6940
June	7580	1780	1820	3810	2260	3620	2250	3430	1530	6460
July	3280	2240	2790	5090	3290	3310	2400	3950	2970	6190
August	4800	3890	6030	5710	4600	5250	6280	6450	5350	3120
September	5050	4850	2440	1730	1540	3680	3850	3930	3500	4750
October	3450	4110	3660	2590	719	5570	2710	4030	4260	6330
November	7620	2420	6060	844	589	6290	3170	7860	4920	3860
December	14,900	2720	4150	865	3710	11,900	8140	13,690	3170	8630

Exempted from Disclosure by Statute – Withheld Under 10 CFR 2.390(a)(3)

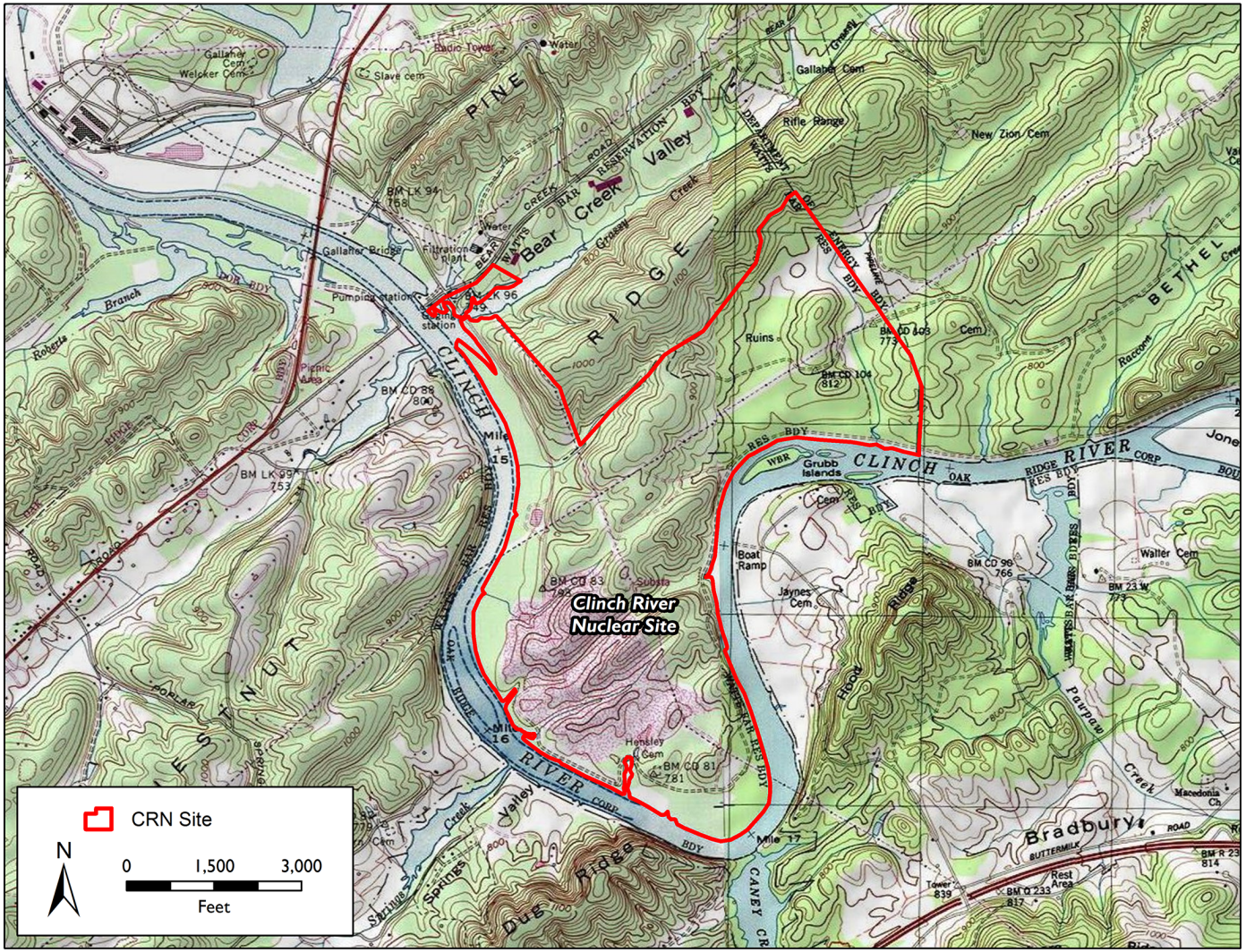
(See Part 7 of this Early Site Permit Application)

