



Bartletts Ferry Operations Primer

**Revision 1
May 2009**



Revisions

Revision 1: Added revision log.
Revised page numbering.
Minor revision to Table 1.
Revision to maintenance drawdown paragraph on page 6.

How Does a Hydro Plant Generate Power?

Hydropower is one of the oldest methods of generating power. A hydro plant uses the stored kinetic energy in water as it moves from the higher reservoir elevation to the lower tailwater elevation to produce clean, renewable power.

Water flows from the reservoir into the intake, through passageways called penstocks, to the turbine blades. There the water turns the turbine, which turns an electric generator to make electricity. Figure 1 shows how this works.

The amount of power generated is directly proportional to the head (difference between reservoir headwater elevation and discharge tailwater elevation) and flow. For any dam, more power can be generated if there is more head, i.e. a higher dam, or if there is more flow in the river.

The amount of flow available upstream of a dam depends on rainfall and the size and geography of the drainage basin, and is affected by water uses and other factors. The drainage basin, also called a watershed, is all of the land upon which rainfall flows to a particular stream, river, or other water body. In general, the larger the drainage basin area, and the more abundant the rainfall, the higher the flow in the river. Flows vary daily, seasonally, and annually. Typically, flows for Georgia are highest in March or April and lowest in September or October.

How is Hydroelectric Power Used?

Only certain sites have sufficient flow and are otherwise suitable for riverine hydro plants, so the amount of hydro energy in Georgia is limited. Hydro represents 6.8 % of the generation capacity (megawatts [MW]) for Georgia Power and provides about 1.9 % of the actual generation (MW-hours), but it is an important component of the generation mix.

Because hydro plants can be loaded quickly, they often are used to supply power during peak power demand periods in the day when other sources of generation are costly. Hydro plants can also be used in system emergencies (e.g., when a large fossil or nuclear plant trips, or when the system transmission grid requires balancing). Generally, peak power demands in Georgia occur most weekday afternoons of warm seasons of the year and also on most weekday mornings in the winter months. Peak power demands can change rapidly, and hydro plants can come on-line faster and much more economically than combustion turbines and other types of quick-loading power generation plants.

How Does Storage Affect Hydro Plant Operations?

Over time, inflow and outflow at a hydro project are generally equivalent. The amount of time over which inflow and outflow are equivalent depends on the amount of usable storage at the hydro project.

A very small reservoir cannot store water, so inflow and outflow are always equal. This type of plant is called a “run of river” plant. It is rarely economical to build turbines large enough to pass the highest of inflows at run of river plants, so during higher flow periods some of the water often must be spilled, bypassing the generation turbines. For these reasons, plants with very small reservoirs generally do not produce much power. Most hydro plants of this type found in Georgia are old mill sites, where steady power throughout the day was traditionally more important than peaking power and spillage was not a concern.

A larger reservoir can store water for hours or days, and may generate during peak power periods when generation from other sources is costly or not readily available. The reservoir is drawn down when generating, and then refilled when not generating. The average discharge over a matter of day(s), or week(s), is equal to inflow over the same period. Bartletts Ferry is an example of this type of reservoir. Georgia Power uses the term “modified run of river plant” when describing Bartletts Ferry because it modifies flows on an hourly to daily basis, but very little on a weekly basis.

A very large reservoir can store water for months, or even years. These reservoirs can capture water for generation during high flow periods of the year for use in lower flow periods of the year. Without this capability to store water, the high inflows at these reservoirs would have to be spilled and not used to generate power. These large reservoirs are called “storage” reservoirs.

What Determines the Size of a Hydro Plant?

Deciding what size dam and reservoir to build is a matter of economics and the physical features of the geographic area. A larger dam has more head, and a greater ability to use more water through storage, but at some point the economic gains from building a larger reservoir solely for power generation will not offset the costs of construction, maintenance, and operation, which can be substantial. Other important benefits such as navigation, flood control, water supply, and recreation often help justify the cost of these large storage reservoirs. Examples of these reservoirs in Georgia are the reservoirs created by the U.S. Army Corps of Engineers’ (Corps’) West Point (West Point Lake) and Buford (Lake Sydney Lanier) dams.

Figure 2 demonstrates how Buford and West Point store some of the inflow during wet months and use it to supplement flows during dry months.

A large storage reservoir can reregulate inflows and provide benefits on-site, as well as to smaller reservoirs downstream. Downstream reservoirs benefit because the large storage reservoir captures high inflows in wet months, which might otherwise be spilled at a smaller downstream plant, and release the water in dry months when it can be used to generate power. Downstream power customers and reservoir users benefit from this reregulation as well.

How is Bartletts Ferry Operated?

Storage at Bartletts Ferry is Limited

Compared to other reservoirs on the Chattahoochee River, Bartletts Ferry is a medium to small sized reservoir with limited storage, as shown below in the table of storage reservoirs on the Chattahoochee River (Table 1). The reservoirs are listed from the most upstream (Buford) to the farthest downstream (George W. Andrews) to the Georgia-Florida line at which point the Chattahoochee River joins the Flint River to become the Apalachicola River. Note that due to the engineering limitations of hydropower facilities, not all storage is usable for generating hydroelectricity. The term “conservation storage” applies to the storage usable for hydro generation in a reservoir.

Table 1
Usable Storage Volumes at Hydro Plants
on the Chattahoochee River

Project	Operator	Conservation Storage Acre-feet	Conservation Storage %
Buford	Corps	1,087,600	63.3%
Morgan Falls	GPC	2,400	0.1%
West Point	Corps	306,100	17.8%
Bartletts Ferry	GPC	57,600	3.4%
Goat Rock	GPC	4,830	0.3%
Oliver	GPC	6,120	0.4%
North Highlands	GPC	140	0.0%
W.F. George	Corps	244,400	14.2%
George W. Andrews	Corps	8,200	0.5%
Sub-Total	Corps	1,646,300	95.9%
Sub-Total	GPC	71,090	4.1%
Total	All	1,717,390	100.0%

As Table 1 indicates, the Corps operates reservoirs comprising a total storage volume for the Chattahoochee River of 1,646,300 acre-feet, which constitutes 95.9% of the total

usable storage for the river. All Georgia Power reservoirs on the Chattahoochee River amount to only 71,090 acre-feet, or 4.1% of the total usable storage for the river. As a result, Georgia Power’s hydropower operations, including those at Bartletts Ferry, are limited by and subject to receipt of flows from Corps projects.

Current Operation at Bartletts Ferry

Bartletts Ferry was built in the late 1920s, with additional generating capacity added in the 1980s. There are two powerhouses, the original powerhouse on the west side of the river with four vertical Francis turbines (Units 1 through 4), and a newer powerhouse on the east side of the river with two vertical Francis turbines (Units 5 and 6). For both powerhouses the units are numbered beginning from the middle point of the river outward toward the shoreline. Below is a table of pertinent data:

**Table 2
Data on Bartletts Ferry Turbines**

UNIT	Nameplate Capacity MW	Maximum Hydraulic Capacity CFS	Commercial Operation Date
1	15	2,330	1926
2	15	2,330	1926
3	15	2,260	1928
4	20	2,880	1951
5	54	7,200	1985
6	54	7,200	1985

When the original powerhouse was built there were no upstream Corps reservoirs (Lake Lanier began filling in 1956 and Lake West Point began filling in 1974). Until the construction of West Point, the Bartletts Ferry reservoir (Lake Harding) was drawn down approximately 10 feet in the fall and refilled in the spring to capture winter/spring runoff that otherwise would have been spilled. Even with this drawdown, the limited storage in Lake Harding meant that some water was spilled during periods of higher flow.

West Point is a peaking power plant. Normal operation is to pass minimum flow at all times (~600-800 cfs) and use excess water to peak (~18,000 cfs) during peak power demand periods on weekdays. The minimum flow is passed on weekends, although some peaking also may occur on weekends.

After West Point was constructed, the east powerhouse, with units 5 and 6, was constructed at Bartletts Ferry. With the new powerhouse, the peak power plant hydraulic capacity was increased to approximately 24,000 cubic feet per second (cfs), exceeding the West Point power plant hydraulic capacity of approximately 19,000 cfs.

The large Buford and West Point storage projects upstream of Bartletts Ferry reregulate flow in the river, capturing winter/spring rains and releasing the stored water during the summer/fall. West Point controls about 82% of the inflow into Bartletts Ferry. Only 18% of flows entering the Bartletts Ferry project come from local inflow and do not result from West Point releases. During dry parts of the year or drought, local inflow may be much less than 18%, making Bartletts Ferry more dependent upon West Point releases.

With the Corps providing reregulation of flows, and with the addition of hydraulic capacity at Bartletts Ferry to exceed the hydraulic capacity of West Point, the manner in which the Bartletts Ferry reservoir was operated changed. The reservoir is now operated at near full pond year-round, with no fall drawdowns. The benefit derived by drawing the reservoir down in the fall to capture winter/spring rains is now provided by the operation of the upstream Corps reservoirs (Buford and West Point). Georgia Power makes an annual headwater benefits payment to the Federal government for the benefits at Bartletts Ferry derived from the reregulation of flows by Buford and West Point.

Water released from West Point takes 4 to 6 hours to reach Bartletts Ferry. Desired peaking at Bartletts Ferry often coincides with peaking at West Point; therefore, both plants usually peak during the same time period. This operation lowers the Bartletts Ferry reservoir until the West Point peaking release arrives 4 to 6 hours later and refills Bartletts Ferry. Bartletts Ferry is normally operated between elevations 519 and 521 feet, with normal daily average fluctuations of about $\frac{3}{4}$ foot.

Because Bartletts Ferry discharges directly into the backwaters of the Goat Rock reservoir, with no intervening riverine reach or bypassed reach, it has no FERC-required minimum instantaneous discharge. Although there is no instantaneous discharge requirement, for the eleven year period 1997-2007 daily average discharges exceeded 0 cfs 99.9% of the time and 500 cfs 99.8% of the time.

Bartletts Ferry Operations are Illustrated by the Following Figures:

Figures 3 through 6 show Bartletts Ferry and West Point hourly discharges, and Bartletts Ferry hourly elevations for four one-week periods. These graphs illustrate how the Bartletts Ferry reservoir fluctuates because of inflows, primarily controlled by West Point peaking operations and Bartletts Ferry peaking discharges. Average annual inflow for Bartletts Ferry is approximately 6,150 cfs.

Figure 3 shows a medium range inflow week with no peaking on the weekend from West Point.

Figure 4 shows a medium range inflow week, with peaking by West Point on all seven days of the week. Note that Bartletts Ferry must generate on the weekend to pass the peaking flows from West Point.

Figure 5 shows a week in which there were flood conditions. Note that the flow scale is shifted higher to depict the higher flow releases later in the week.

Figure 6 shows a week with low inflows, and no peaking on the weekend at West Point.

Figures 7 through 17 show the daily maximum and minimum Bartletts Ferry reservoir elevation for each of the years from 1997 through 2007. Some things to note about these graphs are:

The typical operating range for the reservoir is between elevations 519 and 521 feet, with 521 feet being full pond.

Every other year the reservoir was drawn down approximately 8-10 feet, starting in October and lasting about six weeks, to allow for dock and shoreline structure maintenance around the lake (e.g., Figure 7). This drawdown was cancelled in 2007 due to extreme drought conditions (Figure 17).

Figure 18 shows daily lake fluctuation statistics for the period 1997-2007. Daily fluctuations are less than 1.74 feet 99% of the time, with the higher fluctuations mostly from fall maintenance drawdowns. Daily fluctuations are less than 1.00 feet 84% of the time and less than 0.69 feet 50% of the time.

Figure 19 shows statistics on hourly lake elevations for the period 1997-2007. Statistics are shown that include the fall maintenance drawdowns, and excluding these drawdowns. When the fall drawdowns are excluded, the reservoir was below elevation 519 feet only 1% of the time.

