US Army Corps
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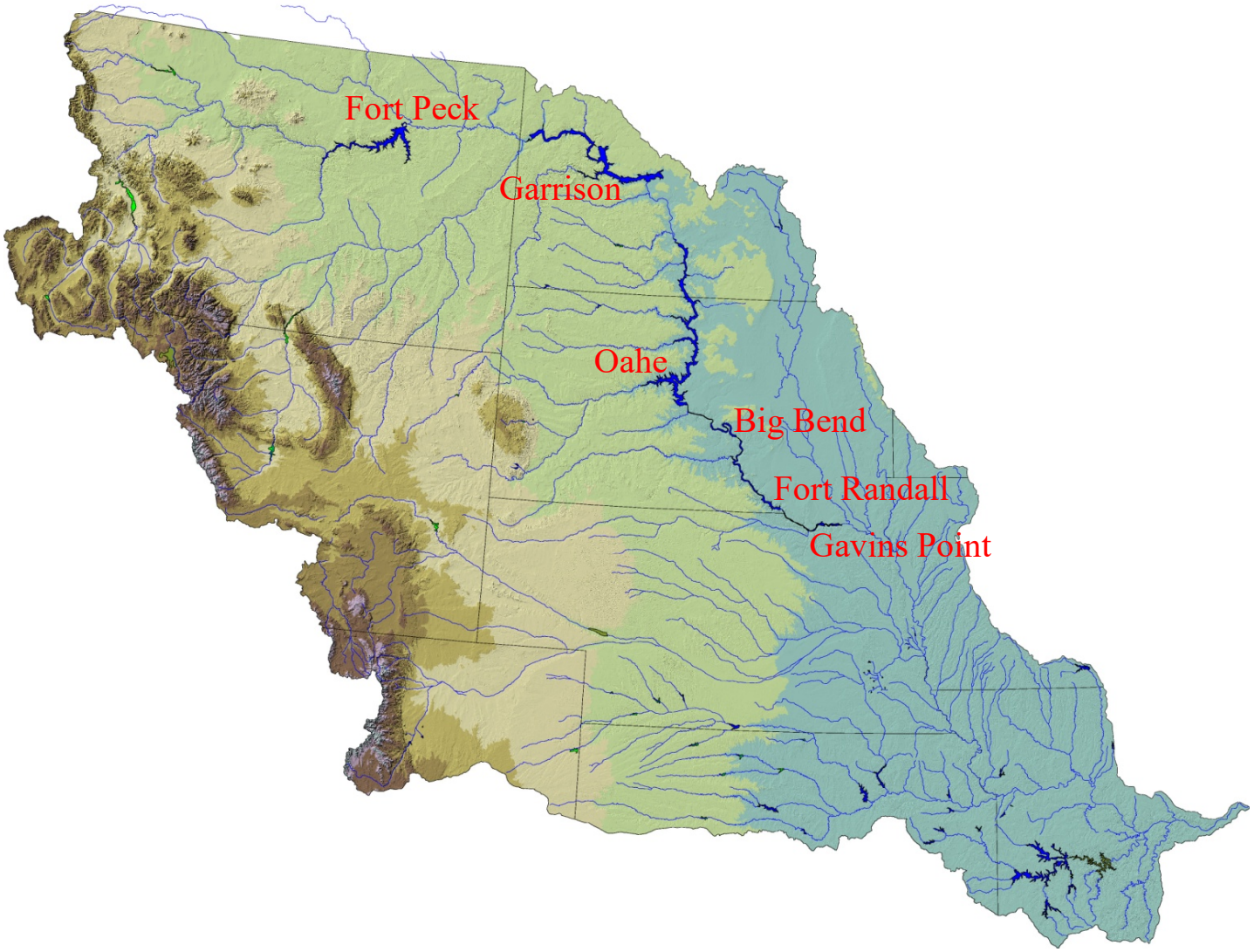
Northwestern Division

Missouri River Mainstem Reservoir System Hydrologic Statistics on Inflows

Technical Report



Missouri River Basin Water Management Division
Omaha, Nebraska

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Missouri River Basin Water Management Division

Technical Report – Hydrologic Statistics on Inflows, December 2020

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LIST OF ABBREVIATIONS AND ACRONYMS

Basin	Missouri River Basin
cfs	cubic feet per second
ft	feet
ft msl	feet above mean sea level in NGVD29
HEC	USACE Hydrologic Engineering Center
kAF	1000 acre-feet
LRS	Long Range Study
M	million
MAF	million acre-feet
Master Manual Review	Missouri River Basin Master Water Control Manual
MRBWM	Missouri River Basin Water Management
msl	mean sea level
NWD	USACE Northwestern Division
POR	Period of Record
ResSim Model	Missouri River Reservoir System Planning Model
SWE	snow water equivalent
System	Missouri River Mainstem Reservoir System
T&E	Threatened and Endangered
USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation

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I. INTRODUCTION

A. Purpose and Scope

The purpose of this report is to describe the methodology, assumptions, data used, and results of the update of the statistical analysis of hydrologic data for the Missouri River Mainstem Reservoir System (System) as presented in the report titled "*Missouri River Mainstem Reservoir System, Hydrologic Statistics on Inflows, Technical Report*", dated July 2015. The 2015 report was based on inflow information for the period from 1898 through 2012. The 2020 study (current study) uses inflow data developed for the Missouri River Reservoir System Planning Model (HEC-ResSim) for the analysis period from 1930 through 2019. This current study contains seven new years of inflow data from 2013 through 2019, including the second highest runoff volume of record, which occurred in 2019. In addition, the runoff volumes for the 1881 event, which were used in the design of the flood control storage of the System, were incorporated, where possible, into the studies to extend the historic inflow period-of-record (POR).

Results of this analysis include the development of hydrologic statistics consisting of regulated and incremental inflow volume probability relationships for various durations for each of the six System reservoirs. The regulated inflow is defined as the local inflow from the incremental drainage into the reservoir plus the release from the upstream project. The incremental inflow is defined as the local inflow into the reservoir only and does not include releases from the upstream project. For example, the incremental inflow into Oahe is the total inflow into Oahe *minus* the routed Garrison release, the System project directly upstream of Oahe.

The resulting inflow volume probability relationships for various durations were based on daily data of observed historical streamflow records. This report contains a summary of the 1881, 2011 and 2019 floods, as well as the current reservoir regulation as outlined in the Missouri River Mainstem Reservoir System Master Water Control Manual (Master Manual). It also contains a description of the assumptions used in the long-term computer model simulation studies whose results were used extensively in the development of the volume probability relationships for this study.

B. Inflow Volume Probability Relationships

Inflow volume probability relationships are used to define the annual probability of the reservoir inflow reaching or exceeding a certain flow for a variety of durations usually ranging from 1 to 183 days. Current standards are to express the probability in terms of annual "percent chance of exceedance." For example, a given inflow that has an annual exceedance probability of 0.01 would have a 1 percent chance of being equaled or exceeded in any given year. The percent chance of exceedance is equal to the annual exceedance probability multiplied by 100. Once the exceedance probability is estimated, the recurrence interval or return period can be computed as the reciprocal of the exceedance probability. For example, a given inflow with a 1 percent chance of exceedance would have a recurrence interval of 100 years. This means that over a long period of time, the given incremental reservoir inflow would be equaled or exceeded on the

average of once every 100 years. However, the 100-year inflow can occur multiple times over a short period (e.g., 5-10 years). This is because the probability of a 100-year inflow is the same every year, and the occurrence of a 100-year inflow in recent years does not reduce or eliminate the probability of a 100-year inflow occurring in the next year.

II. BACKGROUND INFORMATION

A. Basin Description

Six dam and reservoir projects comprise the System: Fort Peck, Garrison, Oahe, Big Bend, Fort Randall, and Gavins Point. These projects were constructed by the U.S. Army Corps of Engineers (USACE) on the main stem of the Missouri River for the purposes of flood control, navigation, irrigation, hydropower, water supply, water quality, recreation, and fish and wildlife. The reservoir projects are operated as a hydraulically and electrically integrated system in order to achieve the multipurpose benefits for which they were Congressionally authorized. Regulation of the projects began with Fort Peck (1940) as the sole mainstem project. Additional projects were added as Fort Randall (1953), Garrison (1955), Gavins Point (1955), Oahe (1962), and Big Bend (1964) were progressively brought into the System. The current System of six projects first filled and began operating as a six-project System in 1967. **Plate 1** shows the location of each of these projects. Pertinent data for each project are listed in **Table 1**.

Table 1
Pertinent Data for Missouri River Mainstem System Reservoir Projects

Description	Fort Peck	Garrison	Oahe	Big Bend	Fort Randall	Gavins Point	System Total
River Mile	1771.5	1389.9	1072.3	987.4	880.0	811.1	------
Drainage Area (sq. mi.)	57,500	181,400	243,490	249,330	263,480	279,480	------
Incr. Drainage Area (sq. mi.)	57,500	123,900	62,090	5,840	14,150	16,000	------
Gross Storage (kaf)	18,463	23,451	22,983	1,810	5,293	428	72,428
Flood Storage (kaf)	3,675	5,706	4,315	179	2,292	133	16,300
Carryover Storage (kaf)	10,700	12,951	13,353	------	1,532	------	38,536
Top of Dam (ft-msl)	2280.5	1875.0	1660.0	1440.0	1395.0	1234.0	------
Max Surcharge Pool (ft-msl)	2253.3	1858.5	1664.4	1433.6	1379.3	1221.4	------
Max Operating Pool (ft-msl)	2250.0	1854.0	1620.0	1423.0	1375.0	1210.0	------
Max Normal Pool (ft-msl)	2246.0	1850.0	1617.0	1422.0	1365.0	1208.0	------
Base Flood Pool (ft-msl)	2234.0	1837.5	1607.5	1420.0	1350.0	1204.5	------
Base Carryover (ft-msl)	2160.0	1775.0	1540.0	1415.0	1320.0	1204.5	------
Spillway Capacity[1] (cfs)	275,000	827,000	304,000	390,000	620,000	584,000	------
Outlet Tunnel Capacity (cfs)	45,000	98,000	111,000	------	128,000	------	------
Powerplant Capacity (cfs)	16,000	41,000	54,000	103,000	44,500	36,000	------
Date of Closure	Jun 1937	Apr 1953	Aug 1958	Jul 1963	Jul 1952	Jul 1955	------

[1] Design discharge capacity at maximum surcharge pool.

B. The Flood of 1881

The Flood of 1881 is sometimes referred to as the System flood control storage design flood. It is known from hydrologic records and gage heights along the Missouri River that the 1881 early spring flood was followed by one of the wettest summers of record. An estimated total volume of flood runoff at Sioux City, Iowa during the March-July 1881 period was more than 40 MAF. At the time when the reservoirs were designed in the mid-1940s, this 5-month volume greatly exceeded the volume for any other year at this location for which records were kept. The severe flood sequence, as reconstructed from available stage records, served as the primary basis for the design of the flood control storage space in the System. The design included maximum release of about 100,000 cfs from Fort Randall and all reservoirs reaching maximum pools at or near the top of their respective Exclusive Flood Control Zones.

The 1881 flood inflows were based on estimates of what occurred, without reduction to allow for regulation effects of upstream tributary reservoirs or for consumptive use by upstream irrigation and other purposes. Regulation criteria used in the 1881 reservoir design studies were based largely on hindsight, with little regard for downstream runoff conditions. Releases of approximately 100,000 cfs, at that time the non-damaging channel capacity, were assumed to be made from mid-April to mid-July from Fort Randall, with slightly lower releases from Garrison to Big Bend, without any requirement for reducing releases to desynchronize with downstream flood peaks. Based on this, the reservoir routed hydrographs for the 1881 flood were not used in the development of the statistically derived regulated inflow volume probability relationships. Incremental inflows were derived from the 1881 unregulated hydrographs and used in the development of the incremental inflow volume probability relationships where available.

Unregulated flow hydrographs were available for March through July 1881 at Fort Peck, Garrison, and Oahe, and March through April 1881 for Fort Randall. The Fort Peck hydrograph as constructed was used as the incremental inflow. For Garrison, Oahe, and Fort Randall incremental inflow hydrographs were developed by routing the upstream hydrographs downstream to the next location and then subtracting the routed hydrograph from the current location hydrograph to derive the incremental inflow into each of the three reservoirs. Incremental inflows were not derived for Big Bend or Gavins Point since hydrographs were not available. As was noted earlier, the 1881 event was considered the highest 5-month runoff period on record when the System was being designed in the 1940s. Since only 5 months (or 153 days) of data were available, it was only used on the 1-day through 120-day volume probability analysis for Fort Peck, Garrison, and Oahe and the 1-day through 60-day analysis at Fort Randall where only the March through April flood hydrograph was available.

C. The Flood of 2011

The 2011 flood event produced the largest volume of runoff for the Missouri River Basin (Basin) above Sioux City, Iowa (upper Basin) ever recorded (the keeping of continuous records started in 1898). The record runoff resulted from higher than normal plains and mountain snowpack along with record setting May rainfall in the upper basin. The impact of this record runoff was that the System used almost all its capacity to control flood water, set record releases at many of the System reservoirs and resulted in damage and disruption along the river. Gavins Point releases peaked at 160,700 cfs, over double the previous recorded peak release of 70,000

cfs in 1997. The peak release from Fort Randall was 160,000 cfs which far exceeded the 1881 design release of 100,000 cfs for that same project. The total annual runoff of 61.0 MAF at Sioux City, Iowa was almost 2.5 times normal. Prior to 2011, the highest annual runoff was 49.0 MAF in 1997. For the March through July runoff period, the 2011 flood event at this same location was 48.4 MAF. This exceeded the 1881 5-month volume by 20 percent, which, as noted earlier, was used in the design of the flood control portion of the system.

D. The Flood of 2019

The 2019 runoff summation for the upper Basin totaled 60.9 million acre-feet (MAF), 239 percent of average, based on the historical period of 1898-2018. The 2019 upper Basin runoff was the second highest runoff in 122 years of record-keeping, exceeded only in 2011. Runoff in 2019 in the upper Basin was caused by a series of hydrologic and weather events that occurred during the entire calendar year. The hydrologic factors that most influenced 2019 runoff were very wet and frozen soil conditions throughout the Missouri River Basin in early March, heavy plains snowpack in the upper Basin, and a series of large precipitation events, most notably the winter storm referred to as the 'bomb cyclone'. The 'bomb cyclone' generated heavy precipitation in Nebraska, southeastern South Dakota and western Iowa and was accompanied by rapidly warming temperatures that melted several inches of plains snow water equivalent (SWE) from March 13-15. The combination of events resulted in record flooding on a number of Missouri River Basin tributaries in Nebraska, South Dakota and Iowa, and on several locations of the Missouri River.

Reservoir inflows during the March 13-15 'bomb cyclone' reached 125,000 cfs into Gavins Point on March 14 with a 0 cfs release from Fort Randall, making March 14, 2019 the highest 1-day incremental inflow in the Gavins Point reach on record. During the spring and summer, heavy precipitation occurred periodically, causing high inflows to continue in the lower four reservoir reaches throughout the year. Record highest monthly runoff volumes occurred during a number of months in the lower four reaches. As a result, 2019 was the highest runoff year on record in the Garrison to Oahe reach, Oahe to Fort Randall reach, and Fort Randall to Gavins Point reach.

Reservoir outflows during 2019 were also very high due to the high volume of water that entered the System; therefore, regulated inflows at longer durations were also near record highs. Average monthly outflows from Oahe exceeded 50,000 cfs from July through November, and the maximum average monthly outflow was 64,900 cfs in November. This was greater than the 56,500 cfs maximum average monthly outflow released in 1997, but less than the 144,200 cfs maximum average monthly outflow released in 2011. The average monthly outflows from Fort Randall exceeded 60,000 cfs from June through November, and the maximum average monthly outflow was 75,000 cfs in October. This was greater than the 66,700 cfs maximum average monthly outflow in 1997, but less than the 156,000 cfs maximum average monthly outflow in 2011.

E. System Regulation

The System has been regulated as an integrated system since 1954, although it was not until 1967 that initial fill of the System was completed. During the period of initial fill, regulation of

the reservoirs was very atypical of regulation after the System was filled. In addition, during the period that the reservoirs have been regulated, regulation philosophy and criteria have been modified and past regulation does not entirely reflect current criteria. For example, beginning in 1986, special release considerations from Fort Randall and Gavins Point were required for threatened and endangered (T&E) least terns and piping plovers to accommodate nesting requirements during the summer months. The 2004 Master Manual revision increased water conservation during drought periods. The 2006 Master Manual incorporated the bi-modal spring pulse release from Gavins Point Dam for the benefit of the endangered pallid sturgeon. The 2018 Master Manual removed the bi-modal spring pulse release from Gavins Point Dam.

III. DATA ACQUISITION

As was discussed in the previous section, when developing hydrologic data for a study of this type, it should be recognized that System regulation criteria, available water supply, and characteristics of the System have changed and will not remain static through the years. Numerous refinements to regulation criteria have been made since System regulation first began. Water resource development in the Basin is a dynamic process with the greatest effects upon regulation of the System being depletions to the available water supply as development progresses. It is anticipated that some continued development could occur in the future. While the System is now considered to be constructed, modifications to project structures are always possible. All of these conditions could affect future probability estimates and hence, these relationships should be used with caution if significant changes are made to System regulation after this report is published.

Based on the changes to the System regulation since the System filled in 1967, the wholesale use of historic regulated data would not be appropriate for developing the regulated inflow volume probability relationships. However, use of long-term System regulation studies is one means of investigating a long-term period of hydrologic record and obtaining data that would be considered satisfactory for probability estimates.

A. Missouri River Reservoir System Planning Study Model

Computer model simulation studies have been used by the Missouri River Basin Water Management (MRBWM) office since the 1960s to simulate the regulation of the System using a long-term hydrologic record. The Daily Routing Model (DRM), the traditional computer model, was developed during the 1990s as part of the Master Manual Review and Update Study (Master Manual Review) to simulate and evaluate alternative System regulation for all of the authorized purposes under a widely varying long-term hydrologic record. The Missouri River Reservoir System Planning Study Model (ResSim Model), the successor to the DRM, uses incremental reservoir reach inflows, streamflow depletions, evaporation data and reservoir operating rules based on the 2018 Master Manual to simulate operations of the System for a period-of-record (POR), 1930-present. The ResSim Model was developed during the 2010s to conduct System planning studies. Depletions for each reach throughout the Basin were estimated by the U.S. Bureau of Reclamation (USBR) from 1930-present at the 2017 level-of-depletion development and applied to the model to calculate all flow records.

For the Master Manual Review, representative daily data were constructed from monthly records to cover the period from 1898 through 1929. As a result, a 100-year record of daily data, extending from 1898 through 1997, was used in evaluating alternatives for the USACE Final Environmental Impact Statement (FEIS). Since then, 23 more years have been added to the observed POR, including an extended drought period from 2000-2007 and historic flood years (2011 and 2019). Due to the additional years with varied runoff conditions and the nature of the estimated flow prior to 1930, current and future System regulation studies will rely solely on data from 1930-present.

Data simulated by the ResSim Model provides the valid probability estimates because:

1) The period of hydrologic records is far greater than the years of experience in System operation;
2) Hydrologic records used in the System operation studies can be adjusted to reflect a more current level of Basin water resource development; and
3) The ResSim Model utilizes a consistent set of reservoir regulation criteria throughout the period of record, based on the 2018 Master Manual.

While there are advantages to using a long-term study for development of probability estimates, it should also be recognized that the long-term studies do not entirely reflect regulation that may have occurred. Reasons for this include:

1) System regulation is extremely complex and precludes writing a computer model that totally simulates System operation, particularly during extreme runoff events;
2) Simplification of regulation criteria is necessary for the long-term studies; and
3) Models are not capable of fully forecasting runoff from plains and mountain snowpack conditions, as is done in real-time regulation. The deviations between historic regulation and model results may be greatest during the extreme events.

For the purposes of this study, the ResSim Model provides data at three locations (nodes) along river reaches between System reservoirs: Wolf Point and Culbertson, Montana, and Bismarck, North Dakota; and at each System project: Fort Peck, Garrison, Oahe, Big Bend, Fort Randall, and Gavins Point. The ResSim Model uses incremental flows between the reservoirs as input and simulates regulated flows into each reservoir.

1. Incremental Reservoir Inflow

Incremental flows represent the total inflow into the Missouri River between two stream gages or System reservoir projects. Incremental flows for the ResSim Model were developed using USGS gage records and data from the MRBWM database. A script associated with the ResSim Model calculates the incremental inflows using USGS gage data, total reservoir inflow, and reservoir outflow data. By means of the script, flows are routed upstream to downstream to calculate the incremental flow between each gage using routing parameters from the ResSim Model. Routing parameters in the ResSim Model were estimated during the DRM development and were verified multiple times during development of the ResSim Model. Although the routing parameters have been verified, they are calibrated for specific magnitudes of flows and some differences from actual incremental flows can occur. In developing the ResSim Model incremental dataset for study purposes, some smoothing was done using a centered-moving average. The period-averages associated with centered-moving average calculation varied between locations as well as for different periods.

2. Regulated Reservoir Inflows

Regulated reservoir inflows represent the total inflow into the System reservoirs, which is the sum of the upstream reservoir discharge and the incremental inflows. This dataset was generated by running the ResSim Model continuously from 1930-2019 with the incremental inflows and

ResSim operations set based on the 2018 Master Manual. Regulated inflows were relatively accurate in comparison to observed reservoir inflows for the 1967-2019 period for the Fort Peck, Garrison, and Oahe reaches. However, the regulated inflows differed substantially in many years in the Big Bend, Fort Randall, and Gavins Point reaches. The difference in regulated inflows was due in part to the design of the ResSim Model to more accurately estimate flood risk for the Missouri River Basin planning studies. The ResSim Model, based on scripted rule curves, calls for gradually increasing releases from Oahe rather than storing floodwater until very high releases are needed. A second factor is the absence of rate-of-change rules, allowing Oahe and reservoirs downstream to increase or decrease releases more rapidly than actual regulation. The result of this design is higher short duration regulated inflows for reservoirs below Oahe, which affects Big Bend significantly because there is very little reservoir storage in the Big Bend reservoir to manage the high inflows. The impact to Fort Randall is less significant due to its larger storage volume; however, any minor differences in discharge from Fort Randall can also have a significant effect on Gavins Point regulated inflows. For the lower three reservoirs, substitution of observed regulated inflows was performed in the years that observed data was available in order to improve the accuracy of the inflow volume probability analysis, particularly for short duration volumes.

As noted above, the criteria incorporated in the ResSim Model reflect current regulation criteria to the maximum extent possible. Although simulated by the ResSim Model fairly accurately in some extreme flood years, the actual reservoir releases in 2011 and 2019 were fine-tuned based on real-time requirements and regulation objectives (e.g., surcharging reservoirs, record project releases). In order to reflect actual operation of the reservoir projects during these significant high inflow events, modeled regulated data from 2011 and 2019 was replaced with observed data in all reservoir reaches with the exception of the Garrison modeled data, which was accurate during 2011 and 2019.

B. Data Analysis

As was noted earlier, this study examined both the regulated inflow into the reservoir as well as the incremental reservoir inflow. To develop the inflow volume-probability relationships, a statistical analysis consisted of using the maximum flow over several durations for each year of available flow records to derive the inflow volumes for the various probabilities ranging from 50 percent to 0.2 percent (recurrence intervals ranging from the 2-year through the 500-year). The different durations consisted of the maximum 1-day high flow for each year, the consecutive 3-day high flow for each year, the consecutive 7-day high flow, and so on, through the consecutive 183-day high flow for each year. For the purpose of this study, the durations were 1-, 3-, 7-, 15-, 30-, 60-, 90-, 120-, and 183-day consecutive periods during the greatest inflow.

The USACE Hydrologic Engineering Center's (HEC) Statistical Software Program (HEC-SSP) was used to plot the historical volume duration data and develop the 1- through 183-day volume probabilities for multiple return periods. To convert the annual maximum flow for each duration to a hypothetical flow for the 50 percent through 0.2 percent probability events (2-year through 500-year recurrence), the log-Pearson Type III distribution was used. The log-Pearson Type III distribution is the standard statistical method used for determining hypothetical flood events. The analysis consisted of 90 years (1930-2019) of simulated daily regulated and incremental inflows from the ResSim Model along with observed daily data from 2011 and

2019. In addition, the incremental inflow analysis included flows from the 1881 event for the 1-day through the 120-day analysis for Fort Peck, Garrison, and Oahe and for the 1-day through the 60-day analysis at Fort Randall, extending the historic POR to 139 years (1881-2019). Weibull plotting positions (probabilities) were determined from the POR and historical volume duration.

1. Statistical Smoothing

When the initial results from the HEC-SSP program were analyzed, it was observed that the probability curves at some of the sites were crossing (i.e., the 1 percent 60-day volumes were greater than the 1 percent 90-day volumes). This can occur in the unadjusted analytical probability curves, especially at the less frequent probabilities, such as 1 percent and 0.2 percent, because the curves at these probabilities are extrapolations past the volume-duration data plotting positions. The most common approach to correcting this is by adjusting the volume duration data mean, standard deviation, and skew statistics. The skew coefficients and standard deviations are plotted versus the mean volume duration data values for the 1-day through 183-day durations. The skew and standard deviations are smoothed using linear or polynomial regression or by graphically fitting smoothed curves. Graphs of the statistically smoothed parameters and the final statistical parameters are provided in **Appendix B**. Curve smoothing was not needed for the Big Bend regulated inflow standard deviation and skew and the Gavins Point regulated inflow skew. Since the problem of probability curves crossing typically occurs on the longer durations, the smoothing of the curves usually amounts to an insignificant volume change in the final analysis. After the curves were smoothed, adjusted standard deviations and skew coefficients were used to derive new analytical volume probabilities for various durations at each location for both, regulated and incremental inflows.

2. Graphical Adjustments

Since the regulated inflows can be highly influenced by the upstream reservoir, a visual check of the analytically derived curves and the plotted historical volume duration data was performed to assess the fit of the curve to the data for each reach. In the Big Bend, Fort Randall, and Gavins Point reaches, the regulated inflow analytical curves do not fit the observed inflow data at the infrequent, high inflow events at all volume durations, due to the greater contribution of high reservoir releases compared to the local inflow. The 2011 inflow is an example of the deviation from the analytical curve because high reservoir releases dominate the downstream reservoir inflows. For example, in the Big Bend reach, the maximum 1-day inflow from the incremental area was 39,600 cfs on June 21, 2011. The maximum 1-day regulated inflow for that day was 195,000 cfs, of which over 155,000 cfs was from the Oahe release.

In reaches where the local inflow can produce multiple floods that are nearly as large as the regulated inflow or make up a large portion of the regulated inflow, the analytical curves fit the observed data much better. This is the case for the Garrison and Oahe reaches. However, as the volume duration increased and the regulated release from the upstream reservoir became a larger part of the total inflow for the less frequent events, the analytical curves begin to diverge from the plotted historical data. In the Oahe reach, the analytical curves at the low probabilities deviate from the volume duration data from the 30-day duration to the 183-day duration. In the Big Bend, Fort Randall, and Gavins Point reaches, where the upstream reservoir release

comprised the majority of the total regulated inflow for the less frequent events, the analytical curves deviate from the volume duration data at the low probabilities (from 2 to 0.2 percent) for all durations.

In most cases, the maximum regulated inflow events occurred in 2011, which was the highest runoff volume in the 1898-2019 POR. The 2011 regulated inflows were greatly influenced by System regulation during 2011, which required record high reservoir releases in order to evacuate water from the exclusive flood control storage from the System and maintain flood control flexibility. These reservoir releases were as high as 160,000 cfs, and coincided with unregulated incremental inflow; therefore, regulated inflows during 2011 were usually higher than the upstream reservoir release. Since record high releases were made from the System reservoirs for over three months during 2011, the 2011 regulated inflows are typically the maximum duration volumes for the 15-day to 183-day durations from the reaches extending from Garrison to Gavins Point.

In reaches where the regulated inflow analytical curves do not fit the observed data plotting positions for the low-probability inflows, curves were graphically fit to the historical data plotting positions. In the reservoir reaches from Garrison to Gavins Point, the 2011 volume plotting positions deviated substantially from the analytical curves. Drawing graphically fit curves through the 2011 volume plotting positions resulted in very high inflow volumes, at probabilities from 1 percent to 0.2 percent. Consistent with the method used in the 2015 report, the 2011 duration volume probabilities were adjusted based on the probability of the 2011 annual runoff summation above Sioux City. The 2011 runoff summation probability was previously determined in a post-2011 flood analysis "*Frequencies of the Upper Missouri Basin Runoff in 2011*". The inflow probability curves have been updated with reservoir inflow data from 2012 to 2019, and are tabulated in **Appendix E**. The 2019 runoff volume was 60.9 MAF, just 0.1 MAF less than the record 2011 volume. The result of the annual runoff volume analysis was an increase in the probability of the runoff volumes similar to the 2011 and 2019 volumes. The probability for the 2011 annual runoff volume changed from a range of 0.2 to 0.1 percent (500- to 1000-year recurrence interval) to 0.5 to 0.2 percent (200- to 500-year recurrence interval). The updated five-month (March-July) probability plotted in a range of 0.2 to 0.1 percent (500- to 1000-year recurrence interval). Based on the updated analysis, the probability of 0.5 percent (200-year recurrence interval) was used as the plotting position for the 2011 maximum regulated inflow for all durations where the analytical curve did not fit the historical regulated inflow data. For the reaches from Garrison to Gavins Point, the graphical curves were fit to the 2011 duration volumes plotted at the 0.5 percent probability. The resulting volume probability magnitudes for the graphically fit curves in the current study plot slightly higher than the 2015 study.

The results from the updated analysis include the volume probability relationships at all reservoir projects as shown on **Plate 2** through **Plate 34** plotted against the period-of-record peak inflow for regulated and incremental inflows. The analytical curves in combination with the graphical curves, where applicable, are the adopted volume probabilities.

A tabular listing of the adopted volume probabilities by project for regulated and incremental inflows are shown in **Appendix A**. The graphical representations and table of the smoothed standard deviations and skews are shown in **Appendix B**. A listing of the annual peak inflows

derived from this analysis for the different durations are listed in **Appendix C** and **Appendix D** for the regulated and incremental inflows, respectively. Specific results of the analysis for each of the reservoir projects are discussed in the next section.

IV. FORT PECK

A. Historical Data

Historical records for Fort Peck (Fort Peck Lake) reservoir inflows date back to 1937 when Fort Peck Dam was closed. It was not until the six-project System filled in June 1967 that the records reflected normal System regulation. During the period of 1967 through 2019, the average daily inflows into Fort Peck have ranged from a low of 1,000 cfs on 17 separate occasions to a high of 160,000 cfs on September 25, 1986. Historical daily maximum, minimum, and mean values of reservoir inflows for each month are listed in **Table 2.**

Table 2
Fort Peck Historical Regulated Inflows (1967-2019)

	Daily Reservoir Inflow by Month (cfs)				
Month	**Mean**	**Maximum**	**Year**	**Minimum**	**Year**
January	7,100	20,000	1974	1,000	2012
February	8,600	65,000	1986	1,000	1989, 2006
March	11,800	140,000	1978	2,000	2003
April	10,500	50,000	1978	3,000	2005
May	15,900	91,000	2011	3,000	2002
June	19,500	101,000	2011	2,000	1977
July	11,900	65,000	1975	2,000	1977
August	7,900	100,000	2014	3,000	multiple
September	7,700	160,000	1986	3,000	multiple
October	7,400	53,000	2016	2,000	2013
November	7,200	15,000	1975	2,000	multiple
December	6,600	15,500	1975	0	2016
Average	10,100				

B. Inflow Volume Probability Analysis

Inflow volume probability relationships for regulated inflows were developed using the ResSim Model data adjusted to the 2017 depletion level from 1930 to 2019 (90 years). In addition, the 1-day through 120-day runoff data for the 1881 event (March through July) were included in the inflow volume probability analysis, which extended the historic period to 139 years. The 2015 study provided inflow volume probability relationships for incremental and regulated inflows to Fort Peck Dam derived from the DRM model. Since only minor differences between the incremental and regulated inflow volume probabilities were evident; this study does not include volume probabilities for both regulated and incremental inflows. The inflow volume probability relationships in the current analysis for Fort Peck are regulated inflows, which are comprised of regulated releases from USBR reservoirs and incremental inflows from the USBR reservoirs to Fort Peck.

Plate 2 through **Plate 4** show the analytically fit curves for the 1-, 3-, 7-, 15-, 30-, 60-, 90-, 120-, and 183-day duration values over the 90-year period. **Table 3** compares the results of the

current analysis with the 2015 study for the 1- and 15-day durations. Inflows greater than 100 thousand cfs (kcfs) were rounded to the nearest kcfs. Inflows less than 100 kcfs were rounded to the nearest 0.1 kcfs. The inflow volume probabilities for all durations are tabulated in **Appendix A**. The smoothing of skew coefficient of logarithms and standard deviation of logarithms are plotted in **Appendix B** along with a table of the smoothed statistics. Annual duration flow volumes for the consecutive 1-day through 183-day regulated inflows are tabulated in **Appendix C**.

Table 3
Fort Peck Regulated Inflow Volume Probabilities
for 1-Day and 15-Day Durations
2020 Study POR: 1881, 1930-2019

Percent Chance Exceedance	Average Daily Inflow in 1000 cfs			
	2015 Study		2020 Study	
	1-Day	15-Day	1-Day	15-Day
0.2	212	110	224	114
1.0	144	83.5	157	83.9
2.0	119	72.7	132	72.4
4.0	97.2	62.2	109	61.5
10.0	71.7	48.6	80.9	47.9
20.0	54.5	38.3	61.6	38.0
50.0	33.0	24.0	37.1	24.7
90.0	16.5	11.4	17.5	13.1

V. GARRISON

A. Historical Data

Historical records for Garrison (Lake Sakakawea) reservoir inflows date back to 1953 when Garrison Dam was first closed. It was not until the System filled in June 1967 that the records reflected normal System regulation. During the period of 1967 through 2019, the average daily inflows into Garrison have ranged from a low of 1,000 cfs on 15 separate occasions to a high of 190,000 cfs on June 13, 2011. Historical daily maximum, minimum and mean values of reservoir inflows for each month are listed in **Table 4**.

Table 4
Garrison Historical Regulated Inflows (1967-2019)

	Daily Reservoir Inflow by Month (cfs)				
Month	**Mean**	**Maximum**	**Year**	**Minimum**	**Year**
January	15,100	30,000	1975	1,000	1988
February	18,400	71,500	1971	6,000	2002, 2009
March	26,800	180,000	1972	4,000	2010
April	23,500	160,000	1979	7,000	2005, 2008
May	30,500	168,000	2011	5,000	2002
June	48,800	190,000	2011	11,000	1987
July	33,500	150,000	2011	4,000	1988
August	18,800	72,000	2011	5,000	1988, 2010
September	17,400	55,000	1986	5,000	1988, 1992
October	17,600	41,000	1971	7,000	multiple
November	16,200	39,000	1997	1,000	2000
December	14,000	31,000	1997	1,000	multiple
Average	23,300				

B. Inflow Volume Probability Analysis

Inflow volume probability relationships for regulated and incremental inflows were developed using the ResSim Model data adjusted to the 2017 depletion level from 1930 to 2019. A smoothed incremental inflow time series from the ResSim Model analysis was used for the incremental volume probability analysis, because some of the peak unsmoothed incremental inflows were higher than the peak regulated inflows from the ResSim Model. The smoothed incremental inflow time series was smoothed using a three-day center-moving-average. In addition to the ResSim Model data, the 1-day through 120-day runoff data for the 1881 event was included with the incremental inflow volume analysis, which extended the historic period of record to 139 years for those durations. Finally, no observed daily inflow data was substituted into the analysis time series.

Plate 5 through **Plate 10** show the final curves for the analytically fit and the graphically fit curves, where applicable. Graphically fit curves were plotted at all durations for the regulated

inflow volume probability relationships for the high volume, lower probability portions of the curve. For the 1-day through 7-day durations, graphical curves were plotted through the plotting positions; and, for the 15-day through 183-day durations, the graphical curves were plotted through the 2011 volumes at the 0.5 percent probability (200-year return period). For the incremental volume probabilities, graphical curves were plotted through the plotting positions for the high volume, lower probability portions of the curves. **Table 5** and **Table 6** compare the results of the current analysis with the 2015 study for the 1-day and 15-day durations for the regulated and incremental inflows, respectively. The regulated and incremental inflow volume probabilities for all durations are tabulated in **Appendix A**. The smoothing of skew coefficient of logarithms and standard deviation of logarithms are plotted in **Appendix B** along with a table of the smoothed statistics. Annual duration flow volumes for the consecutive 1-day through 183-day regulated and incremental inflows are tabulated in **Appendix C** and **Appendix D**, respectively.

Table 5
Garrison Regulated Inflow Volume Probabilities
for 1-Day and 15-Day Durations
2020 Study POR: 1930-2019

Percent Chance Exceedance	Average Daily Inflow in 1000 cfs			
	2015 Study		2020 Study	
	1-Day	15-Day	1-Day	15-Day
0.2	412	195	490	205
1.0	267	149	325	152
2.0	219	131	265	132
4.0	178	114	210	115
10.0	133	92.2	146	93.7
20.0	104	76.2	114	78.5
50.0	69.2	53.9	75.2	56.2
90.0	44.3	33.3	45.9	34.4

Table 6
Garrison Incremental Inflow Volume Probabilities
for 1-Day and 15-Day Durations
2020 Study POR: 1881, 1930-2019

Percent Chance Exceedance	Average Daily Inflow in 1000 cfs			
	2015 Study		2020 Study	
	1-Day	15-Day	1-Day	15-Day
0.2	414	147	430	155
1.0	259	123	280	124
2.0	210	112	228	112
4.0	169	101	183	98.7
10.0	128	87.6	129	81.4
20.0	97.1	72.4	101	67.9
50.0	65.8	52.3	65.4	47.6
90.0	44.5	30.8	37.9	27.3

VI. OAHE

A. Historical Data

Historical records for Oahe (Lake Oahe) reservoir inflows date back to 1958 when Oahe Dam was first closed. It was not until the System filled in June 1967 that the records reflected normal System regulation. During the period of 1967 through 2019, the average daily inflows into Oahe have ranged from a low of 500 cfs on December 22-23, 1990 to a high of 210,000 cfs on June 21, 2011. Historical daily maximum, minimum and mean values of reservoir inflows for each month are listed in **Table 7.**

Table 7
Oahe Historical Regulated Inflows (1967-2019)

	Daily Reservoir Inflow by Month (cfs)				
Month	**Mean**	**Maximum**	**Year**	**Minimum**	**Year**
January	22,500	40,000	1973	5,000	1975
February	26,600	80,000	2009	9,000	2002
March	30,800	204,000	1987	6,800	1968
April	27,400	160,000	2009	8,000	1968, 1991
May	28,900	130,000	1996	7,000	2008
June	31,600	210,000	2011	9,000	2005
July	29,700	153,000	2011	10,000	2008, 2010
August	27,500	115,000	2011	9,000	2009, 2010
September	23,400	69,000	2011	9,000	multiple
October	21,200	84,000	2019	8,000	2003, 2007
November	21,600	55,000	2019	3,000	2007
December	20,100	40,000	1977	500	1990
Average	25,900				

B. Inflow Volume Probability Analysis

Inflow volume probability relationships for regulated and incremental inflows were developed using the ResSim Model data adjusted to the 2017 depletion level from 1930 to 2019. A smoothed incremental inflow time series from the ResSim Model analysis was used for the incremental volume probability analysis, because some of the peak unsmoothed inflows were higher than the peak regulated inflows from the ResSim Model. The smoothed incremental inflow time series was smoothed using a three-day center-moving-average method. In addition to the ResSim Model data, the 1-day through 120-day runoff data for the 1881 event was included with the incremental inflow volume analysis, which extended the historic period of record to 139 years for those durations. In the regulated inflow time series, daily MRBWM observed inflow data was substituted for the simulated ResSim Model regulated inflow data in order to improve the accuracy of the duration volumes in the years 1975, 1997, 2011, and 2019, which were high flow flood years.

Plate 11 through **Plate 16** show the final curves for the analytically fit and the graphically fit curves, where applicable. For the regulated inflows, graphically fit curves were adopted for the

30-day through 183-day durations. The graphically fit curves were drawn through the observed 2011 duration volumes at the 0.5 percent probability (200-year return period). The incremental analytical curves fit the duration volume plotting positions well, so graphical curves were not necessary. **Table 8** and **Table 9** compare the results of the current analysis with the 2015 study for the 1-day and 15-day durations for the regulated and incremental inflows, respectively. The regulated and incremental inflow volume probabilities for all durations are tabulated in **Appendix A**. The smoothing of skew coefficient of logarithms and standard deviation of logarithms are plotted in **Appendix B** along with a table of the smoothed statistics. Annual duration flow volumes for the consecutive 1-day through 183-day regulated and incremental inflows are tabulated in **Appendix C** and **Appendix D**, respectively.

Table 8
Oahe Regulated Inflow Volume Probabilities
for 1-Day and 15-Day Durations
2020 Study POR: 1930-2019

Percent Chance Exceedance	Average Daily Inflow in 1000 cfs			
	2015 Study		2020 Study	
	1-Day	15-Day	1-Day	15-Day
0.2	369	178	491	258
1.0	222	121	294	164
2.0	177	103	233	133
4.0	141	86.1	182	107
10.0	102	67.7	128	79.3
20.0	78.6	55.6	95.3	61.6
50.0	53.0	41.3	58.7	41.1
90.0	36.5	31.1	34.1	26.7

Table 9
Oahe Incremental Inflow Volume Probabilities
for 1-Day and 15-Day Durations
2020 Study POR: 1881, 1930-2019

Percent Chance Exceedance	Average Daily Inflow in 1000 cfs			
	2015 Study		2020 Study	
	1-Day	15-Day	1-Day	15-Day
0.2	365	174	460	231
1.0	217	109	287	142
2.0	170	86.3	228	112
4.0	129	67.0	177	85.9
10.0	86.3	45.4	119	57.1
20.0	59.8	31.7	82.3	39.0
50.0	30.7	16.1	40.9	18.9
90.0	12.1	6.0	14.2	6.3

VII. BIG BEND

A. Historical Data

Historical records for Big Bend (Lake Sharpe) reservoir inflows date back to 1963 when Big Bend Dam was first closed. It was not until the System filled in June 1967 that the records reflected normal System regulation. During the period of 1967 through 2019, the average daily inflows into Big Bend have ranged from a low of 0 cfs on many occasions to a high of 195,000 cfs on June 21, 2011. Historical daily maximum, minimum and mean values of reservoir inflows for each month are listed in **Table 10.**

Table 10
Big Bend Historical Regulated Inflows (1967-2019)

	Daily Reservoir Inflow by Month (cfs)				
Month	**Mean**	**Maximum**	**Year**	**Minimum**	**Year**
January	20,500	59,000	1976	1,000	1979
February	18,100	45,000	1981	500	1974, 1977
March	18,700	64,000	1997	0	2008, 2010
April	21,500	65,000	1997	500	1978, 1979
May	22,500	83,000	2011	0	2001
June	27,300	195,000	2011	0	2008
July	30,700	155,000	2011	0	2008
August	33,300	133,000	2011	0	1993
September	29,700	78,000	2011	0	1993
October	24,400	64,000	2019	500	1977
November	23,300	65,000	2019	0	1974
December	20,500	65,000	2019	300	1973, 1976
Average	24,300				

B. Inflow Volume Probability Analysis

Inflow volume probability relationships for regulated and incremental inflows were developed using the ResSim Model data adjusted to the 2017 depletion level from 1930 to 2019. An unsmoothed incremental inflow time series from the ResSim Model was used in the incremental volume probability analysis. There was no incremental flood hydrograph available for the 1881 event at Big Bend. The incremental inflows exhibited numerous periods of time when flows were below zero. Below-zero flows could not be used in the probability analysis because all analyzed data is log-transformed and fit to the log-Pearson Type III distribution. Therefore, the below-zero duration volumes were omitted from the analysis. These omissions from the record shortened the analysis period from 90 years of data to a minimum of 70 years of data at the 183-day duration. Fewer years were omitted from the record at shorter durations. Despite the shorter number of data years at the longer durations, there was adequate data to perform the incremental volume probability analysis.