Figure 2.4.1-1. Clinch River Water Supply Withdrawals Location Map



Source: Reference 2.4.1-1

Figure 2.4.1-2. Site Location Map



Source: Reference 2.4.1-1

Figure 2.4.1-3. Topographic Map

Figure 2.4.1-4. Not Used

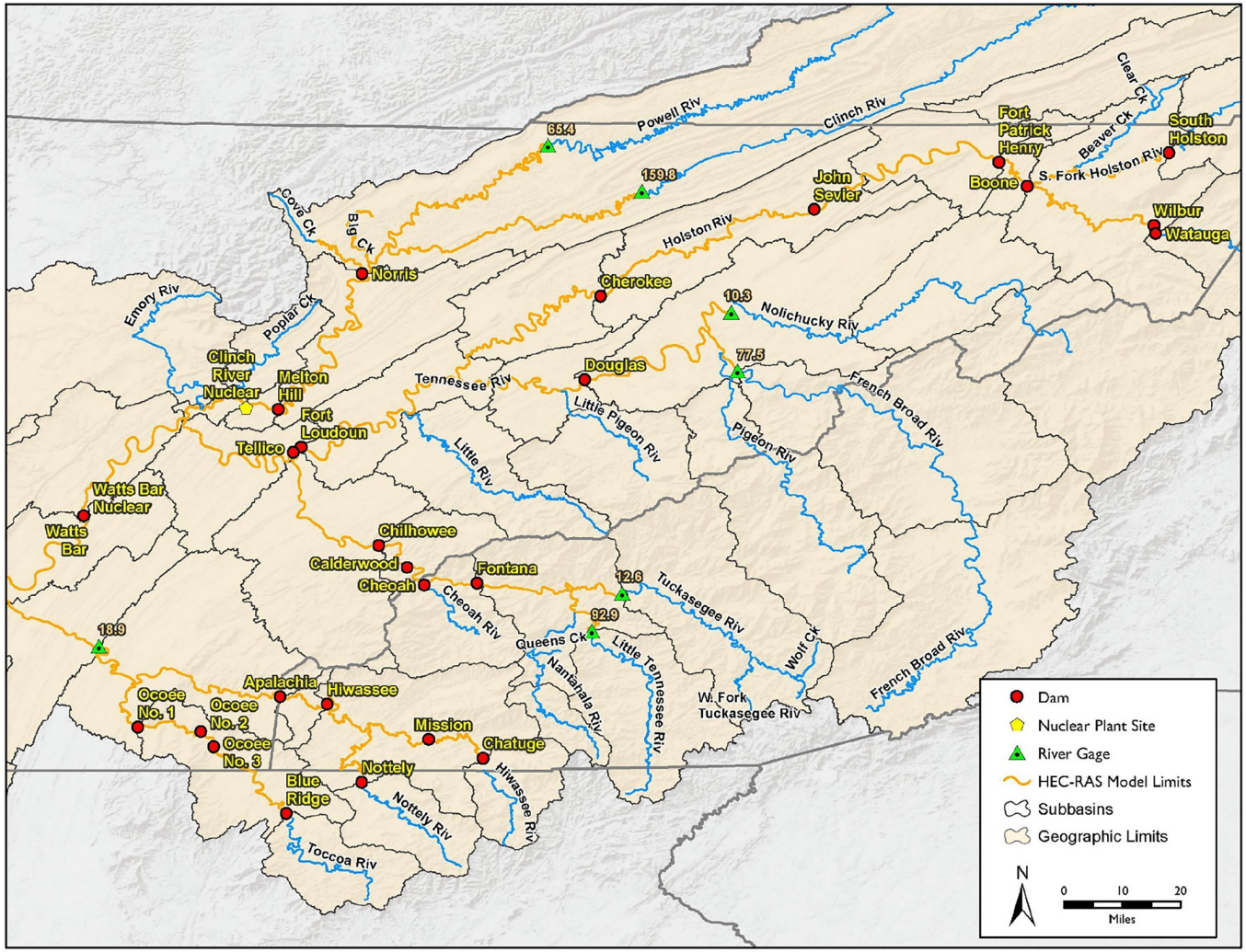


Figure 2.4.1-5. (Sheet 1 of 2) Tennessee River System

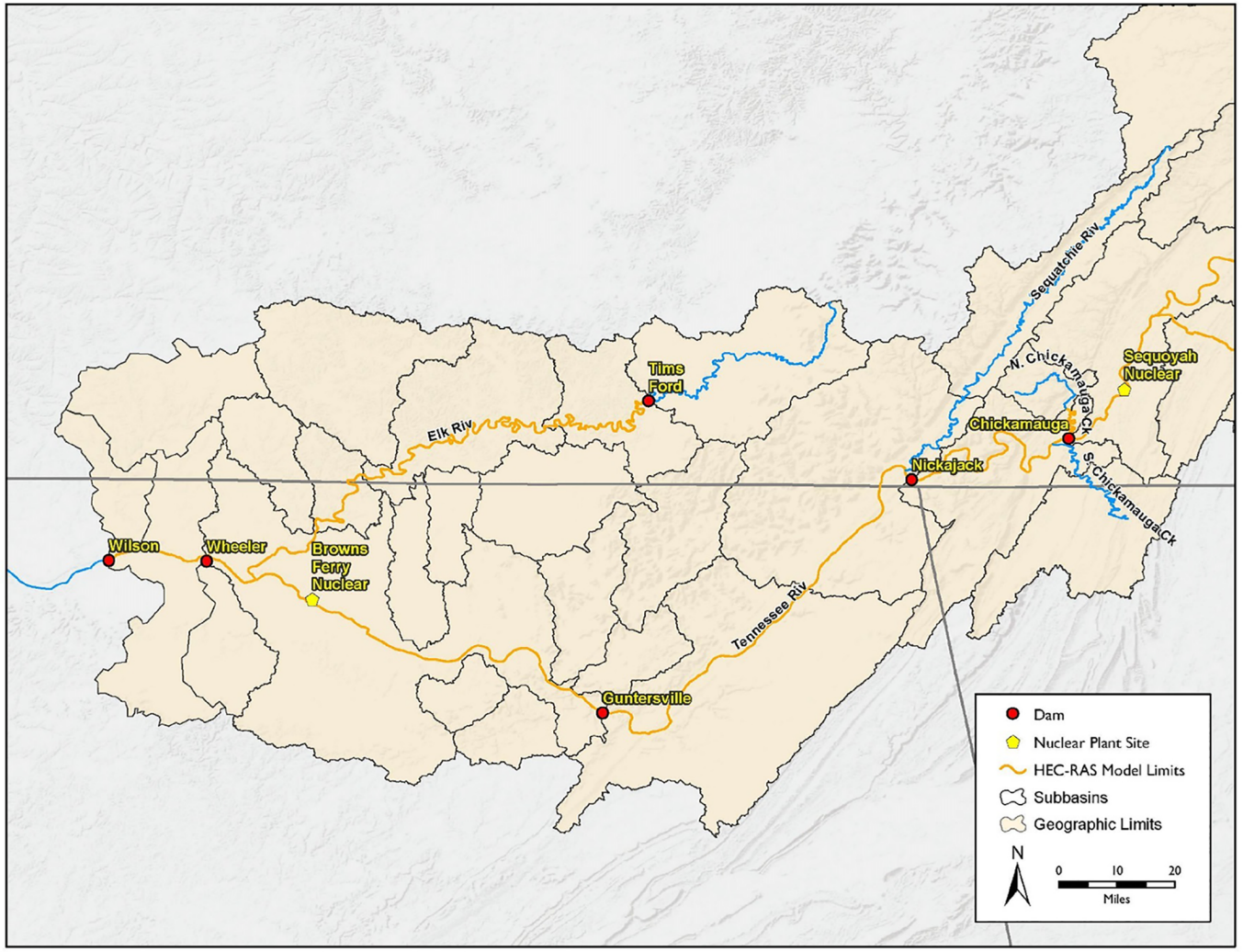
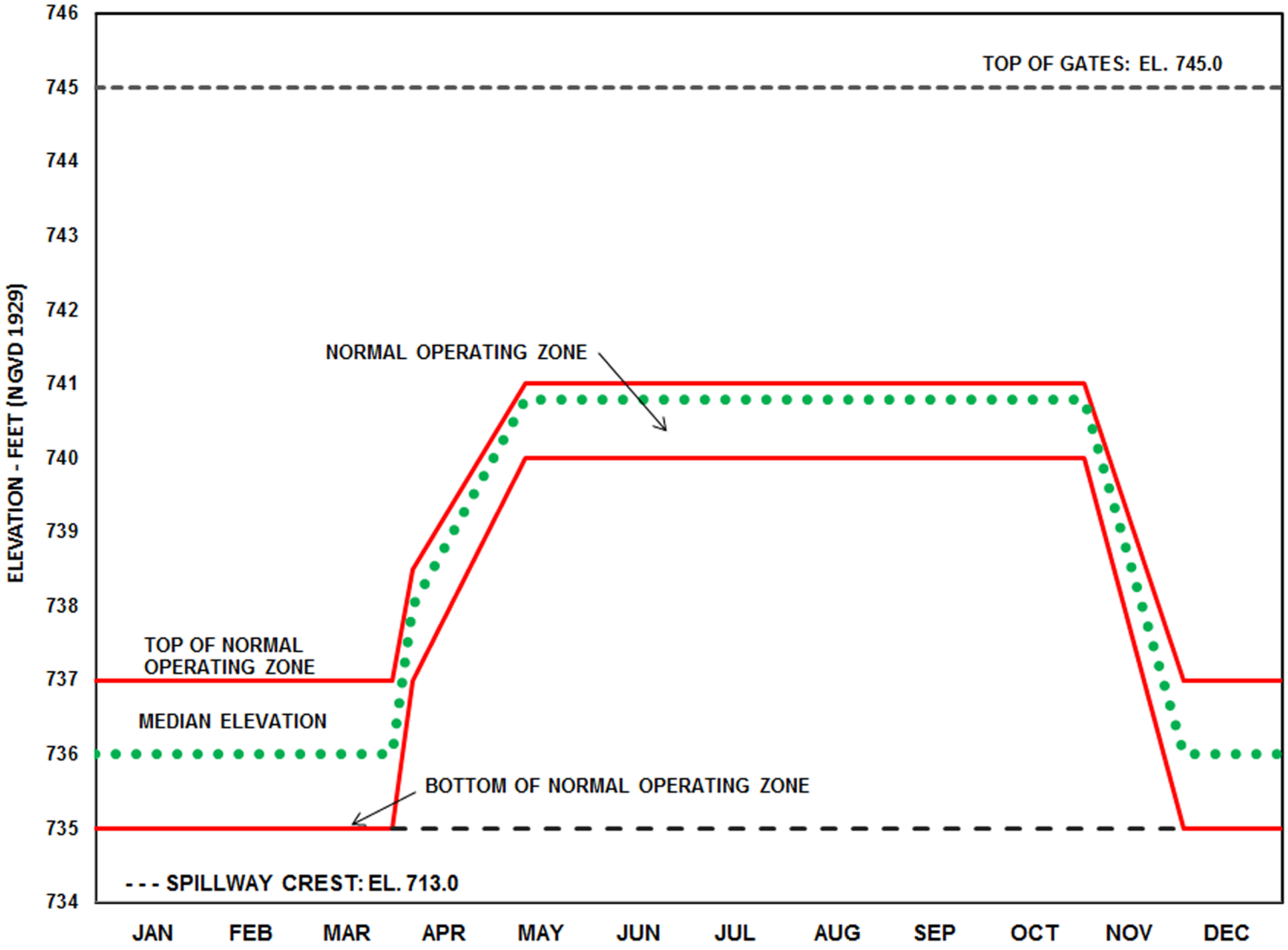
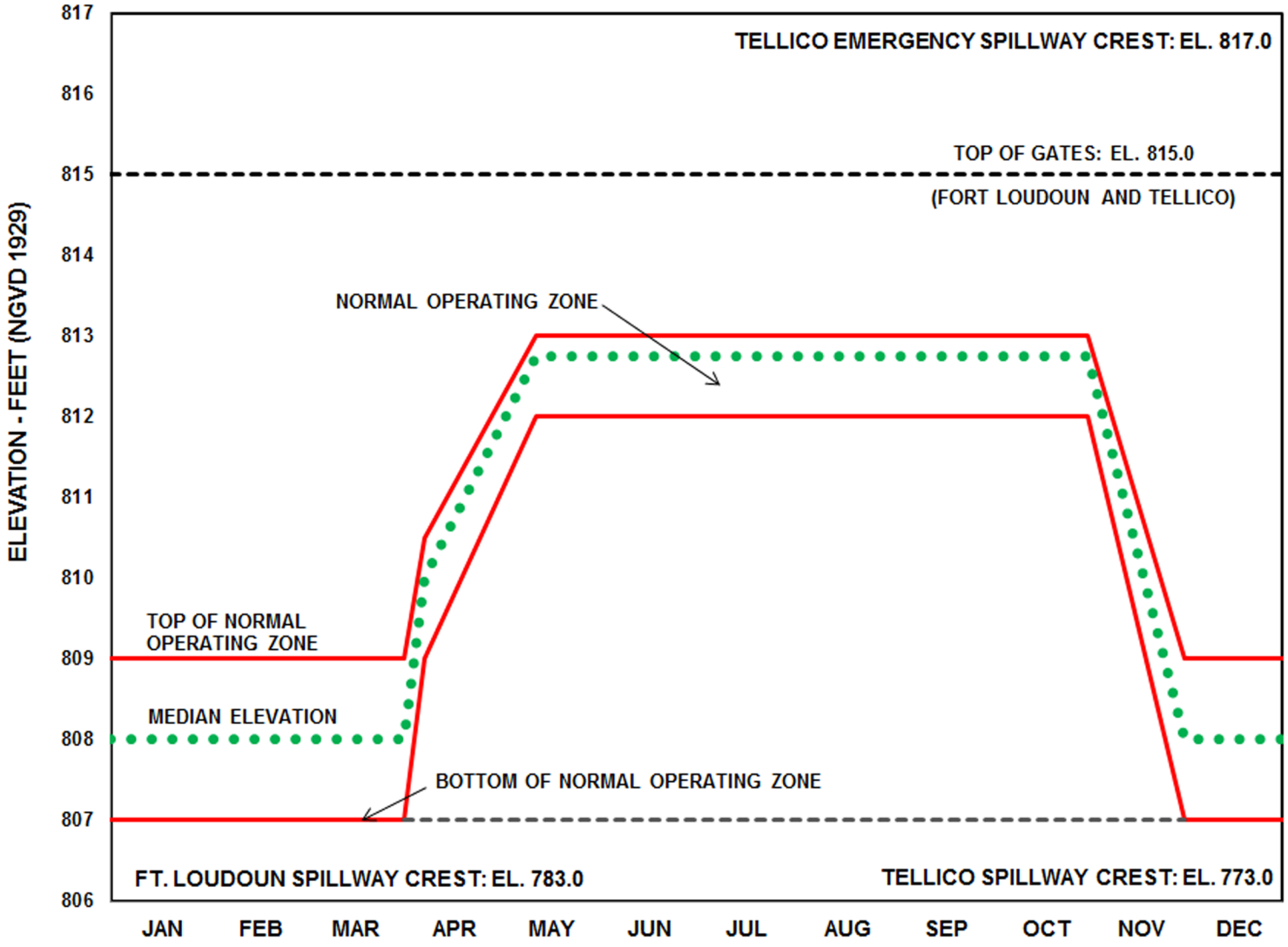