Figures 20 and 21 show statistics on rolling 7-day average inflow and outflow for the period 1997-2007. These graphs are the same except for the scale of the y axis. From these graphs it can be seen that on a weekly basis, inflow and outflow are approximately equal, i.e. there is negligible storage change on a weekly time step. Differences in inflow and outflow occur on an hourly to daily basis as illustrated in Figures 3 through 6.

Figures 22 and 23 show statistics on hourly and daily discharges for the period 1997-2007. These graphs are the same except for the scale of the y axis. For the eleven year period 1997-2007 daily average discharges exceeded 0 cfs 99.9% of the time and 500 cfs 99.8% of the time.

FIGURES

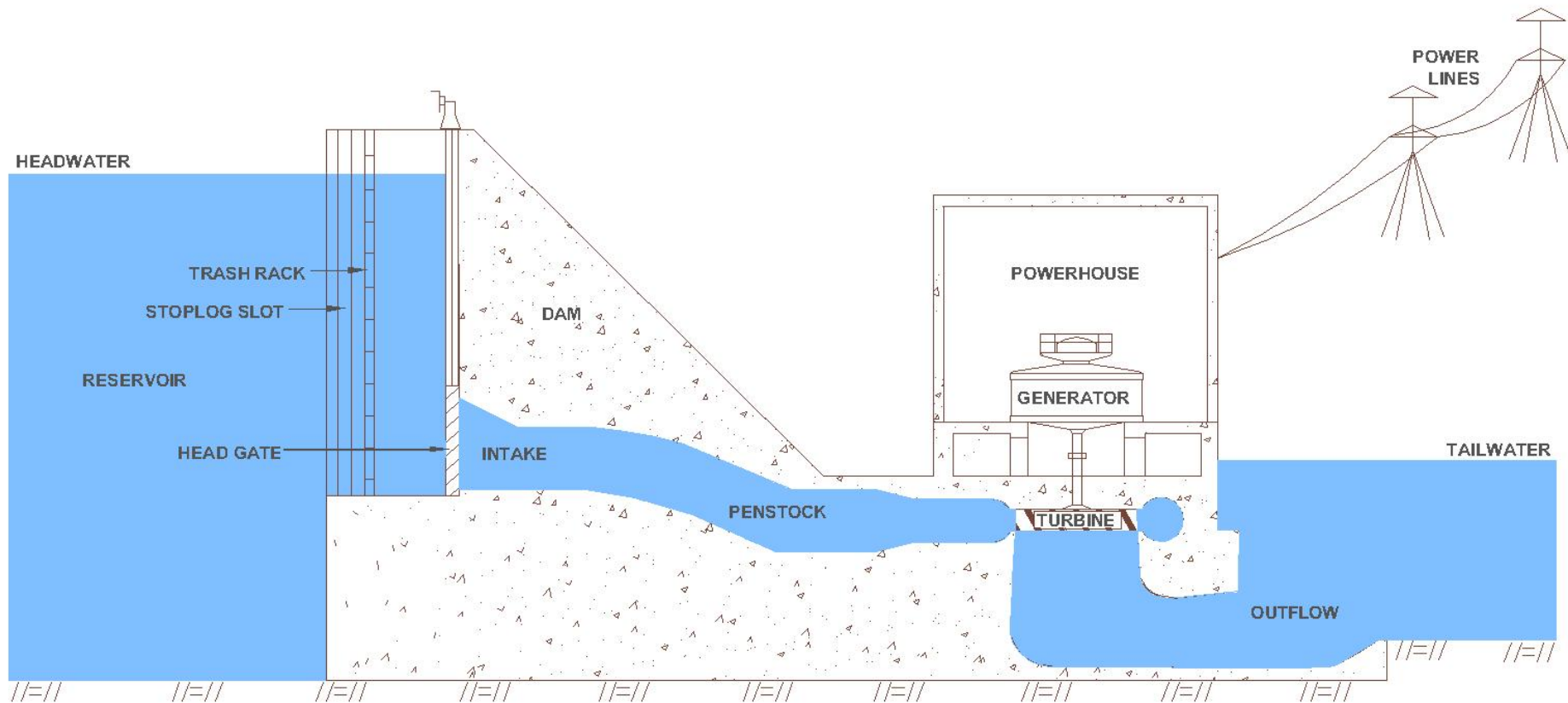


FIGURE 1

**West Point
Average Monthly Flows
with and without Buford and West Point
January 76 to July 08**

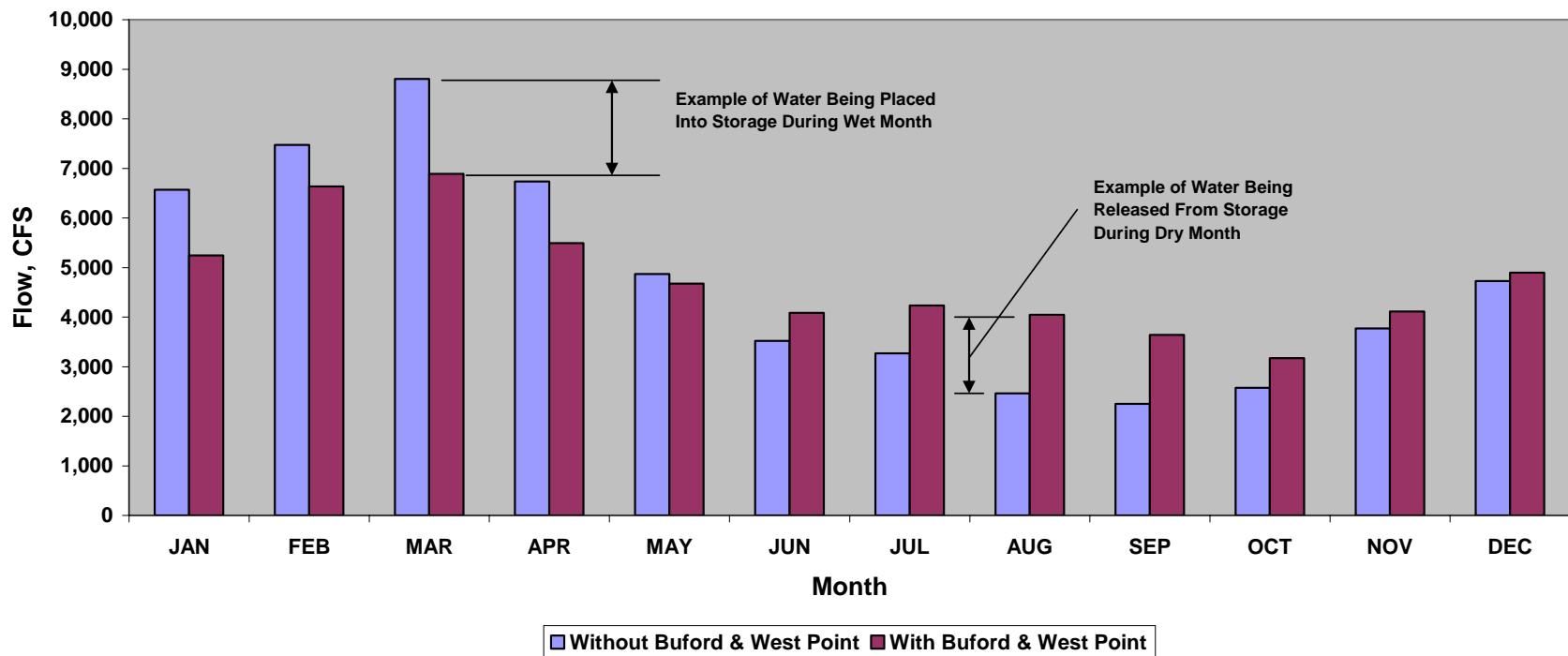


FIGURE 2

Bartletts Ferry
Example of One Week of Operation
Medium Inflow (4,742 CFS Average Inflow)
With No Weekend West Point Peaking

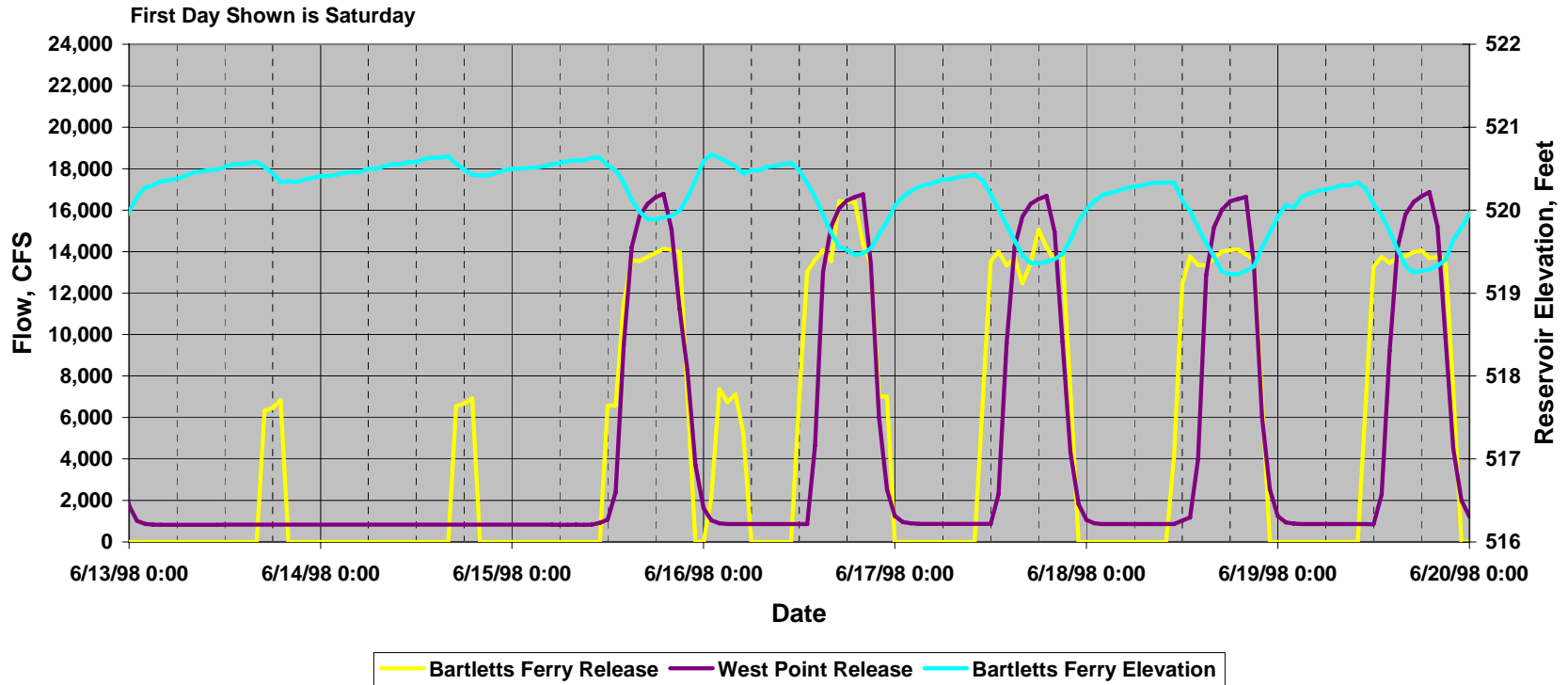


FIGURE 3

Bartletts Ferry
Example of One Week of Operation
Medium Inflow (5,201 CFS Average inflow)
With Weekend West Point Peaking