The regulated inflow time series for Big Bend was smoothed with a 13-day center-moving-average; however, while the ResSim Model regulated inflow is valid for determining the effects of System regulation, Big Bend's observed data is more representative of the regulated inflows needed for this study. The daily MRBWM observed inflow data was substituted for the simulated ResSim Model regulated inflow data from 1964-2019. ResSim Model regulated inflow was used from 1930-1963.

Plate 17 through **Plate 22** show the final curves for the analytically fit and the graphically fit curves, where applicable. Graphically fit curves were adopted for the 1-day through 183-day regulated inflows. The graphically fit curves were drawn through the observed 2011 duration volumes at the 0.5 percent probability (200-year return period). The incremental analytical curves fit the duration volume plotting positions well, so graphical curves were not necessary. **Table 11** and **Table 12** compare the results of the current analysis with the 2015 study for the 1-day and 15-day durations for the regulated and incremental inflows, respectively. The regulated and incremental inflow volume probabilities for all durations are tabulated in **Appendix A**. The smoothing of skew coefficient of logarithms and standard deviation of logarithms are plotted in **Appendix B** along with a table of the smoothed statistics. Annual duration flow volumes for the consecutive 1-day through 183-day regulated and incremental inflows are tabulated in **Appendix C** and **Appendix D**, respectively.

Table 11
Big Bend Regulated Inflow Volume Probabilities
for 1-Day and 15-Day Durations
2020 Study POR: 1930-2019

Percent Chance Exceedance	Average Daily Inflow in 1000 cfs			
	2015 Study		2020 Study	
	1-Day	15-Day	1-Day	15-Day
0.2	195	159	280	220
1.0	103	85.5	145	120
2.0	75.0	63.0	112	93.0
4.0	63.0	58.0	86.9	73.4
10.0	58.0	51.7	68.4	59.1
20.0	53.5	46.2	56.6	49.3
50.0	46.0	37.4	42.9	37.2
90.0	43.9	29.7	33.8	27.7

Table 12
Big Bend Incremental Inflow Volume Probabilities
for 1-Day and 15-Day Durations
2020 Study POR: 1930-2019

Percent Chance Exceedance	Average Daily Inflow in 1000 cfs			
	2015 Study		2020 Study	
	1-Day	15-Day	1-Day	15-Day
0.2	71.9	26.7	73.9	31.7
1.0	43.0	15.0	51.0	18.9
2.0	33.6	11.3	42.1	14.5
4.0	25.6	8.4	33.8	10.8
10.0	17.0	5.3	23.6	6.8
20.0	11.7	3.5	16.6	4.3
50.0	5.9	1.6	8.1	1.8
90.0	2.2	0.5	2.4	0.4

VIII. FORT RANDALL

A. Historical Data

Historical records for Fort Randall (Lake Francis Case) reservoir inflows date back to 1952 when Fort Randall Dam was first closed. It was not until the System filled in June 1967 that the records reflected normal System operation. During the period of 1967 through 2019, the average daily inflows into Fort Randall have ranged from a low of 0 cfs on many occasions to a high of 218,000 cfs on June 21, 2011. Historical daily maximum, minimum and mean values of reservoir inflows for each month are listed in **Table 13.**

Table 13
Fort Randall Historical Regulated Inflows (1967-2019)

	Daily Reservoir Inflow by Month (cfs)				
Month	**Mean**	**Maximum**	**Year**	**Minimum**	**Year**
January	22,100	63,000	1976	900	1982
February	20,200	60,000	1997	0	several
March	21,900	100,000	1978	0	several
April	24,200	80,000	1997	0	several
May	25,800	100,000	2011	0	several
June	30,300	218,000	2011	0	several
July	32,100	167,000	2011	0	several
August	34,700	141,000	2011	0	1993
September	30,600	115,000	2019	0	several
October	24,200	67,000	1975, 1997	0	several
November	23,300	74,000	2019	0	several
December	21,500	68,000	2019	0	1976
Average	26,000				

B. Inflow Volume Probability Analysis

Inflow volume probability relationships for regulated and incremental inflows were developed using the ResSim Model data adjusted to the 2017 depletion level from 1930 to 2019. A smoothed incremental inflow time series from the ResSim Model analysis was used in the incremental volume probability analysis, because some of the peak unsmoothed inflows prior to closure of the Mainstem System were higher than the peak regulated inflows. The smoothed incremental inflow time series was smoothed using a three-day center-moving-average method. In addition to the ResSim Model data, the 1-day through 30-day runoff for the 1881 event was included with the incremental inflow volume analysis, which extended the historic period of record to 139 years for those durations.

The regulated inflow time series for Fort Randall was also smoothed with a 15-day center-moving-average because numerous 1-day to 15-day flow duration volumes were higher than the observed volumes. Additionally, the longer-term duration volumes exceeded the observed duration volumes during the observed period. To mitigate the over-estimation of inflows from the ResSim Model data, the daily MRBWM observed inflow data was substituted for the ResSim

Model regulated inflow data from 1953-2019. ResSim Model regulated inflow was used from 1930-1952, including the unsmoothed daily data for 1952.

Plate 23 through **Plate 28** show the final curves for the analytically fit and the graphically fit curves, where applicable. Graphically fit curves were adopted for the 1-day through 183-day regulated inflows. The graphically fit curves were drawn through the observed 2011 duration volumes at the 0.5 percent probability (200-year return period). The incremental analytical curves fit the duration volume plotting positions well, so graphical curves were not necessary. **Table 14** and **Table 15** compare the results of the current analysis with the 2015 study for the 1-day and 15-day durations for the regulated and incremental inflows, respectively. The regulated and incremental inflow volume probabilities for all durations are tabulated in **Appendix A**. The smoothing of skew coefficient of logarithms and standard deviation of logarithms are plotted in **Appendix B** along with a table of the smoothed statistics. Annual duration flow volumes for the consecutive 1-day through 183-day for regulated and incremental inflows are tabulated in **Appendix C** and **Appendix D**, respectively.

Table 14
Fort Randall Regulated Inflow Volume Probabilities
for 1-Day and 15-Day Durations
2020 Study POR: 1930-2019

Percent Chance Exceedance	Average Daily Inflow in 1000 cfs			
	2015 Study		2020 Study	
	1-Day	15-Day	1-Day	15-Day
0.2	218	180	295	260
1.0	140	97.0	175	135
2.0	112	72.0	137	102
4.0	85.0	65.0	108	78.6
10.0	74.0	56.0	79.9	60.8
20.0	65.0	48.7	65.6	49.8
50.0	50.8	37.2	49.2	37.4
90.0	44.1	30.7	38.5	29.8

Table 15
Fort Randall Incremental Inflow Volume Probabilities
for 1-Day and 15-Day Durations
2020 Study POR: 1881, 1930-2019

Percent Chance Exceedance	Average Daily Inflow in 1000 cfs			
	2015 Study		2020 Study	
	1-Day	15-Day	1-Day	15-Day
0.2	112	43.8	108	49.8
1.0	71.8	27.7	80.1	34.0
2.0	58.0	22.3	68.9	28.2
4.0	46.1	17.6	58.0	23.0
10.0	32.7	12.4	44.0	16.7
20.0	24.0	9.1	33.5	12.5
50.0	13.9	5.2	19.4	7.2
90.0	6.6	2.5	7.8	3.2

IX. GAVINS POINT

A. Historical Data

Historical records for Gavins Point (Lewis and Clark Lake) reservoir inflows date back to 1955 when Gavins Point Dam was first closed. It was not until the System filled in June 1967 that the records reflected normal System regulation. During the period of 1967 through 2019, the average daily inflows into Gavins Point have ranged from a low of 2000 cfs on March 3, 2007 to a high of 168,000 cfs on June 27, 2011. Historical daily maximum, minimum and mean values of reservoir inflows for each month are listed in **Table 16.**

Table 16
Gavins Point Historical Regulated Inflows (1967-2019)

	Daily Reservoir Inflow by Month (cfs)				
Month	**Mean**	**Maximum**	**Year**	**Minimum**	**Year**
January	17,600	32,000	1987, 1998	5,000	1975
February	16,600	50,000	1997	5,000	1982
March	19,900	125,000	2019	2,000	2007
April	25,700	62,000	2019	4,000	1993
May	29,300	78,000	2019	3,000	2007
June	32,600	168,000	2011	5,000	2014
July	35,600	164,000	2011	4,000	1993
August	37,400	154,000	2011	5,000	1993
September	37,500	93,000	2011	14,000	2008
October	35,600	82,000	2019	5,000	2007
November	32,300	82,000	2019	5,000	1992
December	19,800	71,000	2019	6,000	1973, 2008
Average	28,400				

B. Inflow Volume Probability Analysis

Inflow volume probability relationships for regulated and incremental inflows were developed using the ResSim Model data adjusted to the 2017 depletion level from 1930 to 2019. A smoothed incremental inflow time series from the ResSim Model analysis was used in the incremental volume probability analysis, because some of the peak unsmoothed inflows prior to closure of the Mainstem System were higher than the peak regulated inflows. The smoothed incremental inflow time series was smoothed using a three-day center-moving-average method. There was no incremental flood hydrograph available for the 1881 event at Gavins Point.

The regulated inflow time series for Gavins Point was also smoothed with a 9-day center-moving-average; however, the ResSim Model overpredicted many inflows over the period of simulation record for both short and long durations. To mitigate the over-estimation of inflows from the ResSim Model data, the daily MRBWM observed inflow data was substituted for the ResSim Model regulated inflow data from 1963-2019. ResSim Model regulated inflow was used from 1930-1962, including the unsmoothed daily data for 1952.

Plate 29 through **Plate 34** show the final curves for the analytically fit and the graphically fit curves, where applicable. Graphically fit curves were adopted for the 1-day through 183-day regulated inflows. The graphically fit curves were drawn through the observed 2011 duration volumes at the 0.5 percent probability (200-year return period). The incremental analytical curves fit the duration volume plotting positions well, so graphical curves were not necessary.

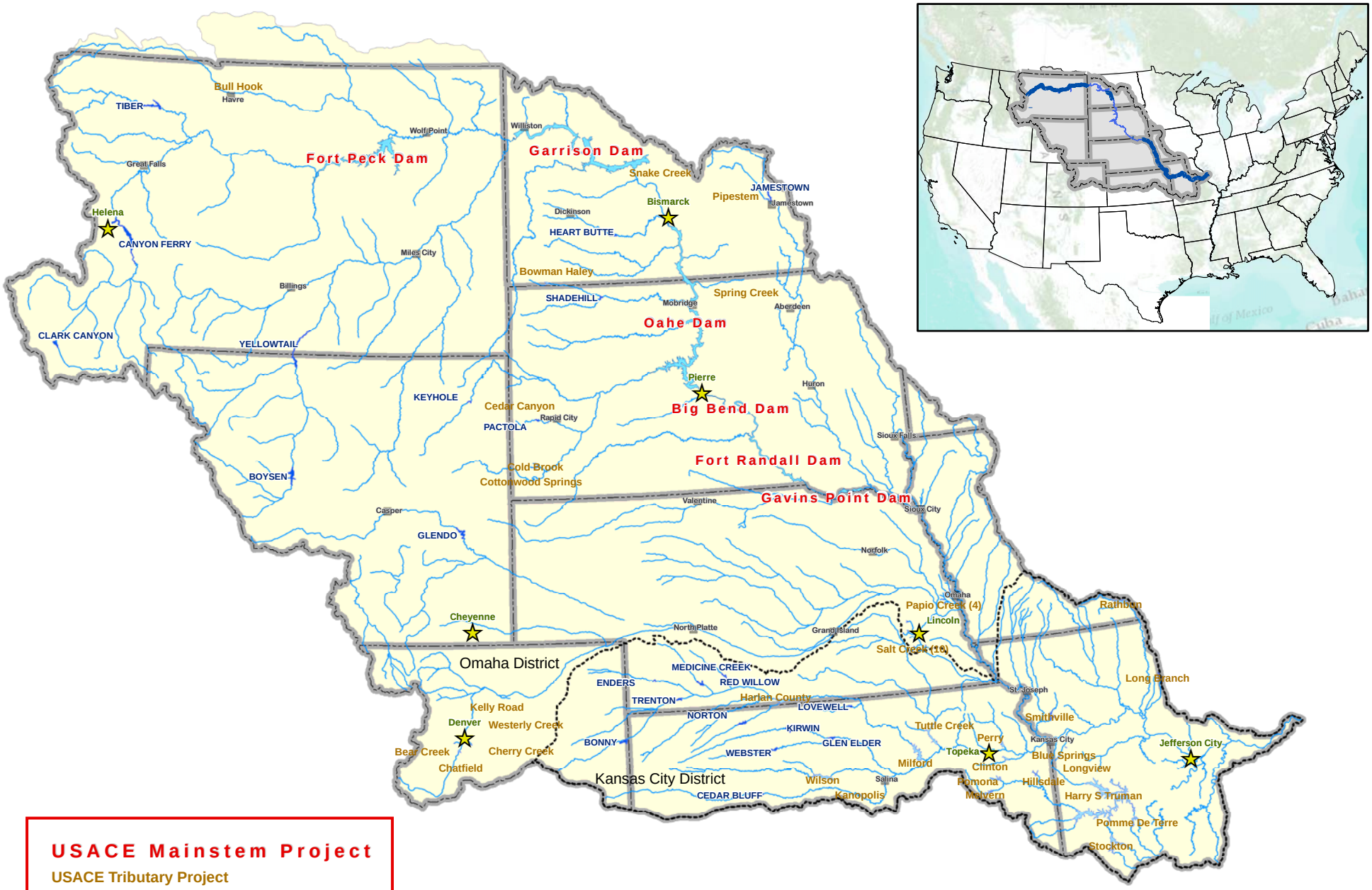
Table 17 and **Table 18** compare the results of the current analysis with the 2015 study for the 1-day and 15-day durations for the regulated and incremental inflows, respectively. The regulated and incremental inflow volume probabilities for all durations are tabulated in **Appendix A**. The smoothing of skew coefficient of logarithms and standard deviation of logarithms are plotted in **Appendix B** along with a table of the smoothed statistics. Annual duration flow volumes for the consecutive 1-day through 183-day for regulated and incremental inflows are tabulated in **Appendix C** and **Appendix D**, respectively.

Table 17
Gavins Point Regulated Inflow Volume Probabilities
for 1-Day and 15-Day Durations
2020 Study POR: 1930-2019

Percent Chance Exceedance	Average Daily Inflow in 1000 cfs			
	2015 Study		2020 Study	
	1-Day	15-Day	1-Day	15-Day
0.2	168	161	240	225
1.0	97.0	90.0	130	118
2.0	74.0	68.0	103	90.0
4.0	69.0	62.0	82.1	74.7
10.0	61.0	54.5	64.3	59.3
20.0	54.5	47.5	53.1	49.2
50.0	44.1	36.8	40.4	37.3
90.0	36.2	29.7	32.6	28.9

Table 18
Gavins Point Incremental Inflow Volume Probabilities
for 1-Day and 15-Day Durations
2020 Study POR: 1930-2019

Percent Chance Exceedance	Average Daily Inflow in 1000 cfs			
	2015 Study		2020 Study	
	1-Day	15-Day	1-Day	15-Day
0.2	86.4	30.4	123	48.9
1.0	57.6	21.3	69.0	30.1
2.0	47.6	18.0	53.0	24.1
4.0	38.7	15.0	40.3	19.1
10.0	28.5	11.5	27.2	13.7
20.0	21.7	9.0	19.6	10.3
50.0	13.4	5.9	11.6	6.4
90.0	7.1	3.4	6.5	3.8



USACE Mainstem Project

USACE Tributary Project

USBR SECTION 7 PROJECT

★ State Capitol

-------- District Boundary

Missouri River Basin
Federal Reservoir Projects

U.S. Army Engineer Division, Northwestern
Corps of Engineers, Omaha, Nebraska
December 2020