Figure 2.4.1-5. (Sheet 2 of 2) Tennessee River System



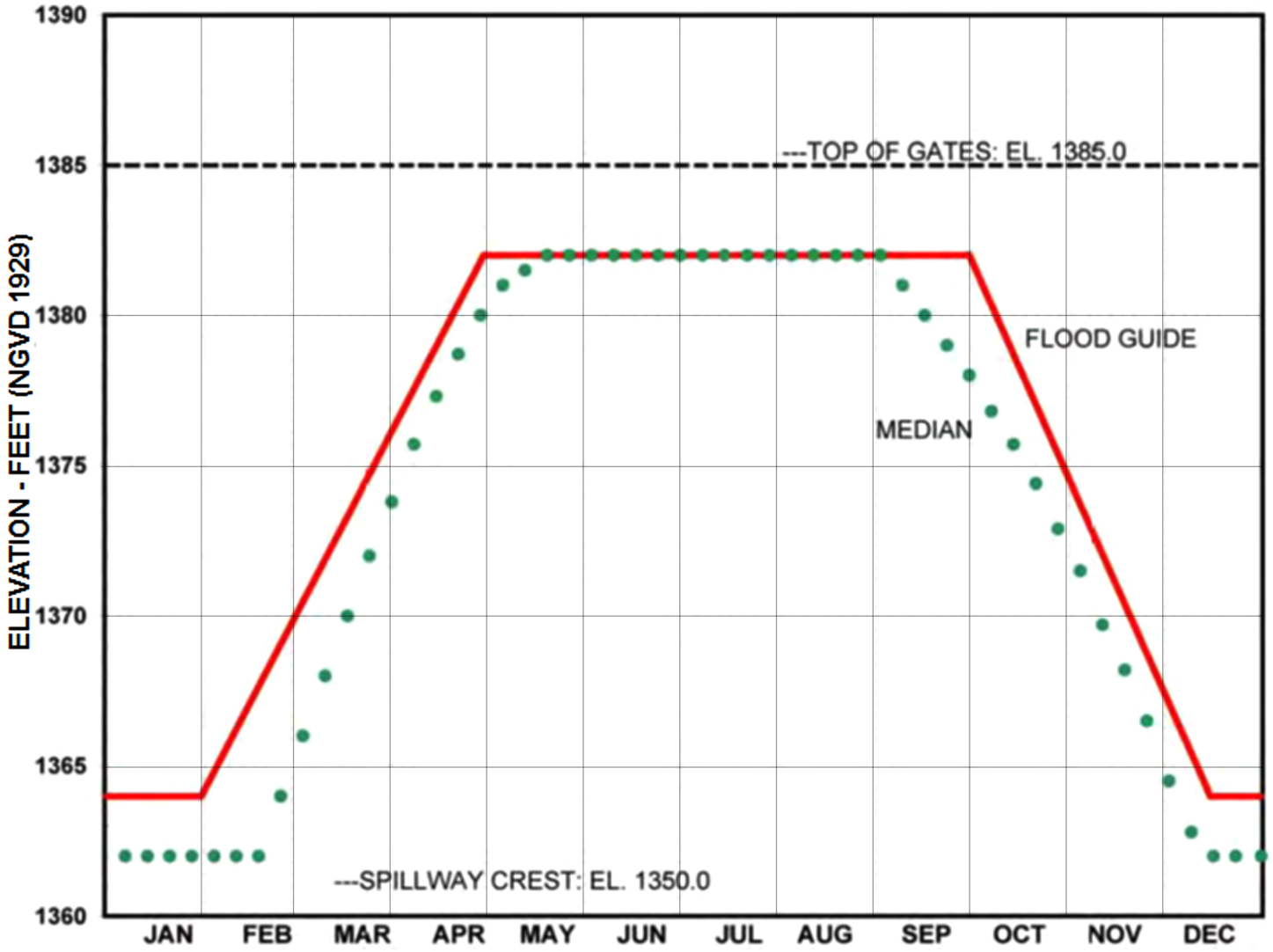
Source: Reference 2.4.1-10

Figure 2.4.1-6. (Sheet 1 of 11) Seasonal Operating Curve, Watts Bar Dam



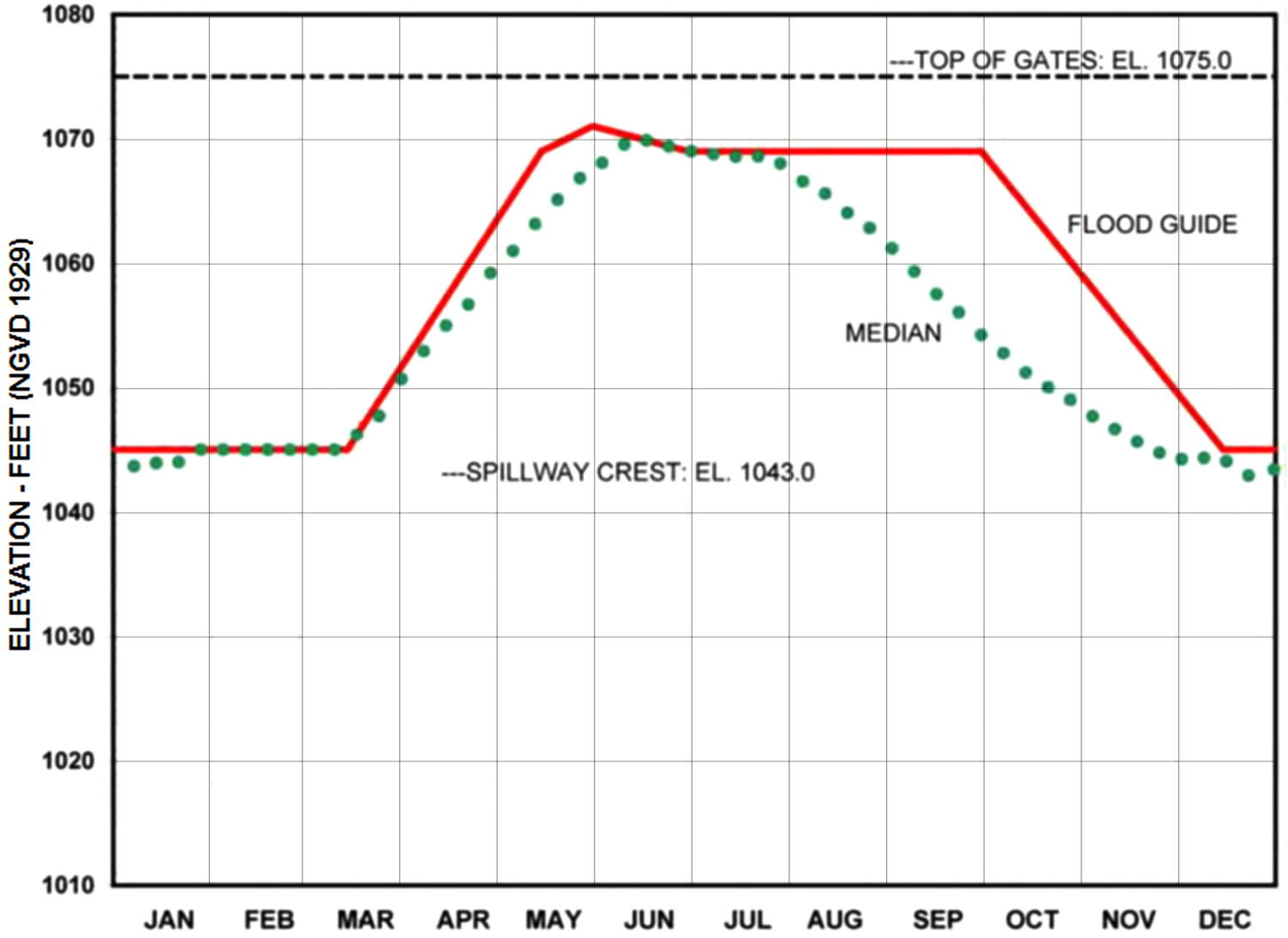
Source: Reference 2.4.1-10

Figure 2.4.1-6. (Sheet 2 of 11) Seasonal Operating Curve, Fort Loudoun and Tellico Dams