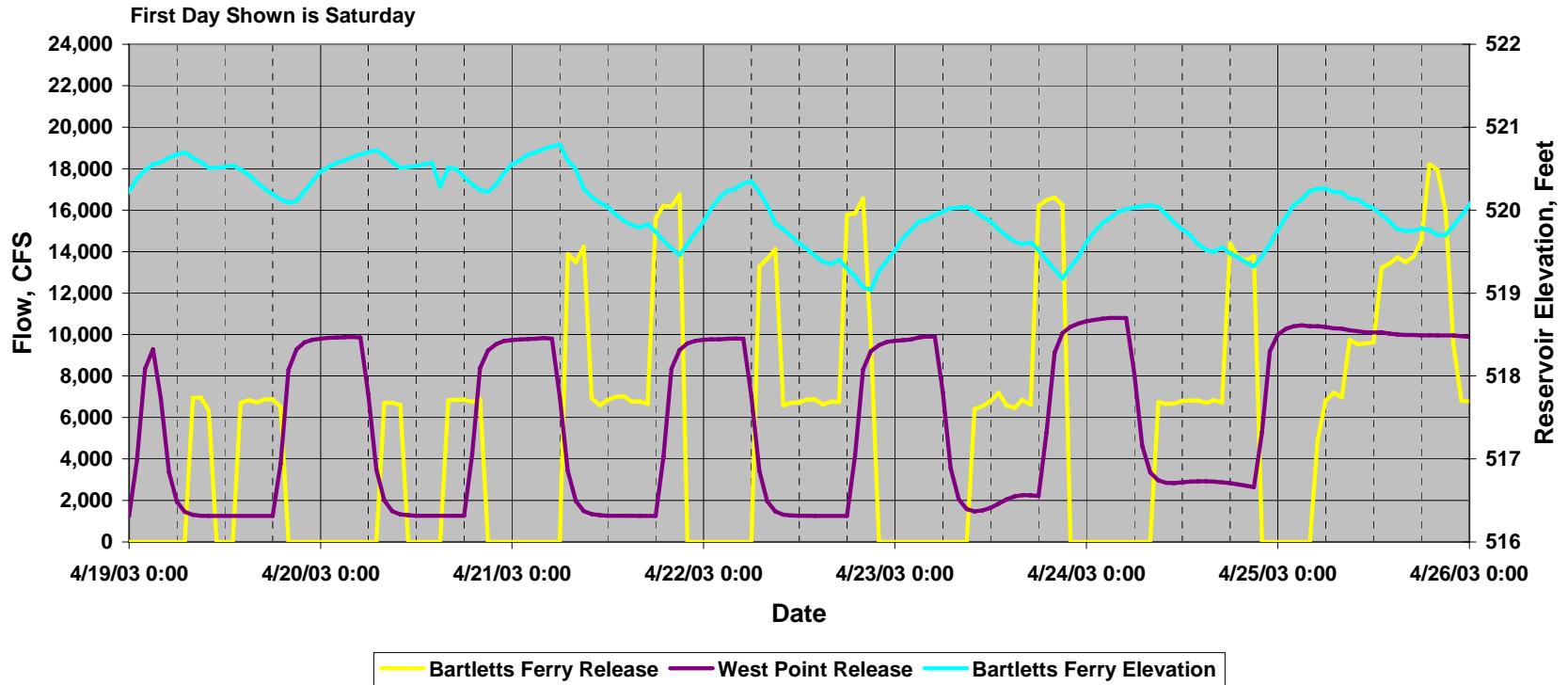


FIGURE 4

Bartletts Ferry
Example of One Week of Operation
Flood Conditions (35,652 CFS Average inflow)
With Weekend West Point Peaking

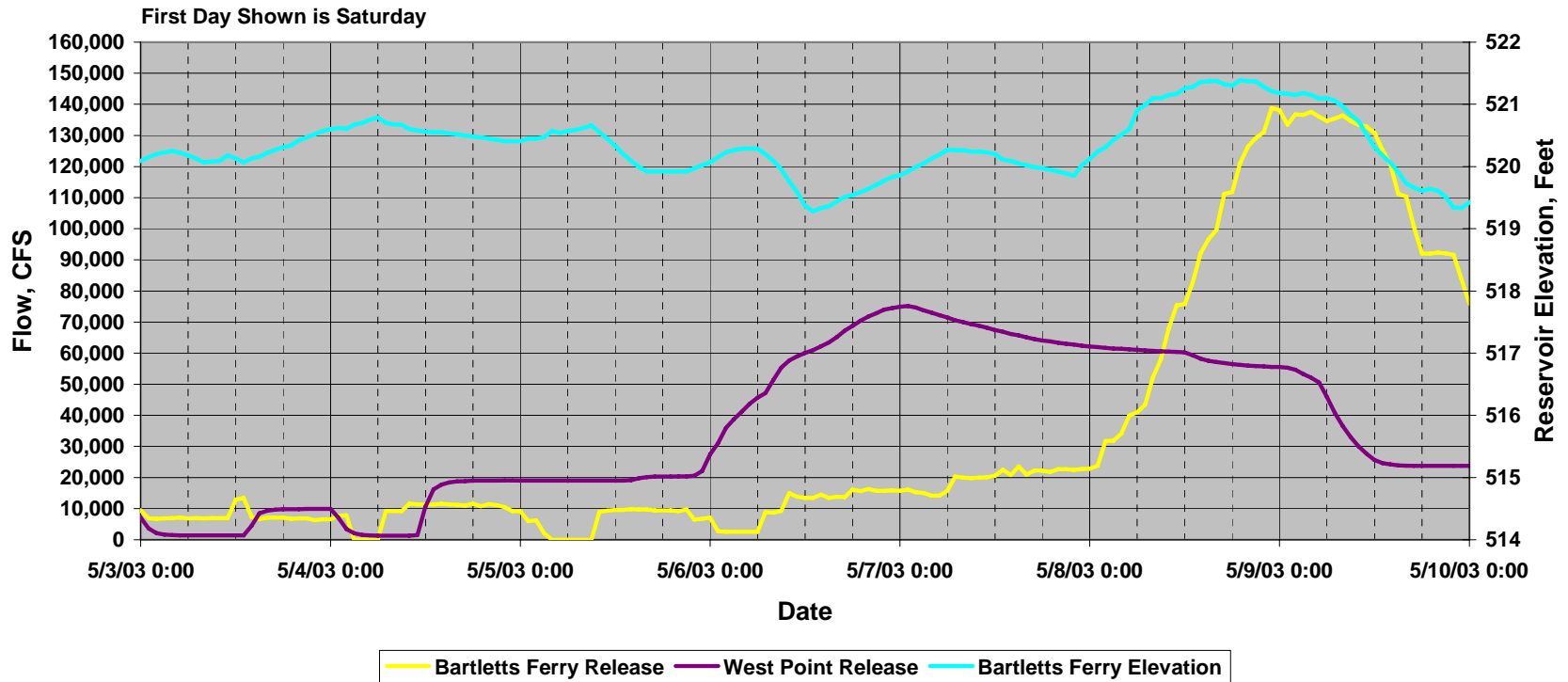


FIGURE 5

Bartletts Ferry
Example of One Week of Operation
Low Inflow (1,352 CFS Average Inflow)
With No Weekend West Point Peaking