Plate 1

Fort Peck - Regulated Inflow
1-, 3-, 7-Day Volume Probability

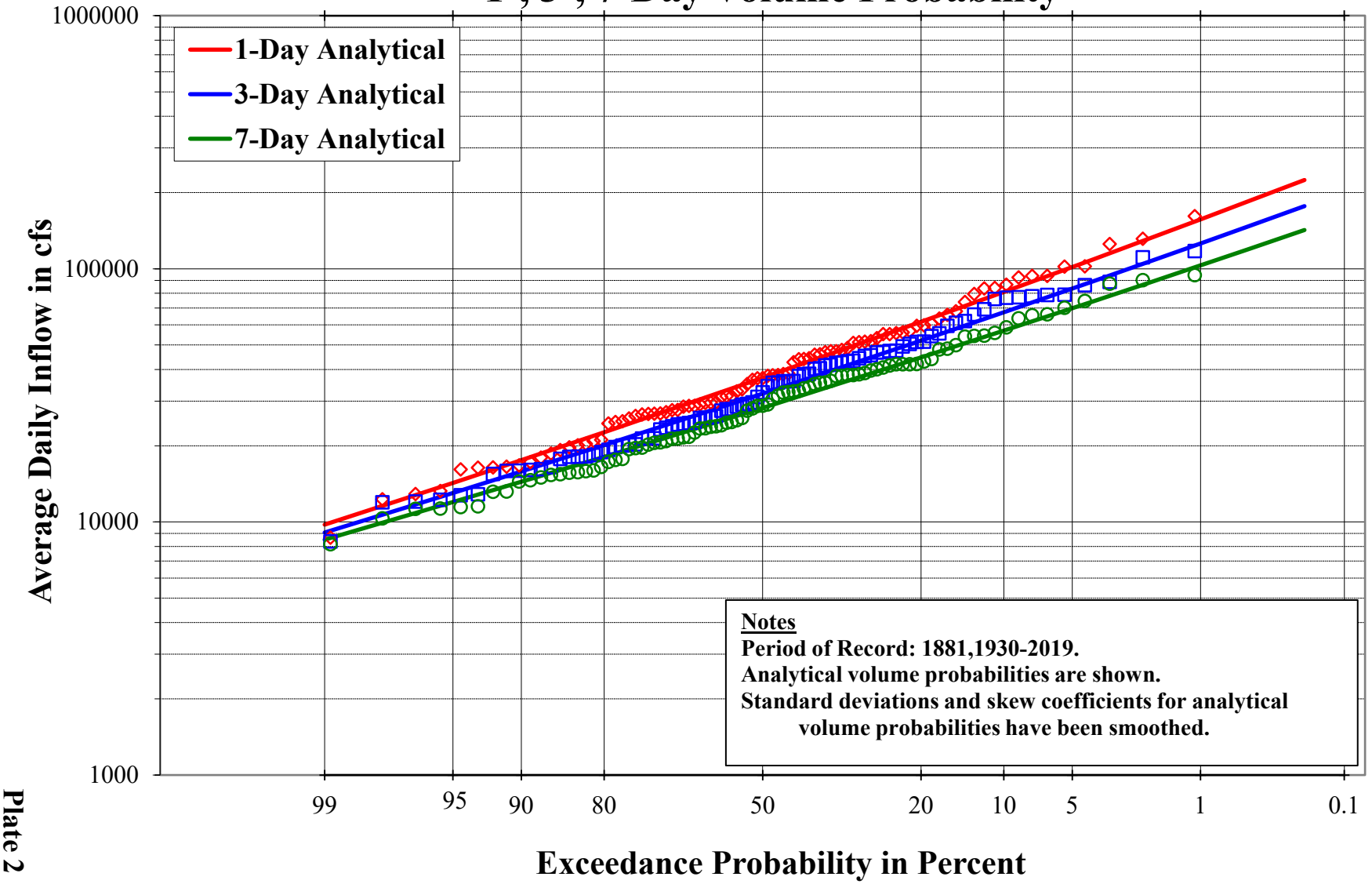


Plate 2

Fort Peck - Regulated Inflow
15-, 30-, 60-Day Volume Probability

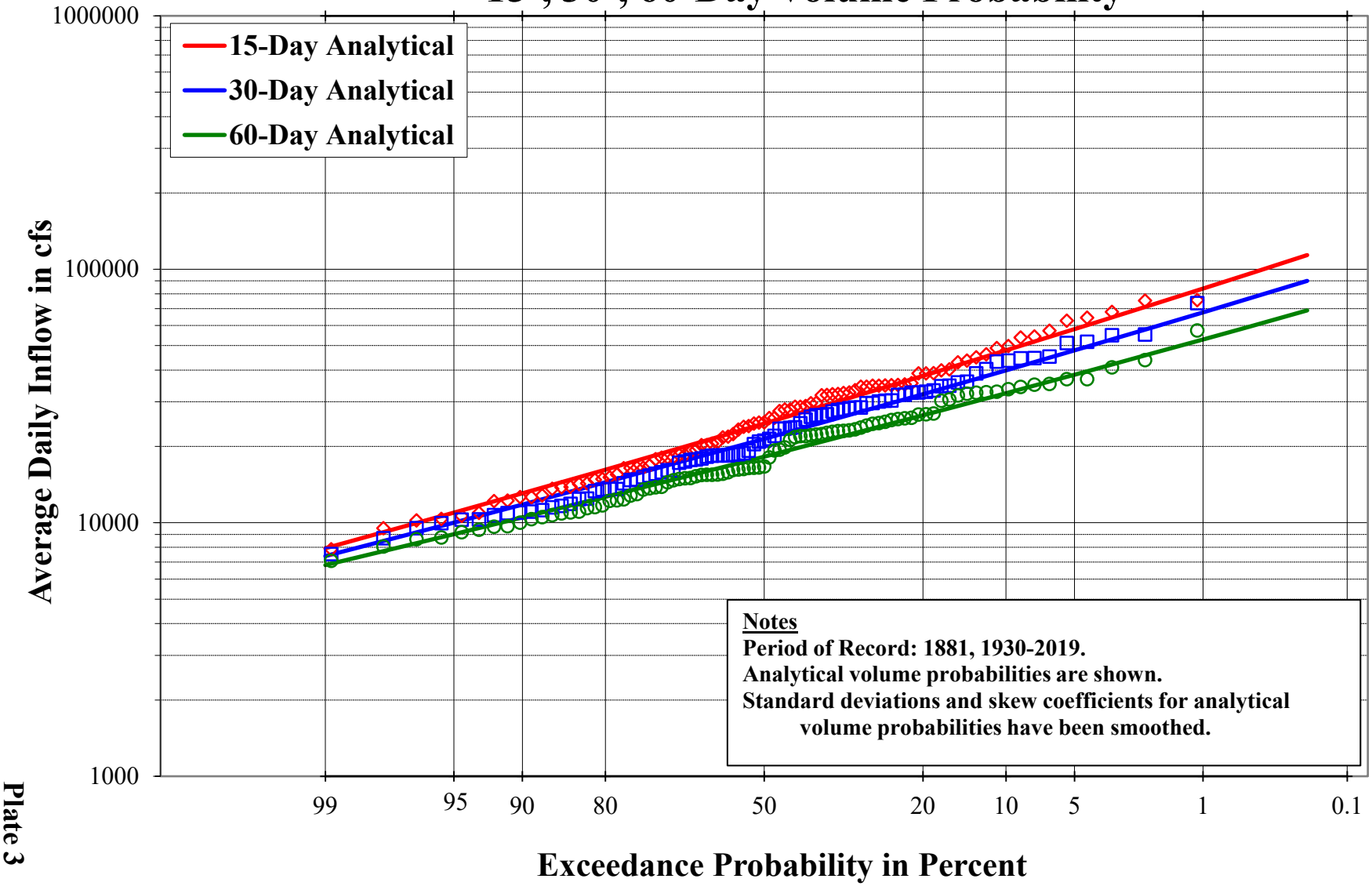


Plate 3

Fort Peck - Regulated Inflow
90-, 120-, 183-Day Volume Probability

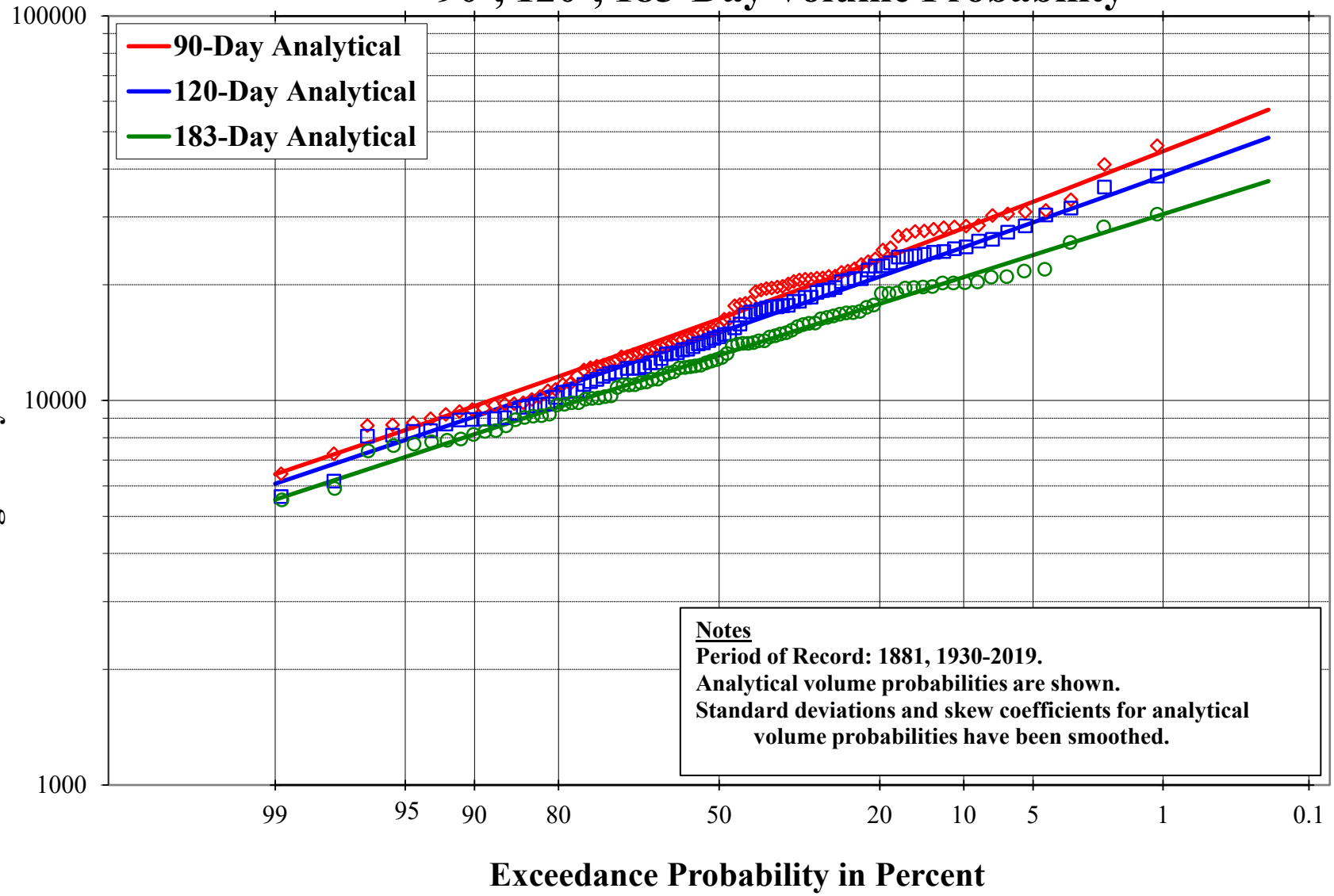


Plate 4

Garrison - Regulated Inflow
1-, 3-, 7-Day Volume Probability

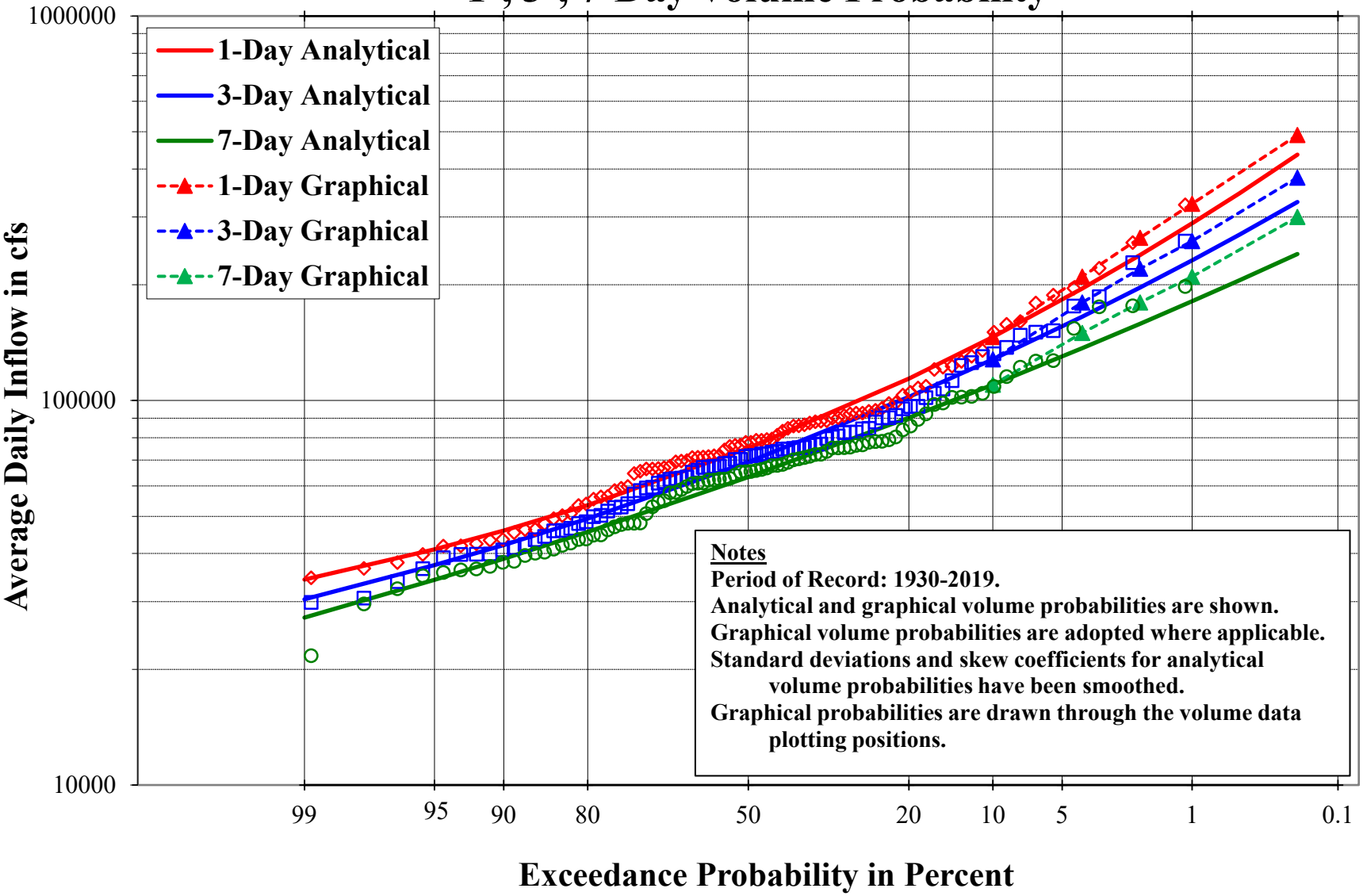


Plate 5

Garrison - Regulated Inflow
15-, 30-, 60-Day Volume Probability

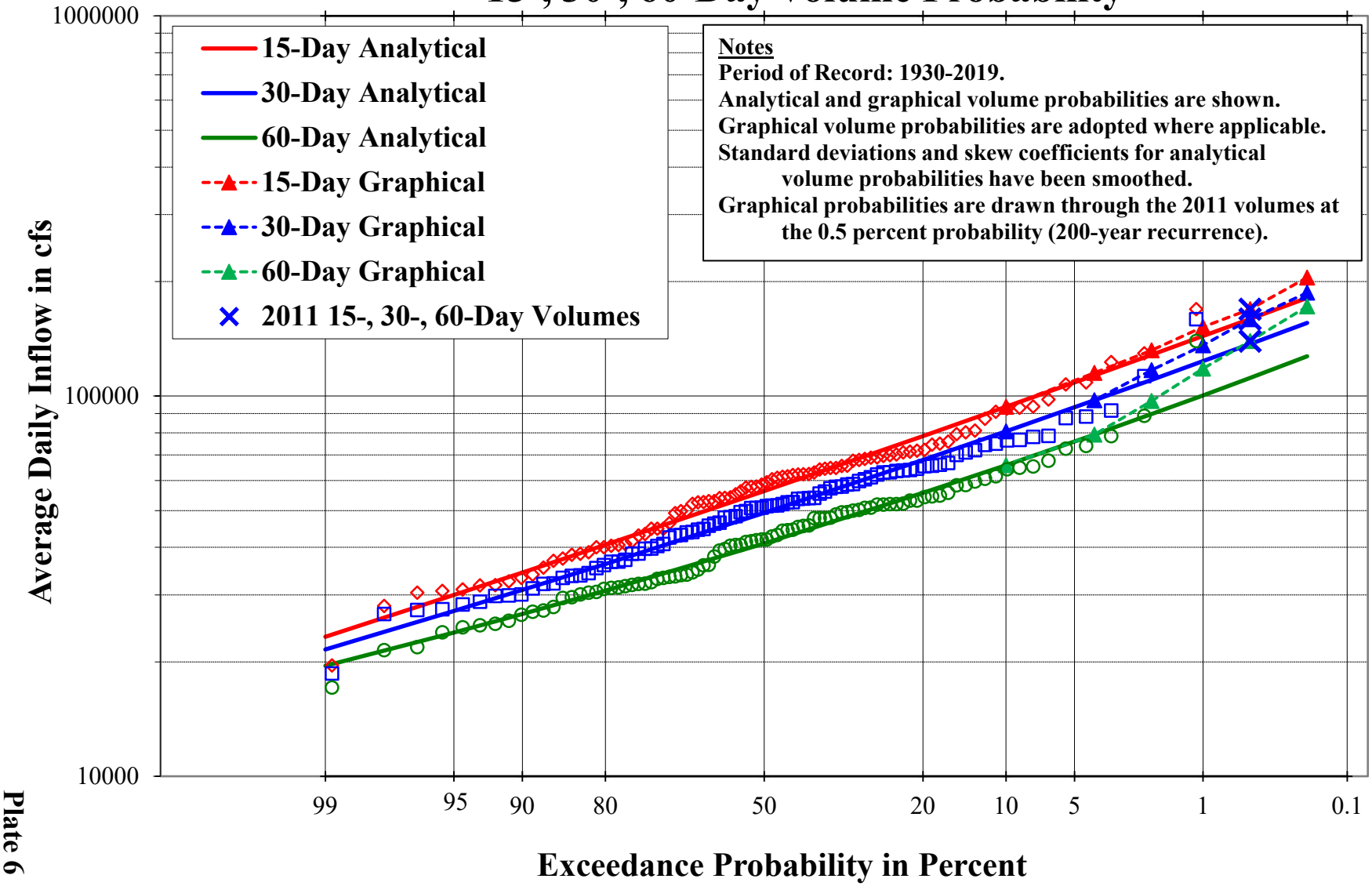


Plate 6

Garrison - Regulated Inflow
90-, 120-, 183-Day Volume Probability

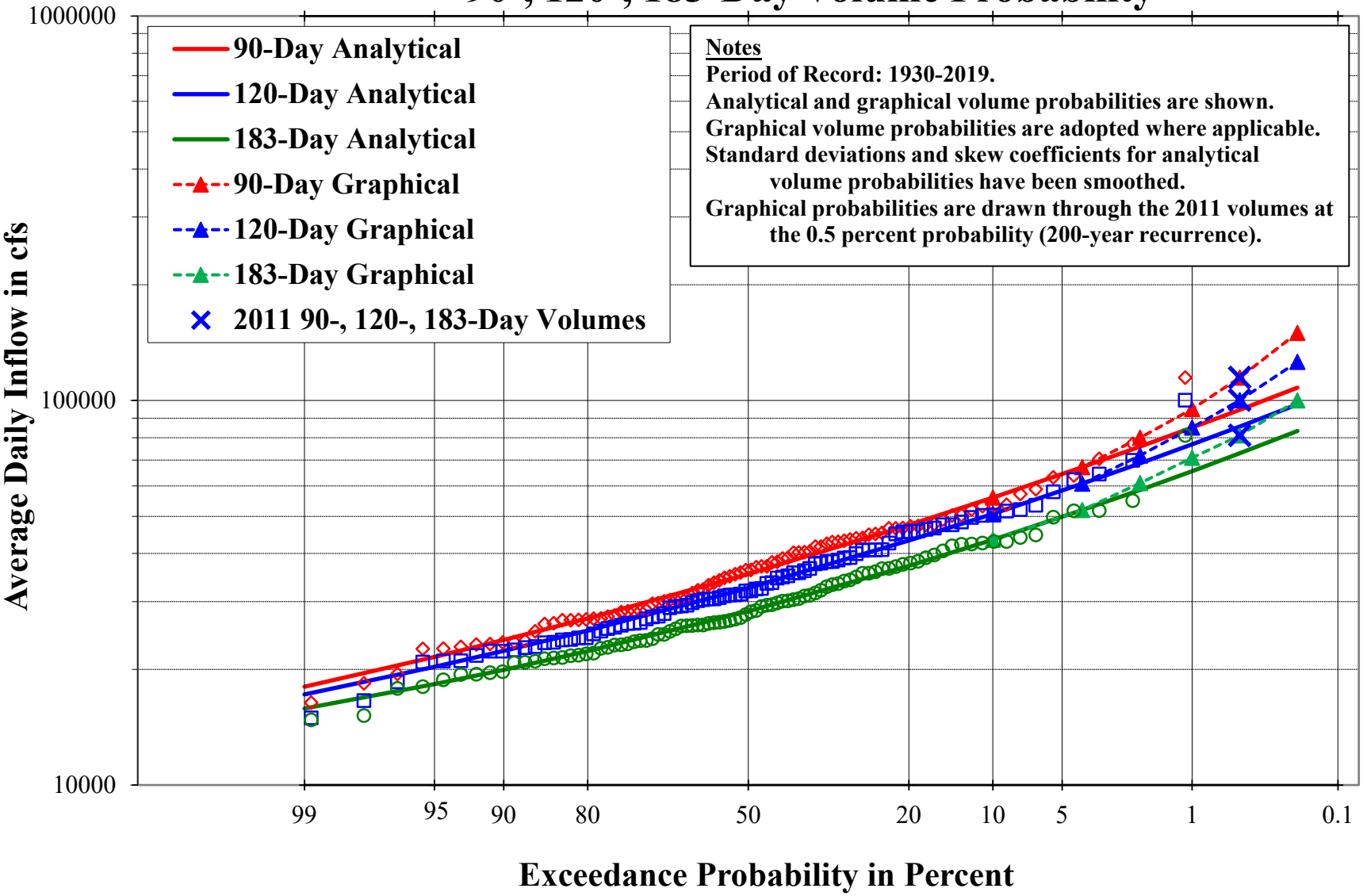


Plate 7

Garrison - Incremental Inflow
1-, 3-, 7-Day Volume Probability

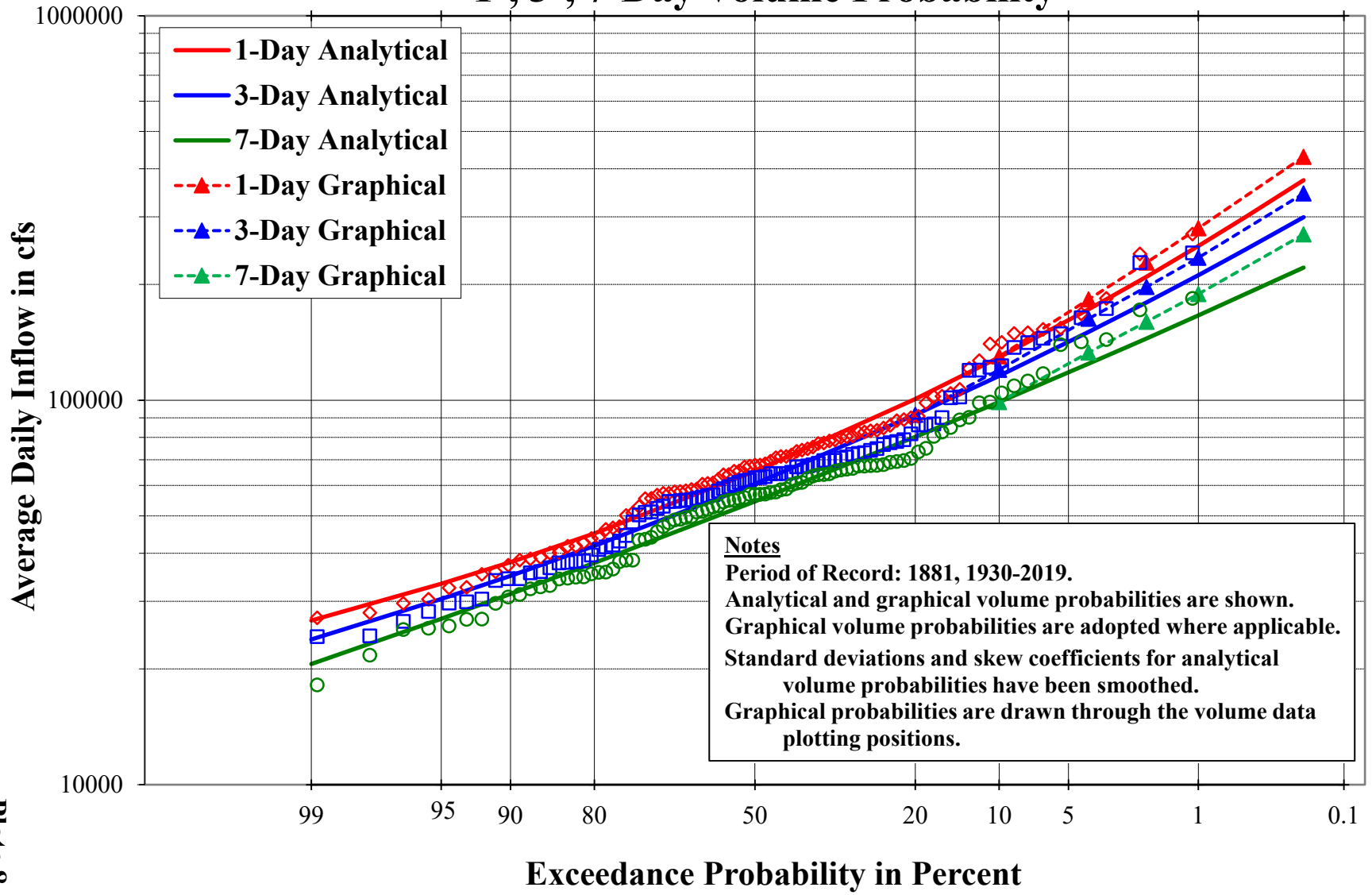


Plate 8

Garrison - Incremental Inflow
15-, 30-, 60-Day Volume Probability

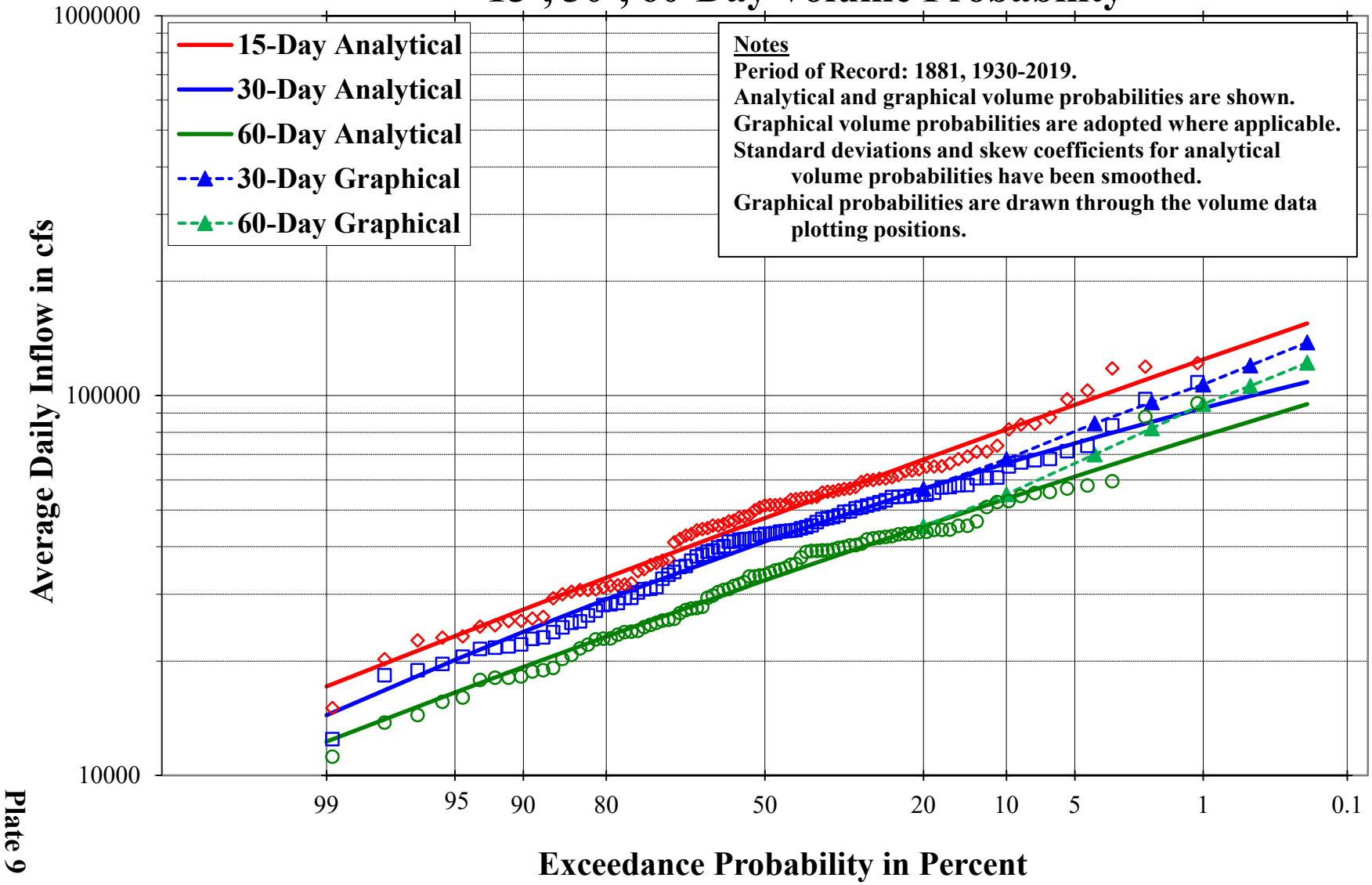


Plate 9

Garrison - Incremental Inflow
90-, 120-, 183-Day Volume Probability

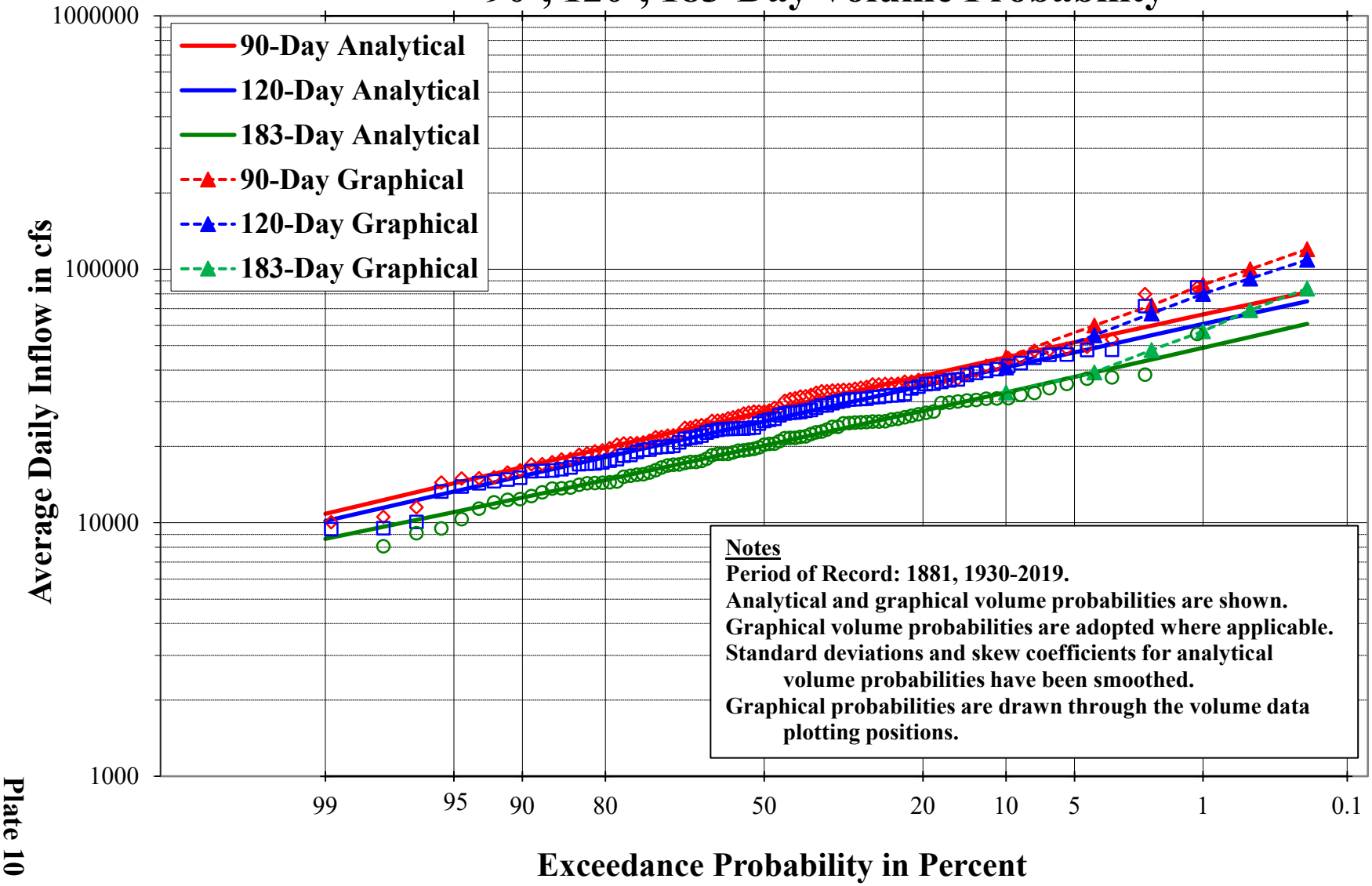


Plate 10

Oahe - Regulated Inflow
1-, 3-, 7-Day Volume Probability

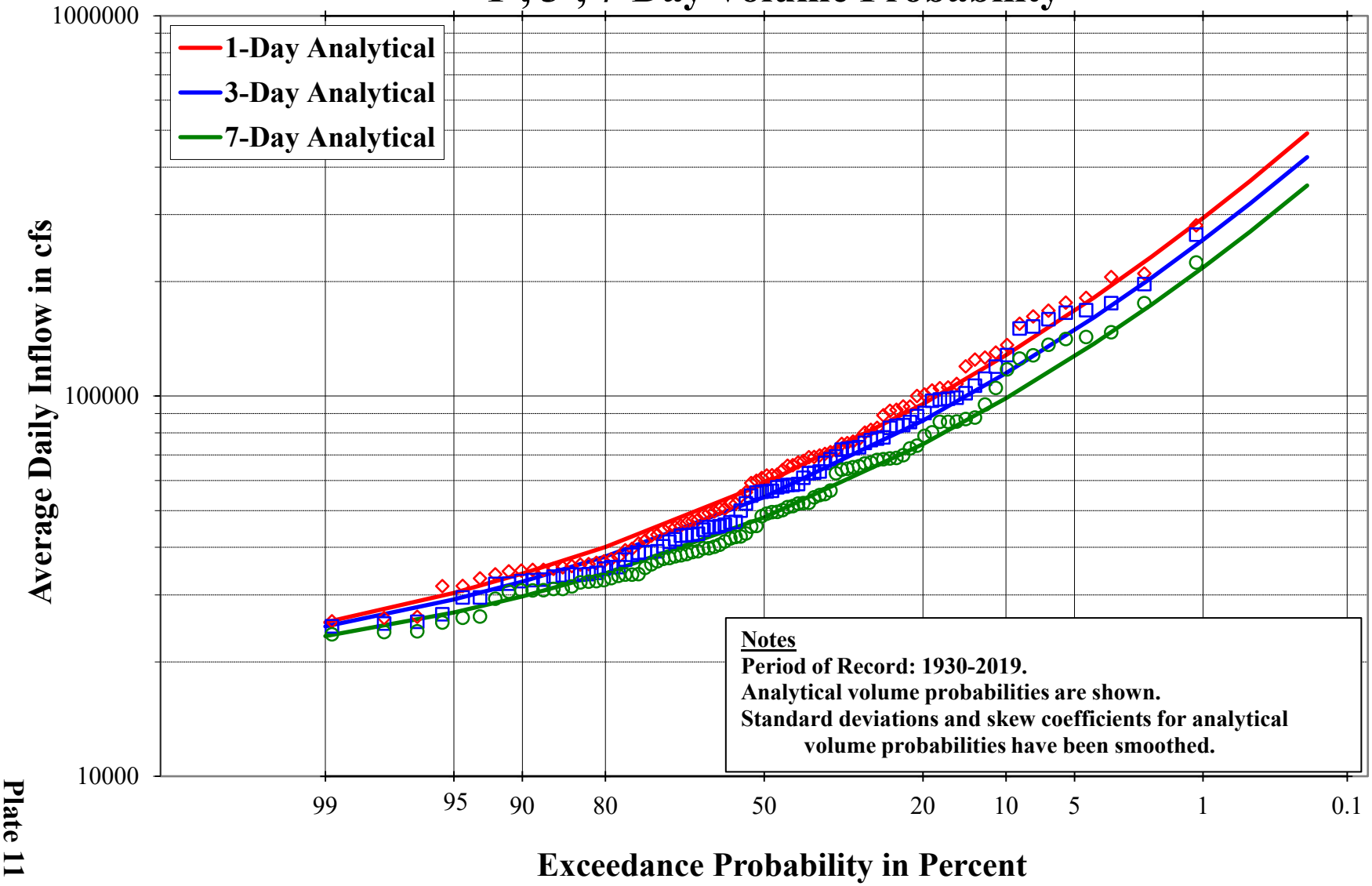


Plate 11

Oahe - Regulated Inflow
15-, 30-, 60-Day Volume Probability

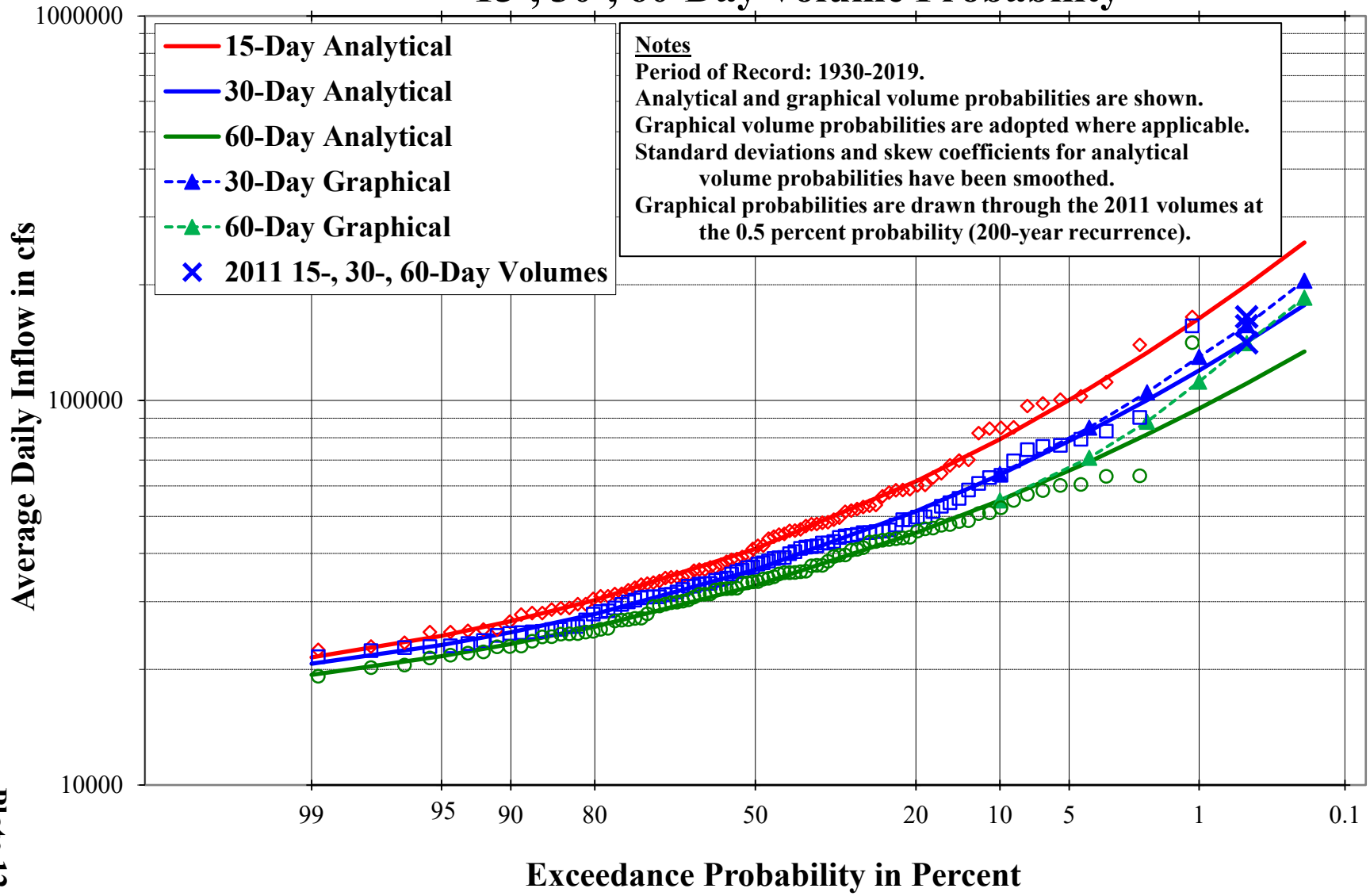


Plate 12

Oahe - Regulated Inflow
90-, 120-, 183-Day Volume Probability

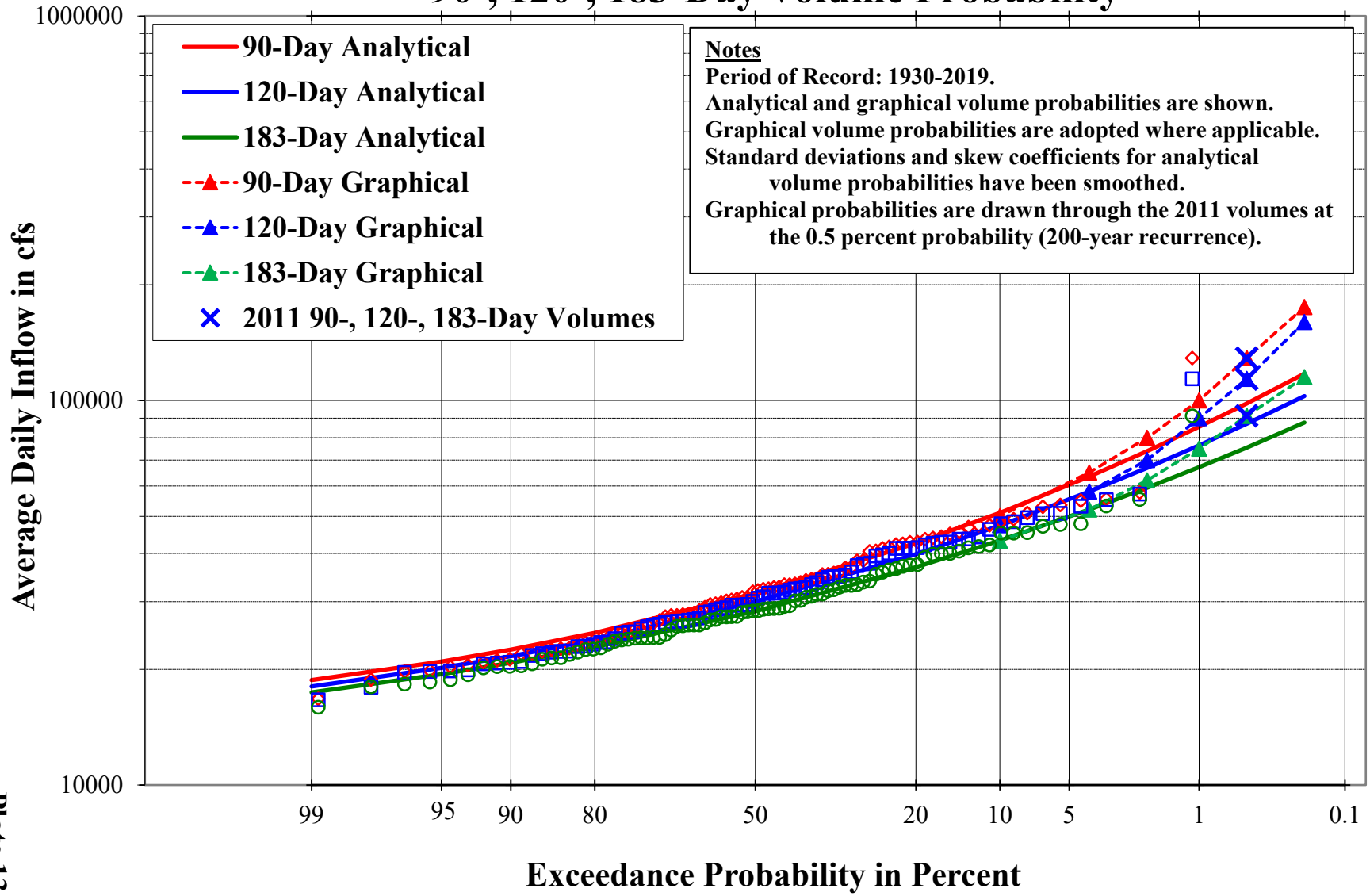


Plate 13

Oahe - Incremental Inflow
1-, 3-, 7-Day Volume Probability

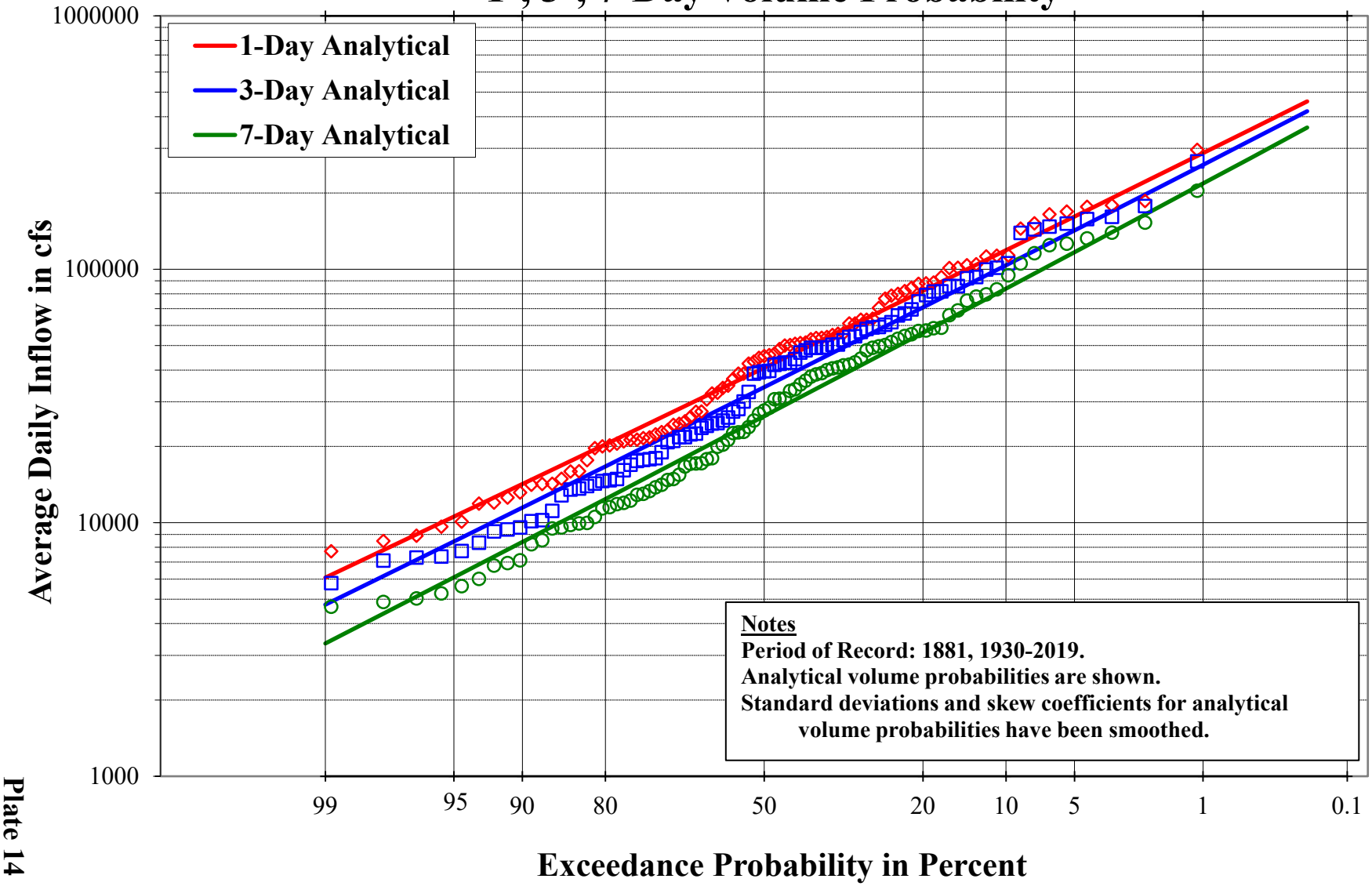


Plate 14

Oahe - Incremental Inflow
15-, 30-, 60-Day Volume Probability

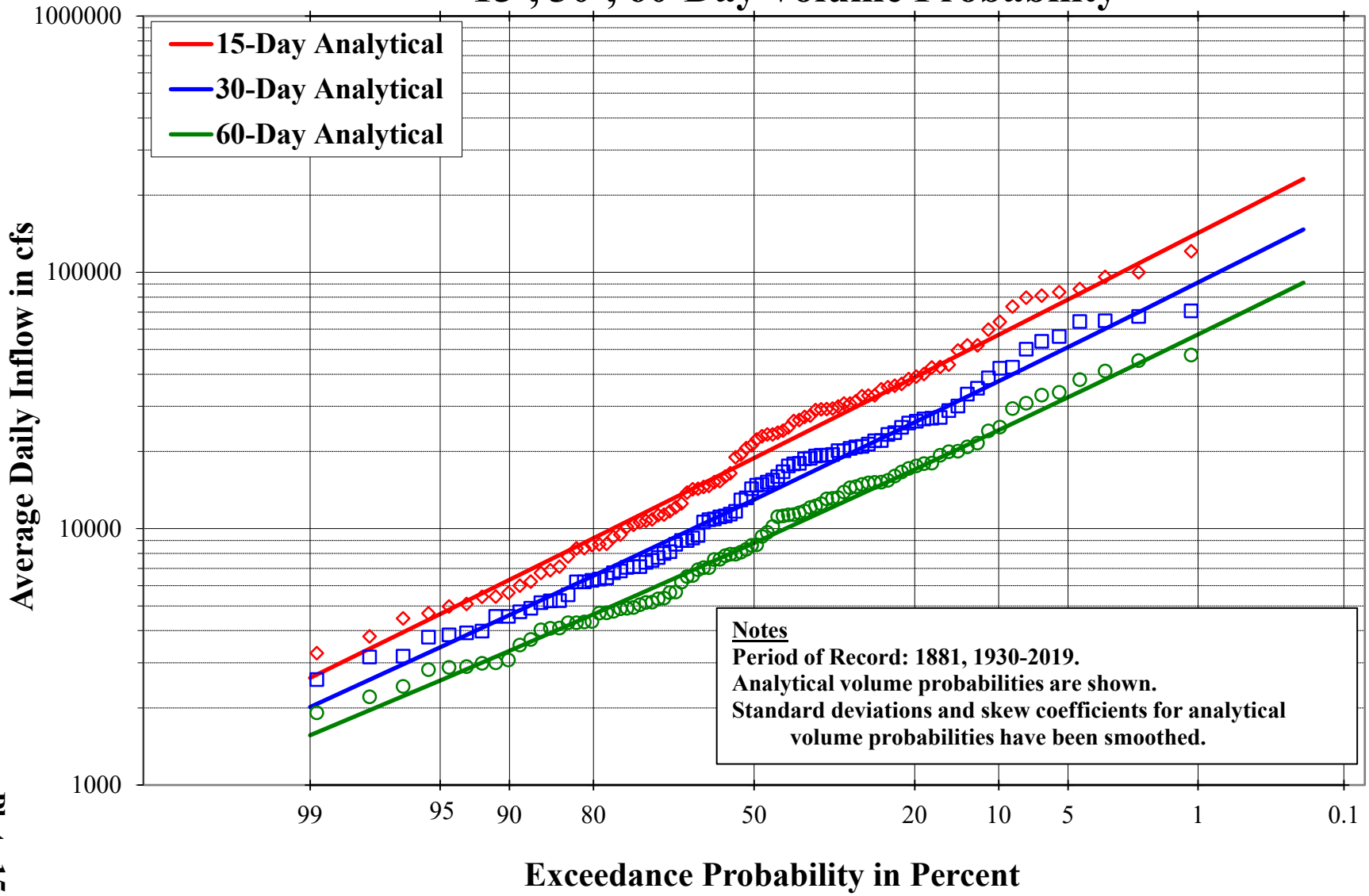


Plate 15

Oahe - Incremental Inflow
90-, 120-, 183-Day Volume Probability

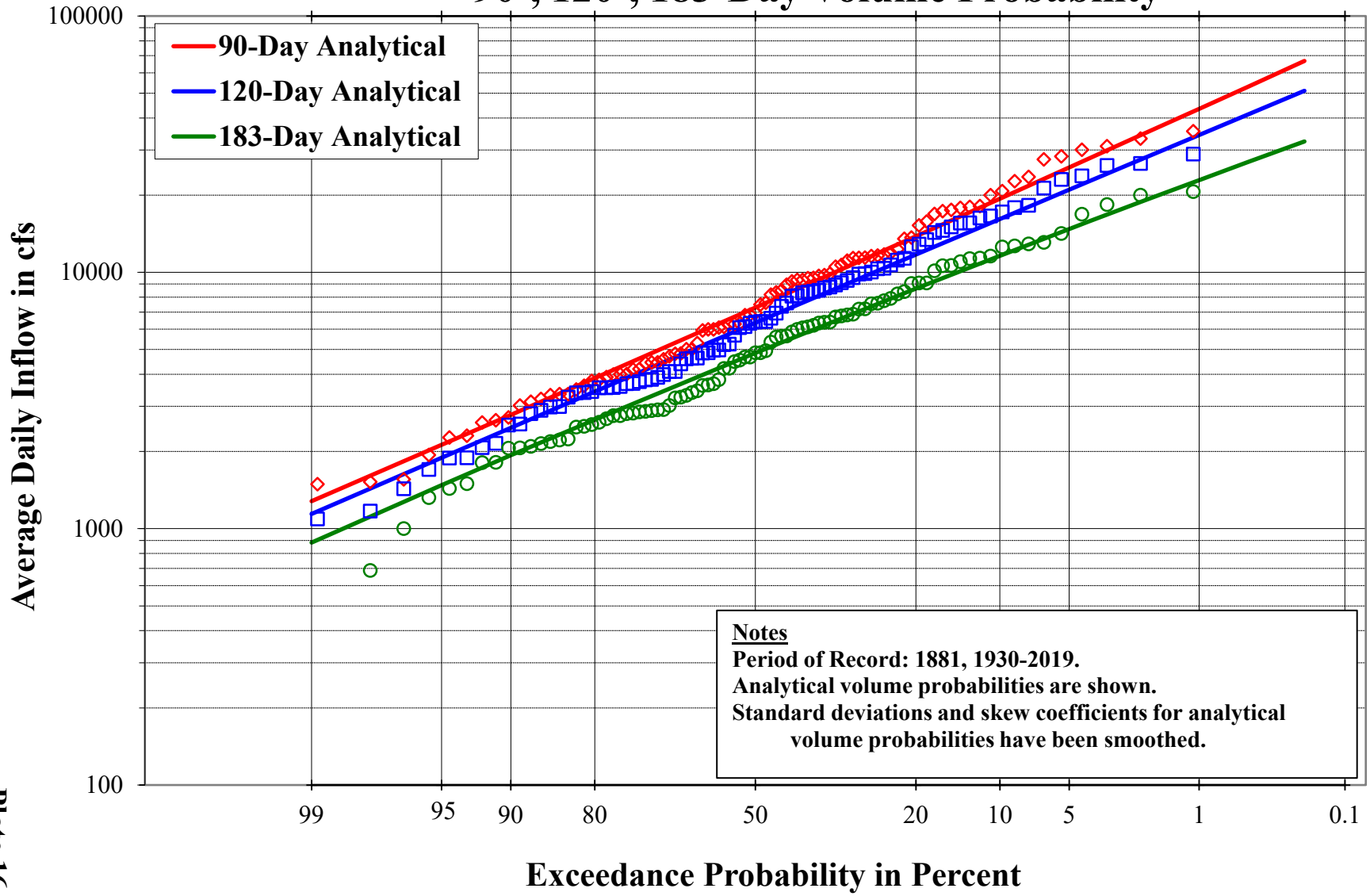


Plate 16

Big Bend - Regulated Inflow
1-, 3-, 7-Day Volume Probability

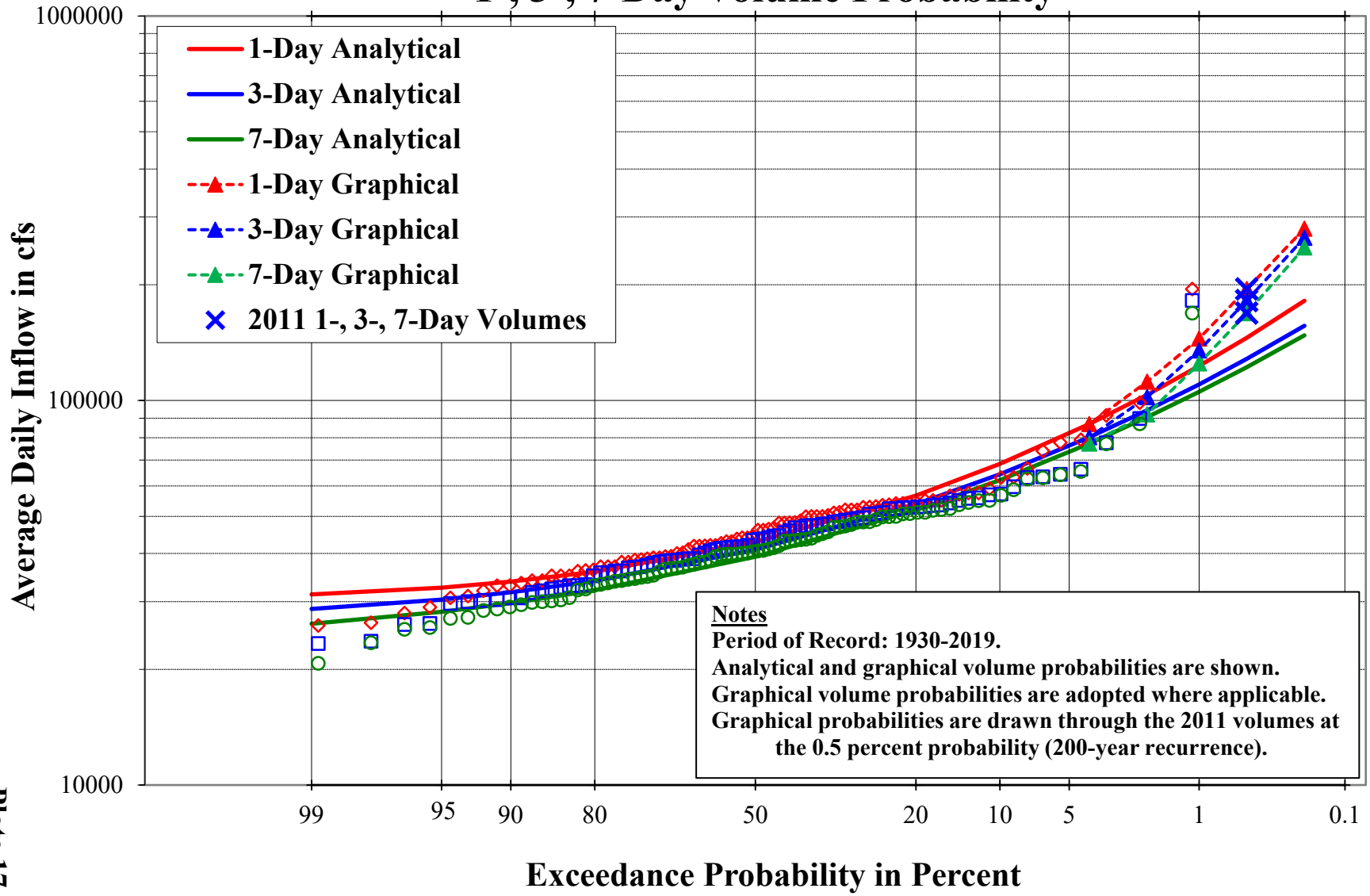


Plate 17

Big Bend - Regulated Inflow
15-, 30-, 60-Day Volume Probability

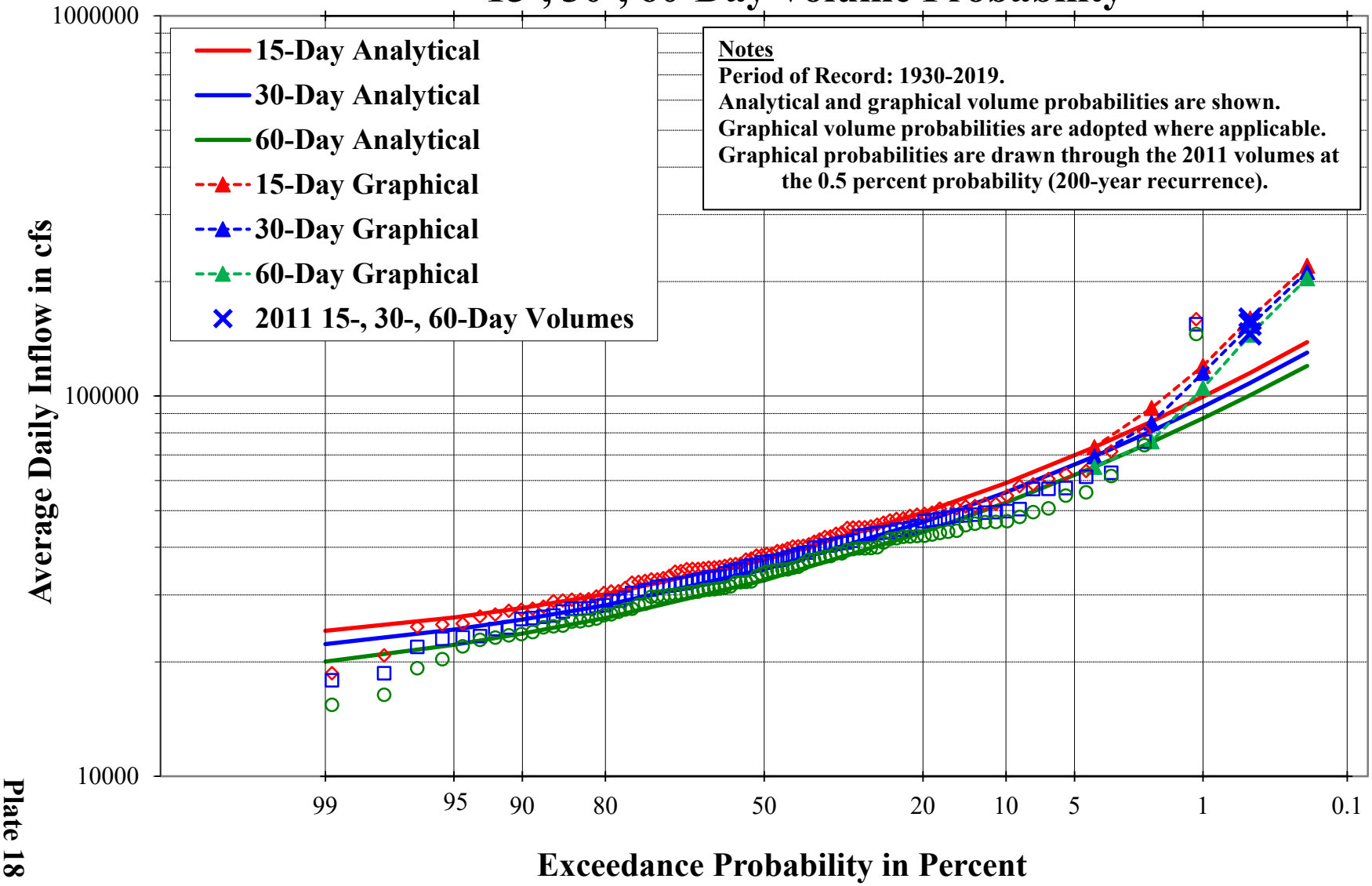


Plate 18

Big Bend - Regulated Inflow
90-, 120-, 183-Day Volume Probability

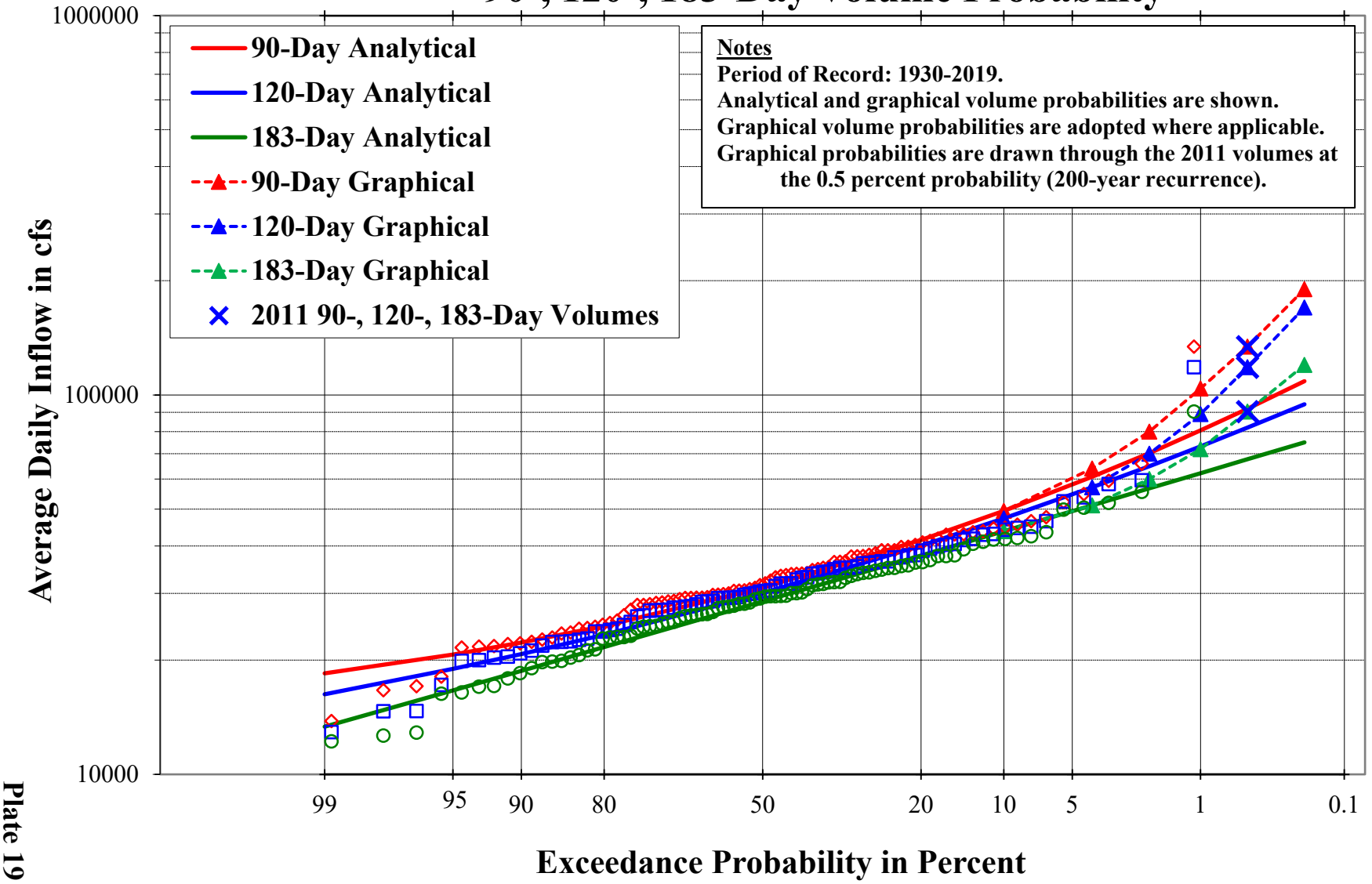


Plate 19

Big Bend - Incremental Inflow
1-, 3-, 7-Day Volume Probability

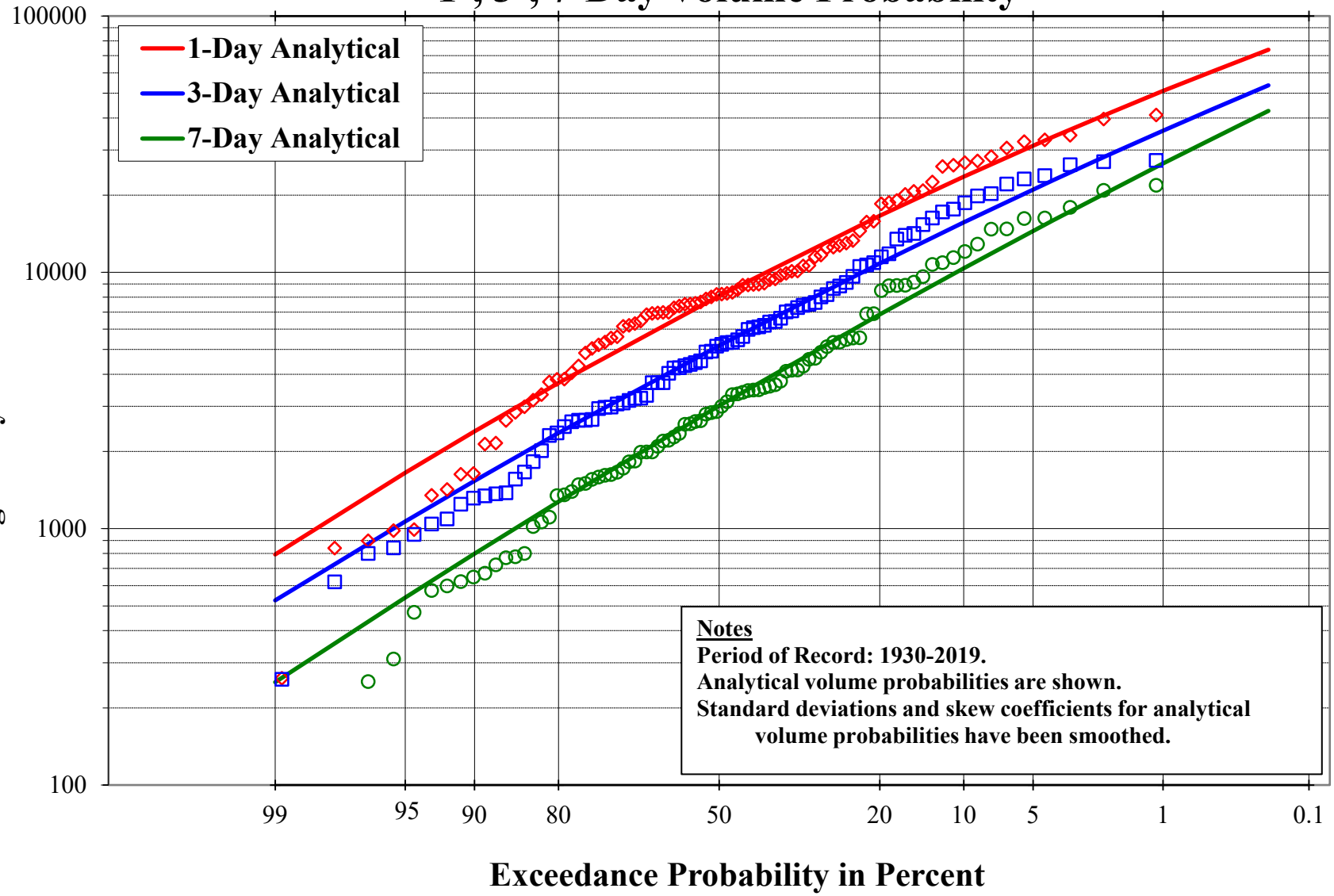


Plate 20

Big Bend - Incremental Inflow
15-, 30-, 60-Day Volume Probability

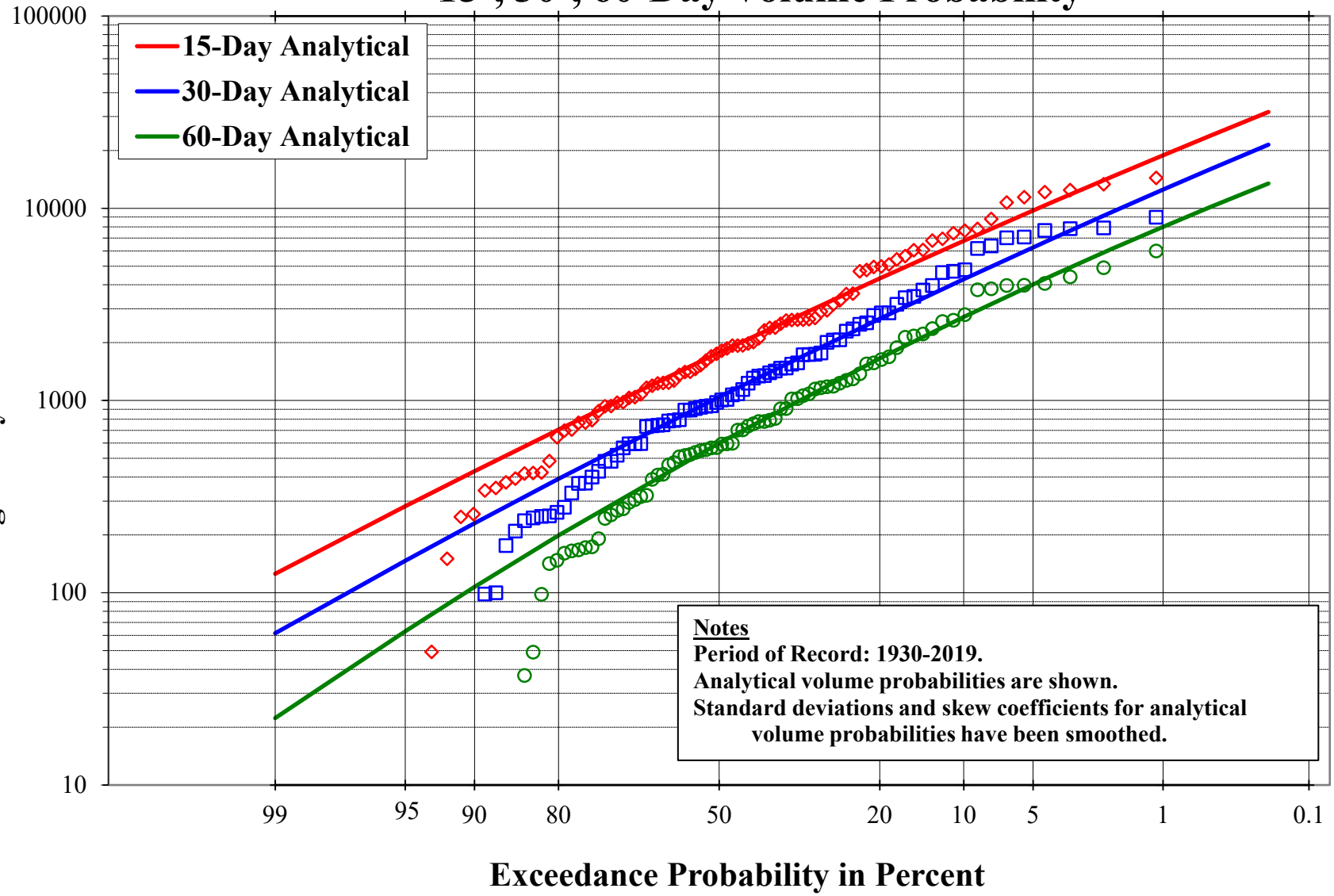


Plate 21

Big Bend - Incremental Inflow
90-, 120-, 183-Day Volume Probability

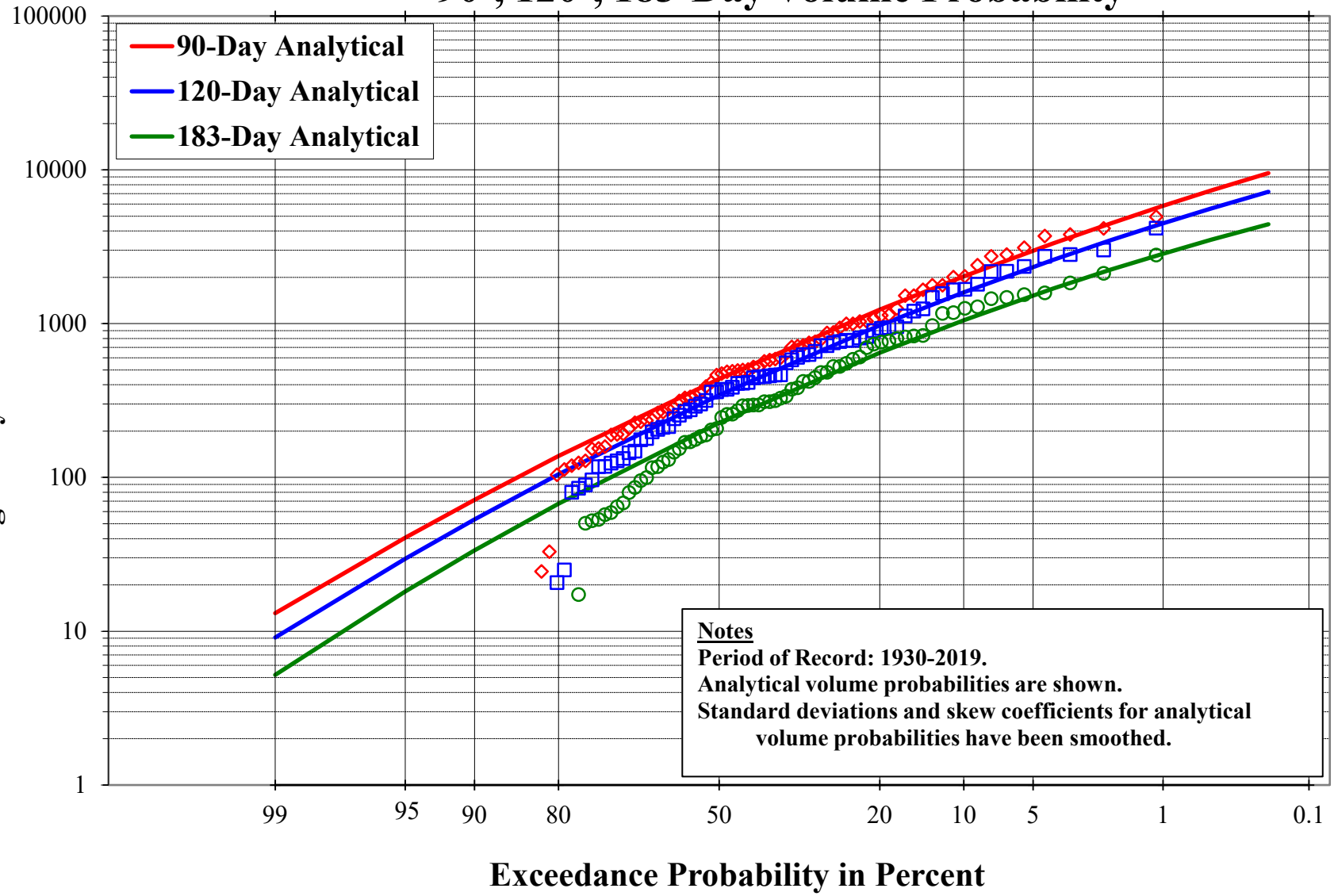


Plate 22

Fort Randall - Regulated Inflow
1-, 3-, 7-Day Volume Probability

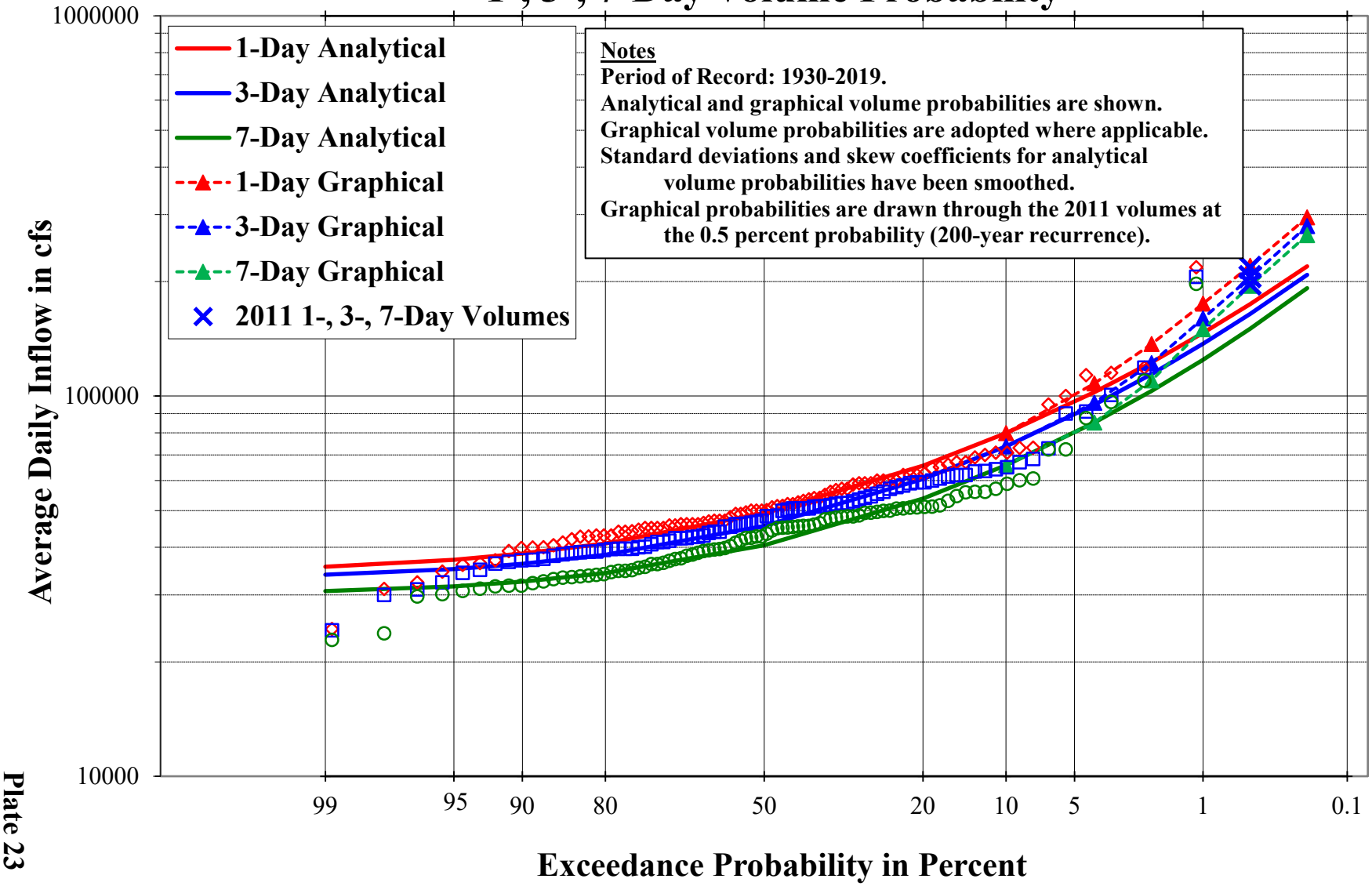


Plate 23

Fort Randall - Regulated Inflow
15-, 30-, 60-Day Volume Probability

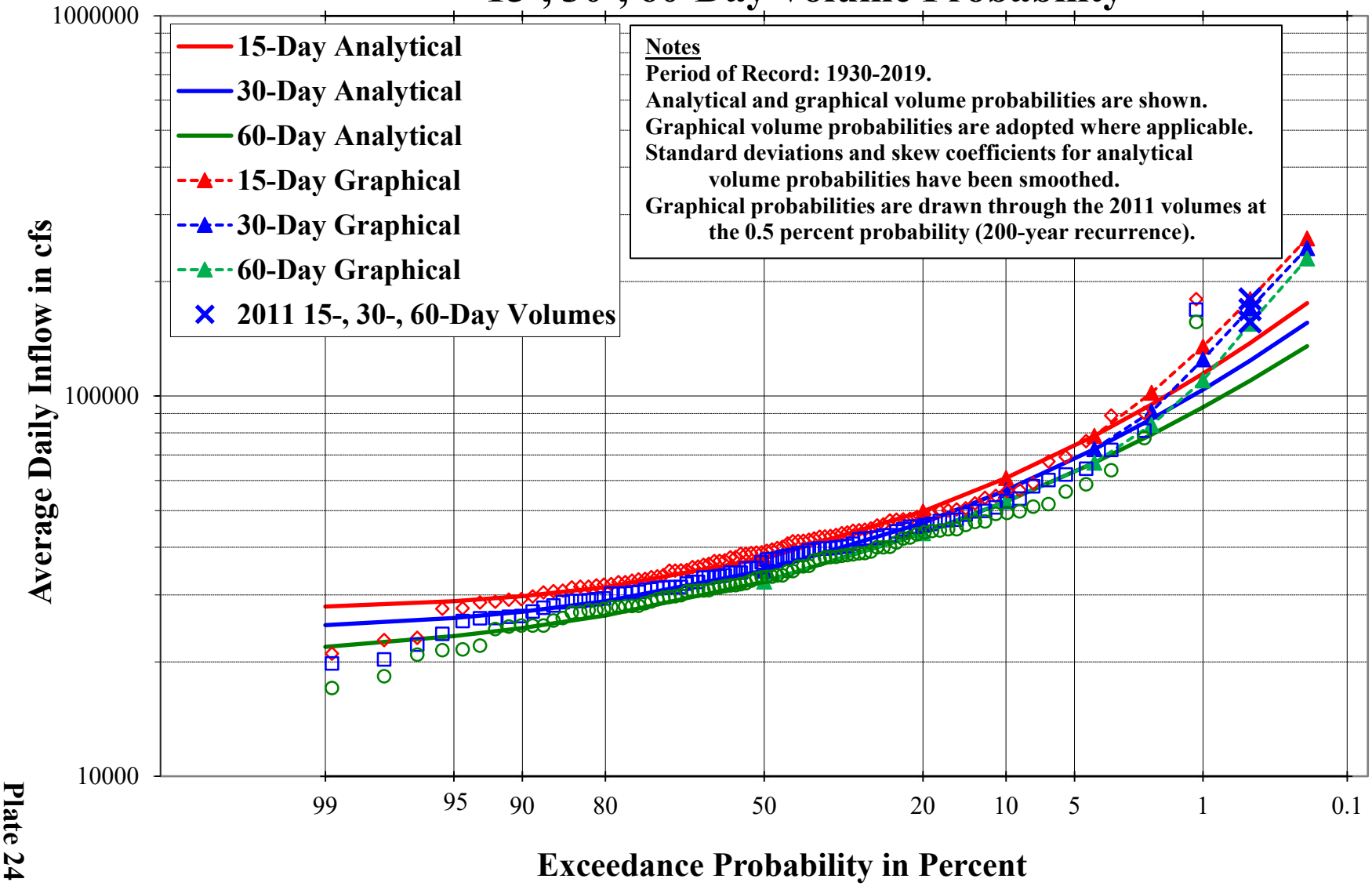


Plate 24

Fort Randall - Regulated Inflow
90-, 120-, 183-Day Volume Probability

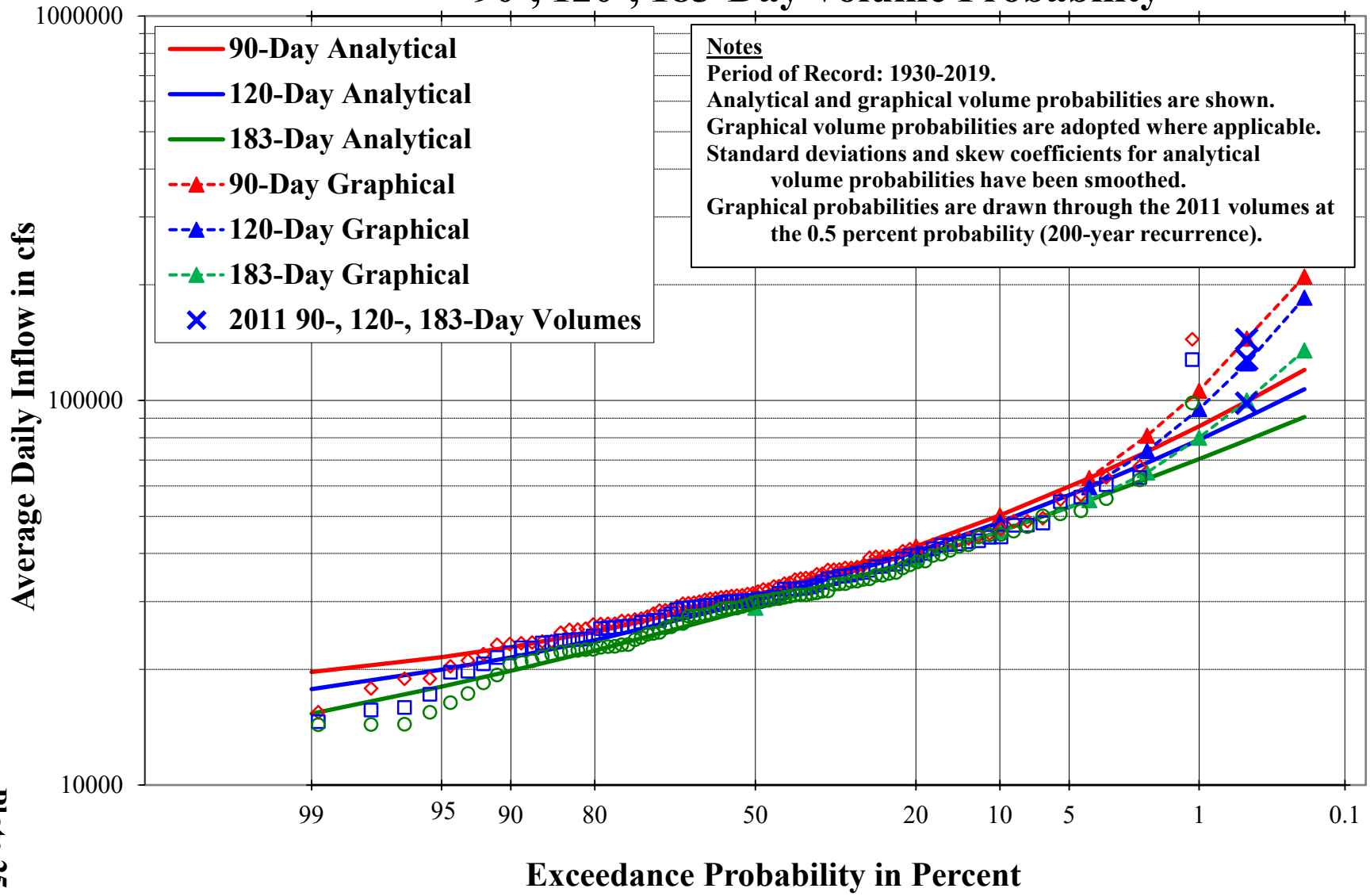


Plate 25

Fort Randall - Incremental Inflow
1-, 3-, 7-Day Volume Probability

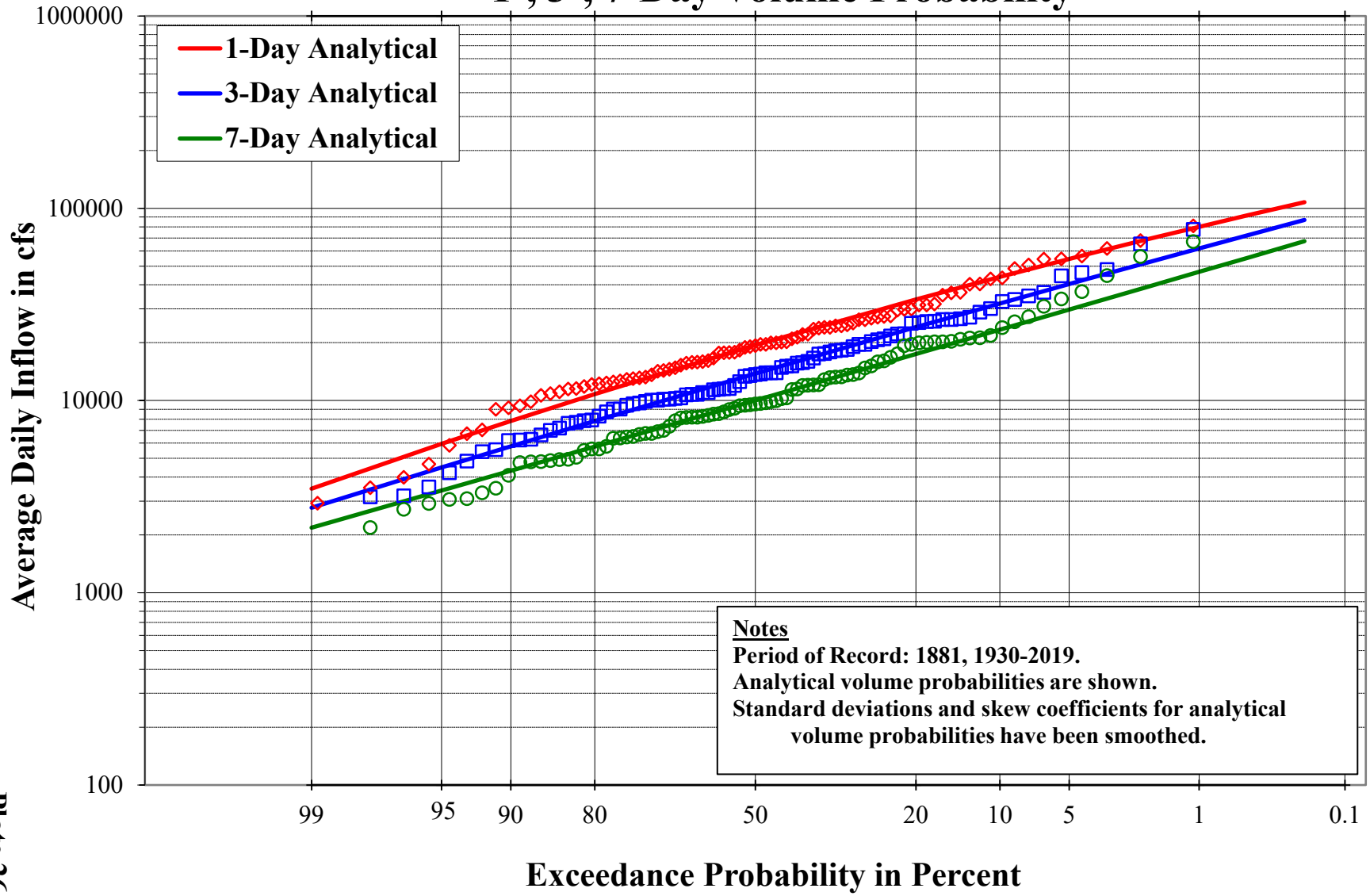


Plate 26

Fort Randall - Incremental Inflow
15-, 30-, 60-Day Volume Probability

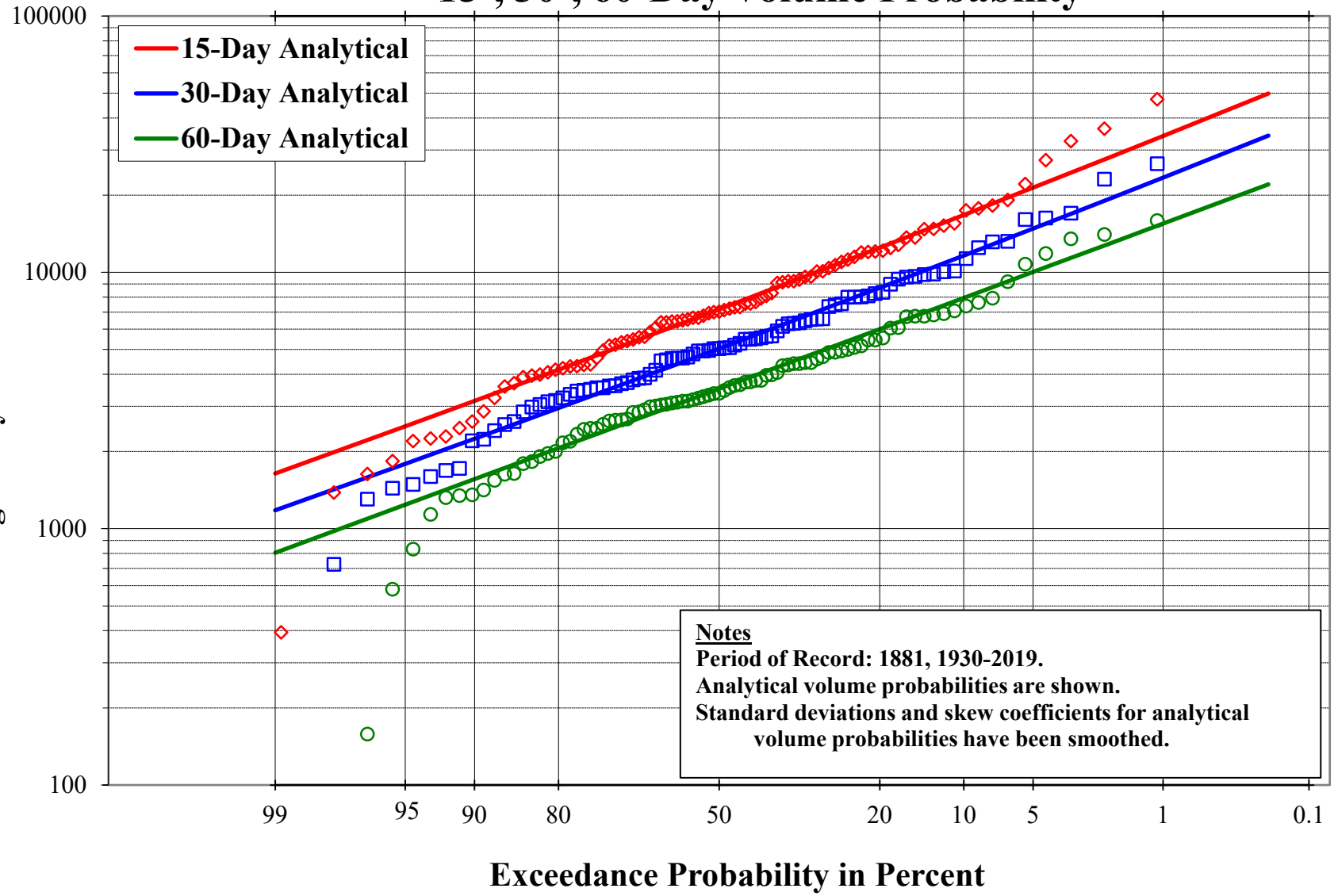


Plate 27

Fort Randall - Incremental Inflow
90-, 120-, 183-Day Volume Probability

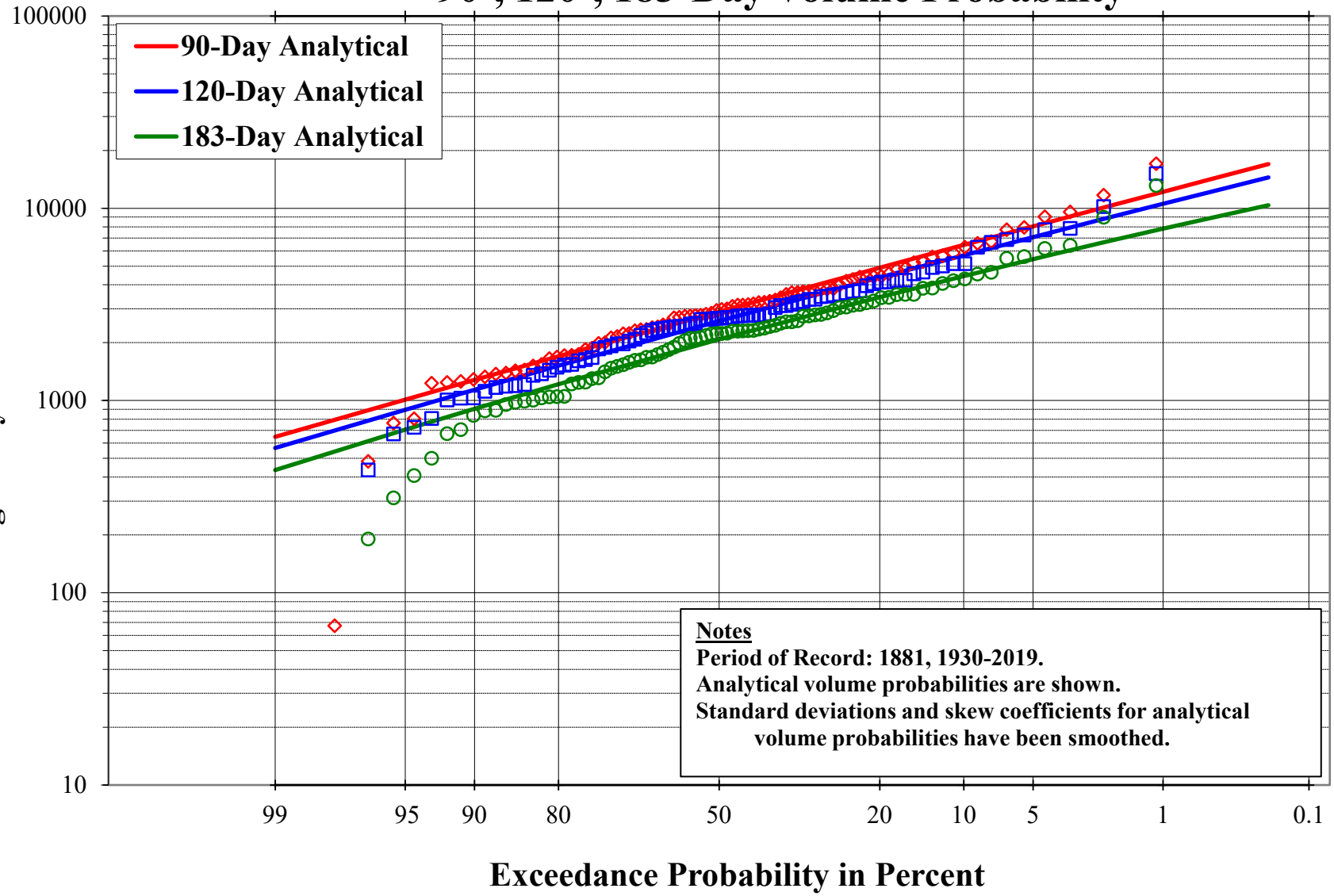


Plate 28

Gavins Point - Regulated Inflow
1-, 3-, 7-Day Volume Probability

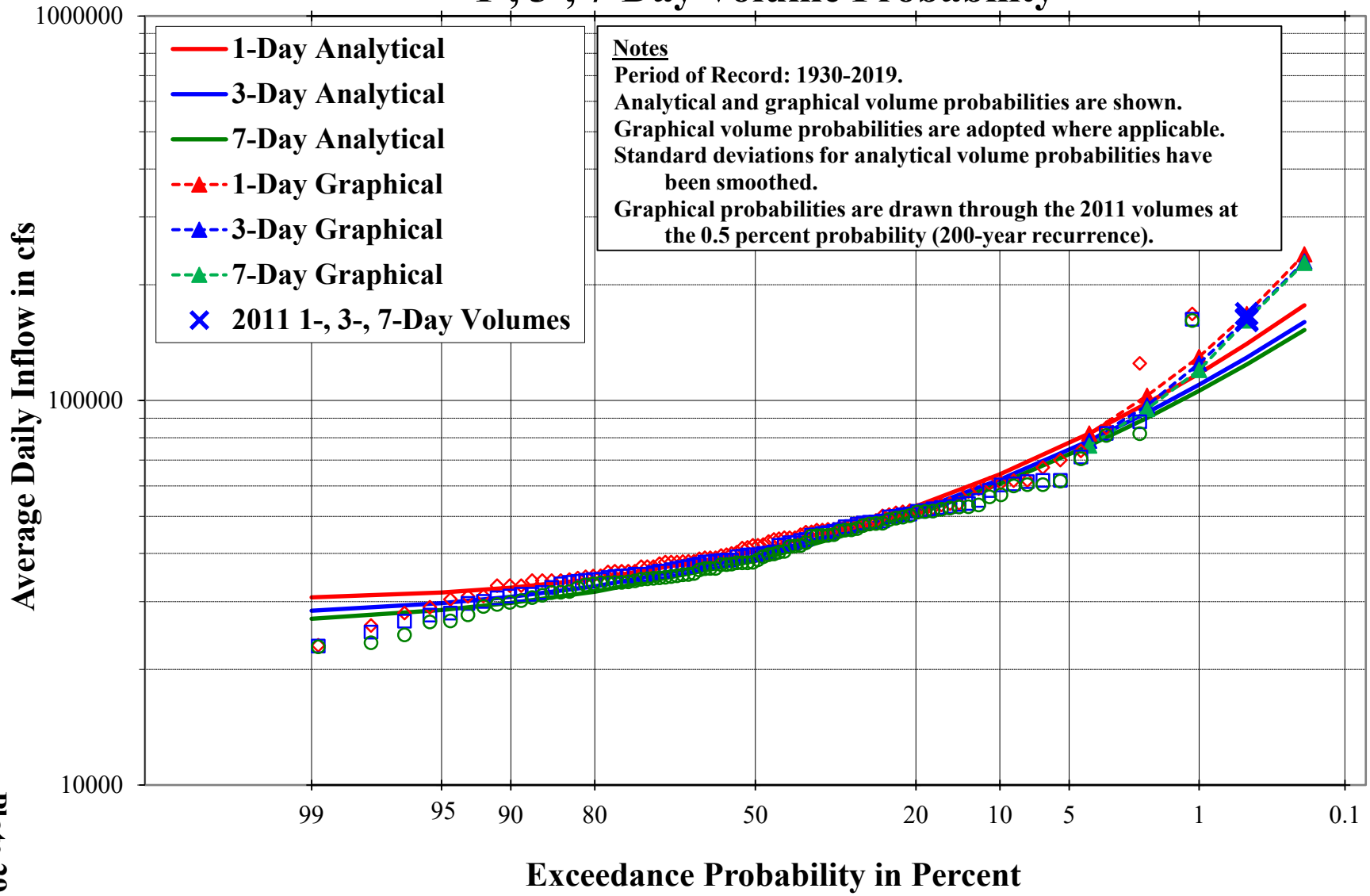


Plate 29

Gavins Point - Regulated Inflow
15-, 30-, 60-Day Volume Probability

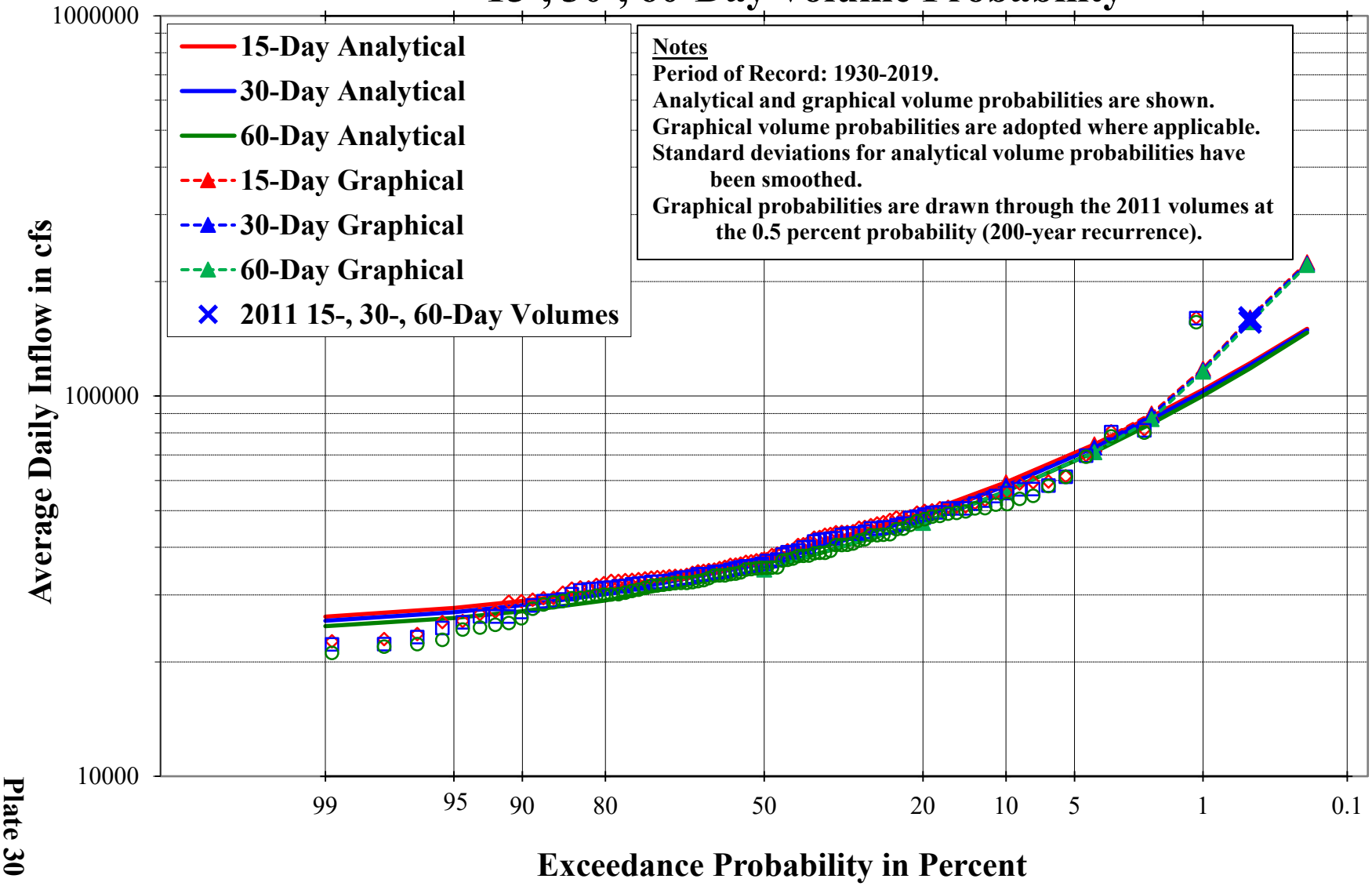


Plate 30

Gavins Point - Regulated Inflow
90-, 120-, 183-Day Volume Probability

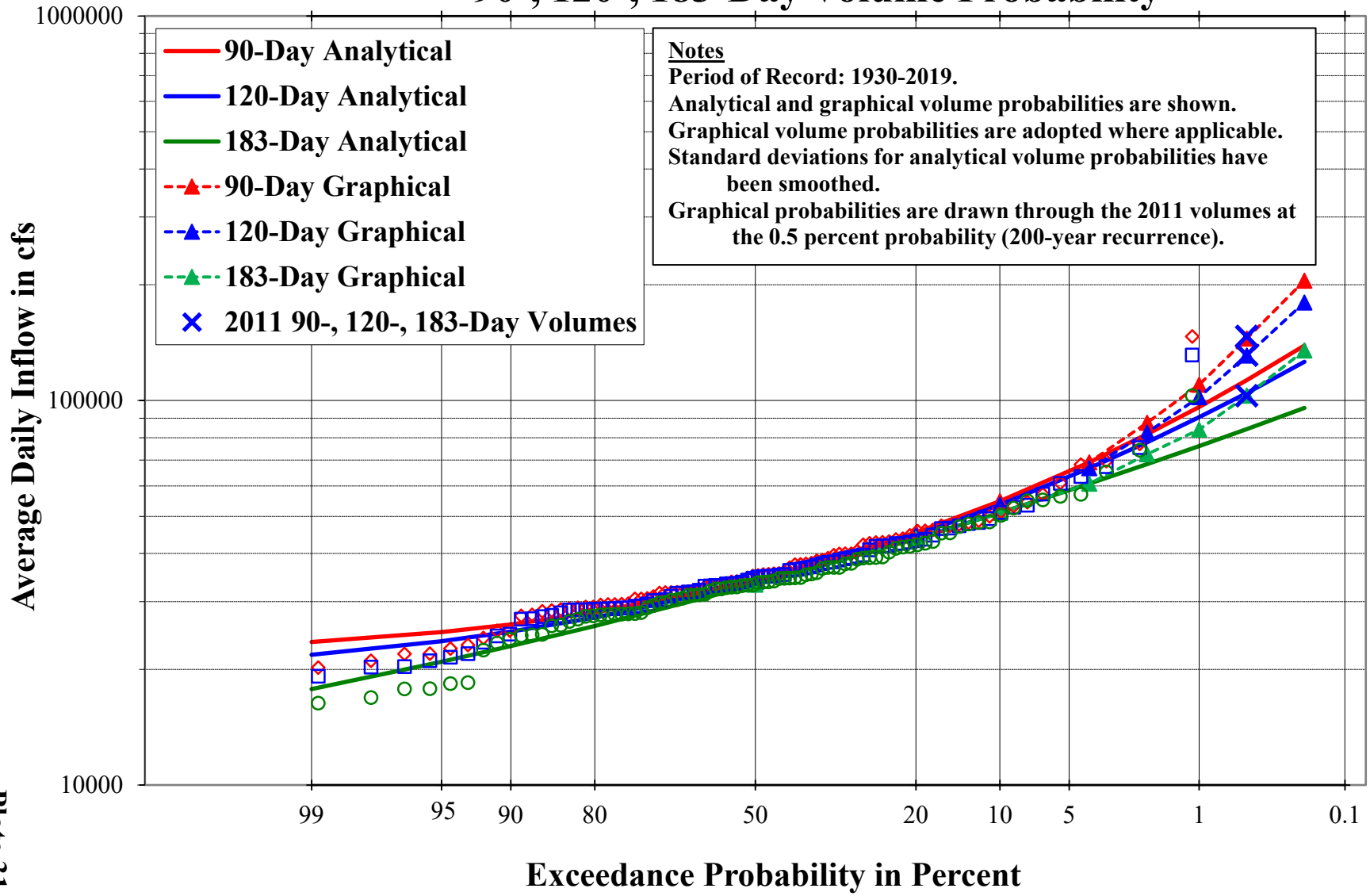


Plate 31

Gavins Point - Incremental Inflow
1-, 3-, and 7-Day Volume Probability

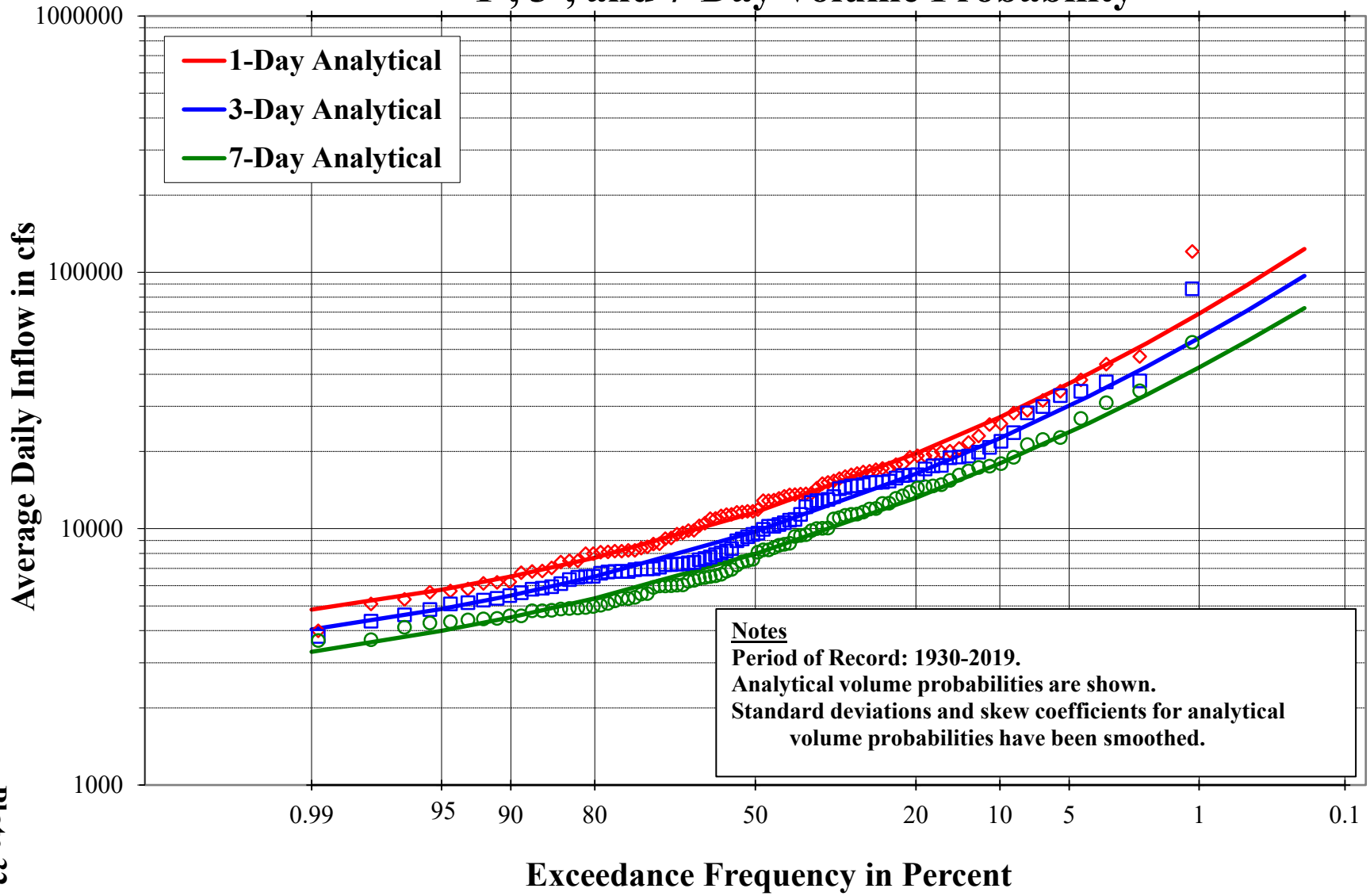


Plate 32

Gavins Point - Incremental Inflow
15-, 30-, and 60-Day Volume Probability

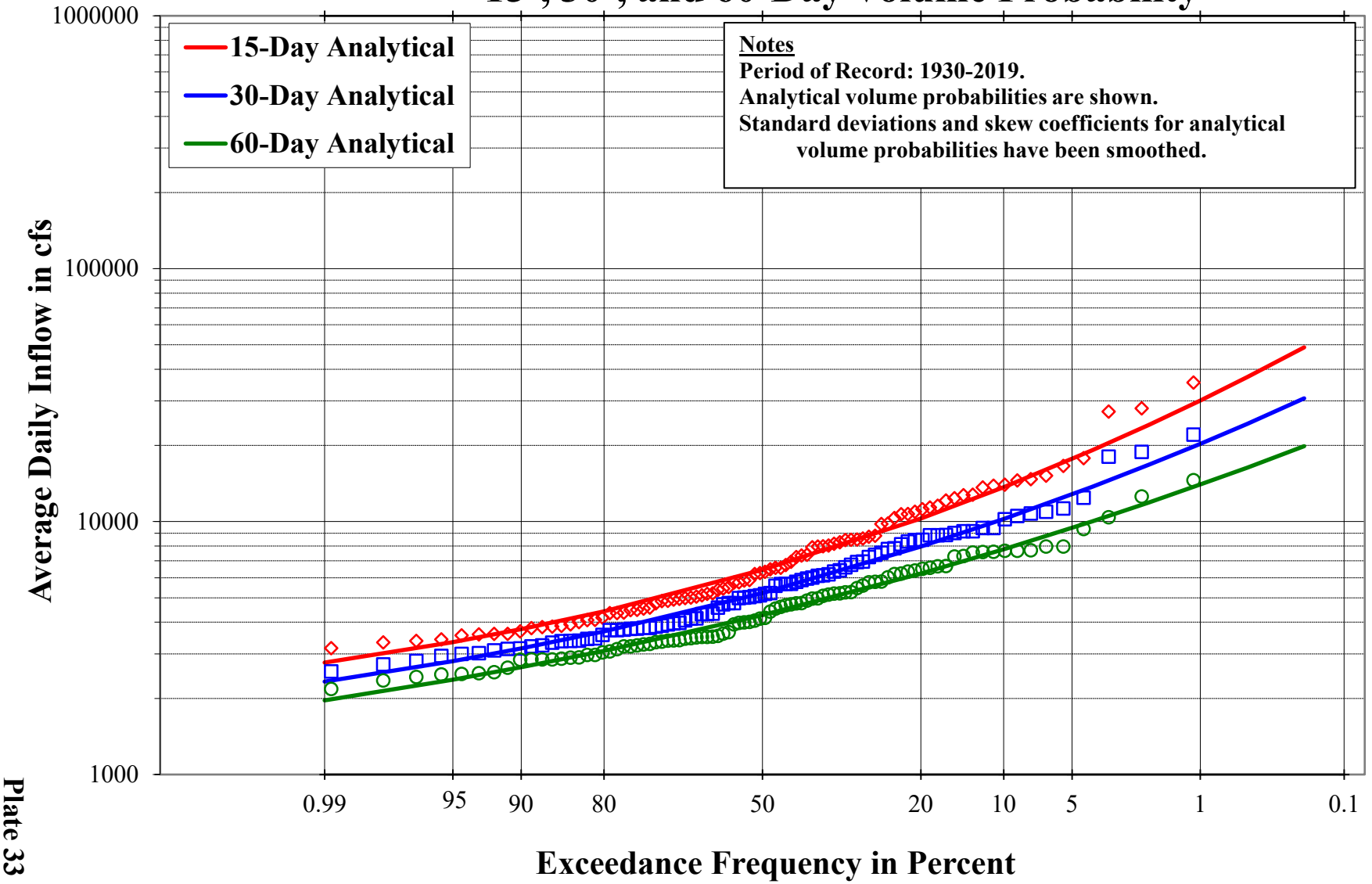


Plate 33

Gavins Point - Incremental Inflow
90-, 120-, and 183-Day Volume Probability

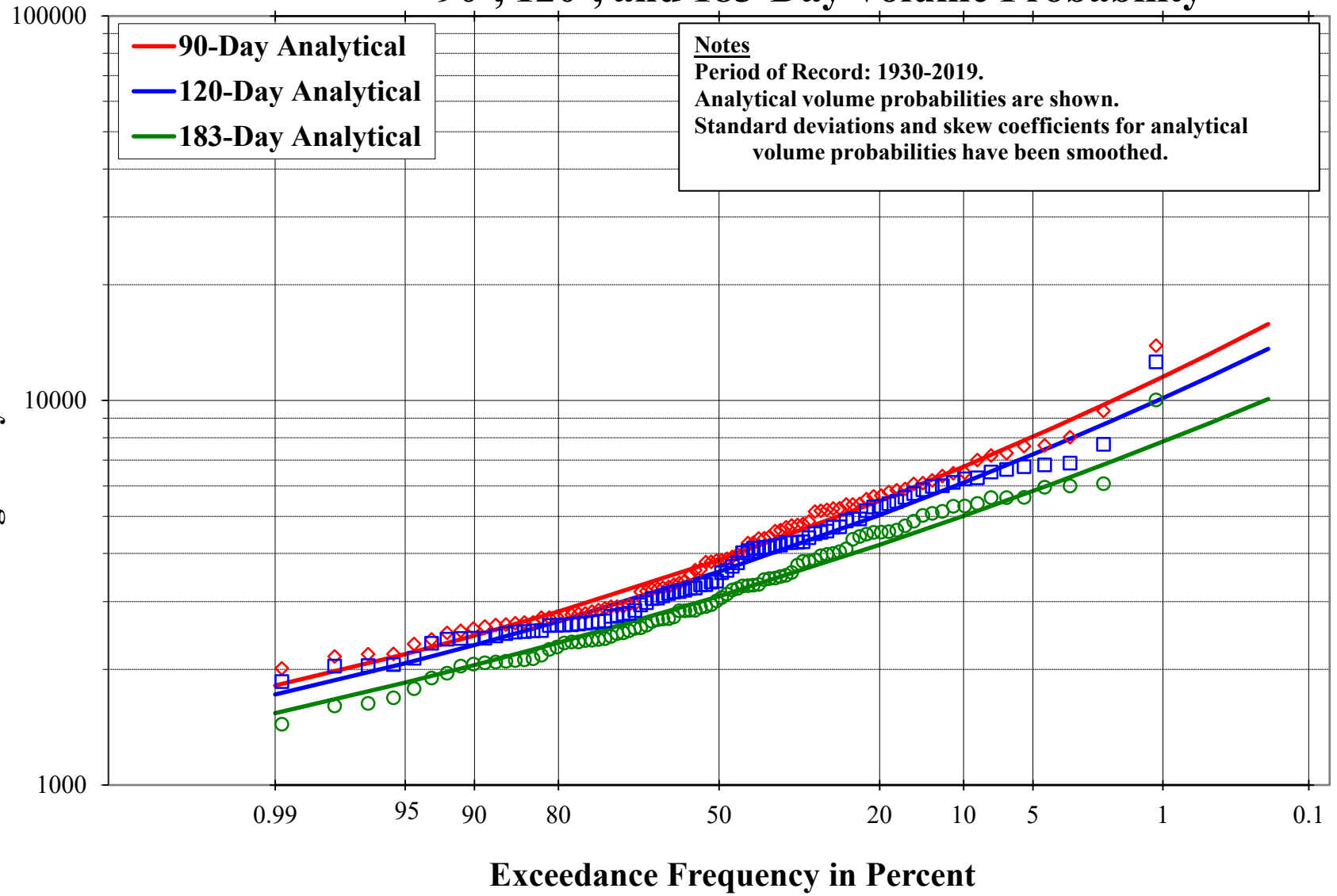


Plate 34

APPENDIX A

Missouri River Mainstem Reservoir System
Inflow Volume Probabilities
Regulated and Incremental

Fort Peck – Regulated Inflow
Volume Probabilities in 1,000 cfs

Percent Chance Exceedence	1-Day	3-Day	7-Day	15-Day	30-Day	60-Day	90-Day	120-Day	183-Day
0.2	224.0	177.0	142.0	114.0	90.0	68.9	57.1	48.2	37.2
1.0	157.0	126.0	103.0	83.9	67.7	52.9	44.5	38.4	30.5