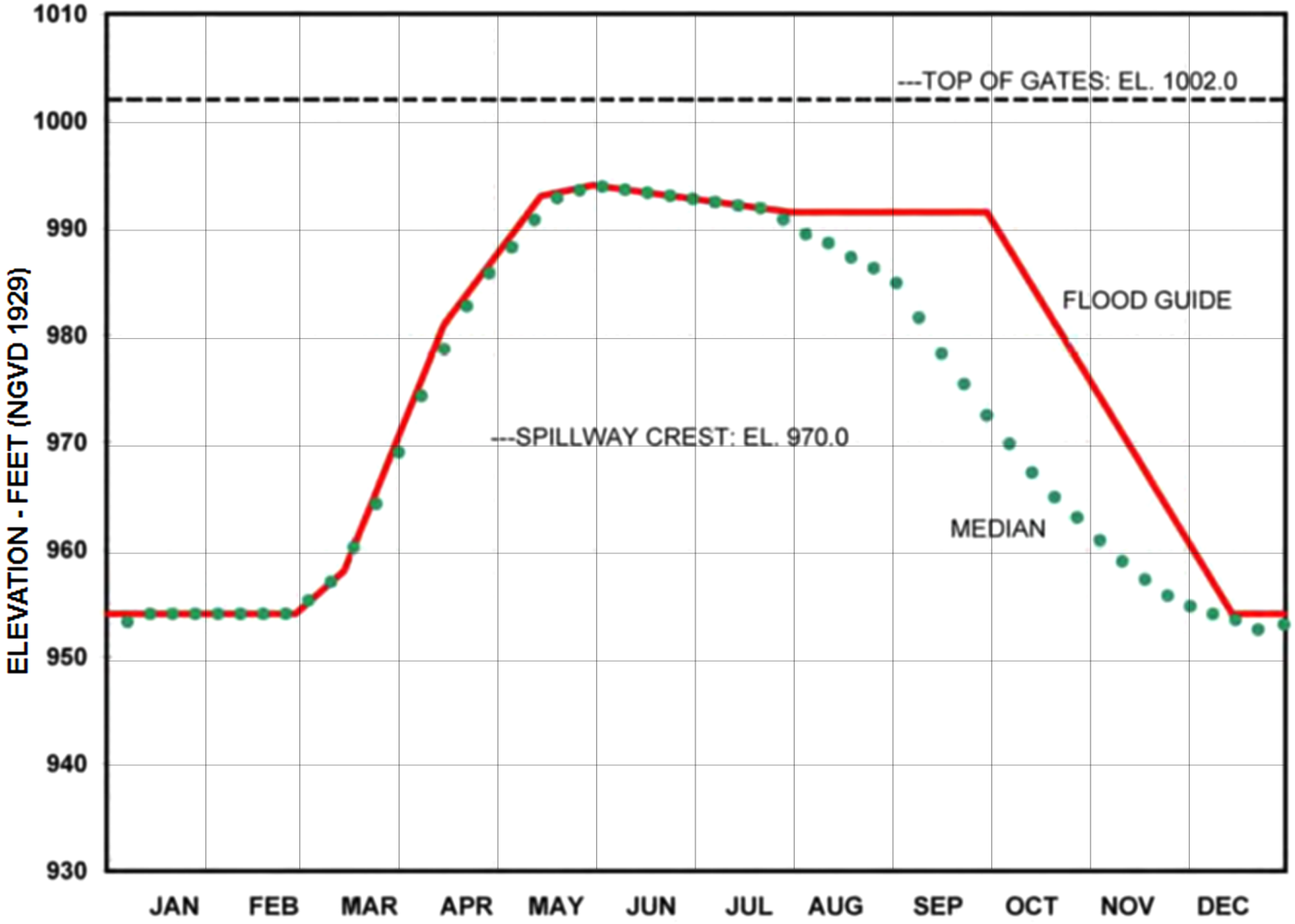
Source: Reference 2.4.1-10

Figure 2.4.1-6. (Sheet 3 of 11) Seasonal Operating Curve, Boone Dam



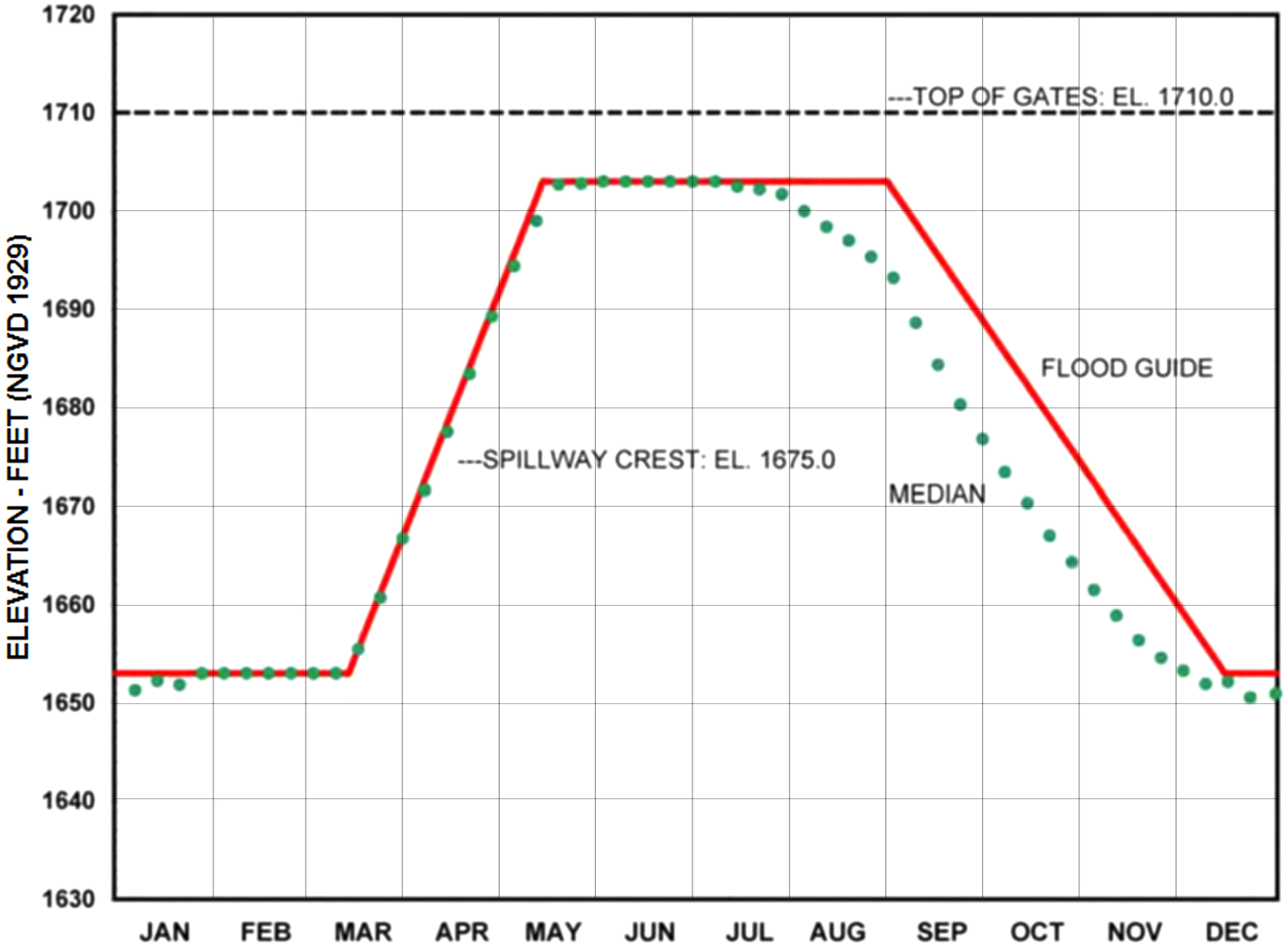
Source: Reference 2.4.1-10

Figure 2.4.1-6. (Sheet 4 of 11) Seasonal Operating Curve, Cherokee Dam