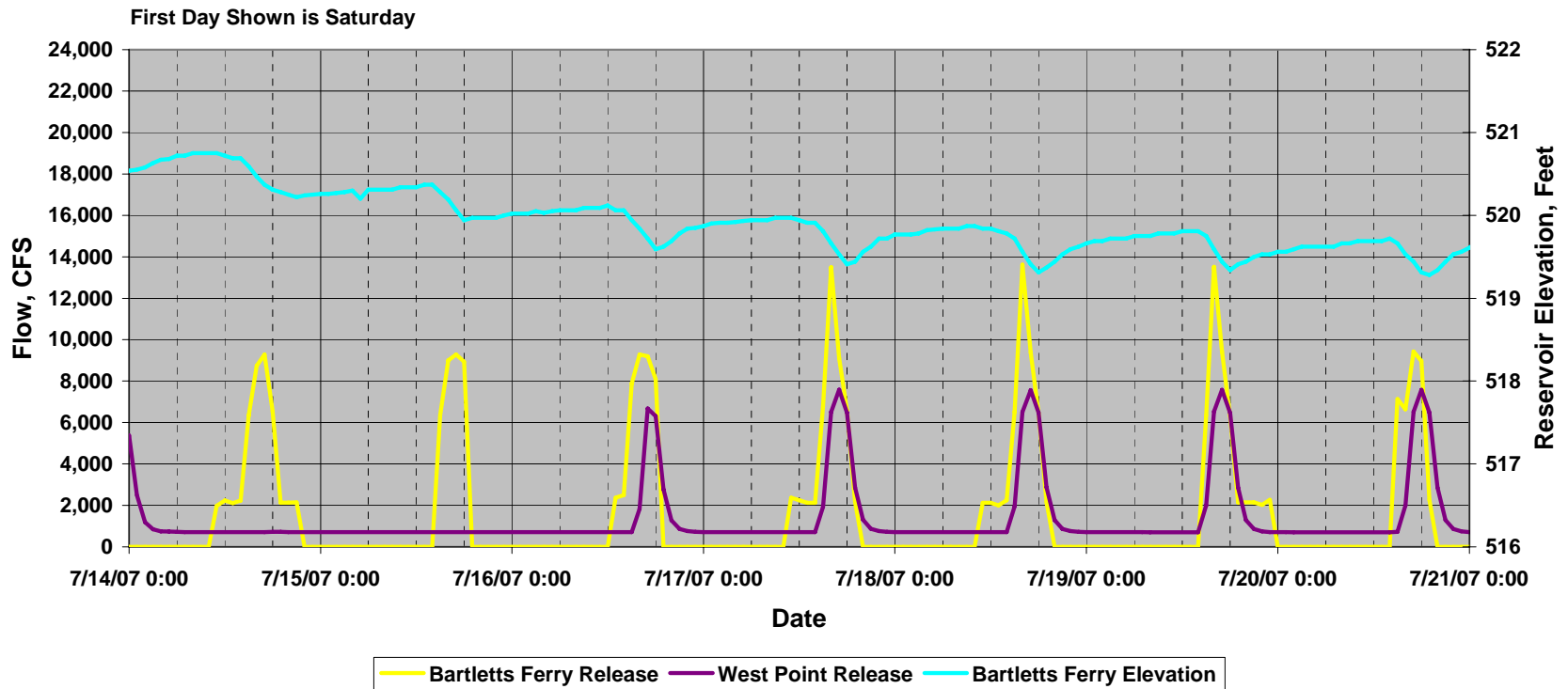


FIGURE 6

**Bartletts Ferry Reservoir
Daily Maximum and Minimum Elevations
1997**

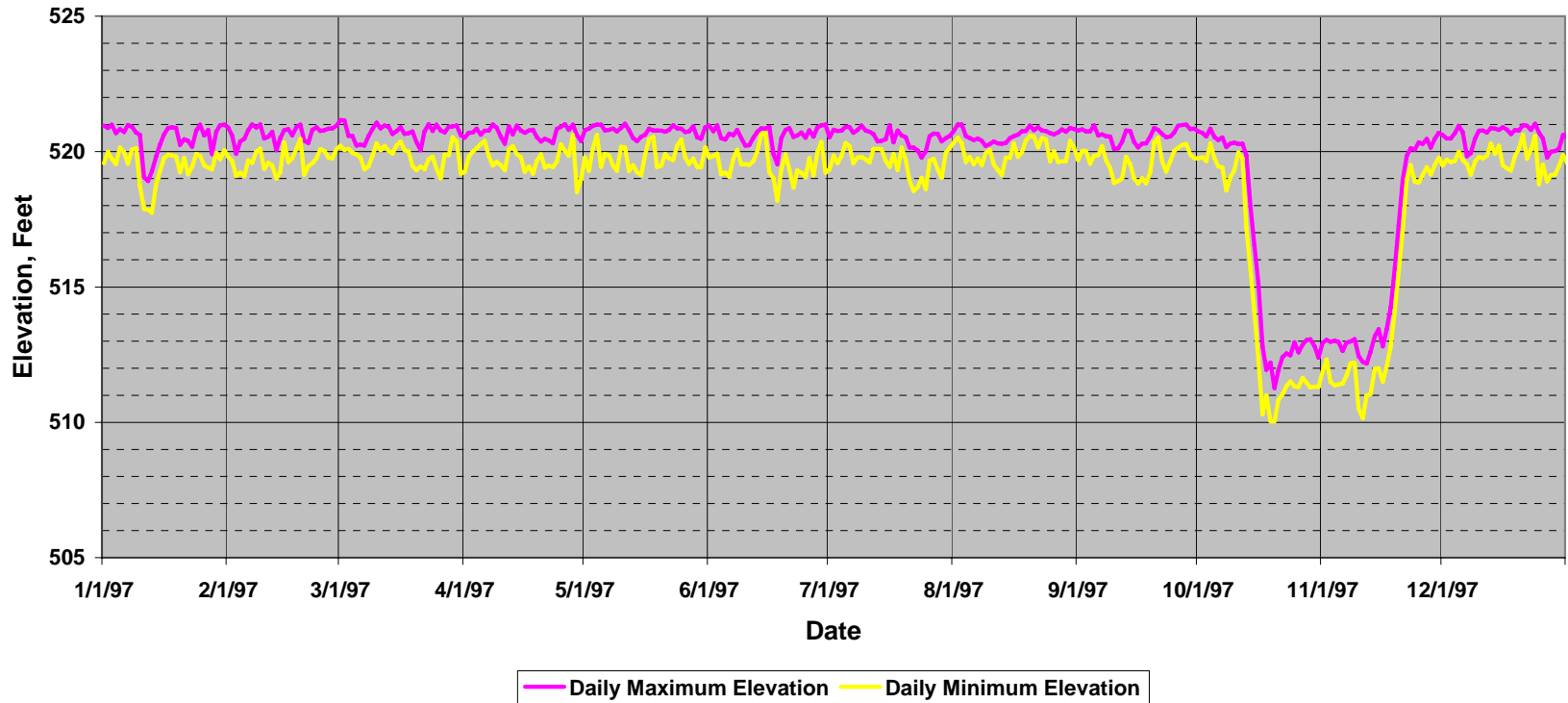


FIGURE 7

**Bartletts Ferry Reservoir
Daily Maximum and Minimum Elevations
1998**

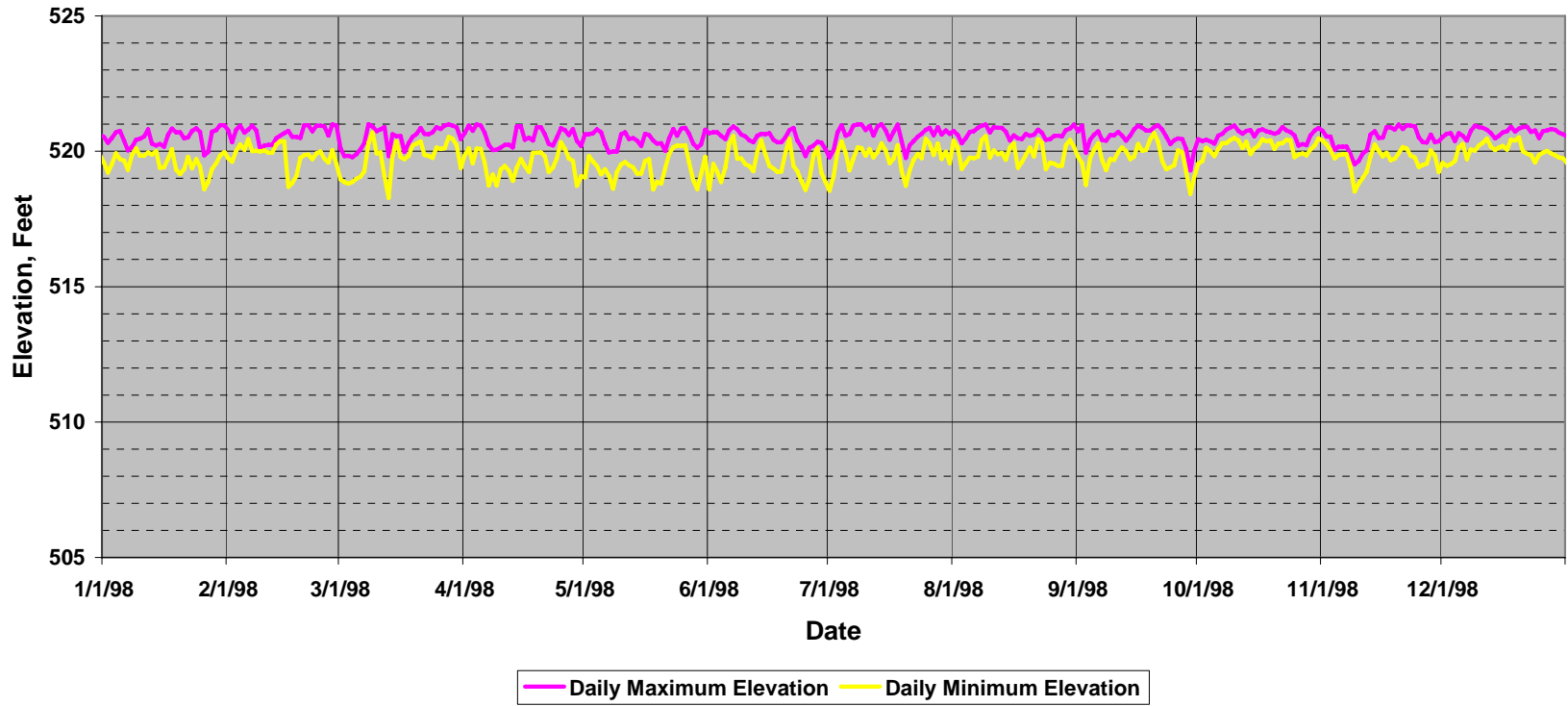


FIGURE 8

**Bartletts Ferry Reservoir
Daily Maximum and Minimum Elevations
1999**

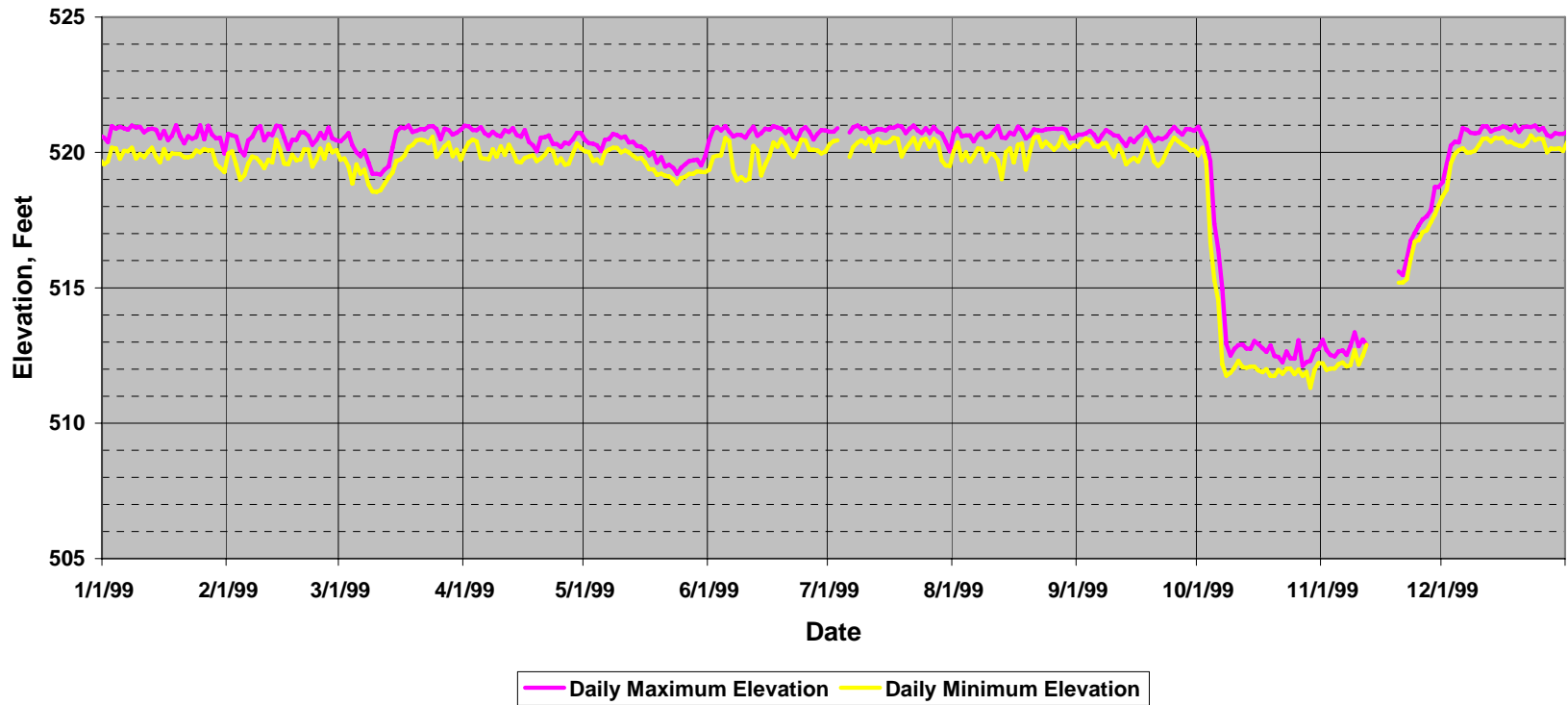