2.0	132.0	107.0	88.1	72.4	58.9	46.5	39.4	34.3	27.7
4.0	109.0	88.9	74.1	61.5	50.5	40.3	34.4	30.3	24.8
10.0	80.9	67.3	56.9	47.9	39.9	32.4	28.1	25.1	20.9
20.0	61.6	52.0	44.6	38.0	32.1	26.6	23.2	21.0	17.9
50.0	37.1	32.1	28.2	24.7	21.4	18.2	16.3	15.0	13.1
90.0	17.5	15.8	14.4	13.1	11.8	10.5	9.7	9.1	8.2

Garrison – Regulated Inflow
Volume Probabilities in 1,000 cfs

Percent Chance Exceedence	1-Day	3-Day	7-Day	15-Day	30-Day	60-Day	90-Day	120-Day	183-Day
0.2	490.0	380.0	300.0	205.0	187.0	172.0	150.0	126.0	100.0
1.0	325.0	260.0	210.0	152.0	136.0	118.0	95.0	85.0	71.0
2.0	265.0	220.0	180.0	132.0	117.0	97.0	80.0	72.0	61.0
4.0	210.0	180.0	150.0	115.0	97.5	79.2	67.1	60.8	51.9
10.0	146.0	128.0	110.0	93.7	80.8	65.8	55.9	50.8	43.4
20.0	114.0	102.0	90.2	78.5	68.0	55.6	47.4	43.2	37.2
50.0	75.2	69.2	63.2	56.2	49.3	41.0	35.4	32.5	28.3
90.0	45.9	42.1	38.8	34.4	30.9	26.7	23.8	22.3	19.9

Garrison – Incremental Inflow
Volume Probabilities in 1,000 cfs

Percent Chance Exceedence	1-Day	3-Day	7-Day	15-Day	30-Day	60-Day	90-Day	120-Day	183-Day
0.2	430.0	345.0	270.0	155.0	138.0	122.0	120.0	109.0	84.0
1.0	280.0	235.0	189.0	124.0	107.0	95.0	87.0	80.0	57.0
2.0	228.0	197.0	160.0	112.0	96.0	82.0	72.0	67.0	48.0
4.0	183.0	163.0	133.0	98.7	84.5	70.0	60.0	55.0	39.2
10.0	129.0	116.0	99.0	81.4	68.0	55.0	44.9	41.0	32.7
20.0	101.0	91.7	80.3	67.9	56.9	45.3	38.0	34.7	27.7
50.0	65.4	60.6	54.5	47.6	41.3	32.6	27.5	25.1	20.1
90.0	37.9	34.9	31.4	27.3	23.9	19.3	16.6	15.3	12.6

Oahe – Regulated Inflow
Volume Probabilities in 1,000 cfs

Percent Chance Exceedence	1-Day	3-Day	7-Day	15-Day	30-Day	60-Day	90-Day	120-Day	183-Day
0.2	491.0	425.0	358.0	258.0	205.0	185.0	175.0	160.0	115.0
1.0	294.0	257.0	218.0	164.0	130.0	112.0	100.0	90.0	75.0
2.0	233.0	205.0	174.0	133.0	105.0	88.0	80.0	70.0	62.0
4.0	182.0	161.0	138.0	107.0	85.0	69.3	65.0	58.0	52.1
10.0	128.0	115.0	98.6	79.3	64.1	55.0	51.1	47.4	43.2
20.0	95.3	86.3	74.7	61.6	51.5	45.3	42.5	39.8	36.9
50.0	58.7	54.3	47.9	41.1	36.3	33.0	31.5	30.0	28.3
90.0	34.1	32.5	29.7	26.7	25.0	23.3	24.9	23.9	22.8

Oahe – Incremental Inflow
Volume Probabilities in 1,000 cfs

Percent Chance Exceedence	1-Day	3-Day	7-Day	15-Day	30-Day	60-Day	90-Day	120-Day	183-Day
0.2	460.0	420.0	363.0	231.0	147.0	91.1	66.8	51.1	32.4
1.0	287.0	258.0	218.0	142.0	91.3	57.2	43.5	34.4	22.9
2.0	228.0	203.0	170.0	112.0	72.3	45.6	35.2	28.2	19.2
4.0	177.0	156.0	129.0	85.9	55.9	35.5	27.8	22.7	15.8
10.0	119.0	104.0	83.9	57.1	37.6	24.2	19.4	16.2	11.6
20.0	82.3	70.8	56.3	39.0	26.0	17.0	13.8	11.7	8.6
50.0	40.9	34.2	26.3	18.9	13.0	8.8	7.3	6.3	4.8
90.0	14.2	11.5	8.4	6.3	4.6	3.3	2.8	2.5	1.9

Big Bend – Regulated Inflow
Volume Probabilities in 1,000 cfs

Percent Chance Exceedence	1-Day	3-Day	7-Day	15-Day	30-Day	60-Day	90-Day	120-Day	183-Day
0.2	280.0	265.0	250.0	220.0	212.0	204.0	190.0	170.0	120.0
1.0	145.0	135.0	125.0	120.0	115.0	105.0	104.0	89.0	72.0
2.0	112.0	102.0	92.0	93.0	85.0	76.0	80.0	70.0	60.0
4.0	86.9	80.3	77.3	73.4	69.4	65.0	64.0	57.1	51.2
10.0	68.4	64.3	62.1	59.1	55.8	52.5	49.5	47.3	43.7
20.0	56.6	53.7	51.9	49.3	46.6	43.8	41.5	40.1	37.8
50.0	42.9	40.9	39.2	37.2	35.0	32.7	31.1	30.0	28.6
90.0	33.8	31.7	29.7	27.7	25.8	23.7	22.3	20.8	18.7

Big Bend – Incremental Inflow
Volume Probabilities in 1,000 cfs

Percent Chance Exceedence	1-Day	3-Day	7-Day	15-Day	30-Day	60-Day	90-Day	120-Day	183-Day
0.2	73.9	53.7	42.6	31.7	21.4	13.5	9.5	7.2	4.4
1.0	51.0	35.7	26.6	18.9	12.5	8.0	5.8	4.5	2.8
2.0	42.1	29.0	20.9	14.5	9.5	6.1	4.5	3.5	2.2
4.0	33.8	22.9	15.9	10.8	7.0	4.5	3.3	2.6	1.7
10.0	23.6	15.7	10.4	6.8	4.3	2.7	2.0	1.6	1.1
20.0	16.6	10.8	6.9	4.3	2.7	1.7	1.2	1.0	0.6
50.0	8.1	5.2	3.0	1.8	1.0	0.6	0.4	0.3	0.2
90.0	2.4	1.5	0.8	0.4	0.2	0.1	0.1	0.1	0.0

Fort Randall – Regulated Inflow
Volume Probabilities in 1,000 cfs

Percent Chance Exceedence	1-Day	3-Day	7-Day	15-Day	30-Day	60-Day	90-Day	120-Day	183-Day
0.2	295.0	280.0	265.0	260.0	245.0	230.0	210.0	185.0	135.0
1.0	175.0	160.0	150.0	135.0	125.0	110.0	106.0	95.0	80.0
2.0	137.0	122.0	110.0	102.0	91.0	84.0	81.0	74.0	65.0
4.0	108.0	96.0	85.1	78.6	72.5	66.8	62.8	59.5	55.1
10.0	79.9	73.7	65.8	60.8	56.5	52.8	50.3	48.3	45.6
20.0	65.6	60.5	53.8	49.8	46.4	43.6	41.8	40.4	38.7
50.0	49.2	45.5	40.5	37.4	34.7	32.5	31.1	30.1	28.9
90.0	38.5	36.2	32.5	29.8	27.1	24.5	22.9	21.5	19.8

Fort Randall – Incremental Inflow
Volume Probabilities in 1,000 cfs

Percent Chance Exceedence	1-Day	3-Day	7-Day	15-Day	30-Day	60-Day	90-Day	120-Day	183-Day