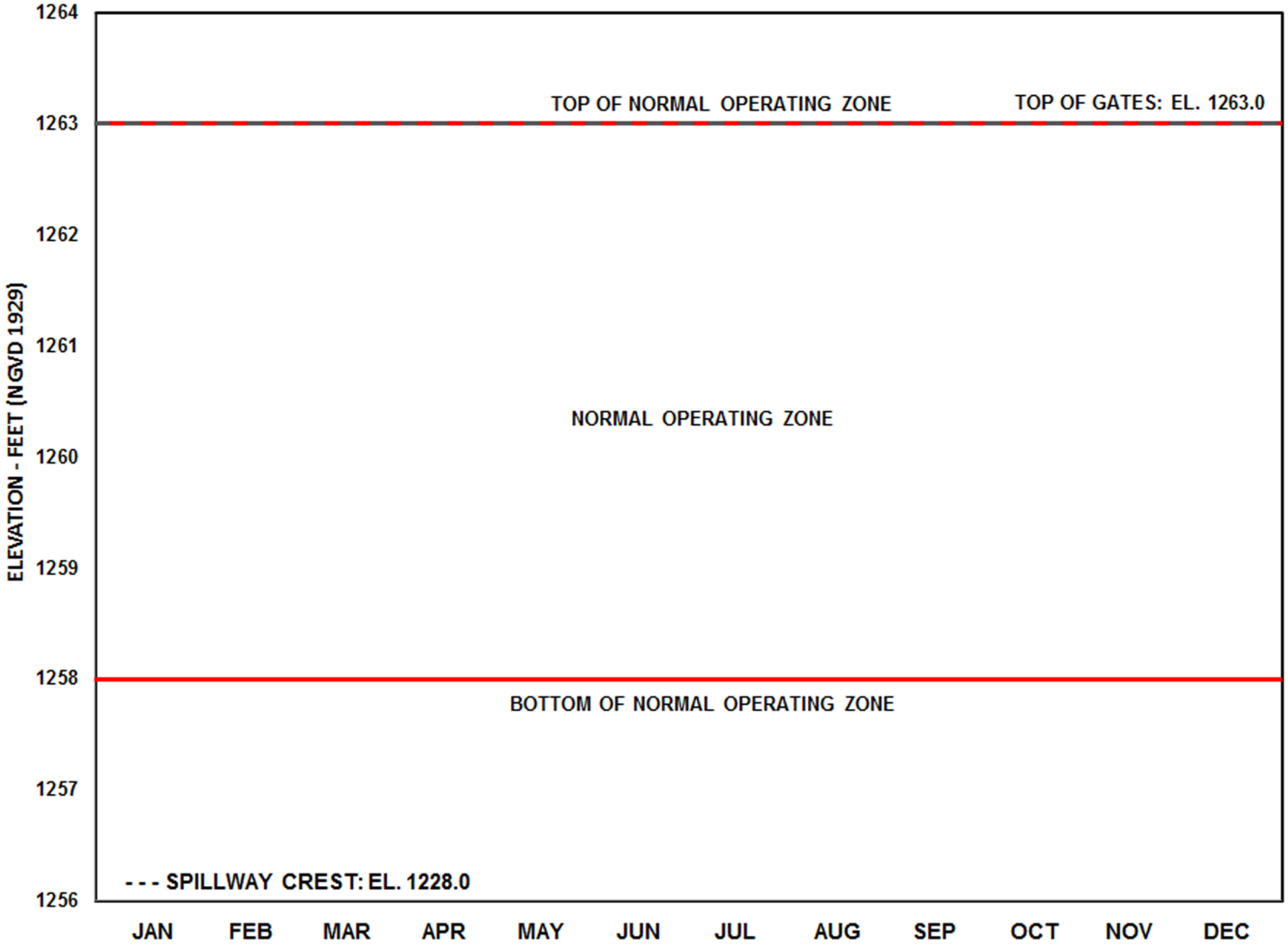
Source: Reference 2.4.1-10

Figure 2.4.1-6. (Sheet 5 of 11) Seasonal Operating Curve, Douglas Dam



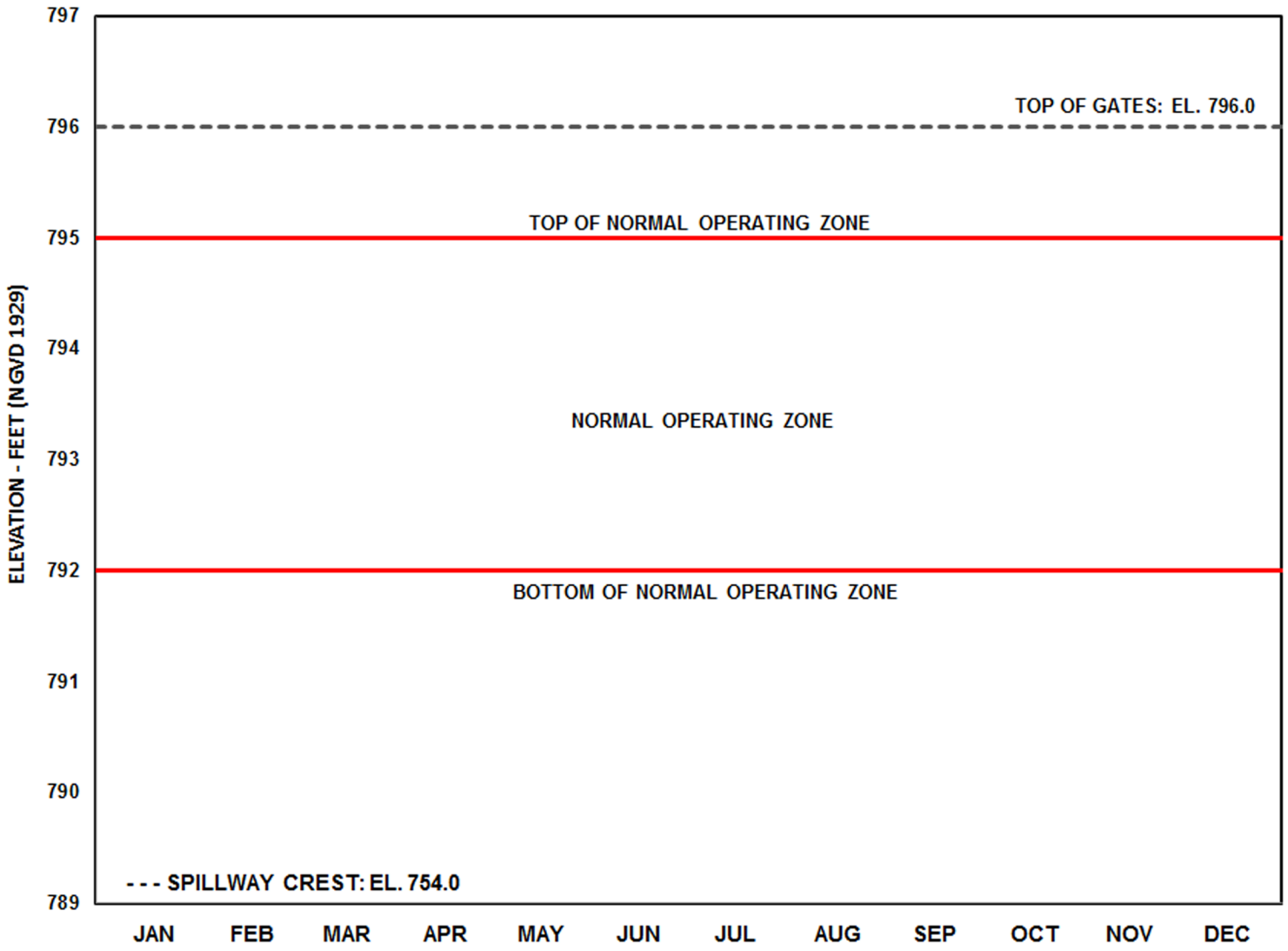
Source: Reference 2.4.1-10

Figure 2.4.1-6. (Sheet 6 of 11) Seasonal Operating Curve, Fontana Dam



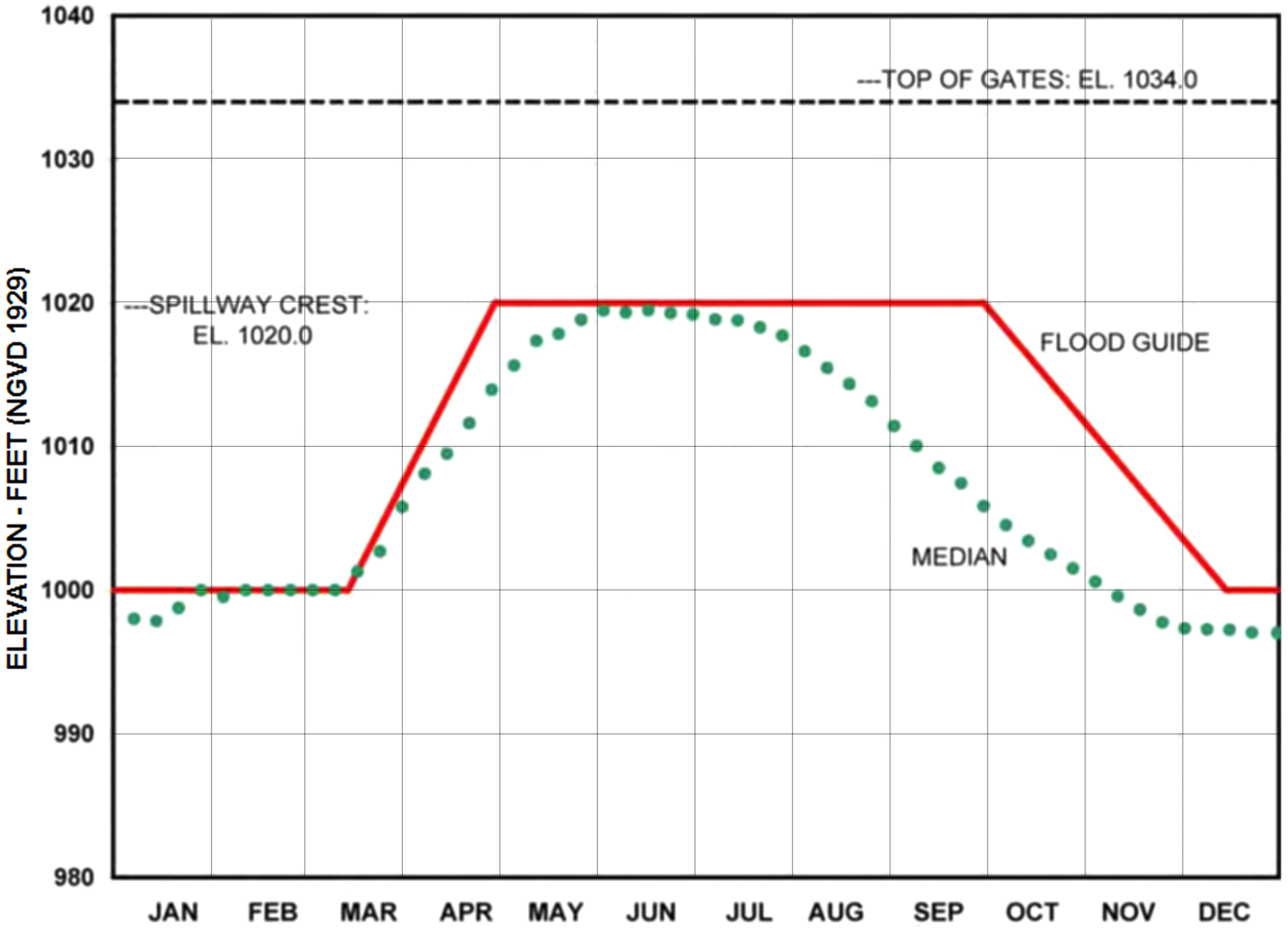