FIGURE 9

**Bartletts Ferry Reservoir
Daily Maximum and Minimum Elevations
2000**

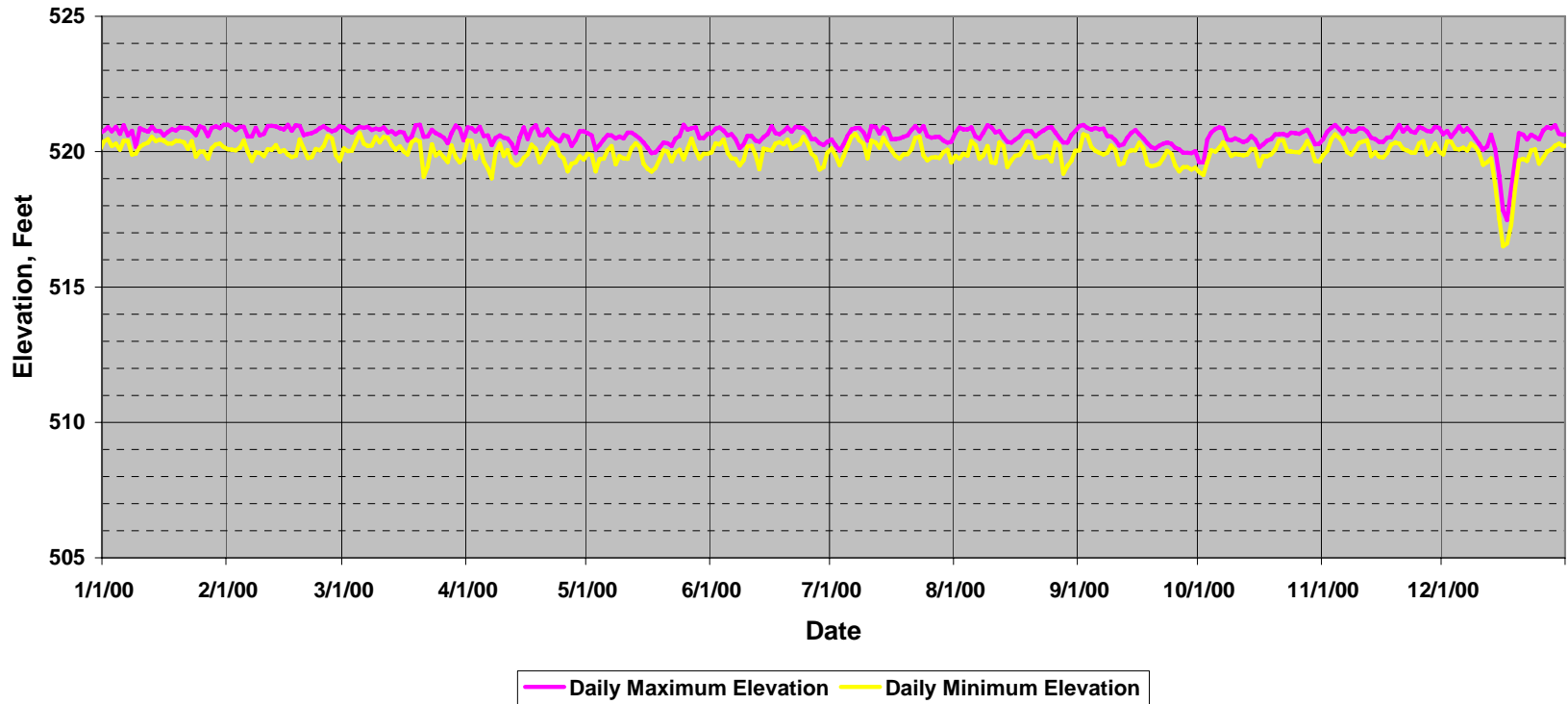


FIGURE 10

**Bartletts Ferry Reservoir
Daily Maximum and Minimum Elevations
2001**

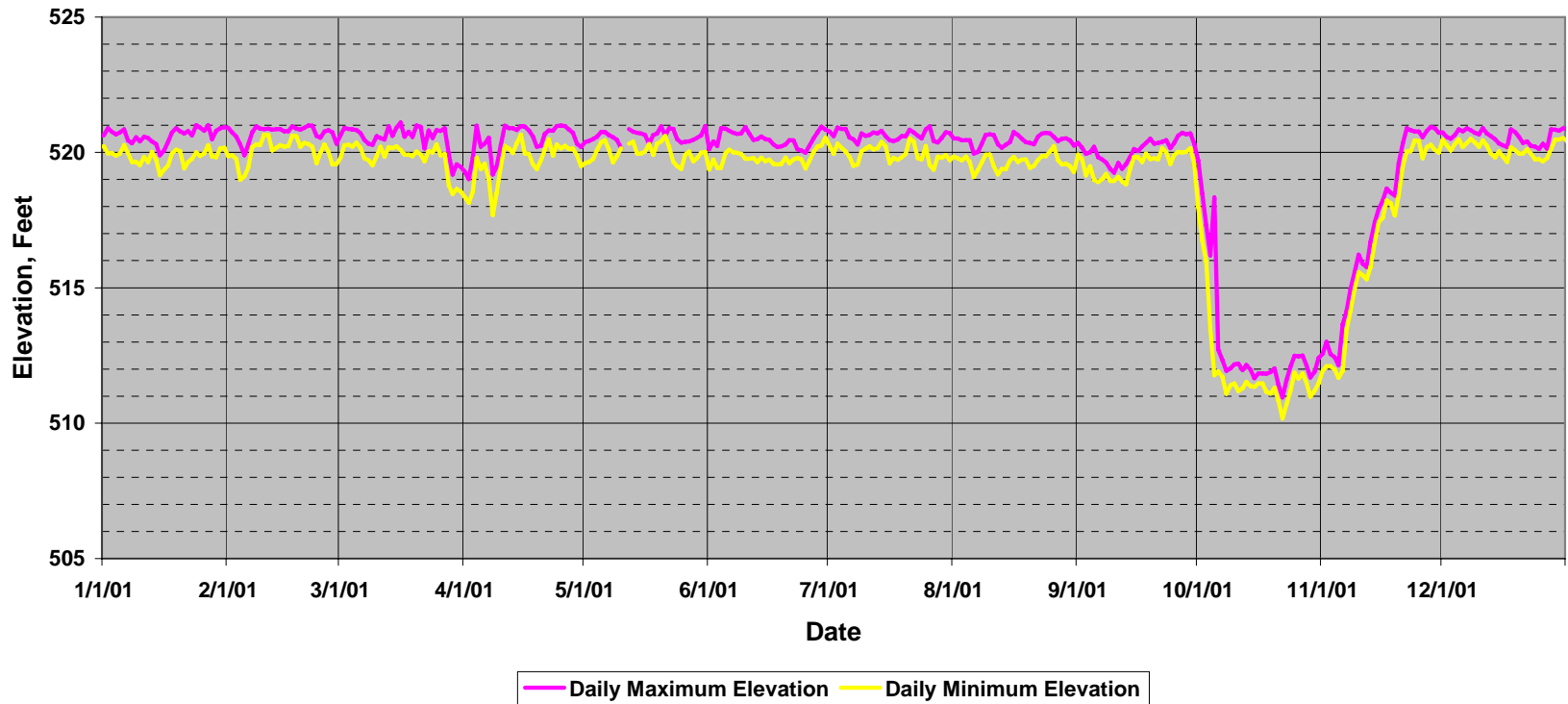


FIGURE 11

**Bartletts Ferry Reservoir
Daily Maximum and Minimum Elevations
2002**

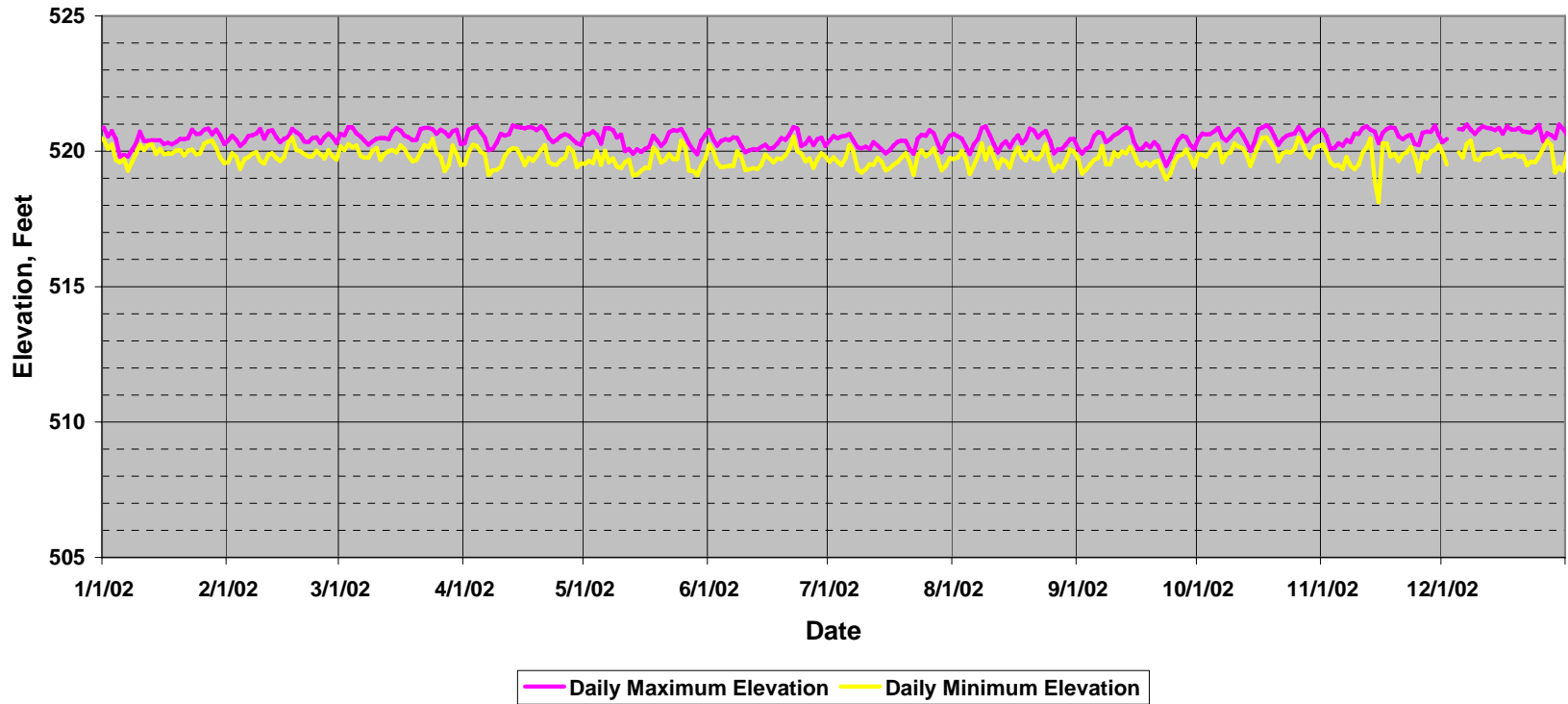


FIGURE 12

**Bartletts Ferry Reservoir
Daily Maximum and Minimum Elevations