0.2	108.0	87.0	67.4	49.8	34.2	22.0	17.0	14.5	10.4
1.0	80.1	61.9	46.7	34.0	23.4	15.5	12.2	10.6	7.8
2.0	68.9	52.2	39.0	28.2	19.5	13.0	10.3	9.0	6.8
4.0	58.0	43.1	31.9	23.0	15.9	10.7	8.6	7.5	5.8
10.0	44.0	32.0	23.3	16.7	11.6	8.0	6.4	5.7	4.4
20.0	33.5	24.1	17.4	12.5	8.7	6.0	4.9	4.4	3.5
50.0	19.4	13.8	10.0	7.2	5.0	3.5	2.9	2.6	2.1
90.0	7.8	5.8	4.3	3.2	2.2	1.6	1.3	1.1	0.9

Gavins Point – Regulated Inflow
Volume Probabilities in 1,000 cfs

Percent Chance Exceedence	1-Day	3-Day	7-Day	15-Day	30-Day	60-Day	90-Day	120-Day	183-Day
0.2	240.0	230.0	228.0	225.0	223.0	221.0	205.0	180.0	135.0
1.0	130.0	125.0	120.0	118.0	117.0	116.0	110.0	102.0	84.0
2.0	103.0	97.0	95.0	90.0	89.0	87.0	87.5	82.5	72.5
4.0	82.1	78.5	76.3	74.7	73.3	71.2	69.1	66.7	60.8
10.0	64.3	62.2	60.7	59.3	58.0	56.1	54.8	53.6	51.1
20.0	53.1	51.7	50.5	49.2	48.1	46.4	45.4	44.8	43.7
50.0	40.4	39.3	38.3	37.3	36.3	35.0	34.1	33.7	33.2
90.0	32.6	30.9	29.7	28.9	28.2	27.2	26.1	25.1	23.0

Gavins Point – Incremental Inflow
Volume Probabilities in 1,000 cfs

Percent Chance Exceedence	1-Day	3-Day	7-Day	15-Day	30-Day	60-Day	90-Day	120-Day	183-Day
0.2	123.0	96.9	72.5	48.9	30.7	19.9	15.8	13.6	10.1
1.0	69.0	55.4	42.6	30.1	20.3	14.0	11.5	10.1	7.8
2.0	53.0	42.9	33.4	24.1	16.8	11.9	9.9	8.8	6.9
4.0	40.3	32.9	25.9	19.1	13.7	10.0	8.5	7.6	6.1
10.0	27.2	22.5	18.0	13.7	10.2	7.8	6.7	6.1	5.0
20.0	19.6	16.4	13.2	10.3	8.0	6.2	5.5	5.0	4.2
50.0	11.6	9.7	8.0	6.4	5.2	4.3	3.8	3.6	3.1
90.0	6.5	5.5	4.5	3.8	3.2	2.7	2.4	2.3	2.1

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APPENDIX B

Missouri River Mainstem Reservoir System
Smoothing of Standard Deviation of Logs
and Skew Coefficient of Logs
Regulated and Incremental

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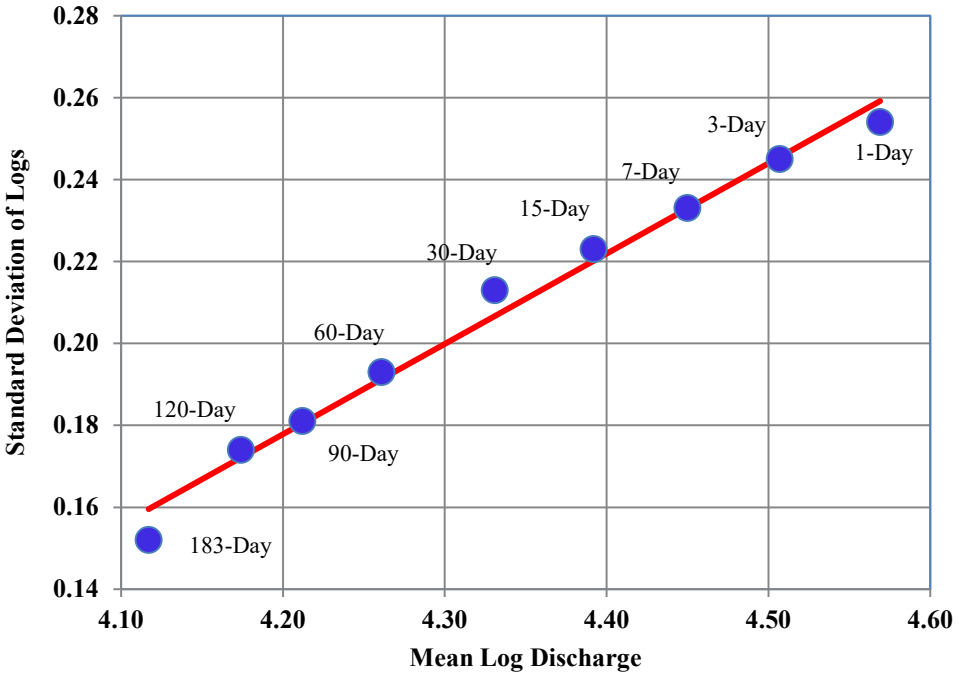
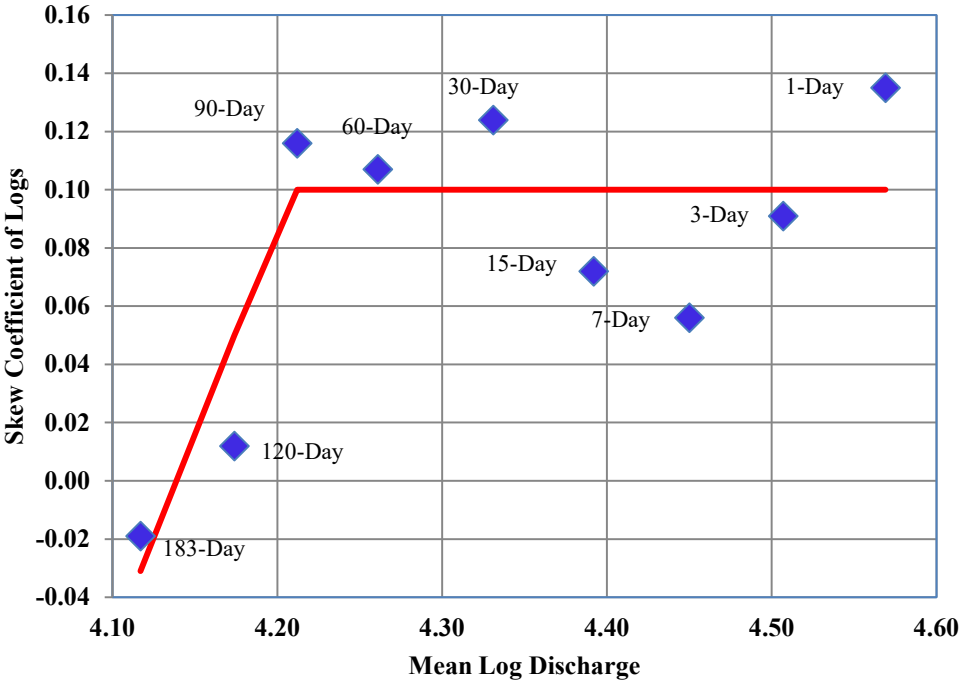
Fort Peck - Regulated Inflow

Smoothing of Standard Deviation of Logs



Duration	Mean Logarithm	Adopted Standard Deviation
1-Day	4.569	0.259
3-Day	4.507	0.246
7-Day	4.450	0.233
15-Day	4.392	0.220
30-Day	4.331	0.207
60-Day	4.261	0.191
90-Day	4.212	0.180
120-Day	4.174	0.172
183-Day	4.117	0.160

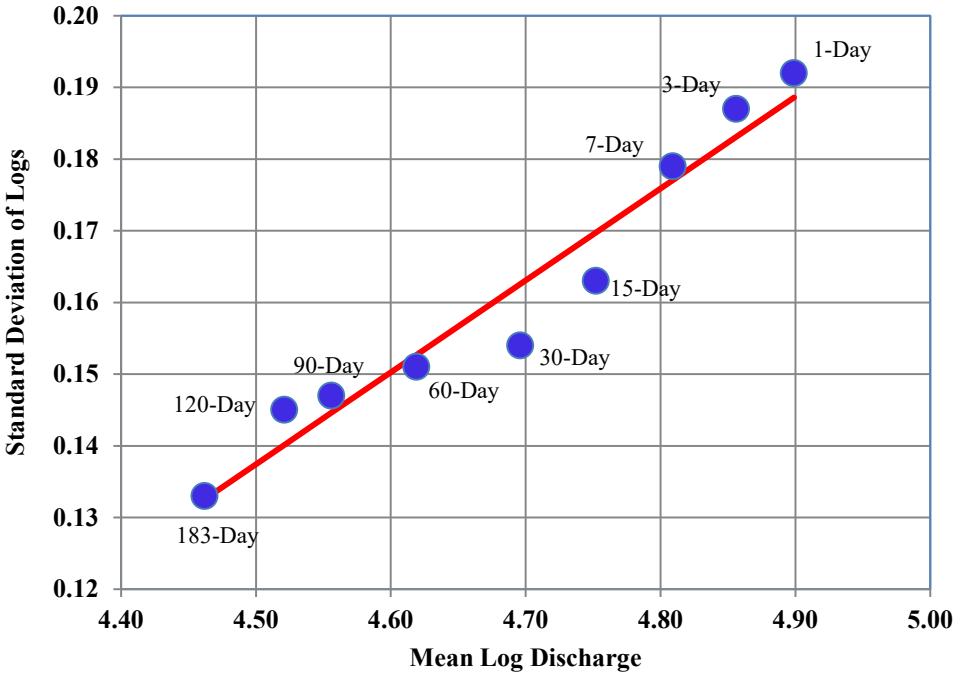
Smoothing of Skew Coefficients of Logs



Duration	Mean Logarithm	Adopted Skew Coefficient
1-Day	4.569	0.100
3-Day	4.507	0.100
7-Day	4.450	0.100
15-Day	4.392	0.100
30-Day	4.331	0.100
60-Day	4.261	0.100
90-Day	4.212	0.100
120-Day	4.174	0.050
183-Day	4.117	-0.031

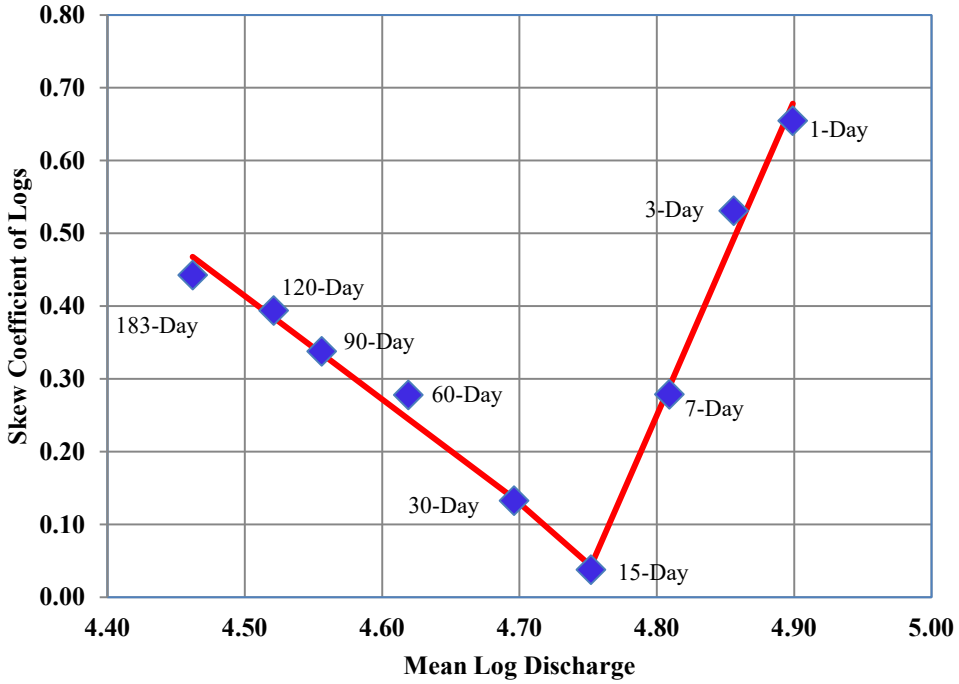
Garrison - Regulated Inflow

Smoothing of Standard Deviation of Logs



Duration	Mean Logarithm	Adopted Standard Deviation
1-Day	4.899	0.200
3-Day	4.856	0.190
7-Day	4.809	0.177
15-Day	4.752	0.170
30-Day	4.696	0.163
60-Day	4.619	0.153
90-Day	4.556	0.145
120-Day	4.521	0.140
183-Day	4.462	0.133

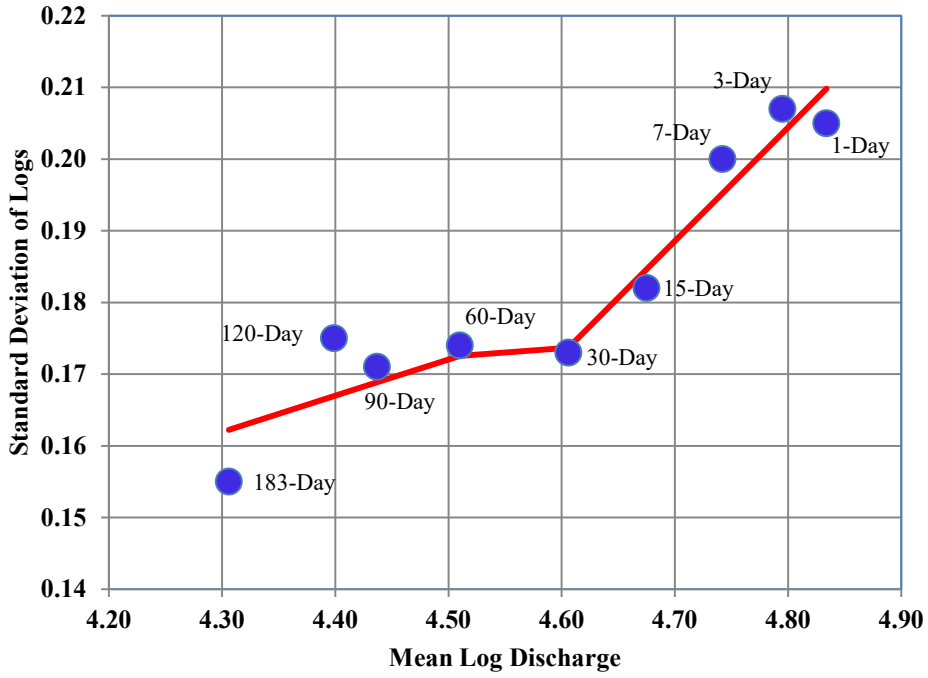
Smoothing of Skew Coefficients of Logs



Duration	Mean Logarithm	Adopted Skew Coefficient
1-Day	4.899	0.678
3-Day	4.856	0.492
7-Day	4.809	0.289
15-Day	4.752	0.080
30-Day	4.696	0.136
60-Day	4.619	0.245
90-Day	4.556	0.334
120-Day	4.521	0.384
183-Day	4.462	0.468

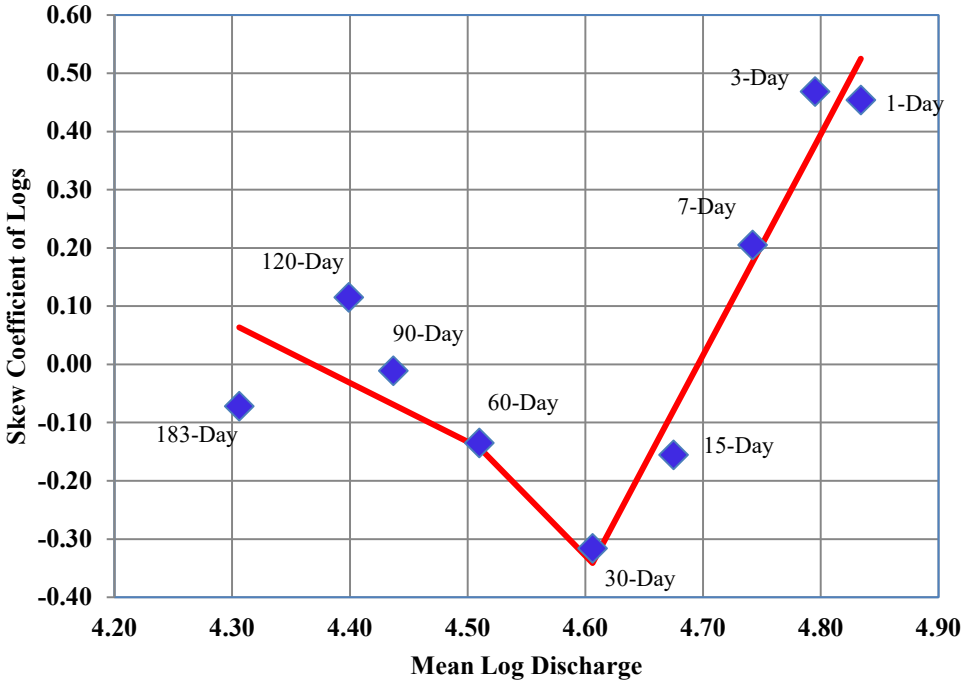
Garrison - Incremental Inflow

Smoothing of Standard Deviation of Logs



Duration	Mean Logarithm	Adopted Standard Deviation
1-Day	4.834	0.210
3-Day	4.795	0.204
7-Day	4.742	0.195
15-Day	4.675	0.185
30-Day	4.606	0.174
60-Day	4.510	0.173
90-Day	4.437	0.169
120-Day	4.399	0.167
183-Day	4.306	0.162

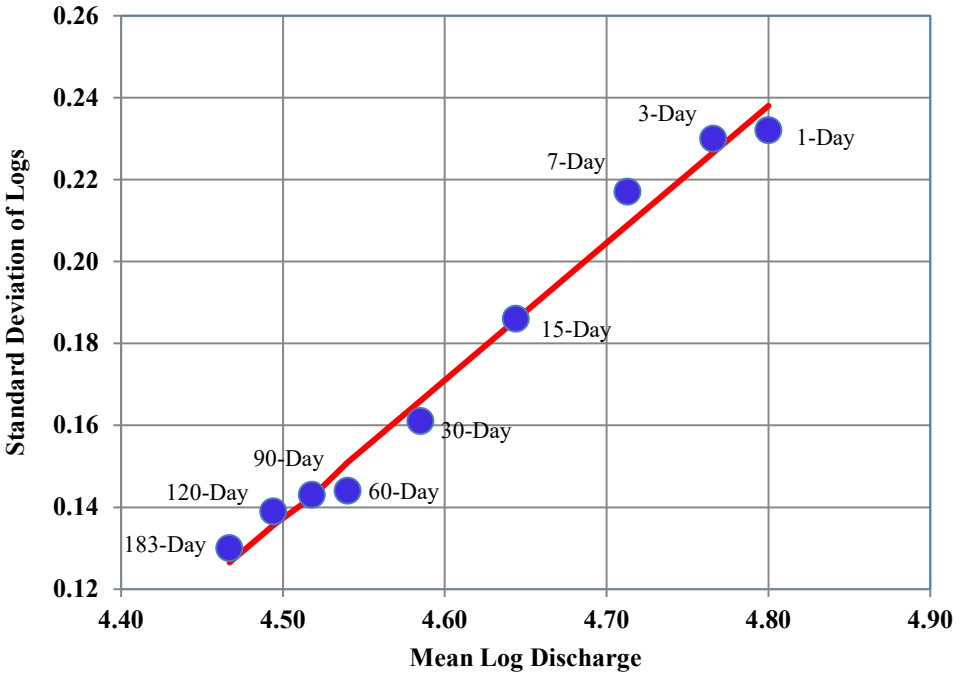
Smoothing of Skew Coefficients of Logs



Duration	Mean Logarithm	Adopted Skew Coefficient
1-Day	4.834	0.525
3-Day	4.795	0.377
7-Day	4.742	0.175
15-Day	4.675	-0.079
30-Day	4.606	-0.341
60-Day	4.510	-0.143
90-Day	4.437	-0.069
120-Day	4.399	-0.031
183-Day	4.306	0.064

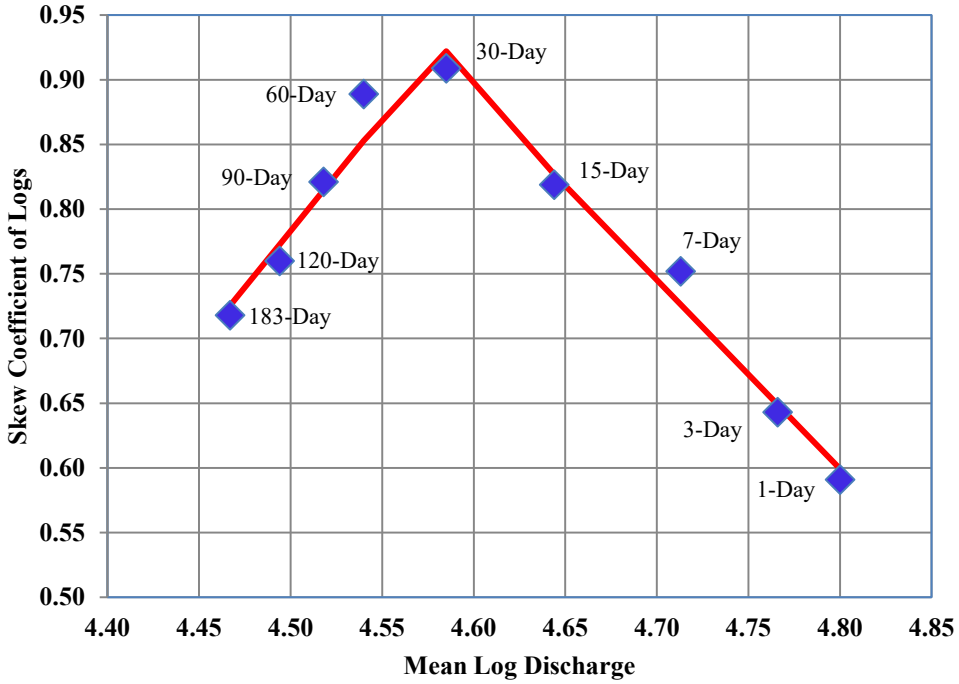
Oahe - Regulated Inflow

Smoothing of Standard Deviation of Logs



Duration	Mean Logarithm	Adopted Standard Deviation
1-Day	4.800	0.230
3-Day	4.766	0.220
7-Day	4.713	0.210
15-Day	4.644	0.191
30-Day	4.585	0.165
60-Day	4.540	0.150
90-Day	4.518	0.143
120-Day	4.494	0.136
183-Day	4.467	0.127

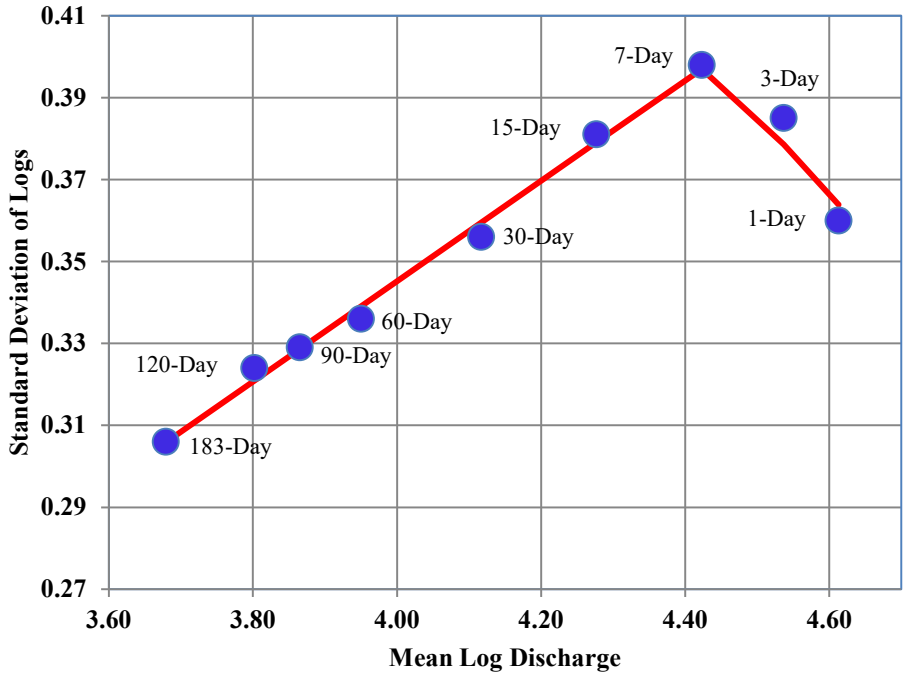
Smoothing of Skew Coefficients of Logs



Duration	Mean Logarithm	Adopted Skew Coefficient
1-Day	4.800	0.820
3-Day	4.766	0.860
7-Day	4.713	0.930
15-Day	4.644	0.940
30-Day	4.585	0.936
60-Day	4.540	0.859
90-Day	4.518	0.821
120-Day	4.494	0.773
183-Day	4.467	0.726