Source: Reference 2.4.1-10

Figure 2.4.1-6. (Sheet 7 of 11) Seasonal Operating Curve, Fort Patrick Henry Dam



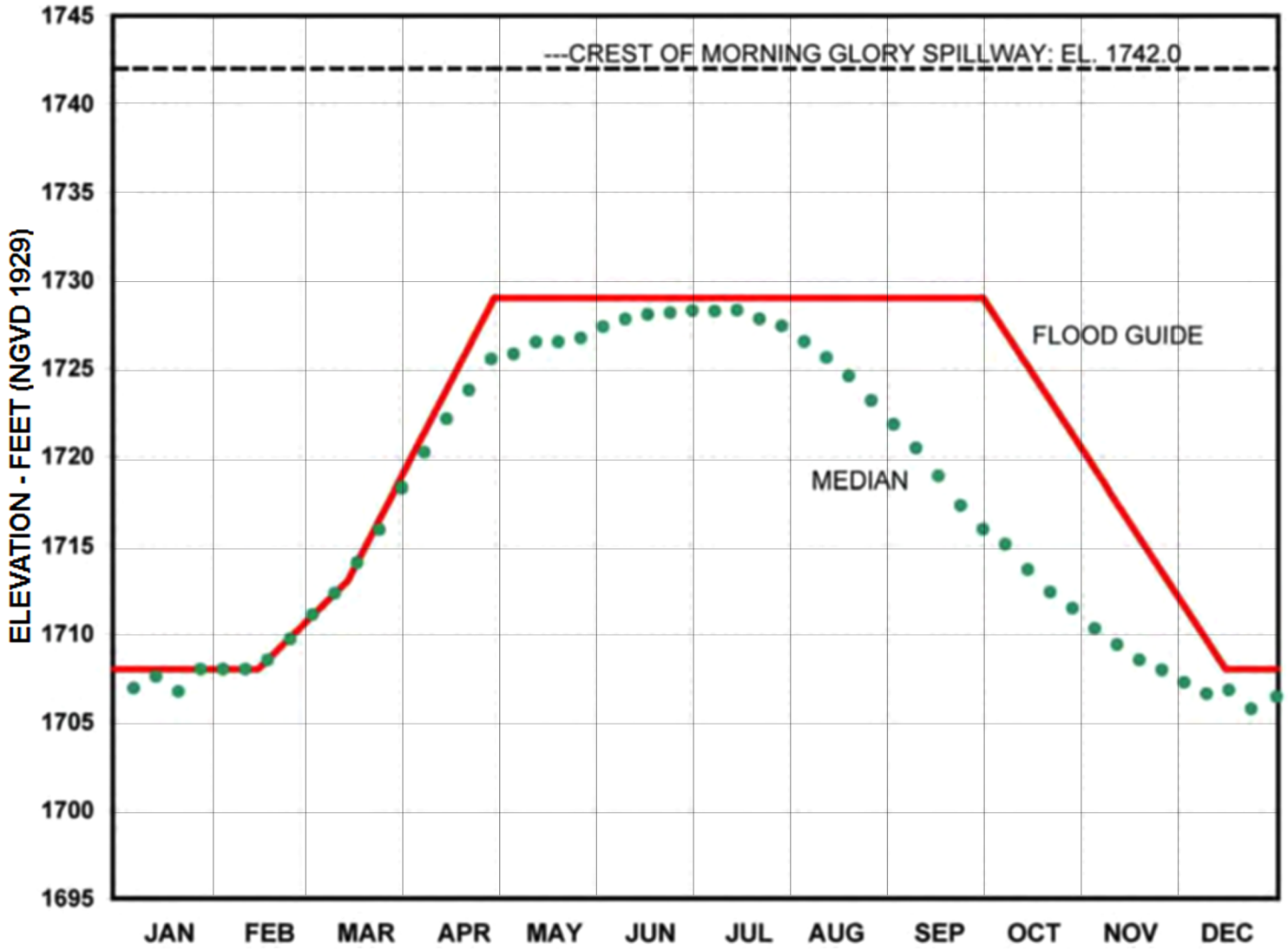
Source: Reference 2.4.1-10

Figure 2.4.1-6. (Sheet 8 of 11) Seasonal Operating Curve, Melton Hill Dam



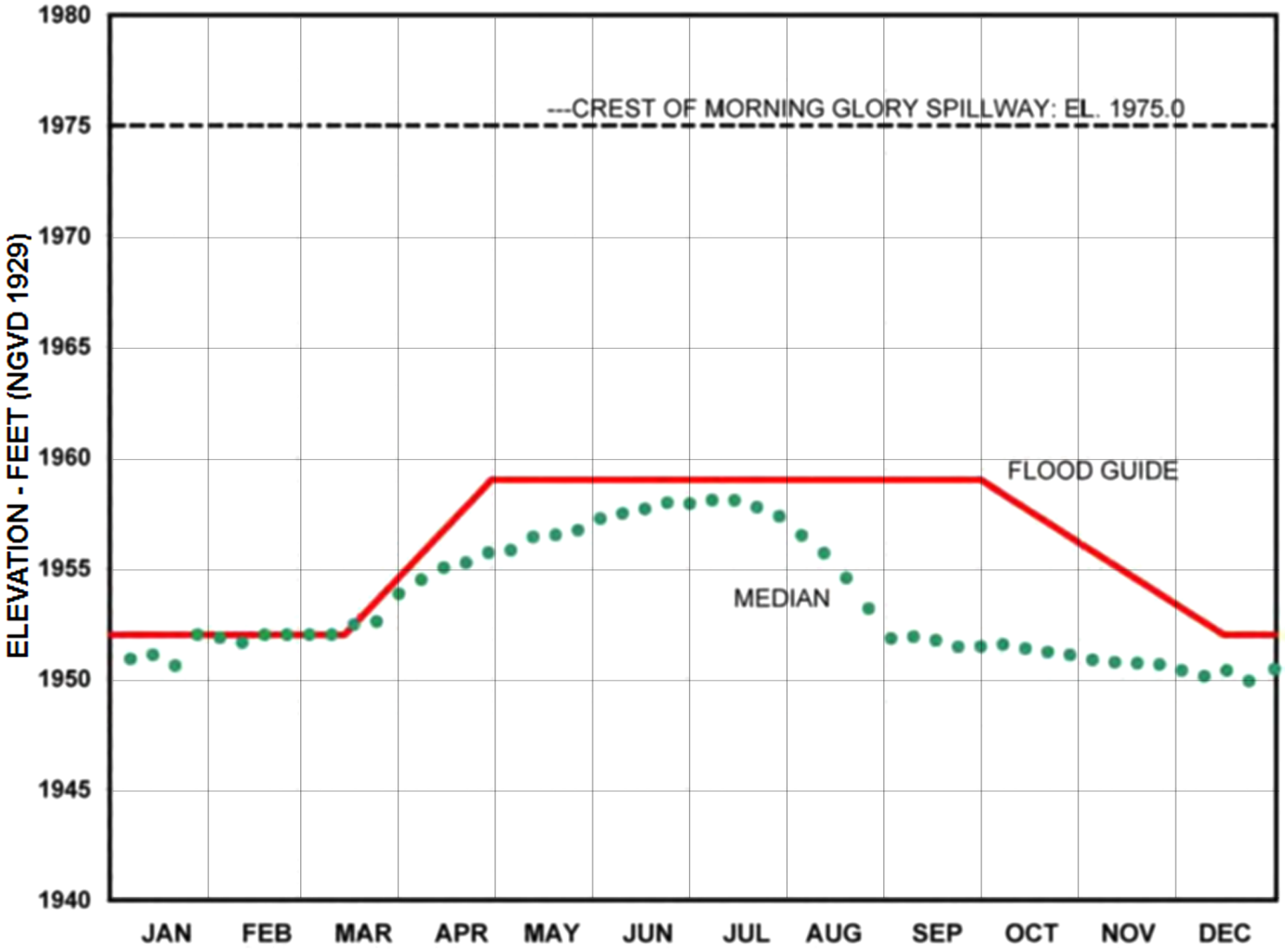
Source: Reference 2.4.1-10

Figure 2.4.1-6. (Sheet 9 of 11) Seasonal Operating Curve, Norris Dam



Source: Reference 2.4.1-10

Figure 2.4.1-6. (Sheet 10 of 11) Seasonal Operating Curve, South Holston Dam



Source: Reference 2.4.1-10

Figure 2.4.1-6. (Sheet 11 of 11) Seasonal Operating Curve, Watauga Dam