2003**

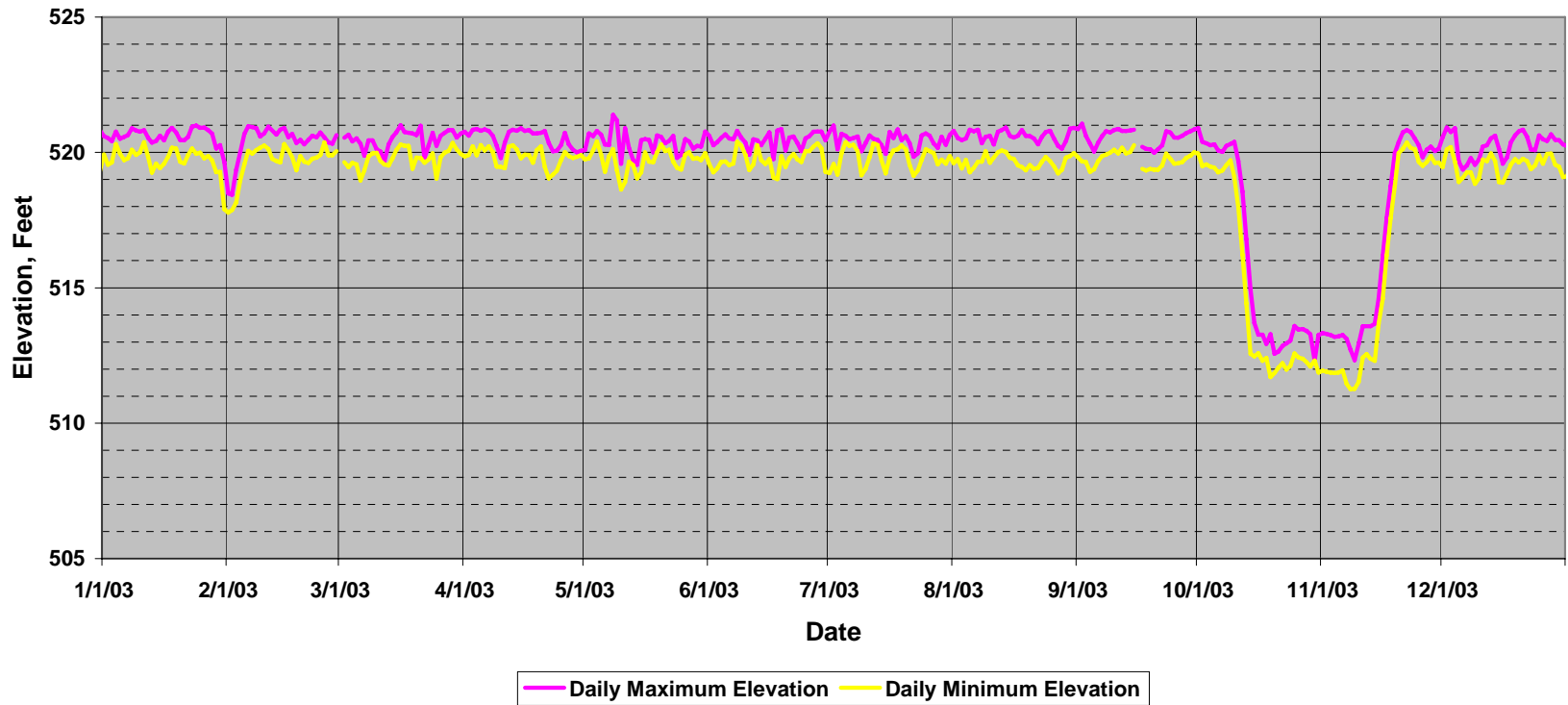


FIGURE 13

**Bartletts Ferry Reservoir
Daily Maximum and Minimum Elevations
2004**

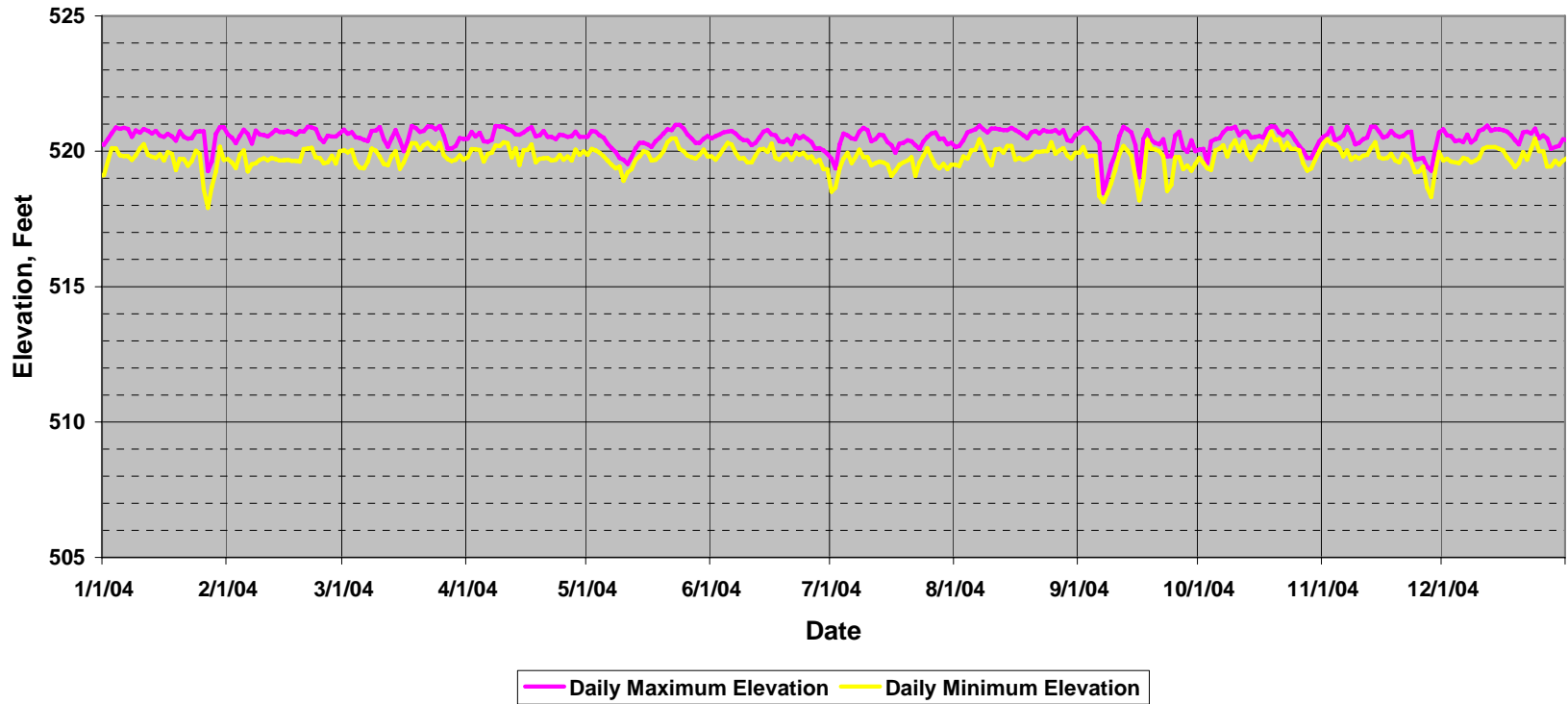


FIGURE 14

**Bartletts Ferry Reservoir
Daily Maximum and Minimum Elevations
2005**

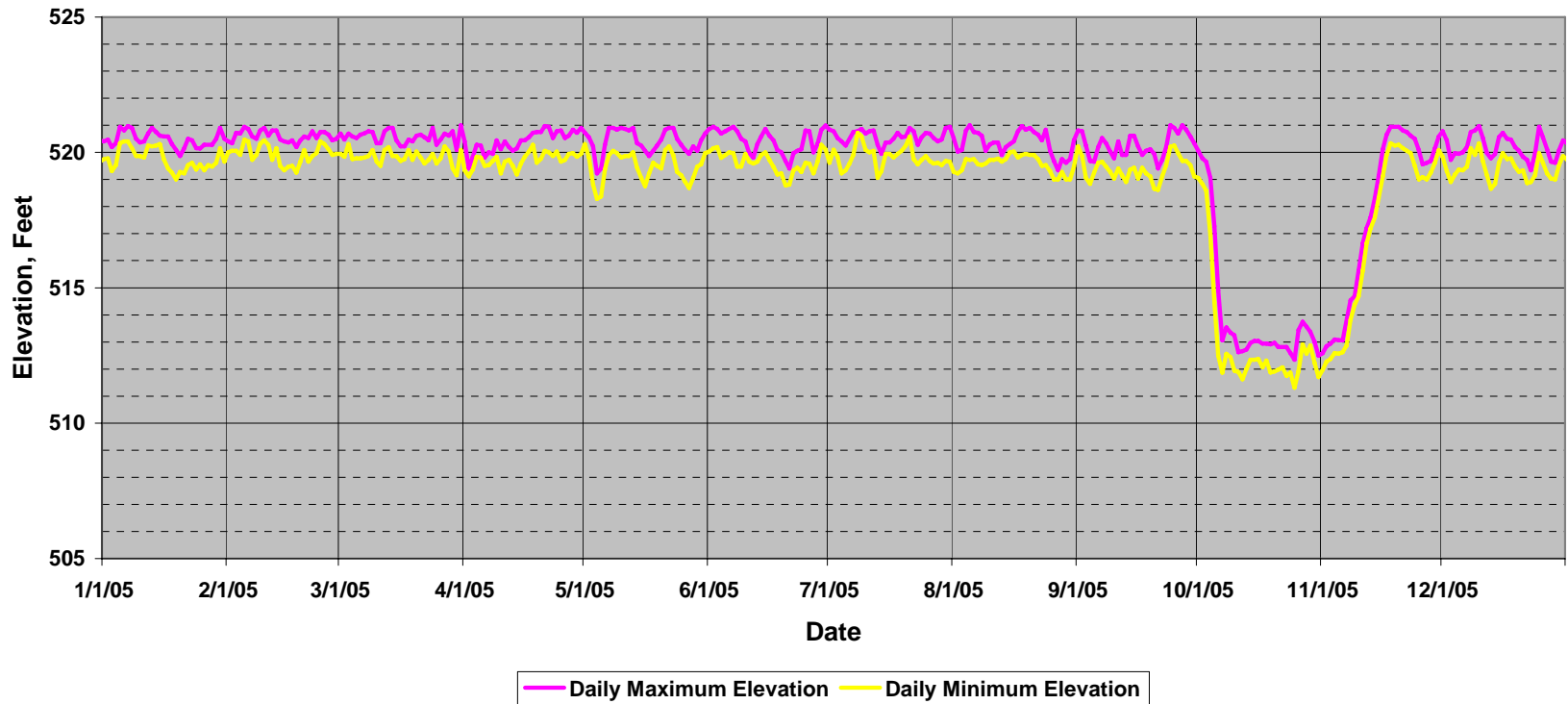


FIGURE 15

**Bartletts Ferry Reservoir
Daily Maximum and Minimum Elevations
2006**