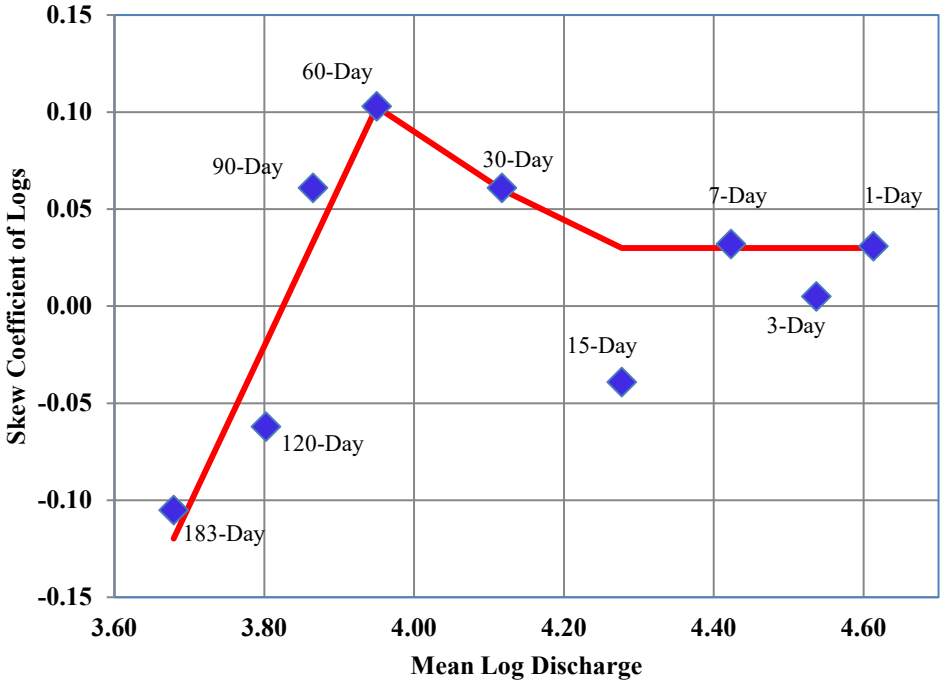
Oahe - Incremental Inflow

Smoothing of Standard Deviation of Logs



Duration	Mean Logarithm	Adopted Standard Deviation
1-Day	4.613	0.360
3-Day	4.537	0.373
7-Day	4.423	0.390
15-Day	4.277	0.373
30-Day	4.117	0.356
60-Day	3.950	0.336
90-Day	3.865	0.329
120-Day	3.802	0.318
183-Day	3.679	0.304

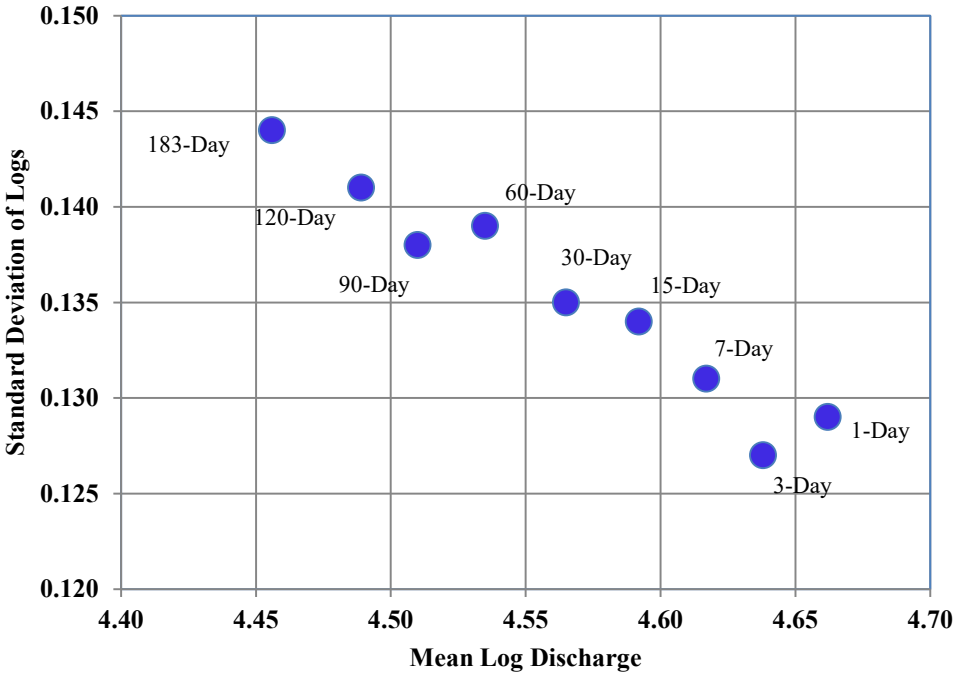
Smoothing of Skew Coefficients of Logs



Duration	Mean Logarithm	Adopted Skew Coefficient
1-Day	4.613	0.030
3-Day	4.537	0.030
7-Day	4.423	0.030
15-Day	4.277	0.030
30-Day	4.117	0.060
60-Day	3.950	0.104
90-Day	3.865	0.032
120-Day	3.802	-0.021
183-Day	3.679	-0.119

Big Bend - Regulated Inflow

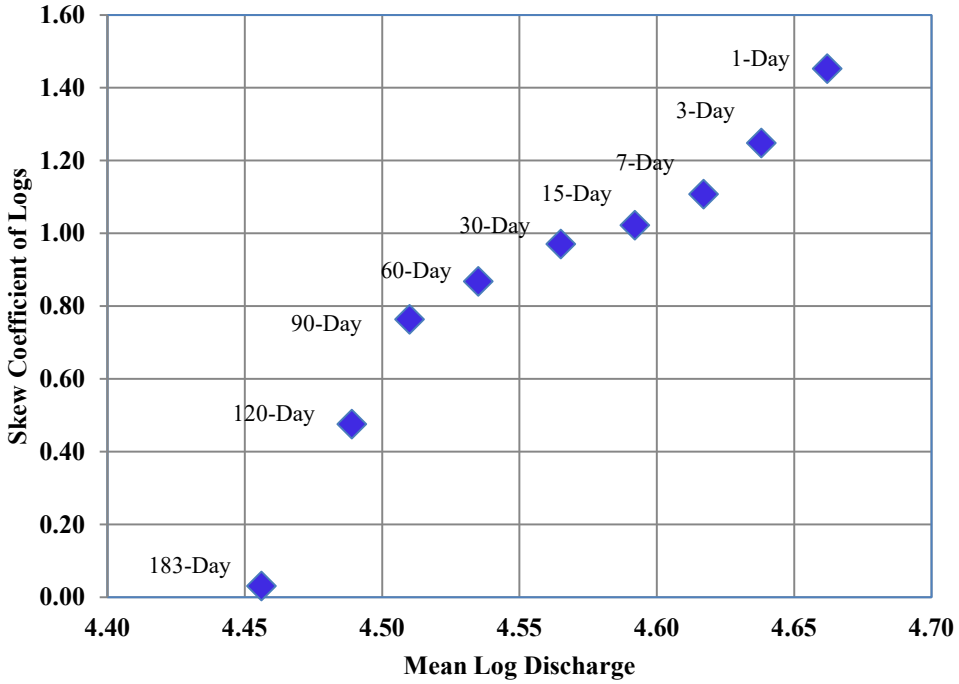
Smoothing of Standard Deviation of Logs



Duration	Mean Logarithm	Adopted Standard Deviation
1-Day	4.662	0.129
3-Day	4.638	0.127
7-Day	4.617	0.131
15-Day	4.592	0.134
30-Day	4.565	0.135
60-Day	4.535	0.139
90-Day	4.510	0.138
120-Day	4.489	0.141
183-Day	4.456	0.144

Note: Standard deviation smoothing was not necessary.

Smoothing of Skew Coefficients of Logs

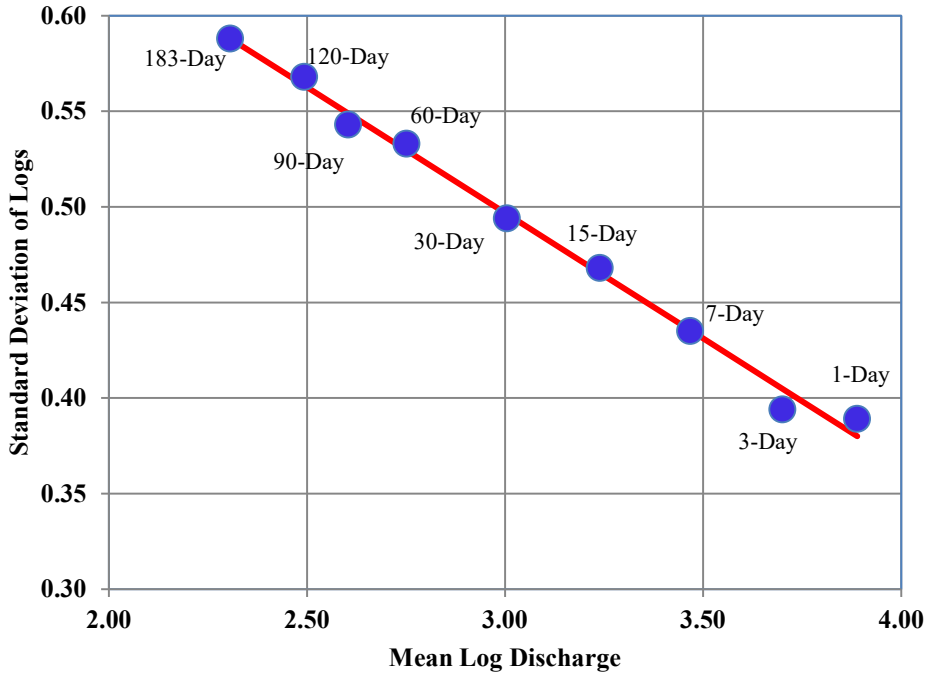


Duration	Mean Logarithm	Adopted Skew Coefficient
1-Day	4.662	1.453
3-Day	4.638	1.249
7-Day	4.617	1.108
15-Day	4.592	1.023
30-Day	4.565	0.971
60-Day	4.535	0.868
90-Day	4.510	0.764
120-Day	4.489	0.476
183-Day	4.456	0.031

Note: Skew coefficient smoothing was not necessary.

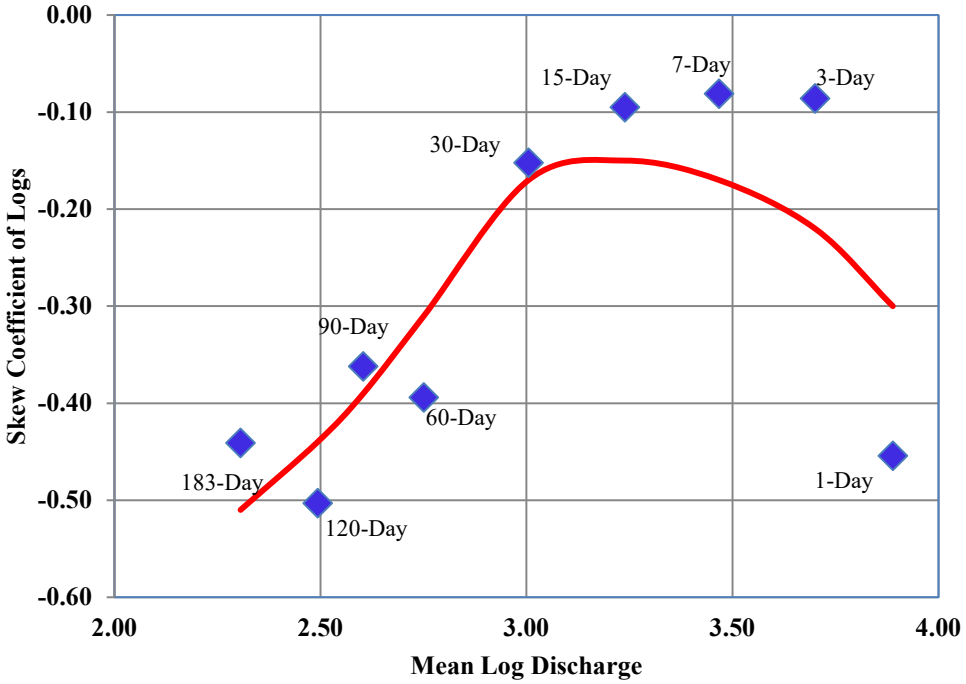
Big Bend - Incremental Inflow

Smoothing of Standard Deviation of Logs



Duration	Mean Logarithm	Adopted Standard Deviation
1-Day	3.889	0.389
3-Day	3.700	0.394
7-Day	3.467	0.435
15-Day	3.239	0.468
30-Day	3.005	0.496
60-Day	2.751	0.550
90-Day	2.604	0.570
120-Day	2.493	0.580
183-Day	2.306	0.590

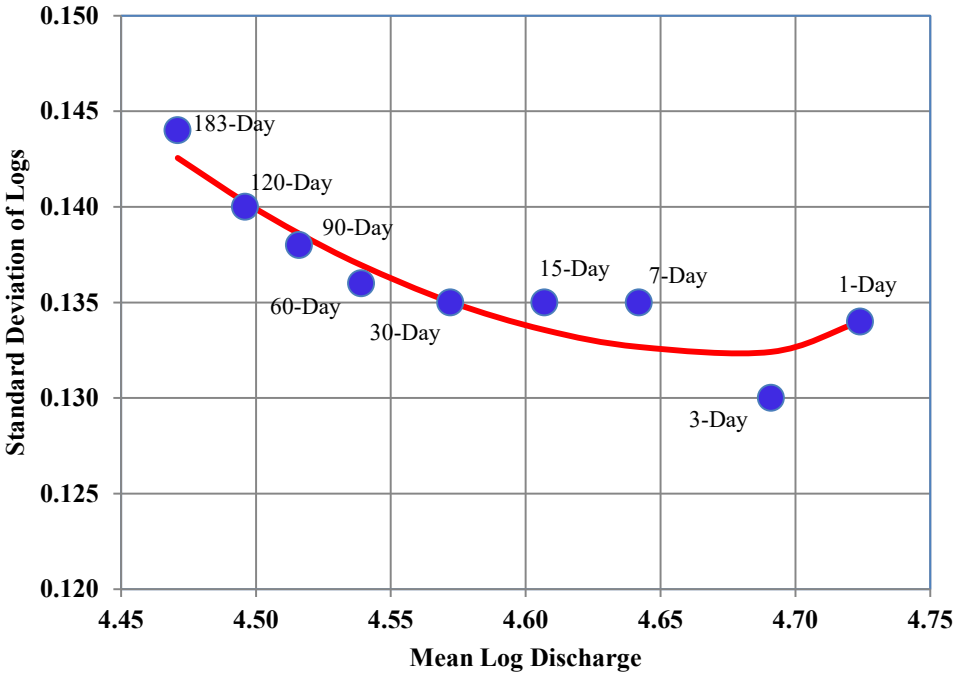
Smoothing of Skew Coefficients of Logs



Duration	Mean Logarithm	Adopted Skew Coefficient
1-Day	3.889	-0.300
3-Day	3.700	-0.220
7-Day	3.467	-0.170
15-Day	3.239	-0.150
30-Day	3.005	-0.170
60-Day	2.751	-0.310
90-Day	2.604	-0.390
120-Day	2.493	-0.440
183-Day	2.306	-0.510

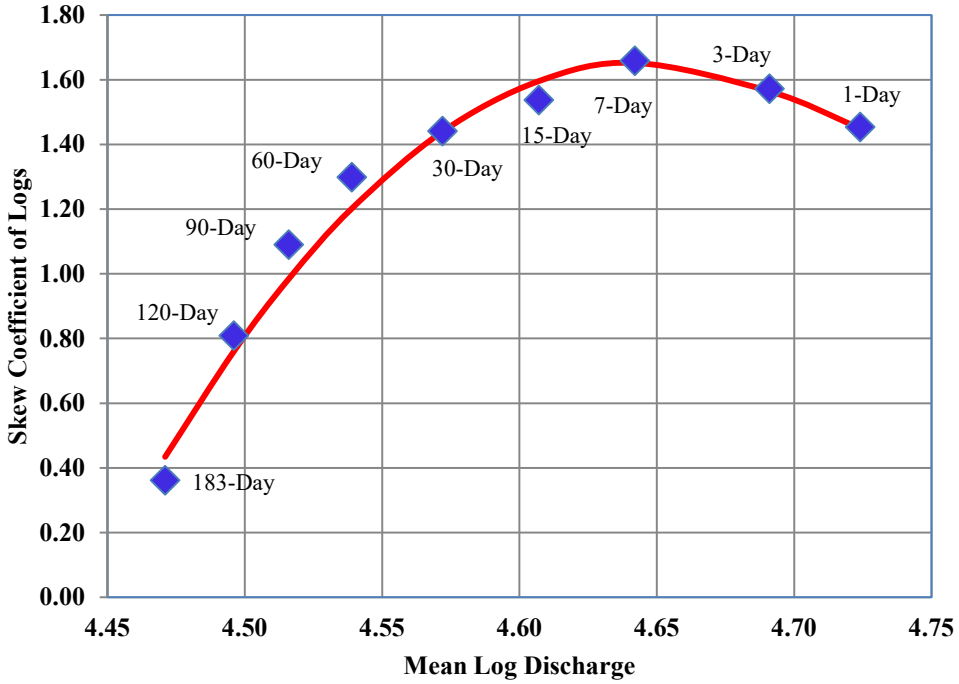
Fort Randall - Regulated Inflow

Smoothing of Standard Deviation of Logs



Duration	Mean Logarithm	Adopted Standard Deviation
1-Day	4.724	0.134
3-Day	4.691	0.132
7-Day	4.642	0.133
15-Day	4.607	0.134
30-Day	4.572	0.135
60-Day	4.539	0.137
90-Day	4.516	0.139
120-Day	4.496	0.140
183-Day	4.471	0.143

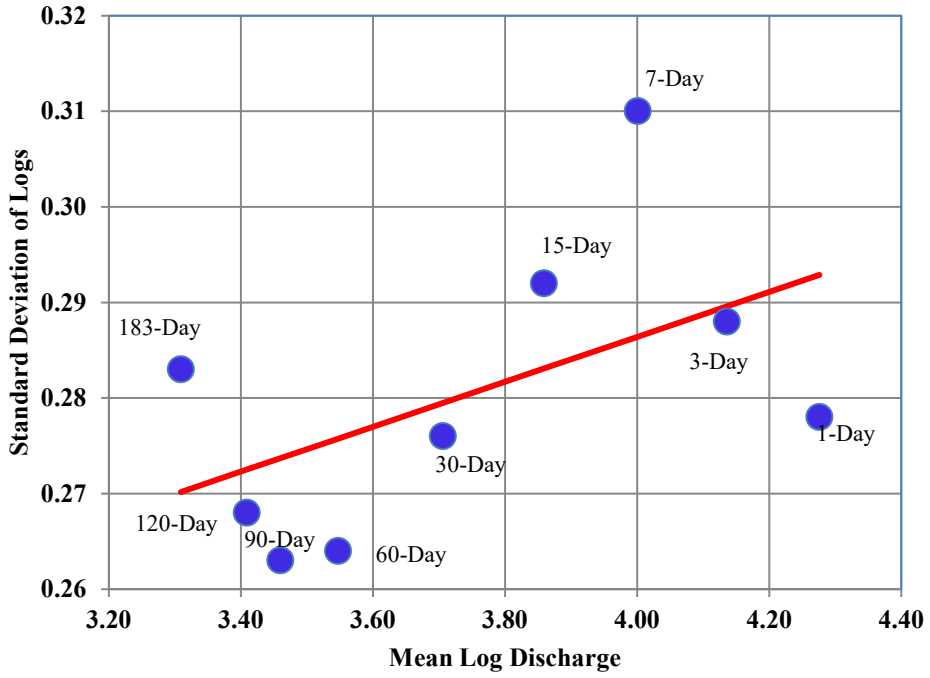
Smoothing of Skew Coefficients of Logs



Duration	Mean Logarithm	Adopted Skew Coefficient
1-Day	4.724	1.450
3-Day	4.691	1.564
7-Day	4.642	1.652
15-Day	4.607	1.596
30-Day	4.572	1.440
60-Day	4.539	1.202
90-Day	4.516	0.984
120-Day	4.496	0.760
183-Day	4.471	0.434

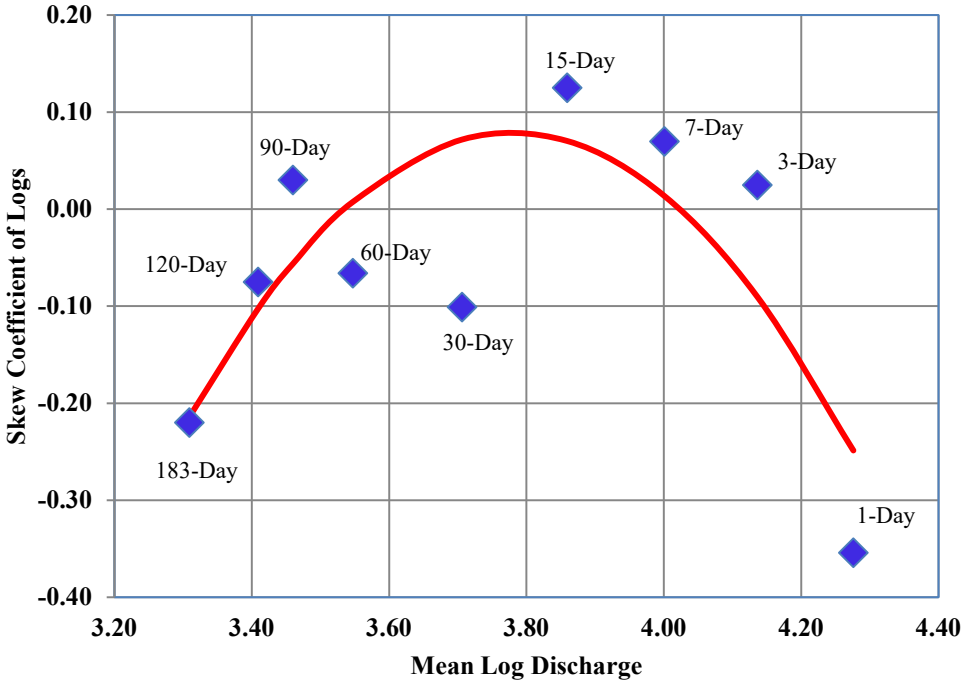
Fort Randall - Incremental Inflow

Smoothing of Standard Deviation of Logs



Duration	Mean Logarithm	Adopted Standard Deviation
1-Day	4.276	0.293
3-Day	4.136	0.290
7-Day	4.001	0.286
15-Day	3.859	0.283
30-Day	3.706	0.279
60-Day	3.547	0.276
90-Day	3.460	0.274
120-Day	3.409	0.273
183-Day	3.309	0.270

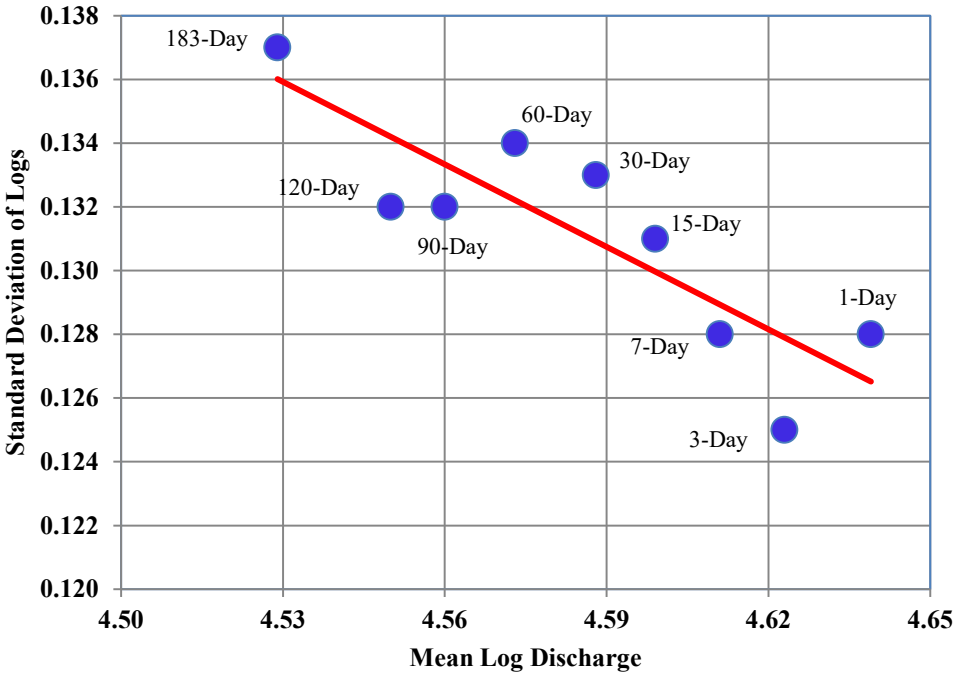
Smoothing of Skew Coefficients of Logs



Duration	Mean Logarithm	Adopted Skew Coefficient
1-Day	4.276	-0.249
3-Day	4.136	-0.090
7-Day	4.001	0.013
15-Day	3.859	0.070
30-Day	3.706	0.072
60-Day	3.547	0.007
90-Day	3.460	-0.056
120-Day	3.409	-0.103
183-Day	3.309	-0.214

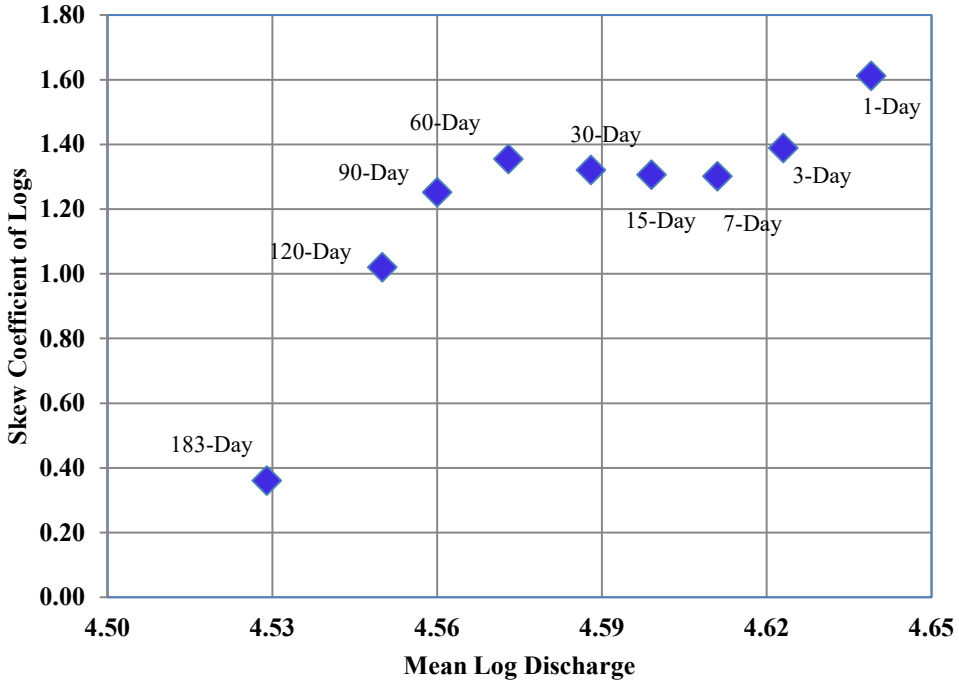
Gavins Point - Regulated Inflow

Smoothing of Standard Deviation of Logs



Duration	Mean Logarithm	Adopted Standard Deviation
1-Day	4.639	0.127
3-Day	4.623	0.128
7-Day	4.611	0.129
15-Day	4.599	0.130
30-Day	4.588	0.131
60-Day	4.573	0.132
90-Day	4.560	0.133
120-Day	4.550	0.134
183-Day	4.529	0.136

Smoothing of Skew Coefficients of Logs

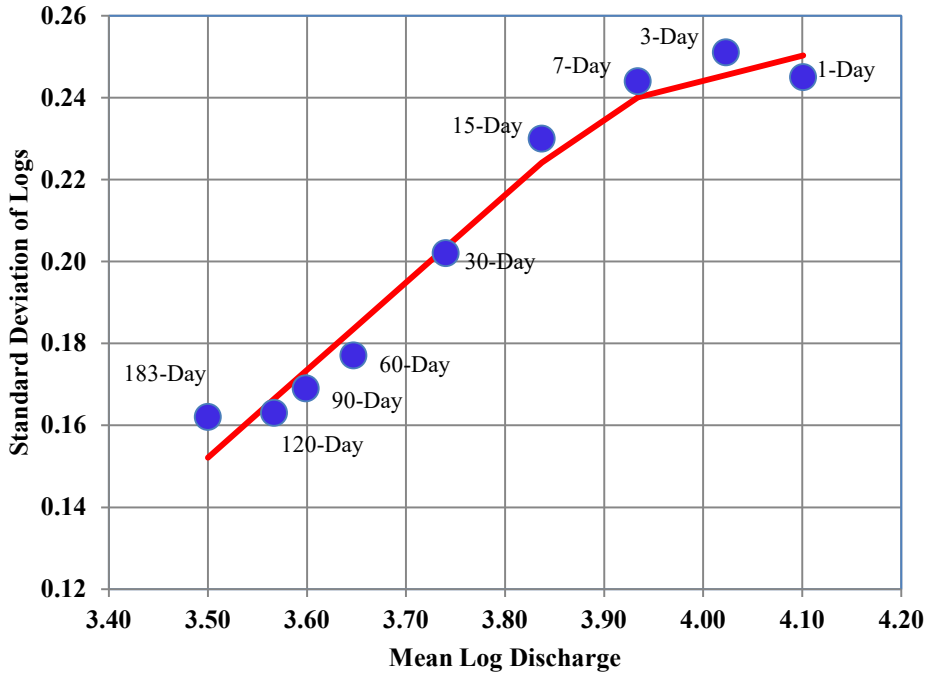


Duration	Mean Logarithm	Adopted Skew Coefficient
1-Day	4.639	1.612
3-Day	4.623	1.389
7-Day	4.611	1.302
15-Day	4.599	1.307
30-Day	4.588	1.321
60-Day	4.573	1.355
90-Day	4.560	1.252
120-Day	4.550	1.021
183-Day	4.529	0.361

Note: Skew coefficient smoothing was not necessary.

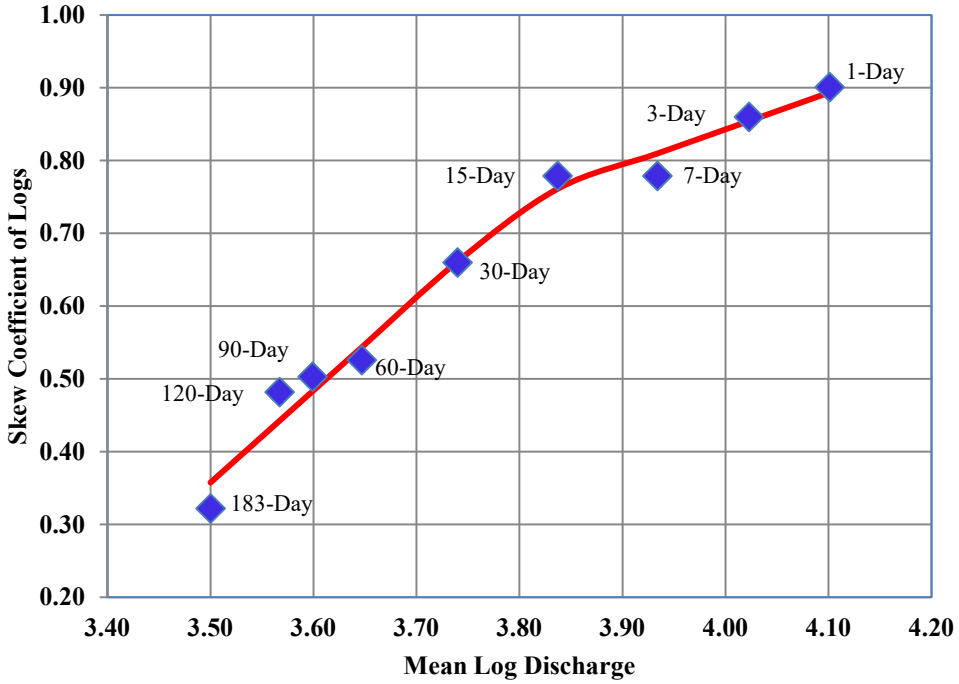
Gavins Point - Incremental Inflow

Smoothing of Standard Deviation of Logs



Duration	Mean Logarithm	Adopted Standard Deviation
1-Day	4.101	0.250
3-Day	4.023	0.246
7-Day	3.934	0.240
15-Day	3.837	0.224
30-Day	3.740	0.203
60-Day	3.647	0.184
90-Day	3.599	0.173
120-Day	3.567	0.166
183-Day	3.500	0.152

Smoothing of Skew Coefficients of Logs



Duration	Mean Logarithm	Adopted Skew Coefficient
1-Day	4.101	0.894
3-Day	4.023	0.854
7-Day	3.934	0.810
15-Day	3.837	0.761
30-Day	3.740	0.661
60-Day	3.647	0.544
90-Day	3.599	0.483
120-Day	3.567	0.442
183-Day	3.500	0.358

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APPENDIX C

Missouri River Mainstem Reservoir System
Highest Annual Mean Inflow for the
1-, 3-, 7-, 15-, 30-, 60-, 90-, 120-, and 183-Day Durations

Regulated Inflows

Fort Peck Regulated Inflow, 1881, 1930-2019
Highest Mean Value for Duration in Days, in 1,000 cfs

Year	1-Day	3-Day	7-Day	15-Day	30-Day	60-Day	90-Day	120-Day	183-Day
1881	84.0	78.8	65.5	54.3	44.6	35.3	30.9	31.7	
1930	17.2	15.9	15.7	14.8	12.5	10.5	9.4	9.0	8.3
1931	8.7	8.4	8.2	7.9	7.5	7.1	6.4	5.6	5.5
1932	28.5	27.5	23.9	21.9	18.7	15.5	13.3	12.1	10.1
1933	26.2	25.8	25.7	24.9	20.4	15.3	13.0	11.4	9.7
1934	27.1	24.6	19.4	13.9	11.9	10.9	10.2	9.7	9.0
1935	16.1	15.9	15.0	12.6	11.5	10.7	9.8	8.7	7.6
1936	16.4	16.1	15.4	14.2	11.1	8.6	9.0	8.3	7.7
1937	12.9	12.2	10.3	9.5	8.7	8.1	7.3	6.2	5.9
1938	60.6	51.6	48.0	43.0	34.8	27.0	21.7	18.6	14.3
1939	56.9	42.6	32.4	23.3	17.7	13.5	12.4	12.6	11.3
1940	16.4	12.7	11.3	10.2	9.5	8.7	8.6	8.3	7.8
1941	18.0	12.0	11.3	10.9	10.3	9.2	8.6	8.1	7.4
1942	59.5	50.4	43.0	38.9	32.7	24.2	20.6	18.1	15.2
1943	92.5	78.9	66.2	53.8	45.3	32.9	27.0	25.1	20.2
1944	83.5	62.1	48.3	39.9	32.0	21.8	17.6	14.9	12.5
1945	26.8	25.8	24.1	21.7	18.4	14.4	12.2	10.6	8.9
1946	25.6	18.1	16.0	13.6	11.2	11.0	9.9	9.3	8.6
1947	93.8	77.2	54.4	34.8	23.8	22.3	20.7	20.8	16.6
1948	73.9	69.1	58.6	57.3	51.8	41.0	33.3	28.5	22.0
1949	24.8	21.4	20.9	19.0	17.9	14.7	14.0	13.2	11.9
1950	44.3	38.4	35.0	34.4	30.4	23.2	19.7	17.4	14.9
1951	33.4	29.3	27.5	24.7	23.5	22.0	20.1	19.4	16.5
1952	86.5	77.9	63.8	43.6	29.6	25.8	23.4	20.5	16.9
1953	125.2	117.5	94.3	75.3	55.4	36.8	27.9	22.8	17.1
1954	19.7	17.7	15.9	14.3	13.3	12.8	12.3	11.7	10.2
1955	19.2	18.0	17.3	16.5	16.1	15.5	14.5	13.3	11.6
1956	32.8	31.2	28.7	24.8	21.1	16.5	14.4	13.2	11.8
1957	26.6	25.7	24.6	24.1	21.4	18.1	15.1	13.6	12.2
1958	25.0	24.3	23.4	20.5	18.4	16.5	15.0	13.8	12.2
1959	38.6	35.5	32.5	29.6	26.6	22.0	19.2	17.5	15.8
1960	51.5	47.4	33.7	22.4	18.6	16.7	16.3	15.4	12.9
1961	16.5	15.5	15.3	15.1	13.6	11.7	10.7	9.8	8.2
1962	44.0	41.5	38.0	32.0	26.6	22.1	18.0	15.8	13.2
1963	31.4	27.9	25.2	23.9	23.5	19.4	16.3	14.5	12.2
1964	93.8	86.1	74.5	62.7	51.2	36.8	30.6	26.0	19.7
1965	47.3	42.5	40.7	38.8	35.8	30.7	28.3	26.3	21.7
1966	27.7	26.2	23.8	18.1	15.6	14.9	14.1	14.1	14.0
1967	55.7	55.5	53.9	49.8	43.6	33.6	27.5	23.7	19.7
1968	37.8	36.0	32.8	28.9	25.5	22.4	19.6	17.6	16.3
1969	55.2	46.7	39.7	35.2	28.5	23.1	21.5	22.4	19.1
1970	45.9	43.3	37.7	34.9	34.6	32.6	28.4	24.8	20.3
1971	37.0	35.4	30.6	28.7	27.9	24.6	22.6	20.7	19.0
1972	53.2	49.3	38.3	32.2	28.3	23.0	20.4	19.7	17.5
1973	29.6	19.8	16.5	14.9	13.5	12.4	11.6	11.0	9.9
1974	59.7	47.3	38.8	32.7	28.1	25.4	21.1	19.1	15.9
1975	79.6	75.9	70.1	64.4	54.9	43.8	41.1	35.9	28.3
1976	55.2	37.7	36.0	35.6	33.3	30.3	26.8	23.8	20.2
1977	44.0	21.3	14.4	12.8	10.7	9.7	9.2	8.9	10.8
1978	131.4	110.9	90.1	67.9	43.3	31.8	31.2	30.4	25.8
1979	67.9	59.5	55.8	45.0	32.6	26.7	25.0	23.6	19.8
1980	36.4	34.4	32.9	31.8	30.1	25.0	20.8	17.7	14.7
1981	63.6	61.2	54.3	48.9	44.6	35.0	28.6	24.3	19.0
1982	45.8	45.3	42.0	40.3	38.9	34.3	28.1	24.4	20.9
1983	31.1	29.7	28.8	26.0	22.0	19.3	17.9	16.7	14.1
1984	29.6	29.1	28.1	27.6	26.2	22.6	19.8	18.1	15.9
1985	16.7	16.4	14.6	13.8	12.4	11.4	11.0	10.6	11.4

1986	161.2	76.9	41.9	28.7	20.9	19.8	17.8	17.0	15.6
1987	26.7	16.1	13.2	12.2	10.9	10.0	9.6	10.5	11.0
1988	13.3	12.8	11.5	10.4	10.0	9.7	9.5	8.9	7.9
1989	28.8	24.7	21.6	16.8	16.1	15.4	14.3	14.3	12.8
1990	20.4	20.2	19.6	17.8	15.8	13.8	12.5	11.9	11.0
1991	38.0	32.5	29.1	28.0	27.5	24.7	21.0	18.5	15.0
1992	12.3	12.0	11.5	10.6	10.3	9.4	8.8	8.1	9.1
1993	46.8	38.3	31.5	29.7	26.8	23.4	20.8	19.3	16.8
1994	65.8	54.2	40.1	28.0	18.8	15.5	15.0	14.7	14.3
1995	37.9	36.0	35.5	34.7	29.7	26.8	24.6	21.9	17.7
1996	48.7	43.1	35.4	33.4	32.9	26.0	23.0	22.4	19.6
1997	51.7	51.4	49.9	46.3	40.4	32.8	27.6	24.0	20.3
1998	42.7	40.5	37.7	34.8	30.3	22.8	19.4	17.2	14.6
1999	28.7	24.4	22.6	20.2	18.5	16.1	14.7	13.5	12.4
2000	21.1	19.2	17.8	15.5	13.6	12.3	11.1	10.2	9.2
2001	31.4	18.4	13.2	12.2	11.0	10.3	9.7	9.0	7.9
2002	35.1	27.9	23.5	20.8	19.2	15.8	13.7	12.1	9.8
2003	29.5	23.2	20.5	16.5	14.3	13.0	12.0	11.2	10.2
2004	20.9	18.9	15.7	12.6	11.7	11.1	9.8	8.9	8.3
2005	38.4	28.5	21.7	18.5	17.5	15.0	13.4	12.1	10.3
2006	27.6	23.9	21.4	18.1	15.4	13.7	13.0	12.5	11.2
2007	26.7	23.5	20.6	19.4	17.8	15.0	13.5	12.2	11.0
2008	47.8	41.8	38.0	34.9	31.9	25.7	20.7	17.5	13.9
2009	24.5	21.4	21.3	20.3	18.4	16.5	15.5	14.0	12.3
2010	36.9	35.9	34.0	32.5	28.5	23.7	19.6	17.0	14.1
2011	102.1	88.8	87.3	75.6	73.6	57.3	46.0	38.4	30.5
2012	18.6	18.1	17.6	16.4	15.1	13.9	12.7	11.9	12.7
2013	51.3	46.9	42.0	32.3	23.7	16.2	13.2	11.6	10.1
2014	101.9	66.0	44.0	25.9	18.2	16.3	15.3	14.8	14.1
2015	29.1	20.3	20.2	18.1	14.7	11.5	10.1	9.8	9.9
2016	56.0	40.2	24.8	16.5	14.8	12.2	10.6	9.6	9.1
2017	20.1	20.0	19.7	18.5	17.3	15.6	13.8	12.8	11.1
2018	47.2	45.6	42.1	38.8	36.0	32.3	30.3	27.4	21.0
2019	50.9	44.3	41.5	34.4	24.7	21.2	22.0	20.4	16.9

Garrison Regulated Inflow, 1930-2019
Highest Mean Value for Duration in Days, in 1,000 cfs

Year	1-Day	3-Day	7-Day	15-Day	30-Day	60-Day	90-Day	120-Day	183-Day
1930	66.4	61.5	54.4	43.0	33.7	31.1	27.6	27.5	26.1
1931	37.9	36.6	35.0	31.0	27.5	21.5	18.4	16.6	15.1
1932	83.3	76.8	71.6	62.2	58.7	44.5	36.2	32.4	26.3
1933	76.0	61.0	58.7	52.9	47.9	39.2	32.1	30.3	25.5
1934	39.8	29.9	21.7	19.6	18.6	17.1	15.3	15.0	14.8
1935	95.5	75.4	61.1	52.6	50.7	33.9	25.1	22.5	19.4
1936	88.3	52.7	39.5	30.7	27.4	23.9	22.7	21.7	18.0
1937	69.8	65.9	50.8	49.8	38.5	33.4	27.4	23.5	19.4
1938	122.1	96.5	76.7	70.2	57.7	45.6	36.9	31.2	24.7
1939	187.9	150.5	115.4	71.4	43.1	32.1	30.5	30.5	25.9
1940	47.8	41.4	37.9	32.6	30.1	25.2	22.6	21.0	19.7
1941	46.2	43.4	40.1	36.9	33.8	27.3	23.6	23.4	21.8
1942	69.5	67.5	65.3	59.3	50.8	42.7	35.7	31.2	26.8
1943	257.4	228.2	176.4	107.3	74.4	60.6	49.0	52.0	43.0
1944	120.4	107.2	104.3	93.1	76.5	59.6	47.2	45.0	35.8
1945	71.9	71.5	66.2	53.9	48.4	42.0	34.6	29.8	27.8
1946	58.3	49.9	46.9	44.8	42.5	36.0	30.0	27.0	25.1
1947	220.7	148.0	98.5	71.0	61.1	49.5	44.8	45.6	37.8
1948	76.5	75.0	72.4	67.9	62.2	54.2	46.5	41.0	36.6
1949	135.0	125.4	102.5	69.6	46.1	33.5	33.6	31.9	27.3
1950	122.9	112.6	89.2	65.4	52.0	42.0	39.0	38.1	32.8
1951	91.3	84.6	75.3	61.3	44.5	40.6	38.1	38.1	34.8
1952	323.0	260.0	197.8	129.5	91.6	67.6	58.8	51.6	41.9
1953	77.9	75.6	73.7	64.1	56.1	45.3	38.8	34.5	31.2
1954	94.3	68.5	48.0	37.4	32.1	30.4	27.1	26.3	24.0
1955	65.5	59.2	47.6	43.4	39.6	32.1	30.3	29.1	26.0
1956	64.6	63.3	62.1	57.8	51.5	41.7	34.9	31.0	27.0
1957	74.4	73.7	70.6	68.3	63.9	52.0	43.2	36.6	30.1
1958	45.3	44.3	42.0	38.5	37.1	33.1	28.3	25.5	23.2
1959	90.3	80.9	71.1	55.2	48.0	35.9	30.3	29.4	26.1
1960	126.5	123.4	108.7	74.9	46.5	30.5	27.0	26.0	22.7
1961	34.6	33.8	32.4	31.8	28.8	21.9	19.5	18.6	17.8
1962	71.1	65.1	64.0	58.5	52.5	47.7	40.3	35.6	30.1
1963	98.6	90.2	77.9	68.9	65.6	50.8	41.7	35.6	30.5
1964	86.0	80.4	75.3	67.6	66.7	53.1	43.8	39.1	33.4
1965	98.2	91.5	80.4	79.4	78.1	65.3	57.1	53.4	44.7
1966	46.3	39.0	36.3	33.9	31.2	29.5	26.4	24.7	22.8
1967	92.3	87.9	83.9	80.3	76.7	64.2	53.1	46.6	39.0
1968	84.6	79.6	76.5	69.9	64.4	49.5	42.9	38.9	34.1
1969	109.0	96.7	75.5	64.4	55.4	47.8	43.5	45.5	37.5
1970	86.5	82.8	78.2	71.9	70.0	61.6	53.3	46.2	38.2
1971	92.7	82.7	78.4	74.5	72.1	58.3	50.2	48.3	43.0
1972	179.4	176.1	154.0	108.6	71.1	52.2	47.5	50.3	42.4
1973	66.3	62.7	61.0	52.5	51.6	43.1	37.0	31.4	28.2
1974	93.7	90.1	85.8	75.8	66.0	55.6	46.5	42.6	35.6
1975	130.3	130.1	126.7	122.9	112.9	88.7	77.2	69.9	54.9
1976	71.9	71.9	67.7	64.7	63.0	58.3	52.0	47.5	42.6
1977	56.2	47.9	44.7	40.0	32.2	27.1	23.7	22.3	20.8
1978	150.6	132.3	122.2	93.8	74.9	73.9	63.8	62.2	51.7
1979	157.8	137.4	102.1	81.2	65.4	54.5	50.4	49.7	42.3
1980	49.3	45.9	42.6	41.5	36.7	32.4	28.3	26.5	26.0
1981	71.2	67.4	62.1	60.4	53.6	44.4	37.0	32.4	29.8
1982	79.1	76.5	75.6	68.9	59.8	51.9	45.0	40.8	36.6
1983	56.3	53.9	47.9	46.3	43.9	40.6	35.3	30.7	28.4
1984	71.2	67.2	62.7	56.1	49.8	44.2	37.9	33.6	29.4
1985	42.4	39.8	35.7	30.4	28.3	24.9	23.3	22.9	21.5
1986	92.8	84.5	72.5	64.7	53.9	45.7	40.3	37.6	33.9

1987	36.6	30.6	29.6	28.1	26.7	24.7	22.6	22.3	21.3
1988	41.9	39.9	36.5	35.4	33.3	27.9	22.9	20.9	18.8
1989	43.3	42.2	40.3	38.3	34.2	31.4	28.3	27.4	23.6
1990	50.2	46.5	41.1	38.8	36.6	31.3	26.8	23.9	22.0
1991	87.4	77.0	70.1	65.6	63.0	53.1	41.7	35.0	29.4
1992	59.8	50.3	43.5	40.4	35.9	29.6	26.9	24.2	21.0
1993	76.4	68.8	60.8	52.9	51.4	47.9	43.9	38.5	31.6
1994	78.9	74.8	62.4	57.7	43.0	33.2	31.6	32.0	26.5
1995	77.9	72.6	67.9	62.3	57.2	51.8	46.6	39.9	33.2
1996	103.3	95.1	92.3	87.1	78.6	64.8	53.6	50.3	44.1
1997	107.7	104.3	101.9	98.0	88.4	72.7	63.1	57.9	51.7
1998	69.2	62.3	59.8	54.0	49.5	40.4	36.3	33.4	30.3
1999	71.5	70.3	69.0	62.9	60.4	50.9	45.2	40.9	37.0
2000	53.8	52.8	47.9	44.8	40.8	34.4	29.7	26.4	23.3
2001	41.8	39.9	37.0	31.8	29.8	25.6	23.5	22.8	20.8
2002	59.1	57.1	52.9	44.8	40.3	33.8	28.2	25.1	21.9
2003	66.9	62.9	57.5	50.0	44.7	35.0	29.6	29.2	24.6
2004	43.5	40.9	38.2	33.2	29.9	26.6	23.2	21.0	19.6
2005	89.9	72.0	62.5	52.0	45.6	41.5	34.0	28.9	23.8
2006	55.4	48.4	44.7	40.8	39.7	31.6	28.5	25.7	21.7
2007	66.5	58.3	54.9	49.2	43.8	37.8	30.7	27.9	23.7
2008	85.8	72.8	65.1	61.5	57.8	51.8	42.4	36.1	29.1
2009	79.4	59.5	57.7	54.2	50.9	47.7	40.2	37.8	32.1
2010	88.7	70.2	65.4	62.4	58.5	50.0	40.5	34.7	31.0
2011	195.9	186.2	175.2	169.2	159.3	139.5	114.8	100.3	81.2
2012	53.3	51.6	46.1	40.6	35.3	30.1	26.2	24.1	23.1
2013	81.2	74.7	66.8	57.5	52.6	41.3	33.1	30.5	26.4
2014	88.1	82.5	79.1	72.1	63.5	54.7	47.7	45.7	39.6
2015	78.8	73.4	68.2	62.0	53.7	39.6	32.2	30.2	26.6
2016	50.9	45.8	43.7	40.0	38.5	31.8	27.1	23.8	21.4
2017	67.5	67.0	65.7	60.9	54.0	48.8	42.9	40.9	35.6
2018	105.0	101.7	97.6	91.0	87.5	78.4	70.5	64.4	49.7
2019	160.6	151.9	126.9	92.7	63.7	50.2	47.1	47.6	40.7

Oahe Regulated Inflow, 1930-2019
Highest Mean Value for Duration in Days, in 1,000 cfs

Year	1-Day	3-Day	7-Day	15-Day	30-Day	60-Day	90-Day	120-Day	183-Day
1930	45.2	42.0	37.5	34.7	34.5	33.8	33.2	32.1	29.1
1931	25.6	25.5	25.4	25.2	25.0	24.8	24.2	23.5	22.1
1932	63.9	58.4	43.5	28.8	28.4	27.1	26.3	26.2	24.1
1933	44.6	43.4	40.1	38.1	36.9	34.5	32.6	32.3	28.7
1934	34.0	33.9	33.6	32.6	31.3	30.8	30.8	30.1	27.4
1935	61.9	56.0	41.5	30.5	30.0	29.1	28.0	26.6	24.2
1936	49.2	45.9	34.0	25.0	24.5	24.3	23.2	22.3	20.2
1937	65.5	61.0	50.2	33.9	23.3	21.8	20.5	19.9	18.3
1938	71.2	62.9	49.5	31.4	23.0	19.2	16.8	16.7	15.9
1939	100.0	88.6	66.4	41.1	34.3	33.8	32.4	31.5	28.4
1940	35.4	32.8	31.1	31.0	30.7	27.9	27.4	26.5	24.1
1941	93.9	85.4	68.8	45.9	29.5	20.5	18.8	17.9	18.5
1942	62.2	58.3	49.6	36.9	30.3	25.0	23.5	23.2	21.2
1943	167.6	159.2	141.3	84.5	49.7	46.6	45.5	43.6	37.3
1944	119.6	111.2	95.1	60.2	37.6	30.1	29.6	28.6	28.6
1945	75.2	73.0	65.4	51.7	38.8	33.5	26.8	26.7	25.3
1946	46.9	42.9	38.1	34.8	33.3	32.5	31.8	30.6	28.8
1947	103.4	97.2	78.6	53.5	49.8	48.5	47.4	43.6	40.0
1948	60.9	58.7	52.3	48.1	44.4	44.1	42.2	41.2	36.5
1949	105.4	99.0	85.7	70.1	46.1	35.4	27.8	26.8	26.1
1950	176.1	168.3	136.4	98.3	79.3	54.9	43.9	37.7	33.9
1951	80.1	77.3	68.5	52.2	40.0	38.2	35.6	34.8	32.0
1952	281.1	265.9	224.5	139.5	83.3	58.4	52.9	50.9	47.6
1953	69.8	68.2	64.4	47.8	41.9	39.6	36.7	35.2	33.0
1954	35.7	35.5	35.3	34.7	34.1	33.6	32.7	30.8	27.0
1955	40.9	40.3	38.9	38.5	37.8	37.1	34.3	31.7	28.1
1956	52.1	50.0	45.5	44.8	44.0	41.0	38.4	37.2	32.7
1957	36.0	34.3	33.9	33.6	32.9	32.1	30.8	29.5	26.1
1958	34.6	33.7	32.6	31.0	30.8	29.8	27.6	25.8	24.1
1959	34.7	34.0	32.8	32.1	31.8	31.4	30.3	29.4	26.4
1960	39.3	38.2	36.1	33.2	25.4	24.3	21.1	20.8	20.4
1961	26.3	24.8	23.6	23.5	22.9	22.9	19.7	19.6	18.0
1962	59.1	52.2	40.6	37.5	30.9	25.4	22.3	20.7	20.4
1963	37.7	37.1	36.7	36.3	35.9	35.7	35.3	34.8	31.4
1964	45.6	41.4	39.0	38.7	38.2	37.3	35.8	34.7	31.4
1965	61.8	55.7	49.1	48.2	47.4	45.8	45.0	44.2	42.1
1966	101.0	98.0	85.6	60.3	45.3	34.8	30.1	28.9	27.4
1967	81.6	76.6	67.9	51.3	44.6	43.5	42.4	42.2	40.6
1968	48.8	45.2	42.6	41.9	41.6	41.5	40.5	39.4	35.3
1969	70.4	69.3	62.6	49.6	40.4	35.7	34.1	34.2	33.1
1970	59.9	57.6	52.3	45.8	44.9	43.7	42.8	42.5	40.0
1971	77.0	75.3	69.9	58.8	51.4	47.6	46.9	46.3	41.7
1972	124.6	119.5	105.0	82.2	60.9	50.8	51.0	49.6	45.2
1973	46.3	45.3	39.8	36.3	32.9	31.3	27.6	28.2	28.2
1974	49.7	43.2	37.3	35.1	33.4	32.5	32.0	31.6	30.9
1975	72.0	66.7	65.0	64.7	63.9	60.5	54.9	53.1	47.8
1976	65.8	56.3	52.1	49.0	45.8	42.9	41.7	41.3	39.8
1977	50.5	35.2	31.6	26.6	25.4	25.1	24.0	24.0	23.9
1978	136.3	128.2	117.6	102.6	74.6	52.6	47.4	48.4	47.1
1979	89.1	83.9	66.8	58.5	49.0	43.3	41.3	41.3	39.1
1980	42.9	38.8	30.8	28.0	26.9	25.6	24.8	25.0	24.6
1981	34.9	33.5	32.3	31.4	30.9	29.2	28.4	28.1	27.4
1982	126.2	98.4	80.3	67.8	54.2	47.4	44.3	41.5	37.0
1983	52.1	45.5	42.2	41.9	41.3	35.7	33.2	29.3	27.4
1984	55.8	54.8	48.3	39.6	39.1	37.3	34.4	32.4	28.8
1985	45.2	43.1	39.8	36.1	32.2	29.5	25.4	26.0	26.1
1986	93.9	83.5	74.1	63.0	55.7	48.7	43.6	39.7	35.8

1987	205.6	175.4	125.4	85.1	63.0	46.4	32.3	31.6	30.1
1988	31.6	29.5	26.1	25.4	24.8	24.7	22.6	22.9	23.2
1989	41.7	38.9	33.2	29.5	25.9	24.7	23.7	23.0	22.5
1990	33.1	29.5	26.3	25.0	23.8	23.0	22.5	22.2	21.4
1991	54.5	44.5	37.9	34.6	31.3	26.9	24.7	23.5	22.6
1992	36.7	35.5	32.5	29.5	28.3	27.2	22.1	21.7	22.7
1993	69.2	56.2	51.0	47.2	39.0	32.4	29.5	27.2	25.9
1994	66.8	62.6	54.1	47.7	42.6	35.8	33.3	32.7	30.8
1995	92.0	82.5	72.8	53.2	45.3	39.6	38.3	37.6	33.7
1996	130.2	106.5	87.1	69.8	58.5	51.1	49.1	47.8	45.2
1997	162.0	150.7	147.3	111.7	76.4	63.8	57.7	57.1	55.3
1998	47.4	46.7	45.3	44.2	43.0	36.0	30.5	28.7	29.3
1999	75.9	72.3	54.9	52.9	45.6	43.0	40.6	40.1	37.4
2000	50.5	46.5	42.7	39.2	33.4	31.4	29.8	29.3	28.4
2001	69.0	57.9	55.2	46.2	36.8	29.9	26.0	24.8	23.8
2002	26.1	25.2	24.0	22.9	22.4	22.0	21.9	22.0	21.4
2003	34.9	32.6	30.8	28.9	25.8	23.7	22.7	22.3	21.9
2004	36.2	32.9	30.8	27.7	25.1	22.9	20.9	20.9	20.7
2005	36.4	32.1	29.3	25.4	22.8	21.4	20.3	19.8	18.8
2006	31.7	26.7	23.9	22.5	21.6	20.2	19.8	19.8	19.4
2007	37.2	33.9	31.1	28.0	24.9	22.2	21.2	20.8	20.3
2008	107.6	101.7	85.6	56.4	41.7	32.4	29.0	26.7	24.2
2009	181.3	165.7	143.0	100.5	90.4	63.5	48.5	42.9	36.2
2010	74.8	73.4	64.0	58.4	53.1	39.3	36.7	35.8	32.2
2011	210.0	197.0	175.4	164.9	156.5	141.4	128.9	113.8	91.2
2012	35.1	32.1	30.6	28.6	27.9	26.9	24.8	25.5	25.9
2013	67.5	63.3	56.5	43.7	36.2	30.3	27.9	27.0	26.9
2014	82.5	77.9	68.2	57.7	49.0	43.9	42.9	42.8	41.4
2015	104.8	72.6	51.4	45.0	42.6	40.8	35.3	33.2	30.2
2016	43.2	39.0	33.9	33.4	28.8	26.7	25.4	25.0	23.7
2017	39.7	38.7	38.4	36.8	35.4	34.3	33.7	33.6	33.2
2018	91.4	90.2	87.7	84.9	76.0	60.1	53.5	50.8	45.3
2019	155.0	152.3	128.0	96.8	69.7	57.1	55.5	55.2	53.2

Big Bend Regulated Inflow, 1930-2019
Highest Mean Value for Duration in Days, in 1,000 cfs

Year	1-Day	3-Day	7-Day	15-Day	30-Day	60-Day	90-Day	120-Day	183-Day
1930	52.9	52.3	51.2	49.0	47.5	42.9	39.7	37.4	35.0
1931	40.2	40.2	40.1	38.4	35.9	35.6	35.2	34.2	31.5
1932	38.6	38.4	38.0	37.2	35.6	31.6	29.2	27.2	24.5
1933	53.6	52.9	51.8	51.2	48.5	41.2	37.6	33.1	28.9
1934	52.7	52.6	52.4	51.3	49.5	46.7	42.9	41.8	37.8
1935	48.7	48.5	48.3	45.9	43.4	39.6	34.8	31.3	30.1
1936	41.8	41.6	41.1	40.3	38.7	37.1	33.3	29.7	23.2
1937	33.5	33.2	32.4	30.6	27.6	25.6	22.1	20.8	17.1
1938	26.4	26.2	25.7	24.7	23.2	23.2	21.6	20.0	16.3
1939	44.4	44.1	43.1	41.4	38.8	38.6	37.6	36.0	35.4
1940	50.3	49.6	48.3	45.2	44.6	40.0	37.9	36.4	33.7
1941	36.2	36.0	35.9	32.4	29.0	25.8	23.5	22.3	18.5
1942	36.3	36.0	35.1	33.7	32.2	30.0	25.5	24.2	19.1
1943	48.2	47.7	47.1	45.4	43.5	39.3	36.4	33.9	32.1
1944	56.5	55.6	53.6	49.4	40.4	34.5	31.9	30.6	28.2
1945	41.9	41.6	40.8	39.1	35.9	34.0	32.4	30.3	27.4
1946	48.1	47.7	46.8	45.1	44.5	42.7	41.3	39.3	36.3
1947	77.8	77.6	77.1	71.5	61.3	49.5	44.5	44.2	41.7
1948	51.2	51.1	50.8	50.6	49.8	46.2	43.8	41.5	39.2
1949	43.6	43.6	43.2	42.6	40.8	38.0	33.7	34.7	32.2
1950	66.5	66.3	65.4	58.6	47.2	45.8	43.0	38.8	35.0
1951	53.4	52.3	49.8	48.4	46.9	44.2	40.2	35.4	29.6
1952	91.5	89.8	87.0	80.8	75.9	74.3	65.9	59.5	50.5
1953	57.5	56.8	55.0	50.7	45.0	42.7	41.8	40.3	36.7
1954	57.5	57.1	56.7	54.6	50.4	42.8	39.0	35.0	31.7
1955	63.2	63.1	63.0	62.4	57.0	50.6	44.7	40.5	36.2
1956	49.9	48.8	46.9	43.5	42.8	39.8	37.5	36.5	34.6
1957	39.0	38.8	38.5	38.1	36.6	32.4	28.3	26.1	24.3
1958	37.0	36.9	36.6	36.1	34.2	30.4	28.0	27.5	26.4
1959	38.8	38.3	37.3	35.5	34.6	33.5	31.5	29.2	26.8
1960	41.8	41.4	40.7	39.7	38.3	35.0	30.5	28.5	24.9
1961	39.4	38.8	38.0	35.8	33.3	32.6	29.3	27.0	25.2
1962	30.7	30.2	29.1	26.6	23.4	22.0	22.2	20.3	16.4
1963	46.7	45.9	44.6	43.8	41.2	38.6	35.0	34.1	34.4
1964	42.5	41.0	34.5	32.3	30.4	29.7	27.2	25.2	23.0
1965	39.3	37.7	33.2	29.7	27.7	26.5	24.8	22.8	20.6
1966	38.5	36.7	34.7	35.2	30.4	28.3	28.6	27.7	24.6
1967	46.3	44.5	39.8	35.1	31.5	29.7	28.7	27.1	25.8
1968	98.7	47.2	40.1	36.2	35.1	31.2	29.9	29.3	28.4
1969	55.0	53.3	51.2	50.6	48.8	43.7	39.8	37.3	34.0
1970	54.0	53.5	49.9	45.2	41.1	39.9	38.3	36.0	32.9
1971	59.0	55.8	54.9	52.0	48.0	46.6	46.5	45.0	42.4
1972	55.0	54.2	52.1	47.7	43.1	42.1	40.8	39.9	37.6
1973	51.0	47.3	45.1	35.5	33.4	30.5	28.4	27.1	30.2
1974	53.0	49.0	43.9	40.4	36.8	34.6	33.8	31.9	29.6
1975	63.0	59.7	58.6	58.0	57.3	55.8	54.8	53.8	49.9
1976	55.0	50.8	49.0	42.7	41.7	39.8	39.0	37.9	40.5
1977	54.0	46.7	43.1	34.6	32.6	31.1	29.2	28.0	26.3
1978	57.0	55.0	54.3	52.1	49.4	48.1	47.7	46.5	43.5
1979	50.0	44.5	41.9	39.3	38.0	35.4	34.5	33.8	35.6
1980	54.0	53.0	50.8	47.5	39.9	35.0	33.1	31.8	30.0
1981	48.0	43.7	39.9	35.1	34.9	32.3	30.5	29.9	29.5
1982	46.0	43.3	39.9	35.1	32.9	31.0	30.0	28.6	27.7
1983	46.0	45.3	41.4	40.2	37.1	32.5	31.0	30.0	27.9
1984	54.0	52.7	47.6	46.5	43.8	42.3	39.0	37.8	34.1
1985	44.0	41.3	36.4	32.9	31.7	30.6	29.8	28.5	29.4
1986	50.0	47.3	43.4	40.7	40.0	37.8	33.5	32.9	31.8

1987	36.0	35.0	33.0	30.3	30.3	27.1	29.0	29.1	29.5
1988	40.0	38.3	36.9	34.5	32.1	30.9	30.5	29.2	27.6
1989	37.0	35.7	33.6	32.7	31.7	30.0	29.2	29.2	26.5
1990	34.0	32.0	30.1	27.9	26.3	24.9	23.6	22.6	22.8
1991	52.0	39.7	36.7	36.1	33.5	29.8	28.0	24.0	23.0
1992	42.0	37.3	34.0	29.1	24.7	23.7	22.4	21.9	19.8
1993	28.0	23.3	20.7	18.7	16.6	16.4	16.7	14.7	12.9
1994	41.0	38.7	34.9	32.9	29.0	27.5	26.3	26.2	25.2
1995	48.0	46.7	45.6	45.0	43.9	43.2	42.8	42.8	37.6
1996	52.0	49.3	48.4	47.1	45.6	44.0	43.5	43.0	42.0
1997	79.0	63.3	62.6	60.5	57.0	54.7	52.3	52.5	51.9
1998	37.0	35.7	33.9	30.7	29.5	27.6	29.7	36.2	41.0
1999	43.0	41.7	40.4	38.5	37.6	37.5	36.3	35.1	33.4
2000	39.0	38.0	37.6	35.4	31.9	31.3	30.8	30.4	29.1
2001	33.0	32.7	29.9	27.3	26.1	23.9	21.8	20.5	19.8
2002	43.0	37.0	34.3	33.2	31.0	28.5	28.1	27.5	24.6
2003	33.0	30.0	28.7	27.4	27.1	25.5	25.1	24.8	22.9
2004	34.0	32.3	30.3	29.2	26.5	24.8	24.2	23.8	21.2
2005	38.0	30.3	27.1	26.3	21.9	20.3	18.1	17.2	17.0
2006	38.0	33.0	30.7	29.0	28.2	26.7	24.3	22.4	19.9
2007	32.0	29.7	27.3	25.1	23.0	19.3	17.1	14.7	12.7
2008	26.0	23.7	23.4	20.8	18.7	15.4	13.8	12.9	12.2
2009	35.0	31.7	30.0	29.1	27.6	26.0	24.5	23.8	20.3
2010	50.0	48.3	43.6	41.9	40.5	37.2	36.5	35.0	30.8
2011	195.0	182.0	168.9	159.3	154.5	145.7	134.0	118.3	90.4
2012	42.0	40.7	39.7	38.1	36.6	34.8	33.9	32.6	32.1
2013	35.0	30.7	29.4	28.9	28.1	24.6	22.7	21.2	21.4
2014	44.0	42.0	39.3	37.4	36.9	36.2	33.8	31.8	28.2
2015	31.0	30.7	28.4	27.6	25.9	23.5	22.9	22.4	26.1
2016	29.0	26.3	25.4	25.2	24.1	22.8	21.7	19.9	17.9
2017	35.0	33.0	32.1	31.3	30.8	30.2	29.2	27.7	26.3
2018	52.0	50.7	49.9	48.8	48.5	46.9	45.5	44.6	41.6
2019	74.0	64.3	64.1	63.5	62.9	61.7	59.4	58.2	55.5

Fort Randall Regulated Inflow, 1930-2019
Highest Mean Value for Duration in Days, in 1,000 cfs

Year	1-Day	3-Day	7-Day	15-Day	30-Day	60-Day	90-Day	120-Day	183-Day
1930	50.1	49.9	49.3	47.5	46.1	42.2	39.3	37.0	35.1
1931	39.1	39.0	38.7	37.7	35.3	34.6	34.6	33.7	31.2
1932	36.4	36.2	36.1	35.5	34.3	30.7	28.4	26.8	24.8
1933	52.5	52.1	51.2	50.1	47.0	40.0	36.7	32.5	28.7
1934	51.4	51.3	51.0	50.3	48.7	45.8	42.2	41.2	37.4
1935	45.7	45.4	44.9	44.3	42.2	38.6	34.2	31.5	30.5
1936	39.9	39.7	39.5	38.7	37.3	35.8	32.3	28.8	22.8
1937	31.1	31.0	30.7	29.2	26.4	24.8	21.9	20.7	17.3
1938	24.4	24.2	23.8	23.1	22.2	22.1	21.1	19.8	16.4
1939	42.6	42.3	41.7	40.2	38.2	37.8	36.9	35.5	35.1
1940	46.8	46.5	45.6	43.6	43.0	39.0	37.2	35.7	33.3
1941	32.4	32.4	32.2	30.7	27.7	24.9	23.2	22.1	18.5
1942	34.5	34.3	33.4	32.7	31.2	29.2	24.9	23.7	21.9
1943	45.7	45.3	45.0	43.8	42.3	38.0	35.3	33.1	31.9
1944	53.5	52.9	51.1	47.4	39.7	33.7	31.4	30.2	27.9
1945	39.9	39.6	39.1	37.7	35.2	33.4	31.9	30.0	27.5
1946	46.4	46.0	45.5	44.5	44.1	42.5	41.2	39.6	36.7
1947	73.2	72.8	72.4	69.1	60.2	49.0	44.5	44.2	41.8
1948	51.3	51.2	50.9	50.6	49.9	46.7	45.1	42.4	39.8
1949	42.8	42.6	42.3	41.5	39.9	37.2	33.4	34.4	31.9
1950	62.4	61.4	60.1	56.2	47.2	46.8	43.8	39.5	35.5
1951	51.0	50.7	49.9	48.8	47.3	44.7	41.4	36.2	30.6
1952	118.8	118.7	109.7	88.8	81.2	77.5	67.4	60.4	51.6
1953	113.5	100.6	96.5	90.2	72.2	52.0	46.3	42.2	38.0
1954	44.1	40.7	39.8	38.5	38.0	37.0	35.4	32.4	29.1
1955	49.0	48.5	48.1	45.7	39.5	32.0	30.8	29.4	30.0
1956	53.9	50.3	40.3	34.8	33.3	31.8	31.1	30.5	28.8
1957	67.0	62.0	53.0	42.7	33.3	28.0	25.4	23.8	22.3
1958	49.4	46.2	45.3	39.5	33.4	27.8	27.0	26.5	22.9
1959	37.0	34.9	33.3	27.7	26.0	24.4	23.7	23.4	22.5
1960	65.1	60.0	48.2	37.0	28.7	27.0	26.3	25.5	20.9
1961	40.5	37.1	35.4	33.4	30.2	27.0	25.4	25.6	23.9
1962	44.5	42.3	36.9	31.8	26.3	21.5	18.9	17.2	14.4
1963	41.2	40.1	39.6	34.9	32.1	29.8	28.7	27.9	24.2
1964	50.0	38.8	34.4	33.0	30.2	29.5	27.9	25.9	23.2
1965	45.0	38.9	34.0	30.8	29.1	27.8	26.2	24.4	22.5
1966	56.6	53.4	47.4	39.9	37.2	30.7	30.8	29.9	27.6
1967	64.7	61.9	54.5	42.8	39.7	34.6	32.9	30.8	28.9
1968	70.0	63.3	50.6	38.8	37.3	33.7	32.8	32.3	31.3
1969	67.0	63.5	56.0	52.2	49.7	44.6	41.1	38.7	35.7
1970	58.5	58.2	50.0	46.0	42.5	41.2	39.2	37.0	33.3
1971	62.0	60.7	58.8	56.6	52.9	49.3	48.5	47.4	44.8
1972	69.0	64.2	55.8	49.8	45.3	43.9	42.9	42.0	40.8
1973	59.0	56.0	47.6	36.9	34.4	31.4	29.8	29.7	34.3
1974	60.0	54.0	46.3	42.7	38.7	35.6	34.4	32.7	31.0
1975	71.0	67.0	60.7	59.0	57.9	56.1	55.3	54.6	50.7
1976	60.0	54.5	48.2	44.4	42.0	40.1	39.0	40.0	44.7
1977	60.0	50.7	38.3	36.2	32.5	31.6	29.7	28.6	28.9
1978	100.0	68.3	56.0	54.0	51.0	49.7	48.5	47.4	44.2
1979	55.0	48.3	44.3	43.1	40.3	37.7	36.3	35.2	39.5
1980	57.0	55.3	50.6	47.3	40.9	35.7	33.6	32.3	30.2
1981	57.0	51.7	42.7	36.8	36.5	33.5	31.5	30.5	30.1
1982	59.0	52.3	42.7	38.5	33.8	31.8	30.6	29.4	27.5
1983	53.0	50.7	43.4	41.9	37.7	33.2	31.1	30.0	27.7
1984	59.0	57.7	49.6	48.1	44.7	43.3	39.5	37.5	33.9
1985	47.0	43.7	36.1	33.5	31.5	30.6	30.0	29.0	33.4
1986	56.0	52.3	45.4	42.2	40.2	38.2	34.6	32.5	31.3

1987	54.0	47.0	45.9	35.6	31.4	32.2	31.0	30.2	31.6
1988	46.0	44.0	37.3	36.0	32.5	30.8	30.3	29.3	28.3
1989	43.0	40.0	33.9	32.4	31.4	30.0	29.1	29.1	26.3
1990	40.0	37.3	31.7	28.7	27.1	25.7	23.6	23.5	23.2
1991	62.0	51.3	39.3	38.8	35.2	30.9	28.5	25.9	24.6
1992	47.0	38.0	33.0	29.1	26.1	24.9	23.3	22.7	20.6
1993	36.0	30.0	22.9	21.0	19.8	18.3	17.8	15.9	14.4
1994	44.0	41.7	36.4	34.7	30.5	28.8	27.1	26.8	25.7
1995	60.0	57.0	48.6	47.1	45.3	44.2	43.3	42.9	38.3
1996	66.0	59.3	51.6	48.7	45.8	44.3	43.5	43.2	42.2
1997	95.0	90.0	72.4	67.3	62.2	58.7	56.9	56.1	55.6
1998	49.0	46.7	37.4	32.9	31.0	32.7	40.6	44.1	47.0
1999	71.0	59.3	47.9	41.7	39.3	38.4	36.3	34.9	33.9
2000	52.0	50.7	45.1	40.9	33.6	31.3	30.5	30.1	31.5
2001	44.0	39.7	33.6	30.5	28.1	26.1	23.4	21.5	22.2
2002	46.0	41.3	38.0	33.8	31.3	29.6	29.6	28.9	25.8
2003	45.0	38.3	31.1	29.7	28.9	27.3	26.7	26.5	25.0
2004	45.0	39.7	34.7	32.4	28.9	27.5	26.3	25.7	23.0
2005	43.0	36.7	29.7	27.6	23.7	21.6	20.4	19.7	19.3
2006	50.0	43.0	34.7	31.5	30.4	28.5	26.2	23.9	21.6
2007	42.0	37.0	30.1	28.8	25.6	20.9	18.9	15.7	15.5
2008	50.0	41.3	31.6	22.8	20.3	17.1	15.5	14.6	14.3
2009	45.0	38.7	31.7	31.5	29.3	28.1	26.7	25.8	22.4
2010	73.0	65.0	49.3	44.9	43.1	40.0	39.3	37.6	34.4
2011	218.0	206.0	197.3	180.0	168.8	156.7	144.2	127.9	98.5
2012	48.0	46.0	41.1	39.2	38.6	37.6	36.4	35.0	50.1
2013	47.0	42.7	33.7	31.4	30.2	27.4	25.5	24.0	26.3
2014	52.0	48.3	42.4	41.6	39.8	38.6	36.7	34.4	30.8
2015	46.0	42.3	35.6	32.0	30.9	28.1	27.4	27.4	29.8
2016	43.0	39.3	32.6	31.9	29.2	24.9	23.5	22.8	21.0
2017	46.0	44.0	34.9	34.7	34.3	33.3	32.2	30.5	29.4
2018	62.0	59.0	57.0	54.7	53.8	51.2	49.4	48.1	45.8
2019	115.0	91.0	87.6	76.1	64.4	63.9	63.2	63.0	62.2

Gavins Point Regulated Inflow, 1930-2019
Highest Mean Value for Duration in Days, in 1,000 cfs

Year	1-Day	3-Day	7-Day	15-Day	30-Day	60-Day	90-Day	120-Day	183-Day
1930	48.1	48.0	47.7	46.6	45.2	42.0	39.6	38.4	36.8
1931	39.5	39.2	38.5	37.0	35.6	35.3	35.0	34.7	33.1
1932	38.7	38.5	37.8	36.0	35.2	32.4	31.6	31.0	29.8
1933	53.9	53.7	52.9	50.7	48.2	43.0	40.0	37.3	34.4
1934	50.5	50.4	50.2	49.9	49.3	46.9	43.5	42.5	39.0
1935	47.4	47.0	46.1	43.2	41.8	38.7	35.9	33.4	32.4
1936	37.7	37.5	37.5	37.2	36.8	35.3	31.8	28.5	23.4
1937	30.9	30.7	30.2	28.8	26.3	24.3	22.6	21.5	17.8
1938	23.1	23.0	22.9	22.6	22.3	21.9	21.0	20.3	16.9
1939	44.8	44.7	44.5	43.9	43.5	40.6	39.9	37.9	36.8
1940	48.8	48.6	47.9	45.1	43.5	38.6	37.6	36.3	34.5
1941	30.4	30.1	29.5	28.9	27.0	24.6	23.1	21.9	18.5
1942	34.2	34.1	33.8	33.3	32.1	31.0	29.0	28.9	27.7
1943	46.3	45.7	44.8	43.9	43.1	40.6	38.3	36.7	34.6
1944	52.6	52.3	51.3	48.3	42.1	39.2	37.5	36.4	32.6
1945	40.3	40.1	39.9	39.3	38.8	37.1	35.5	34.9	30.6
1946	46.2	46.1	46.0	45.3	44.8	43.2	42.5	40.9	39.2
1947	61.9	61.5	60.5	59.3	56.9	50.7	47.2	46.6	45.3
1948	51.8	51.7	51.6	51.1	50.6	49.7	47.2	44.6	42.5
1949	43.7	43.2	42.7	42.4	41.5	37.9	36.8	36.2	35.2
1950	51.4	50.7	49.5	48.0	47.8	47.5	46.1	41.9	39.1
1951	51.7	51.5	51.4	51.2	50.7	48.2	45.8	39.4	34.6
1952	85.0	82.2	82.0	81.7	81.2	78.4	69.6	63.4	55.2
1953	50.1	49.8	49.0	48.0	45.7	44.7	43.7	43.2	41.8
1954	48.3	48.2	48.0	47.3	44.8	40.6	40.0	37.7	33.8
1955	61.0	60.7	60.0	59.6	56.8	50.6	45.8	42.5	39.0
1956	45.5	45.2	44.5	43.3	42.3	41.7	40.6	39.0	36.8
1957	35.8	35.7	35.3	34.7	34.0	31.7	30.5	28.7	27.9
1958	34.6	34.3	33.7	33.1	32.5	31.9	30.9	29.6	28.9
1959	38.2	38.0	37.4	36.0	34.4	33.7	32.8	31.6	29.3
1960	39.7	39.7	39.2	38.5	37.1	35.2	33.8	33.0	30.3
1961	35.0	34.9	34.5	34.3	33.3	33.2	31.7	30.2	28.1
1962	34.8	34.2	34.0	33.7	31.6	30.1	29.5	28.7	24.5
1963	46.0	38.5	33.6	31.9	30.1	29.6	28.9	28.7	27.9
1964	46.7	33.9	31.7	31.1	31.0	29.4	28.7	28.6	27.8
1965	38.2	35.0	33.3	32.6	31.3	30.0	29.5	29.2	27.8
1966	38.1	36.6	34.4	33.7	33.2	32.3	31.8	31.5	31.2
1967	42.2	38.2	36.5	35.5	34.9	34.1	33.8	33.3	31.3
1968	41.3	40.4	38.0	36.8	35.9	34.9	34.6	34.1	33.6
1969	54.0	54.0	53.5	53.3	53.1	52.0	50.0	47.9	43.0
1970	45.5	44.7	44.4	44.1	44.0	43.1	42.2	42.0	40.3
1971	53.5	53.0	52.1	51.3	50.6	49.3	48.7	48.2	47.8
1972	52.0	50.0	49.7	49.3	48.8	48.4	47.7	47.2	45.2
1973	38.0	36.8	35.5	32.9	32.4	32.2	31.7	33.1	37.7
1974	42.0	39.7	37.6	36.7	36.2	35.1	35.1	34.9	33.7
1975	62.0	62.0	61.7	61.5	61.4	61.3	61.1	60.9	56.3
1976	43.5	42.7	40.4	38.9	38.3	38.1	37.8	41.8	48.3
1977	41.5	39.3	36.6	35.0	34.4	33.8	33.1	32.9	32.3
1978	58.0	52.7	52.5	52.4	52.2	51.9	51.3	51.1	48.2
1979	44.0	43.5	41.9	41.3	40.0	38.0	37.5	36.9	41.6
1980	43.0	42.2	40.5	38.2	36.8	35.4	35.3	35.2	33.9
1981	39.0	37.3	36.3	35.3	34.0	33.7	33.1	33.0	32.8
1982	44.0	42.0	41.7	40.6	39.2	36.9	35.5	34.5	33.0
1983	39.0	38.3	37.9	36.3	35.7	35.5	35.3	35.3	32.0
1984	46.0	45.3	44.6	43.9	43.5	43.3	42.8	42.9	38.6
1985	38.0	36.0	34.7	33.6	32.9	32.3	31.7	31.8	35.6
1986	48.0	47.7	45.7	42.6	42.0	41.0	38.9	38.8	37.6

1987	38.0	37.0	35.3	34.6	34.0	32.6	33.1	34.9	35.4
1988	39.0	38.0	37.9	37.2	35.5	34.4	34.0	33.7	33.1
1989	37.0	36.3	33.6	33.0	32.6	32.1	31.8	31.8	31.1
1990	34.0	33.3	32.6	32.2	31.6	30.7	29.5	28.9	27.8
1991	36.0	35.3	34.6	33.4	32.5	31.8	30.6	29.3	27.5
1992	34.0	31.3	29.1	27.1	26.3	26.0	25.2	24.7	23.9
1993	31.0	26.7	23.4	22.9	22.2	21.1	20.2	19.2	16.3
1994	37.0	35.3	33.6	32.7	32.2	31.3	30.5	30.2	30.3
1995	70.0	60.3	56.9	55.9	55.6	54.7	54.4	53.4	47.0
1996	61.0	58.3	56.1	55.6	54.5	53.6	53.1	52.8	50.2
1997	74.0	71.3	70.6	69.9	69.7	69.3	68.1	67.3	65.2
1998	44.0	42.7	41.9	40.7	40.1	37.4	42.7	49.3	54.9
1999	51.0	48.3	47.3	45.7	45.1	44.8	44.6	43.6	41.3
2000	42.0	39.7	36.6	34.9	34.6	34.0	33.5	33.4	36.6
2001	33.0	31.3	30.7	29.5	28.1	27.6	27.5	27.0	26.1
2002	36.0	35.0	33.1	31.4	31.1	30.4	29.6	28.7	27.5
2003	36.0	33.7	31.9	30.4	29.2	28.7	28.3	27.4	27.0
2004	33.0	31.7	31.1	29.4	28.9	28.3	27.7	27.1	26.0
2005	34.0	29.7	27.7	26.7	26.3	25.0	24.1	23.5	22.4
2006	35.0	34.7	34.3	32.8	31.3	29.8	28.4	27.6	24.6
2007	26.0	25.0	24.6	23.7	23.2	22.3	22.0	21.1	18.4
2008	28.0	27.7	26.6	25.6	24.5	22.8	21.9	20.3	17.8
2009	34.0	32.7	31.7	31.4	30.8	30.1	29.1	28.6	26.6
2010	59.0	55.0	52.9	50.1	49.5	49.1	48.2	46.5	42.1
2011	168.0	162.7	161.6	160.7	160.2	156.5	146.8	131.3	102.9
2012	40.0	40.0	39.7	39.3	38.8	38.7	38.5	38.1	57.1
2013	36.0	35.3	34.9	33.5	32.0	29.4	29.4	28.0	29.9
2014	47.0	47.0	46.4	46.3	46.2	45.8	43.0	39.7	34.5
2015	33.0	31.0	29.9	29.1	29.0	28.9	28.6	30.4	32.7
2016	29.0	28.0	26.7	25.5	25.4	25.3	25.2	24.4	24.6
2017	37.0	36.0	35.0	33.9	33.5	32.8	32.3	32.1	31.2
2018	67.0	62.0	60.4	58.9	58.2	58.0	57.0	57.1	52.5
2019	125.0	88.0	81.1	80.7	80.4	80.1	77.2	75.5	74.3

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APPENDIX D

Missouri River Main Stem Reservoir System
Highest Annual Mean Inflow for the
1-, 3-, 7-, 15-, 30-, 60-, 90-, 120-, and 183-Day Durations

Incremental Inflows

Garrison Incremental Inflow, 1881, 1930-2019
Highest Mean Value for Duration in Days, in 1,000 cfs

Year	1-Day	3-Day	7-Day	15-Day	30-Day	60-Day	90-Day	120-Day	183-Day
1881	184.0	173.2	143.8	119.2	98.0	87.9	84.8	84.8	
1930	57.2	55.6	48.0	37.1	28.1	24.0	20.6	20.0	17.9
1931	29.6	28.2	26.9	23.2	19.7	13.8	10.5	9.5	9.5
1932	74.2	71.2	66.2	56.8	53.0	38.8	30.8	27.7	21.0
1933	55.6	55.0	52.7	46.9	41.8	33.4	26.4	25.7	19.6
1934	28.0	24.3	18.2	15.0	12.5	11.2	10.1	9.4	8.1
1935	73.7	69.9	54.4	45.9	44.0	31.5	24.3	19.4	15.2
1936	52.9	51.3	35.7	25.5	21.9	18.1	17.8	17.1	12.7
1937	64.0	58.0	45.5	44.2	32.9	27.8	21.8	18.4	14.5
1938	98.5	86.2	70.5	65.0	52.4	40.4	31.6	26.6	22.4
1939	152.8	144.9	109.1	68.0	39.9	25.2	25.2	24.6	18.7
1940	35.2	34.4	30.8	25.5	23.1	18.1	17.0	14.8	12.1
1941	40.1	38.2	34.5	31.8	28.4	21.6	17.8	17.8	17.0
1942	62.3	61.2	60.2	53.9	45.5	37.5	30.3	27.0	21.6
1943	240.1	228.3	171.9	103.2	66.7	52.8	42.4	46.1	37.0
1944	104.1	102.0	98.9	87.7	71.5	54.4	41.6	40.4	30.4
1945	65.4	64.5	58.8	46.7	41.2	34.9	27.5	23.2	21.6
1946	42.7	40.9	38.4	36.3	33.8	27.6	22.1	19.9	17.4
1947	154.0	137.1	90.3	63.5	50.5	39.1	35.2	36.8	29.7
1948	64.1	63.3	60.9	56.4	50.8	42.1	33.0	31.3	24.9
1949	126.8	119.6	98.4	65.1	42.0	26.8	27.2	25.5	19.9
1950	106.8	101.6	82.7	60.0	43.5	33.4	31.9	30.8	24.9
1951	78.9	74.9	68.0	54.1	37.7	29.3	28.5	28.5	25.1
1952	270.5	241.6	184.0	121.8	83.5	56.9	48.7	41.6	30.5
1953	69.4	67.1	65.4	55.9	47.9	35.2	27.7	23.4	18.7
1954	88.5	63.0	43.3	30.8	24.6	22.8	20.6	19.9	16.8
1955	61.0	55.0	43.4	34.5	29.4	25.6	25.4	23.5	18.5
1956	57.8	56.5	55.8	51.7	45.1	34.6	27.5	25.2	20.5
1957	67.8	67.1	64.0	61.7	57.3	45.4	36.7	30.3	23.9
1958	38.7	37.7	35.4	31.7	30.3	25.8	20.6	19.0	15.5
1959	86.0	76.7	67.7	51.7	40.2	27.5	21.8	23.8	18.9
1960	121.0	119.9	104.5	71.0	43.0	25.7	22.4	20.8	15.5
1961	27.2	26.6	25.3	24.6	21.7	14.4	11.5	10.1	9.1
1962	65.5	59.6	58.5	53.3	47.3	42.4	35.2	31.3	25.1
1963	90.0	81.8	69.7	60.9	57.5	42.7	34.4	29.0	23.9
1964	75.5	69.8	65.9	59.2	58.2	44.4	35.3	29.6	22.7
1965	84.7	78.1	67.4	66.3	65.1	52.5	44.9	42.6	32.5
1966	40.1	29.7	25.5	23.1	20.6	19.2	16.1	16.0	16.1
1967	83.5	79.0	75.0	71.2	67.6	55.7	44.6	39.0	30.9
1968	74.7	69.7	66.5	59.9	54.4	39.3	31.5	27.2	22.9
1969	102.4	90.1	69.3	53.6	47.6	35.9	33.3	35.2	27.1
1970	72.1	68.5	63.5	55.6	54.8	46.7	39.8	33.9	25.6
1971	83.2	70.8	64.4	60.5	58.1	44.3	36.6	36.4	30.9
1972	167.8	164.1	141.8	97.7	60.6	39.1	36.1	38.4	31.0
1973	56.7	53.0	51.2	42.8	41.9	33.7	28.4	23.6	19.2
1974	80.8	77.5	73.4	63.9	54.3	43.8	35.3	31.9	25.1
1975	102.4	72.3	68.9	65.2	60.8	50.9	49.5	44.7	34.0
1976	55.5	54.6	51.4	48.4	44.8	39.7	33.3	31.8	26.0
1977	46.1	37.8	34.7	30.0	22.1	17.8	14.9	13.9	11.4
1978	141.4	123.0	112.2	84.3	60.7	55.4	47.7	48.2	37.5
1979	140.1	121.9	89.0	69.2	54.1	43.1	36.7	34.4	25.7
1980	39.0	35.6	32.3	31.2	26.4	22.1	18.8	17.6	14.3
1981	58.2	54.5	49.8	48.1	41.3	31.8	24.4	19.4	15.3
1982	67.4	65.0	64.1	57.4	48.4	40.4	33.5	30.7	26.5
1983	46.9	44.5	38.4	36.7	34.3	31.0	25.9	21.4	19.4
1984	60.5	56.0	52.0	45.4	39.1	33.6	27.5	23.5	19.3
1985	32.6	29.9	25.9	22.7	18.4	15.6	15.1	14.6	12.4