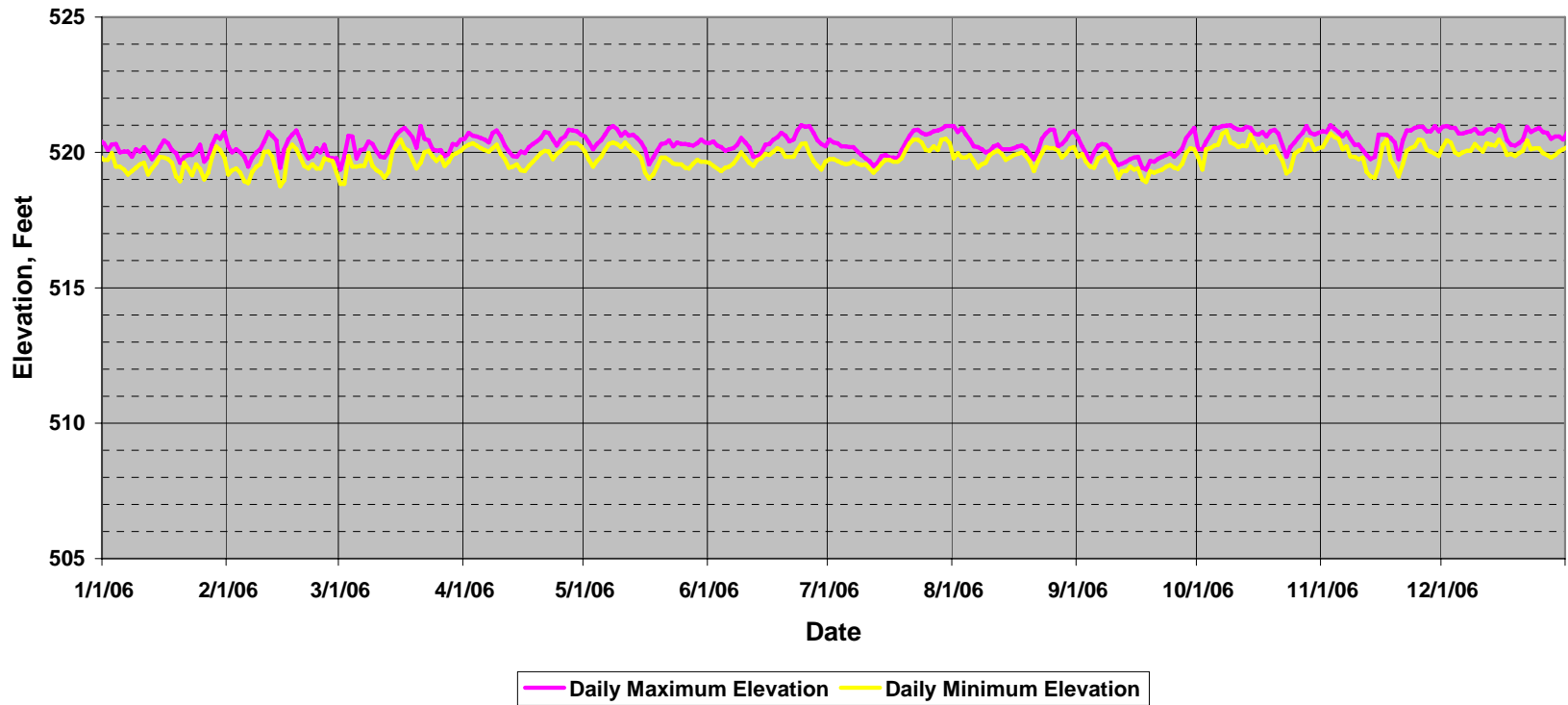


FIGURE 16

**Bartletts Ferry Reservoir
Daily Maximum and Minimum Elevations
2007**

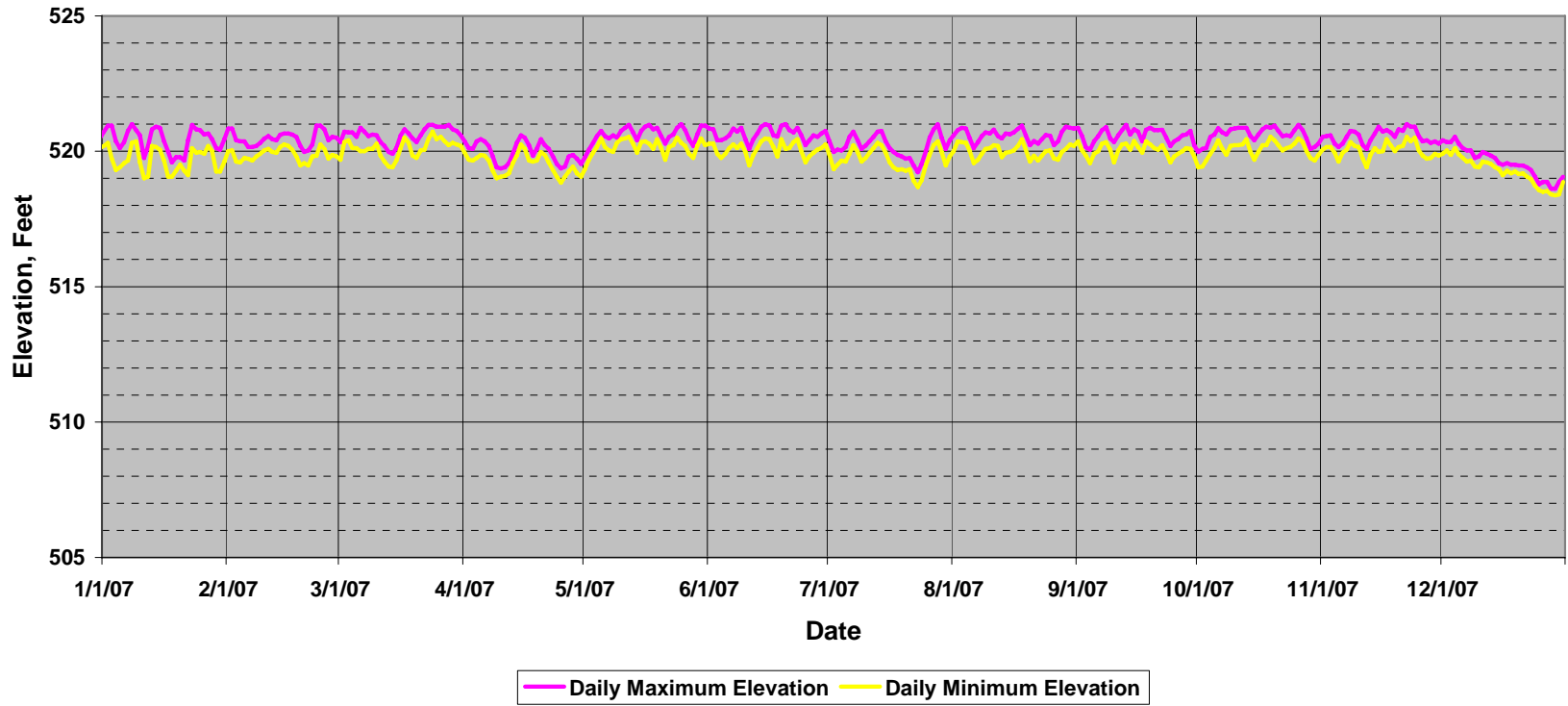


FIGURE 17

**Bartletts Ferry Daily Reservoir Fluctuations
1997 - 2007**

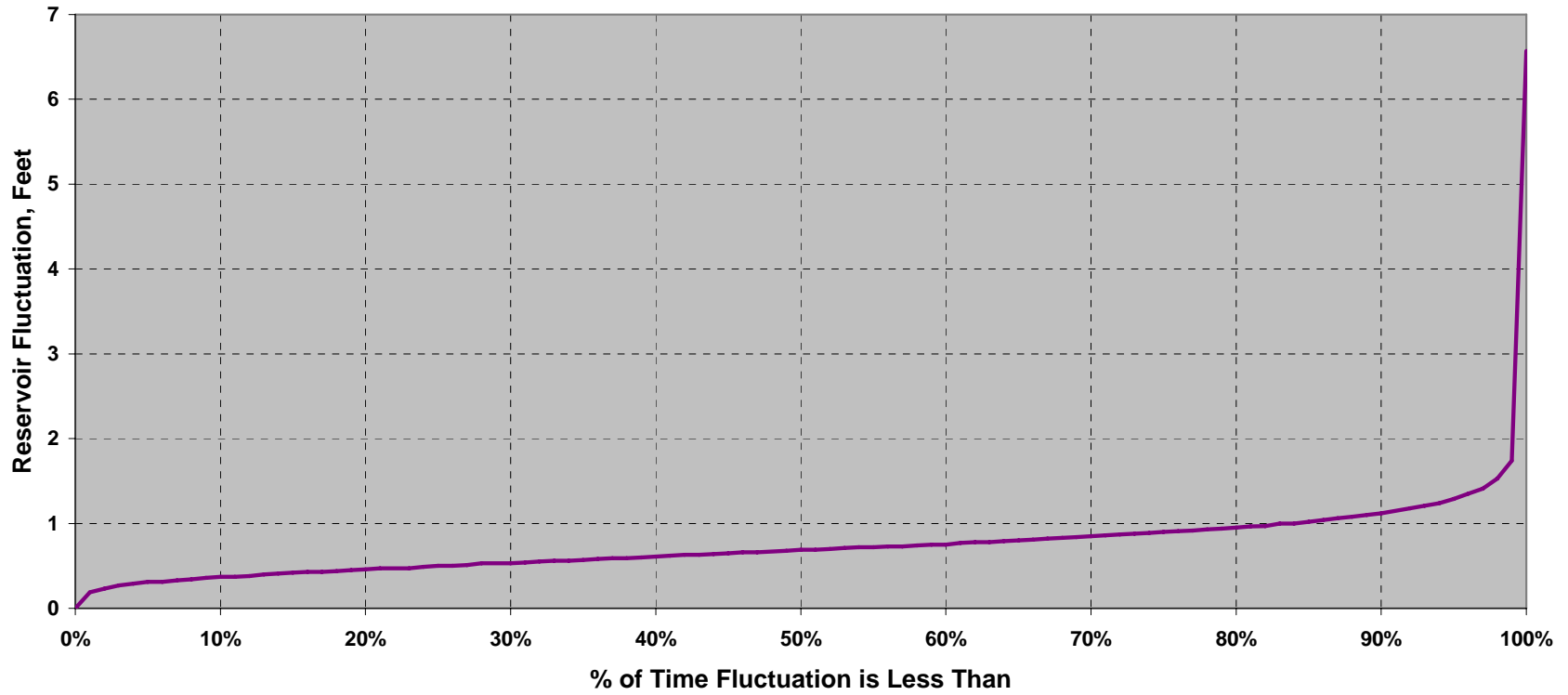


FIGURE 18

**Bartletts Ferry Hourly Reservoir Elevation Statistics
1997-2007**

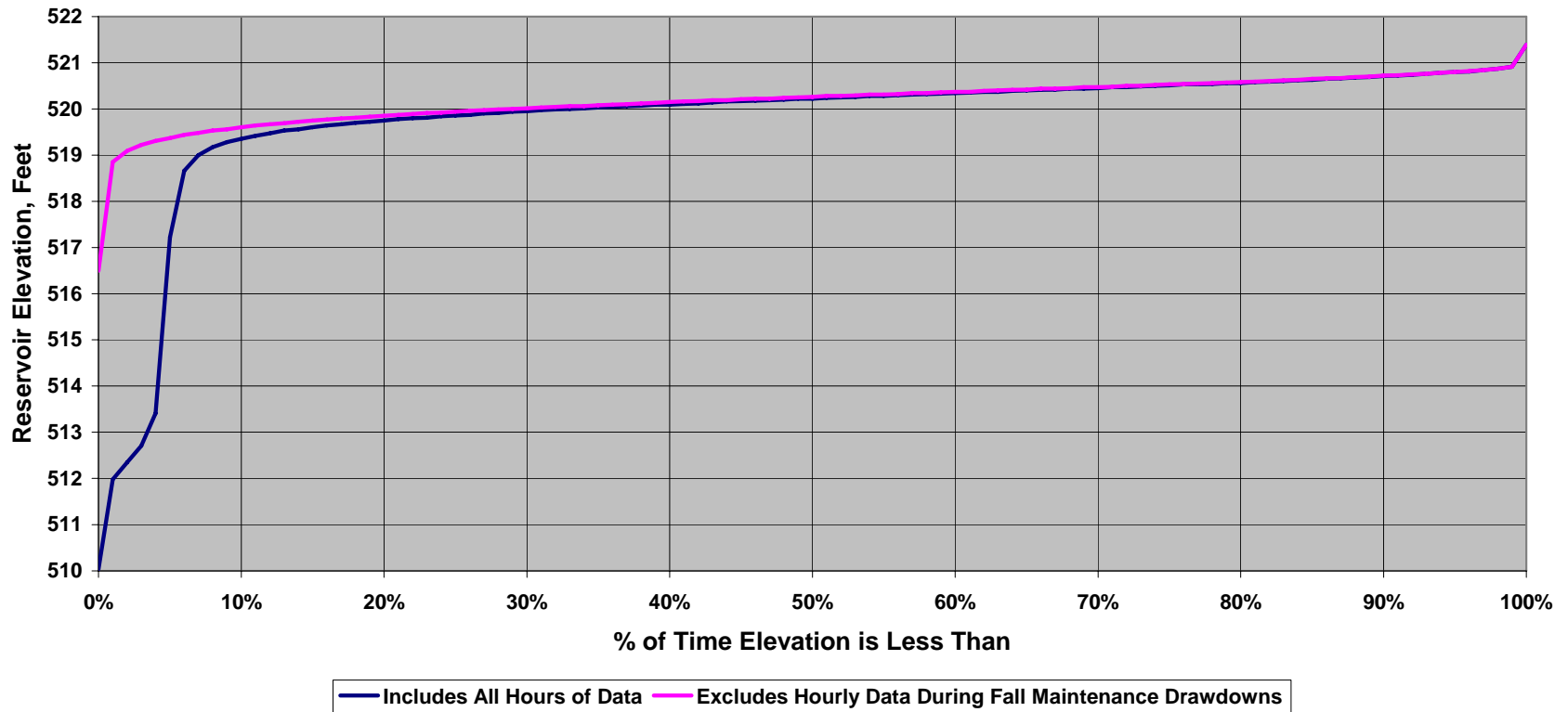


FIGURE 19

**Bartletts Ferry
7- Day Average Inflow and Outflow
1997-2007**

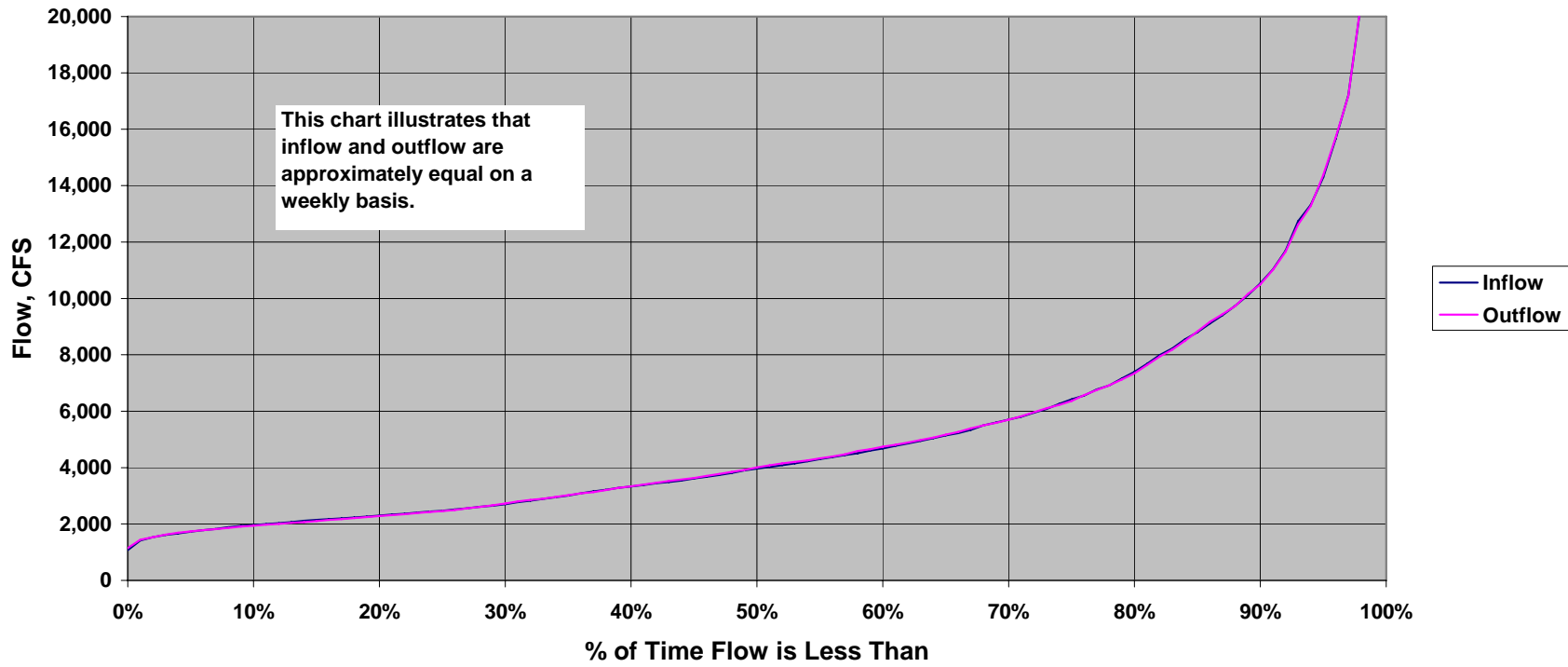


FIGURE 20

**Bartletts Ferry
7- Day Average Inflow and Outflow
1997-2007**

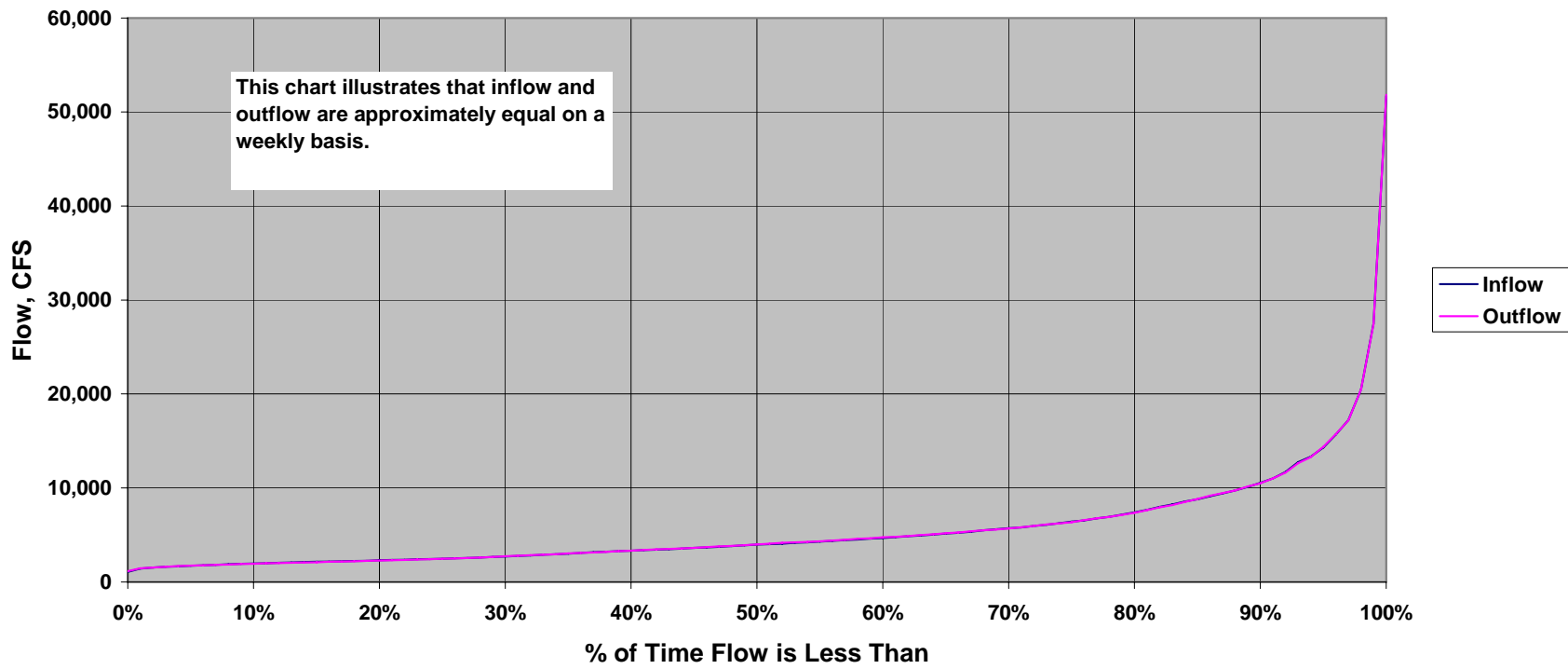


FIGURE 21

**Bartletts Ferry Discharge
1997-2007**

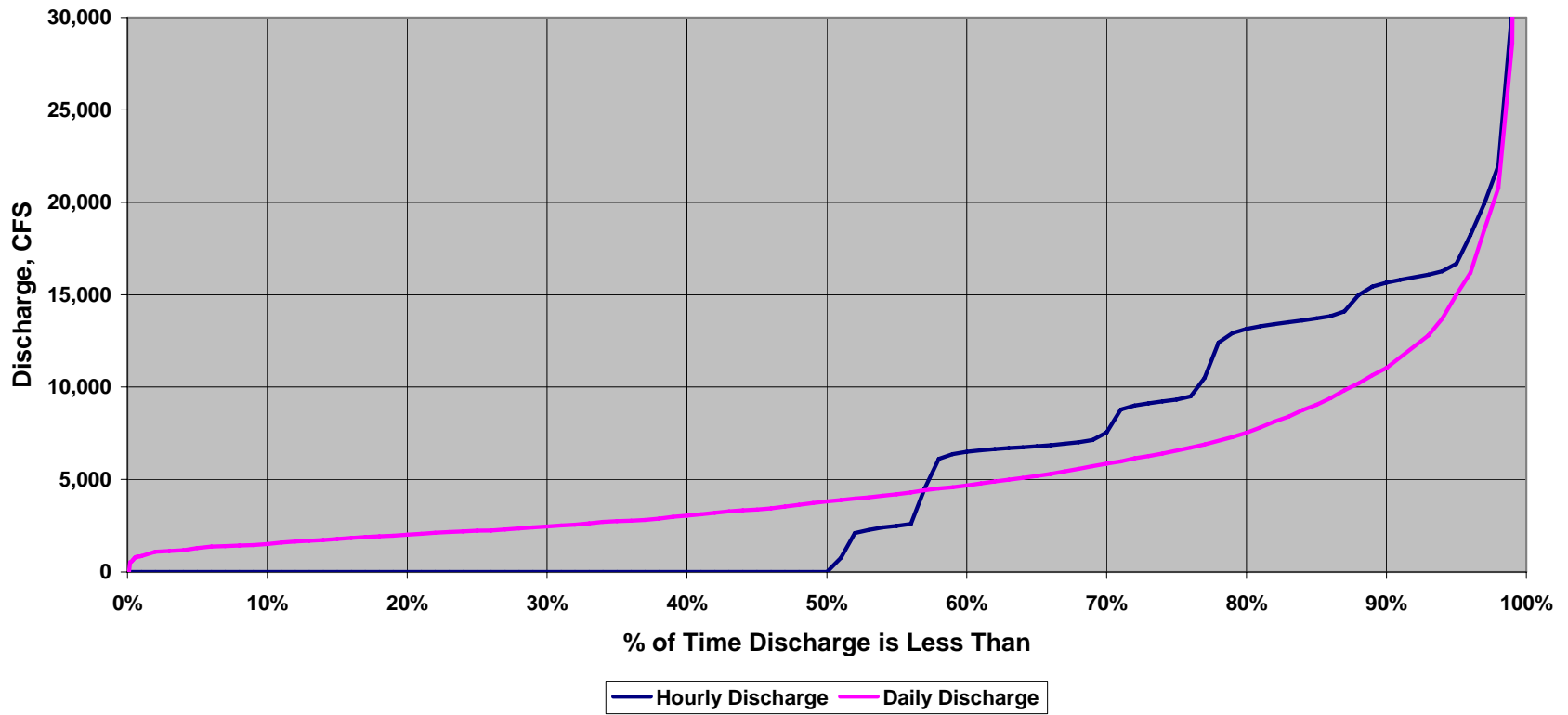


FIGURE 22

**Bartletts Ferry Discharge
1997-2007**

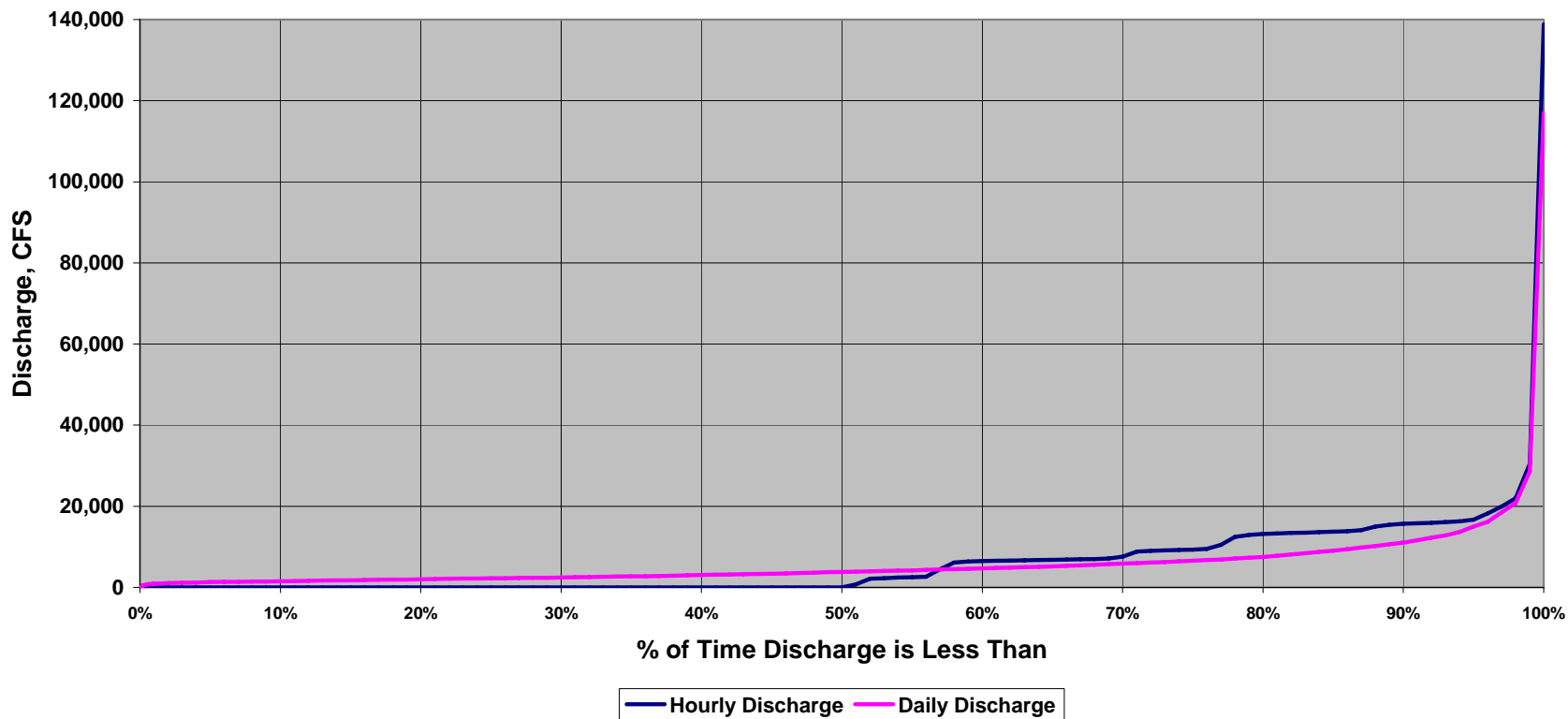


FIGURE 23