1986	82.5	74.1	62.5	55.9	44.3	36.0	31.0	29.1	24.9
1987	30.4	24.4	21.7	20.2	18.9	16.0	15.8	15.1	13.8
1988	32.5	30.4	27.0	25.9	23.9	18.8	14.4	13.3	10.3
1989	37.3	34.3	33.0	29.3	25.2	22.9	21.1	20.1	15.8
1990	41.8	38.1	32.7	30.5	28.2	22.9	19.3	16.5	14.1
1991	78.4	67.9	61.2	56.9	54.1	44.3	33.8	27.1	20.5
1992	51.0	41.5	34.7	31.6	27.1	20.8	18.6	16.3	13.2
1993	67.8	60.4	53.1	44.8	43.3	39.9	36.1	30.8	24.7
1994	71.4	67.5	54.9	49.9	35.4	23.8	23.7	23.5	17.2
1995	67.1	62.0	57.0	51.4	46.4	41.8	36.8	30.0	23.3
1996	77.2	72.7	67.6	63.2	55.5	45.4	36.7	35.4	29.8
1997	89.1	86.8	85.0	81.6	73.8	57.9	48.1	46.0	38.5
1998	57.9	51.1	48.8	43.2	38.8	29.8	26.1	23.5	20.3
1999	60.8	58.8	57.6	51.5	49.6	40.8	35.4	31.6	27.5
2000	44.0	43.0	38.1	34.9	31.0	24.6	20.3	17.3	14.4
2001	35.8	34.0	31.2	26.1	22.9	18.9	17.0	17.0	14.4
2002	50.2	48.2	44.0	35.8	31.4	24.9	19.7	17.1	13.7
2003	58.8	54.8	49.5	41.9	36.7	27.3	22.1	23.0	17.5
2004	38.4	35.8	29.6	24.9	21.5	18.2	15.0	14.3	12.3
2005	82.7	64.5	55.0	44.5	38.1	34.2	27.0	21.8	16.9
2006	46.6	39.6	35.8	32.0	30.9	23.9	20.7	18.5	14.4
2007	58.6	50.3	46.9	41.1	35.6	30.4	23.8	21.6	16.5
2008	77.4	64.4	56.9	53.2	49.4	43.4	34.1	27.9	21.6
2009	70.8	52.3	49.0	45.5	42.2	39.0	32.6	30.7	24.8
2010	80.4	61.8	56.9	53.9	51.4	42.3	33.0	27.3	21.9
2011	149.1	149.0	139.5	117.9	108.5	95.5	79.9	71.5	55.6
2012	43.7	42.0	36.4	30.8	25.5	20.2	17.3	16.0	21.8
2013	71.5	64.5	57.0	47.8	43.3	32.2	25.3	22.7	17.4
2014	80.1	73.0	67.4	60.4	51.8	43.3	37.1	35.9	30.1
2015	68.3	62.9	57.7	51.5	44.1	30.8	24.1	22.1	18.7
2016	41.7	36.7	34.3	30.8	29.3	23.5	19.1	16.1	13.7
2017	57.3	56.8	55.5	50.7	43.8	39.0	33.5	32.2	26.8
2018	90.8	86.3	80.5	73.9	68.1	59.5	53.0	48.1	35.3
2019	149.9	141.3	117.3	83.9	54.9	43.7	38.7	39.7	32.0

Oahe Incremental Inflow, 1881, 1930-2019
Highest Mean Value for Duration in Days, in 1,000 cfs

Year	1-Day	3-Day	7-Day	15-Day	30-Day	60-Day	90-Day	120-Day	183-Day
1881	179.0	177.7	152.7	96.1	53.9	38.2	30.1	23.0	
1930	20.9	16.1	11.4	8.6	6.3	4.3	3.9	3.5	2.8
1931	8.9	5.8	5.3	5.1	4.7	4.7	4.5	4.0	3.3
1932	55.1	49.0	30.9	15.2	9.0	5.4	5.0	4.4	3.3
1933	38.8	27.5	13.8	9.5	6.4	5.3	4.8	4.6	3.7
1934	21.7	12.8	9.5	8.4	7.1	6.2	6.3	6.1	4.9
1935	50.3	44.2	23.9	12.1	10.6	7.9	6.3	5.3	4.9
1936	45.9	39.5	22.9	15.3	8.1	8.0	7.6	6.9	5.6
1937	63.8	56.5	41.0	24.1	13.2	11.3	9.3	8.3	6.4
1938	84.6	61.8	38.5	22.3	11.4	6.6	4.7	4.6	4.7
1939	88.7	86.0	57.4	29.9	14.3	7.0	4.8	3.7	2.6
1940	14.2	10.2	6.9	5.0	3.2	2.2	1.5	1.1	0.7
1941	78.7	74.8	58.5	35.6	18.8	9.7	8.4	6.4	4.5
1942	54.1	50.5	40.0	26.3	20.1	14.4	11.4	8.7	6.1
1943	165.0	151.6	132.4	73.6	38.8	21.6	15.3	12.9	9.1
1944	113.4	101.5	83.4	49.5	26.3	15.4	17.3	13.4	9.0
1945	61.1	59.3	53.3	38.3	21.4	13.1	9.5	8.5	6.3
1946	27.5	24.6	17.8	12.6	11.2	7.8	6.1	4.9	3.8
1947	113.1	85.9	57.2	29.4	18.0	10.2	9.5	9.1	6.1
1948	50.9	47.9	40.7	35.0	25.8	15.1	11.4	8.9	6.2
1949	103.7	92.2	75.3	59.7	35.3	19.3	13.5	10.4	6.9
1950	176.7	160.9	124.4	86.1	67.3	41.2	28.4	21.3	14.2
1951	63.2	60.5	51.6	36.1	18.7	9.3	6.3	5.0	3.4
1952	296.2	266.4	204.2	121.0	64.3	33.2	22.7	17.2	11.4
1953	55.9	52.5	48.0	30.8	19.3	12.3	9.2	8.8	6.0
1954	12.6	10.2	9.6	7.1	5.2	3.5	3.3	3.0	2.2
1955	8.5	7.7	7.1	5.4	4.9	3.0	2.3	1.9	1.4
1956	45.5	42.8	35.2	23.3	16.0	8.6	6.0	4.9	3.4
1957	24.3	22.4	16.7	10.9	6.8	4.7	3.4	3.3	2.1
1958	25.1	24.1	22.7	16.0	9.0	5.2	4.2	3.7	2.9
1959	22.3	21.8	20.3	14.3	8.7	5.2	3.8	3.0	2.2
1960	36.9	32.8	26.9	23.0	14.9	8.1	6.0	5.0	3.2
1961	14.1	9.6	8.2	6.0	3.9	2.4	1.9	1.7	1.3
1962	48.5	42.0	30.7	27.6	21.0	14.9	11.1	9.9	7.2
1963	15.9	13.5	10.0	8.7	6.4	4.3	4.0	3.9	3.0
1964	34.0	28.1	22.6	19.0	13.0	8.7	7.5	6.1	4.2
1965	30.6	26.0	21.2	19.5	14.8	11.3	9.9	8.4	5.9
1966	87.6	81.9	68.8	43.6	28.9	16.6	11.9	10.0	7.6
1967	63.2	59.0	49.7	33.1	20.8	15.2	11.7	11.2	8.4
1968	21.6	19.0	14.9	8.7	7.1	5.0	5.3	4.6	3.6
1969	61.1	58.2	49.1	33.1	23.7	14.6	10.7	10.7	8.2
1970	42.5	39.2	33.1	23.7	20.2	15.2	12.3	10.3	7.5
1971	51.2	49.0	42.9	31.4	23.3	18.0	15.8	14.3	11.0
1972	101.1	93.1	78.0	51.9	30.1	20.1	18.1	15.6	11.3
1973	24.6	21.8	17.1	14.7	10.9	7.6	6.8	6.6	5.6
1974	19.7	14.0	10.6	6.9	4.6	4.0	3.8	3.6	2.9
1975	50.1	46.9	36.4	30.8	26.8	17.6	13.7	11.3	7.9
1976	26.1	17.6	13.3	10.2	7.1	4.8	4.0	4.1	3.6
1977	38.8	13.7	10.0	6.7	5.1	4.1	3.1	2.9	2.5
1978	112.3	105.6	94.7	79.6	50.1	30.9	23.6	18.3	12.9
1979	70.5	54.4	37.7	27.3	17.9	11.5	8.5	7.4	5.6
1980	20.0	17.8	9.8	5.6	4.6	2.9	2.3	1.9	1.5
1981	11.9	9.2	6.8	6.2	5.5	4.1	4.0	3.4	2.8
1982	101.5	79.2	54.6	42.7	27.0	24.1	20.8	17.9	13.1
1983	32.3	25.3	17.1	14.3	10.8	7.1	6.8	5.7	4.7
1984	32.6	30.1	28.4	21.1	15.2	11.2	8.9	8.1	6.4
1985	23.2	21.1	17.2	13.8	9.4	5.7	4.5	3.7	2.8

1986	80.0	65.8	55.4	42.5	27.1	20.8	20.0	16.3	11.6
1987	185.9	157.9	105.4	64.1	42.3	24.9	18.0	14.6	10.1
1988	9.6	7.4	4.7	4.5	3.9	2.9	2.6	2.2	1.8
1989	22.8	20.8	15.5	11.7	8.0	6.5	5.0	4.1	2.9
1990	13.2	9.4	6.0	4.7	3.8	2.8	2.7	2.1	2.1
1991	34.8	24.8	18.0	14.5	11.7	7.6	5.9	5.2	4.2
1992	14.2	11.2	8.5	5.4	4.0	3.1	3.0	2.6	2.1
1993	51.5	38.8	33.7	29.2	20.6	13.9	11.4	9.5	9.1
1994	43.2	39.7	30.8	24.8	19.4	12.1	9.7	8.4	6.7
1995	76.7	66.9	58.9	40.2	24.9	18.0	17.5	15.6	12.6
1996	93.1	69.5	50.3	32.9	22.1	17.2	16.9	16.6	12.7
1997	151.7	143.6	139.4	100.2	64.8	47.6	35.5	28.9	20.7
1998	16.0	14.6	13.0	10.7	7.5	4.3	3.3	3.6	2.9
1999	46.5	42.9	25.3	23.3	15.5	11.7	10.5	9.9	7.7
2000	27.4	23.7	20.0	16.5	11.1	8.3	7.0	6.4	4.9
2001	53.6	42.4	38.9	29.0	19.5	12.5	9.3	8.1	6.8
2002	7.7	7.3	5.0	3.3	2.6	1.9	1.6	1.4	2.1
2003	17.7	14.7	12.9	10.4	6.7	4.9	4.6	3.8	2.8
2004	20.5	17.7	14.7	11.3	7.7	4.9	3.5	3.4	2.5
2005	20.2	14.9	12.0	7.8	5.2	4.3	3.2	2.8	2.2
2006	12.0	8.3	4.9	2.9	2.3	1.9	1.5	1.2	1.0
2007	21.3	18.0	12.2	9.3	6.2	3.7	3.6	3.4	2.5
2008	88.1	81.7	65.9	36.7	22.0	13.1	9.8	7.6	5.3
2009	169.1	147.4	126.2	81.2	70.7	45.3	33.3	26.1	18.4
2010	55.6	54.1	44.4	39.2	33.5	20.0	17.8	15.0	10.7
2011	104.8	99.8	79.7	51.9	42.7	29.4	27.6	23.8	16.9
2012	10.1	7.1	5.6	3.8	3.2	3.0	2.6	2.5	1.8
2013	53.7	49.1	42.0	29.3	19.2	11.1	8.2	6.4	6.8
2014	52.9	50.4	41.8	26.6	16.7	13.2	11.6	12.6	10.6
2015	82.1	49.3	27.7	20.6	17.6	16.0	11.6	9.3	7.2
2016	21.2	16.9	11.8	11.3	7.4	4.9	4.2	3.8	2.9
2017	14.9	14.3	11.5	8.4	6.2	5.6	4.4	3.5	2.7
2018	44.7	22.5	14.1	10.6	9.2	6.9	6.1	6.3	4.6
2019	144.6	139.3	115.9	83.7	56.3	34.1	31.1	26.6	20.0

Big Bend Incremental Inflow, 1930-2019
Highest Mean Value for Duration in Days, in 1,000 cfs

Year	1-Day	3-Day	7-Day	15-Day	30-Day	60-Day	90-Day	120-Day	183-Day
1930	8.6	6.2	3.6	1.9	1.1	0.6	0.5	0.4	0.3
1931	1.6	2.0	1.5	0.9	0.4	0.3	0.3	0.2	0.2
1932	7.0	6.0	3.4	1.7	0.9	0.6	0.5	0.5	0.3
1933	0.3	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1
1934	3.0	1.6	0.6	0.3	0.1	0.0	0.0	0.0	0.1
1935	3.8	2.6	1.4	0.7	0.6	0.5	0.3	0.3	0.2
1936	0.8	0.8	0.6	0.4	0.3	0.2	0.1	0.1	0.1
1937	9.4	6.6	3.6	1.9	1.0	0.7	0.5	0.5	0.4
1938	5.6	3.2	1.6	0.8	0.4	0.1	0.2	0.1	0.1
1939	1.4	1.0	0.8	0.7	0.5	0.2	0.2	0.1	0.1
1940	1.0	0.8	0.6	0.4	0.2	0.2	0.1	0.1	0.1
1941	3.7	2.6	1.6	1.0	0.5	0.3	0.2	0.2	0.1
1942	27.2	19.9	12.9	10.7	7.0	4.4	3.1	2.4	1.5
1943	4.3	3.3	2.6	1.4	0.8	0.4	0.4	0.3	0.2
1944	2.8	2.3	2.0	1.5	1.0	0.5	0.5	0.4	0.3
1945	1.0	0.9	0.7	0.4	0.2	0.2	0.1	0.1	0.1
1946	1.6	1.3	0.8	0.5	0.3	0.2	0.1	0.1	0.1
1947	1.4	1.2	0.8	0.4	0.3	0.3	0.2	0.1	0.1
1948	3.8	3.1	3.0	1.8	0.9	0.5	0.4	0.4	0.3
1949	3.2	3.1	2.8	1.9	1.2	0.7	0.5	0.4	0.2
1950	15.7	13.5	8.9	6.9	3.8	2.4	1.7	1.2	0.8
1951	5.2	2.6	1.6	1.0	0.8	0.4	0.3	0.3	0.2
1952	26.8	23.8	21.9	14.4	7.8	4.0	2.7	2.2	1.5
1953	10.1	9.1	6.9	5.0	2.8	2.2	1.5	1.2	0.8
1954	7.9	2.9	1.3	0.6	0.3	0.2	0.2	0.1	0.1
1955	2.1	1.4	1.1	0.8	0.5	0.3	0.2	0.2	0.1
1956	2.6	2.4	1.8	1.2	0.7	0.4	0.3	0.2	0.1
1957	5.0	4.3	2.6	1.6	1.4	0.8	0.6	0.4	0.3
1958	2.2	1.7	1.0	0.8	0.4	0.3	0.2	0.2	0.1
1959	0.9	0.6	0.3	0.2	0.1	0.0	0.0	0.0	0.0
1960	13.3	9.6	8.5	4.8	2.5	1.3	0.9	0.8	0.5
1961	8.9	4.4	2.2	1.0	0.7	0.5	0.3	0.3	0.2
1962	5.4	3.0	2.0	1.2	0.9	0.8	0.6	0.6	0.4
1963	12.5	8.2	3.5	1.5	1.1	0.8	0.5	0.5	0.3
1964	18.5	11.5	6.9	5.0	2.9	2.1	1.8	1.6	1.3
1965	8.4	3.7	2.6	2.0	1.5	1.0	0.7	0.6	0.4
1966	12.5	10.9	9.2	6.1	3.4	1.9	1.3	0.9	0.8
1967	32.4	20.3	10.9	6.1	4.6	2.6	1.8	1.5	1.0
1968	8.2	7.3	4.6	2.4	1.4	0.8	0.6	0.4	0.2
1969	8.9	6.1	4.2	3.6	2.5	1.3	0.8	0.7	0.5
1970	9.0	5.3	3.6	2.9	1.7	1.1	0.8	0.6	0.3
1971	11.5	10.5	5.5	3.2	1.7	1.2	1.0	0.8	0.4
1972	7.5	6.4	3.3	2.6	1.6	1.0	0.9	0.8	0.7
1973	7.3	4.5	2.6	1.2	0.8	0.7	0.5	0.4	0.3
1974	20.9	10.7	4.6	2.7	1.1	0.6	0.2	0.2	0.2
1975	10.1	7.1	3.5	2.6	1.7	0.8	0.6	0.5	0.3
1976	6.3	2.7	1.5	1.1	0.6	0.5	0.4	0.3	0.3
1977	14.5	7.4	4.1	2.3	2.1	1.6	1.1	1.0	0.7
1978	30.5	23.2	17.9	11.4	6.4	4.0	2.8	2.2	1.6
1979	20.1	11.8	5.3	2.6	1.8	1.1	0.9	0.8	0.8
1980	12.8	5.2	1.7	0.9	0.4	0.2	0.2	0.4	0.5
1981	6.9	3.7	1.4	0.4	0.0	-0.3	-0.3	-0.2	-0.1
1982	13.0	7.6	5.6	4.7	2.9	1.2	0.5	0.4	0.1
1983	8.2	7.0	5.5	3.6	2.1	1.4	1.0	0.8	0.6
1984	7.0	4.9	3.8	3.3	2.3	1.2	1.0	0.9	0.8
1985	7.6	4.2	3.4	2.1	1.5	0.9	0.7	0.6	0.5
1986	25.9	17.7	9.6	7.4	6.2	4.1	3.8	3.0	2.1

1987	19.0	14.2	8.9	5.4	4.7	2.8	2.0	1.7	1.3
1988	5.5	3.2	1.7	1.2	0.7	0.6	0.5	0.5	0.3
1989	7.5	4.4	2.8	1.4	0.9	0.5	0.3	0.3	0.2
1990	11.7	6.1	2.4	1.3	0.6	0.3	0.2	0.1	0.0
1991	41.1	27.0	14.8	8.8	4.8	2.2	1.5	1.1	0.6
1992	7.7	4.9	2.3	1.2	0.9	0.5	0.3	0.1	0.1
1993	9.7	6.4	4.1	2.0	1.3	0.9	0.7	0.7	0.6
1994	18.7	14.0	8.9	5.1	3.2	1.6	1.0	0.7	0.4
1995	26.2	18.7	12.1	7.8	7.1	4.9	3.7	2.7	1.8
1996	22.5	17.2	11.4	5.6	2.4	1.1	0.6	0.8	0.3
1997	34.3	22.1	16.2	12.1	9.0	6.0	5.0	4.2	2.8
1998	6.9	5.2	3.1	2.4	1.5	1.2	1.1	0.9	0.8
1999	28.3	15.4	10.7	6.8	4.0	2.6	2.0	1.7	1.5
2000	9.1	5.5	2.9	1.8	0.7	-0.1	-0.2	-0.4	0.0
2001	8.0	7.5	4.9	2.9	2.0	1.7	1.1	0.6	0.0
2002	4.9	1.8	0.5	-0.1	-0.4	-0.6	-0.7	-0.7	-0.8
2003	6.5	4.2	1.6	0.0	-0.5	-0.9	-1.0	-1.1	-1.1
2004	9.4	3.0	1.1	0.3	-0.3	-0.8	-1.0	-1.0	-1.0
2005	15.8	8.0	3.5	1.4	0.4	0.0	-0.4	-0.5	-0.6
2006	4.1	1.3	0.6	-0.1	-0.3	-0.6	-0.7	-0.8	-0.7
2007	8.3	5.6	2.1	0.9	0.2	-0.1	-0.1	-0.2	-0.6
2008	7.4	5.3	4.3	2.6	1.3	0.6	0.2	-0.1	-0.3
2009	10.6	8.7	5.1	2.5	1.3	0.6	0.3	0.0	-0.3
2010	20.7	16.3	14.7	12.4	7.9	3.8	2.4	1.8	1.2
2011	39.6	27.4	16.3	7.7	3.5	1.6	0.7	0.2	-0.2
2012	9.9	3.2	0.0	-0.4	-0.7	-1.0	-1.0	-1.1	-1.2
2013	6.2	1.4	0.7	0.0	-0.3	-0.6	-0.7	-0.8	-1.0
2014	9.0	3.7	1.8	0.4	-0.3	-0.5	-0.7	-0.8	-0.7
2015	10.6	8.8	5.3	2.6	1.0	0.3	-0.3	-0.6	-1.0
2016	6.8	4.0	2.2	1.9	0.8	0.1	-0.5	-0.6	-0.8
2017	6.2	2.5	2.0	1.0	0.2	-0.5	-0.9	-0.9	-0.9
2018	3.3	1.1	0.1	-0.4	-0.9	-1.2	-1.5	-1.6	-1.8
2019	32.9	26.3	20.9	13.3	7.7	3.8	4.2	2.8	1.2

Fort Randall Incremental Inflow, 1881, 1930-2019
Highest Mean Value for Duration in Days, in 1,000 cfs

Year	1-Day	3-Day	7-Day	15-Day	30-Day	60-Day	90-Day	120-Day	183-Day
1881	68.0	65.3	56.0	36.3	17.0				
1930	5.8	5.4	4.9	4.0	2.5	1.9	1.5	1.4	0.8
1931	2.9	2.8	2.7	1.8	1.5	0.8	0.8	0.7	0.5
1932	12.2	11.4	9.6	7.1	5.2	3.6	2.8	2.4	1.6
1933	9.9	8.7	6.7	5.5	3.5	2.2	1.8	1.5	1.0
1934	3.5	3.2	2.2	1.4	0.7	0.6	0.5	0.4	0.3
1935	10.6	10.0	8.4	6.7	5.0	3.4	2.7	2.2	1.5
1936	9.2	7.9	6.5	5.6	3.4	1.8	1.2	1.0	0.7
1937	11.1	10.3	8.2	5.6	3.8	1.6	1.5	1.5	1.0
1938	20.0	17.5	12.1	6.9	4.7	3.4	1.9	2.1	1.4
1939	27.1	25.8	20.2	12.1	6.3	3.1	2.1	1.6	1.0
1940	4.0	3.6	3.1	1.6	1.4	1.1	0.8	0.7	0.4
1941	16.0	14.9	11.4	7.0	3.7	1.6	1.7	1.4	0.9
1942	17.7	16.6	13.6	12.5	9.0	6.1	4.6	3.5	2.3
1943	36.4	35.0	31.0	19.2	9.6	5.4	3.6	2.8	1.7
1944	26.3	25.2	21.8	14.7	10.1	5.2	3.7	3.7	2.5
1945	14.2	13.7	12.1	9.1	4.6	2.5	1.7	1.2	0.9
1946	6.7	6.2	4.9	3.9	3.2	2.2	1.3	1.6	1.2
1947	22.1	17.9	13.9	10.1	6.2	2.7	2.0	1.9	1.5
1948	11.5	10.8	10.2	9.1	5.6	2.8	2.4	2.4	1.6
1949	24.0	22.3	17.5	12.8	9.9	5.4	3.6	2.6	1.7
1950	21.3	20.7	19.6	15.5	12.5	6.7	4.4	3.4	2.1
1951	18.9	18.2	16.1	12.0	6.3	3.1	2.2	1.9	1.3
1952	81.1	77.6	67.0	47.4	26.6	14.1	9.6	7.3	4.6
1953	29.9	27.1	19.9	12.0	7.5	7.1	5.2	4.2	3.1
1954	9.0	4.8	3.5	2.2	1.3	0.2	0.1	-0.3	-0.3
1955	24.0	21.7	16.8	9.6	5.5	2.6	1.4	0.8	0.2
1956	7.0	3.2	1.4	0.4	0.0	-0.2	-0.1	-0.2	-0.4
1957	14.3	10.7	9.7	6.8	5.9	4.0	3.2	2.8	2.0
1958	10.9	9.0	8.2	7.3	5.1	3.2	2.3	2.0	1.5
1959	4.7	4.2	2.9	2.3	1.6	1.4	1.3	1.0	0.7
1960	50.7	46.3	36.9	27.4	16.3	9.2	6.6	5.1	3.6
1961	11.8	10.1	6.5	4.2	2.6	2.3	1.7	1.5	1.2
1962	31.8	26.4	20.8	15.2	13.2	11.8	9.0	7.9	5.5
1963	14.6	11.0	6.9	5.8	3.9	3.0	2.5	2.2	2.3
1964	24.5	13.5	8.6	6.1	3.7	3.0	2.5	2.0	1.6
1965	12.1	9.0	7.3	6.5	5.3	3.8	3.1	2.8	2.5
1966	27.6	26.7	20.1	12.1	7.4	5.0	4.4	4.0	3.6
1967	29.8	25.7	21.2	14.8	9.6	6.1	4.8	4.1	3.2
1968	29.5	20.9	13.3	7.9	5.6	4.6	4.2	3.6	3.2
1969	31.3	17.6	15.1	10.7	8.4	5.1	4.0	3.7	3.0
1970	12.5	9.4	8.2	6.4	5.0	3.6	3.1	3.3	2.8
1971	18.3	13.7	9.8	7.0	5.0	4.4	3.7	3.4	2.9
1972	20.1	13.9	9.5	7.7	6.4	4.9	4.4	4.2	3.6
1973	43.4	19.6	8.1	5.2	4.1	3.1	2.7	2.8	2.6
1974	54.4	22.2	12.0	6.7	4.5	3.2	2.9	2.6	2.2
1975	24.8	9.6	5.5	4.3	3.6	3.1	3.0	2.7	2.2
1976	15.3	7.6	3.1	2.3	1.7	1.3	1.3	1.1	1.0
1977	26.8	15.1	6.7	5.2	4.6	3.8	3.3	2.8	2.1
1978	54.5	33.6	27.3	17.8	10.1	6.7	5.3	4.6	3.4
1979	31.3	12.5	7.0	4.6	3.3	2.5	2.0	1.9	1.7
1980	13.2	6.2	4.1	2.5	2.4	1.5	1.4	1.2	1.0
1981	15.7	7.7	4.8	2.6	1.7	1.3	1.2	1.0	1.0
1982	22.1	13.9	13.2	10.4	6.5	4.7	3.2	2.7	2.2
1983	25.3	20.2	11.5	9.2	5.5	3.7	3.1	2.7	2.2
1984	17.7	16.0	10.0	6.4	4.6	3.3	3.0	2.8	2.4
1985	13.1	6.3	5.6	4.3	2.9	1.8	1.7	1.4	1.1

1986	21.0	15.7	9.9	7.6	6.5	4.9	4.4	4.1	2.9
1987	20.0	18.3	13.6	9.2	8.0	4.9	3.8	3.1	2.4
1988	16.2	11.5	9.5	5.3	3.5	2.4	2.2	2.0	1.8
1989	11.5	7.0	4.8	3.2	2.2	1.4	1.4	1.2	1.0
1990	9.4	6.6	4.8	3.7	3.0	2.0	1.4	1.2	1.2
1991	24.5	19.0	13.2	9.4	7.5	4.4	3.3	2.6	2.1
1992	13.6	5.6	3.3	2.9	2.2	2.0	1.7	1.7	1.3
1993	20.2	10.2	5.8	4.2	3.6	3.1	2.7	2.5	2.3
1994	15.8	15.2	12.8	7.5	5.5	3.7	2.8	2.4	1.9
1995	40.4	25.5	20.2	13.7	13.1	10.8	7.9	6.3	4.6
1996	35.3	26.4	21.1	11.2	6.6	4.0	3.2	3.2	2.7
1997	42.9	30.1	20.3	13.7	9.4	7.9	7.8	7.7	6.4
1998	19.3	11.0	8.3	6.4	4.9	3.5	2.8	2.7	2.3
1999	48.6	32.8	23.9	17.4	9.8	6.8	5.7	4.7	3.8
2000	12.3	9.7	9.0	6.4	3.9	2.7	2.2	2.4	1.8
2001	23.5	18.4	14.8	10.1	8.3	7.6	5.8	5.2	4.2
2002	13.0	7.2	4.9	3.6	3.1	2.6	2.3	2.3	2.3
2003	12.9	10.3	5.6	4.1	3.6	3.0	2.8	2.8	2.6
2004	12.6	8.3	6.4	4.4	3.6	2.9	2.4	2.4	2.2
2005	27.4	13.4	9.4	7.2	4.9	4.4	3.8	3.2	2.8
2006	14.8	7.8	5.1	4.0	3.1	2.7	2.3	2.4	2.1
2007	26.3	14.0	7.9	4.4	3.2	2.9	2.8	2.5	2.3
2008	36.6	28.8	19.3	11.0	6.6	4.3	3.4	3.1	2.6
2009	19.6	11.4	8.5	6.5	4.6	3.6	3.7	3.5	3.1
2010	40.3	36.6	25.7	18.2	11.3	7.4	6.3	6.9	5.6
2011	56.5	44.5	33.7	22.1	16.1	13.5	11.7	10.2	9.0
2012	17.8	10.1	9.1	7.3	5.1	4.1	3.7	3.6	3.3
2013	17.8	10.8	6.4	5.0	4.0	3.3	3.2	3.0	2.8
2014	15.9	9.9	6.7	5.4	4.8	4.4	3.8	3.5	3.4
2015	19.0	12.0	10.3	8.1	8.0	6.7	5.6	4.9	4.3
2016	23.8	19.6	15.9	11.5	8.1	5.5	4.9	5.0	4.1
2017	16.7	11.5	8.7	8.3	5.6	4.4	4.3	4.1	3.8
2018	19.6	15.7	12.0	9.6	8.0	6.9	6.7	6.7	6.2
2019	61.8	48.0	44.7	32.5	23.1	15.9	17.1	15.1	13.1

Gavins Point Incremental Inflow, 1930-2019
Highest Mean Value for Duration in Days, in 1,000 cfs

Year	1-Day	3-Day	7-Day	15-Day	30-Day	60-Day	90-Day	120-Day	183-Day
1930	4.0	3.8	3.7	3.2	2.7	2.2	2.2	2.0	1.6
1931	7.5	7.3	6.9	6.2	5.7	4.0	3.8	3.3	2.4
1932	16.0	15.7	14.6	12.1	8.5	8.0	7.3	6.0	4.5
1933	19.2	19.2	19.0	16.6	10.8	7.7	7.6	6.3	5.4
1934	9.8	9.5	8.4	5.8	3.8	2.5	2.0	2.1	1.7
1935	8.0	7.2	6.4	5.1	3.7	3.4	2.8	2.7	2.1
1936	17.2	17.1	16.8	14.0	11.0	7.3	5.2	4.2	2.8
1937	6.8	6.3	6.0	4.9	3.4	2.4	2.2	2.1	1.8
1938	6.8	5.9	4.9	4.5	4.1	3.5	3.0	2.6	2.0
1939	13.7	12.9	10.0	7.9	5.7	3.4	2.9	2.4	1.9
1940	5.3	5.1	4.9	4.4	3.4	2.8	2.3	2.0	1.6
1941	5.1	4.4	3.7	3.4	2.6	2.4	2.2	1.9	1.4
1942	34.4	33.0	31.0	27.2	18.8	12.6	9.4	7.7	5.6
1943	11.6	10.8	8.6	5.5	4.3	3.3	3.4	3.0	2.3
1944	15.0	14.7	14.4	12.8	8.1	6.7	6.1	5.6	4.6
1945	16.4	16.2	14.8	12.7	9.2	6.2	5.1	4.3	3.2
1946	5.8	5.6	5.2	4.3	3.8	3.6	3.2	2.8	2.4
1947	19.5	17.7	14.7	11.0	9.0	5.8	5.7	5.4	4.1
1948	11.7	10.6	9.3	7.3	4.8	3.7	2.9	3.1	2.8
1949	20.6	19.9	17.9	15.2	9.2	6.2	5.2	4.5	3.3
1950	20.0	18.9	17.5	14.7	12.4	7.6	5.5	4.3	3.5
1951	13.6	13.0	11.3	10.7	8.3	5.6	5.4	4.9	4.5
1952	38.1	37.3	34.5	28.0	18.0	10.4	8.0	6.5	5.1
1953	13.7	13.3	12.6	10.7	6.8	5.1	4.8	4.4	3.6
1954	6.1	6.1	6.0	5.7	5.1	4.6	4.3	4.2	3.8
1955	8.4	8.4	8.1	7.2	6.0	4.9	4.6	4.3	3.4
1956	13.4	7.4	5.0	4.2	3.8	3.5	3.2	3.1	2.8
1957	13.6	10.2	6.2	3.5	3.2	2.6	2.5	2.5	2.1
1958	8.2	7.0	6.0	5.0	4.1	3.3	2.8	2.4	2.1
1959	11.3	7.1	5.6	3.8	3.3	2.5	2.6	2.4	2.0
1960	47.0	37.7	26.9	17.8	11.3	8.0	6.4	5.3	4.0
1961	7.4	5.8	4.1	3.9	3.6	3.0	2.6	2.5	2.2
1962	43.8	34.4	22.7	13.9	8.8	7.7	6.5	6.7	5.3
1963	11.0	5.4	5.0	4.5	3.9	3.3	2.9	2.6	2.4
1964	23.0	14.7	8.7	4.9	3.2	3.0	2.7	2.6	2.4
1965	9.5	6.5	4.8	3.8	3.2	2.5	2.5	2.4	2.1
1966	17.0	14.5	11.0	7.4	4.8	3.4	2.9	2.5	2.1
1967	19.2	12.7	10.1	8.0	5.6	3.5	2.8	2.7	2.4
1968	12.9	6.8	4.9	3.6	3.0	2.8	2.6	2.5	2.3
1969	16.2	15.3	11.9	10.3	7.5	5.0	3.8	3.2	2.7
1970	8.1	5.9	5.1	4.9	4.3	3.5	3.4	3.2	2.7
1971	15.4	9.6	7.5	5.8	5.2	4.4	4.0	3.6	2.9
1972	9.9	8.0	6.3	5.0	4.3	3.1	3.2	2.9	2.5
1973	9.6	8.2	7.2	6.5	5.8	4.8	4.3	4.1	3.5
1974	7.0	4.8	4.3	4.1	3.4	3.2	2.9	2.8	2.5
1975	8.7	6.9	4.9	4.1	3.7	3.4	3.3	3.1	2.7
1976	8.1	6.8	4.6	3.9	3.1	2.8	2.6	2.4	2.1
1977	11.2	7.7	6.5	5.4	5.1	4.8	4.7	4.5	4.0
1978	29.0	28.3	21.3	13.6	8.8	6.6	5.4	4.6	3.7
1979	11.9	10.4	8.8	6.9	5.7	4.7	3.9	3.3	2.7
1980	14.4	7.8	4.6	4.0	4.0	3.5	3.3	3.1	2.9
1981	5.7	5.1	4.5	3.7	2.9	2.9	2.8	2.7	2.7
1982	15.7	12.9	9.8	8.2	6.4	5.1	4.4	4.3	3.9
1983	11.7	9.9	8.3	6.6	5.9	5.5	5.2	5.2	4.7
1984	15.1	14.3	12.5	11.2	8.8	7.7	7.0	6.6	5.6
1985	9.1	7.6	6.0	5.2	5.0	4.7	4.6	4.2	3.9
1986	12.8	10.9	8.3	6.6	6.1	5.7	5.6	5.5	4.9

1987	19.9	17.6	15.4	12.4	10.2	7.6	6.5	5.9	5.2
1988	11.4	10.2	9.4	8.5	6.9	5.8	5.8	5.3	4.6
1989	7.5	7.0	6.6	5.4	4.7	4.1	3.8	3.6	3.3
1990	10.9	6.7	5.3	5.2	4.6	4.2	3.9	3.7	3.5
1991	8.2	7.4	6.5	5.9	5.0	4.1	3.8	3.8	3.4
1992	10.5	7.0	4.8	3.4	3.1	2.9	2.9	2.8	2.6
1993	25.5	20.8	13.4	8.5	6.1	5.2	5.2	4.7	4.4
1994	17.9	15.2	11.6	8.6	6.6	5.2	4.8	4.7	4.4
1995	28.2	23.7	17.4	11.5	10.5	9.3	7.6	6.8	6.0
1996	17.8	15.1	13.1	9.8	7.8	6.3	5.9	5.7	5.3
1997	25.7	21.9	16.2	11.4	9.4	7.6	7.2	6.9	6.1
1998	13.1	11.4	9.5	8.0	7.3	6.4	6.1	6.1	5.6
1999	19.0	16.2	10.9	8.1	7.4	6.5	6.2	6.3	6.0
2000	8.5	7.2	5.6	4.8	4.0	3.4	3.3	3.3	3.1
2001	16.6	14.9	11.4	8.7	7.8	7.3	5.8	4.9	4.0
2002	6.2	5.3	4.4	3.8	3.4	3.0	2.6	2.6	2.4
2003	8.7	6.8	4.4	3.3	2.8	2.5	2.4	2.3	2.1
2004	8.0	6.5	5.4	4.8	3.9	3.1	2.7	2.6	2.3
2005	13.7	9.3	6.8	6.3	5.2	4.0	3.6	3.2	3.0
2006	6.2	5.5	4.8	4.3	3.8	3.2	2.8	2.6	2.4
2007	21.7	19.1	13.9	8.5	7.0	5.0	4.7	4.1	3.3
2008	17.3	15.1	11.4	8.8	6.2	4.5	4.0	4.0	3.2
2009	8.2	7.3	5.9	4.5	4.1	3.9	3.6	3.4	3.1
2010	31.7	30.0	22.3	14.5	9.4	6.7	5.4	6.0	5.0
2011	16.8	16.1	12.0	9.8	8.5	6.0	4.7	4.9	4.5
2012	6.7	6.8	6.0	4.6	3.7	3.5	3.2	3.2	2.8
2013	5.7	4.6	4.3	3.6	3.0	2.9	2.6	2.6	2.6
2014	10.3	9.0	6.6	5.0	3.8	3.2	2.7	2.8	2.5
2015	8.2	6.5	5.3	3.6	3.4	2.9	2.6	2.5	2.6
2016	12.9	12.2	10.0	8.3	6.3	5.3	4.4	4.1	3.3
2017	9.2	7.9	7.4	6.3	5.0	4.0	3.5	3.4	2.9
2018	11.6	9.1	7.6	6.7	5.9	5.3	4.4	4.1	3.8
2019	120.5	86.2	53.3	35.4	22.1	14.6	13.9	12.6	10.0

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APPENDIX E

Upper Missouri River Basin
Annual Runoff Probabilities

Table E-1. Upper Missouri River Basin Annual Runoff Probability.

Period of Record: 1898-2019 with 1880-1890 Historic Data

Exceedance Probability (percent)	Recurrence Interval (year)	Computed Curve (KAF)
0.1	1000	72,100
0.2	500	67,100
0.5	200	60,500
1.0	100	55,600
2.0	50	50,600
4.0	25	45,600
10.0	10	38,800
20.0	5	33,300
50.0	2	24,800
80.0		18,400
90.0		15,800
95.0		13,800
99.0		10,800

2011 Annual volume = 61,004 KAF

Table E-2. Upper Missouri River Basin March - July Runoff Probability.

Period of Record: 1881, 1898-2019

Exceedance Probability (percent)	Recurrence Interval (year)	Computed Curve (KAF)
0.1	1000	50,400
0.2	500	47,000
0.5	200	42,400
1.0	100	39,000
2.0	50	35,400
4.0	25	31,800
10.0	10	26,800
20.0	5	22,700
50.0	2	16,300
80.0		11,500
90.0		9,500
95.0		8,100
99.0		5,900

2011 March - July volume = 48,380 KAF

Table E-3. Annual Runoff Volume Rankings.

Rank	Year	Annual Runoff KAF	Rank	Year	Annual Runoff KAF	Rank	Year	Annual Runoff KAF
1	2011	61004	46	2017	29560	91	1926	22000
2	2019	60871	47	1913	29496	92	1987	21314
3	1888	58500	48	1979	29479	93	2007	21112
4	1887	51300	49	1950	29369	94	1902	20908
5	1881	50700	50	1889	29200	95	1938	20652
6	1997	49037	51	1920	29199	96	1946	20355
7	2018	42077	52	1951	28856	97	1963	20313
8	1885	41600	53	1906	28713	98	1960	20120
9	1978	40634	54	1882	28500	99	2005	20077
10	2010	38676	55	1948	28353	100	1959	20017
11	1995	37160	56	1947	28279	101	1905	19796
12	1927	36988	57	1898	28088	102	1966	19685
13	1884	36700	58	1914	27897	103	2012	19545
13	1886	36700	59	1976	27687	104	1932	19463
15	1986	36203	60	1970	27312	105	1956	19418
16	1993	36156	61	1924	27098	106	1981	19259
17	1996	35592	62	1983	26802	107	1954	19223
18	1975	35539	63	2008	26631	108	1985	18843
19	2014	35285	64	1925	26479	109	1980	18687
20	1883	35200	65	1998	26412	110	1930	18452
21	1909	34893	66	1918	26301	111	2006	18171
22	1907	34651	67	2015	25807	112	1933	18166
23	1952	34232	68	1904	25491	113	1989	17700
24	1982	33598	69	1953	25367	114	2003	17445
25	1912	33597	70	1942	25105	115	1939	17271
26	2009	33416	71	1974	25009	116	1958	16971
27	1917	33295	72	2013	24740	117	1941	16714
28	1971	33134	73	1929	24653	118	1990	16691
29	1916	32997	74	1901	24598	119	2000	16490
30	1972	32962	74	1903	24598	120	1992	16448
31	1915	32794	76	1922	24101	121	1955	16410
32	1908	32683	77	2016	24089	122	2004	16162
33	1965	32473	78	1994	23859	123	1977	16080
34	1899	32391	79	1968	23744	124	2002	15737
35	1880	32100	80	1964	23705	125	1936	14339
36	1890	31700	81	1900	23194	126	1935	14323
37	1943	31394	82	1910	23190	127	1937	14315
38	1923	31222	83	1949	23189	128	1919	13891
39	1999	31175	84	1973	23140	129	1961	12432
40	1967	31026	85	1921	22801	130	1988	12352
41	1984	30824	86	1945	22729	131	1940	12101
42	1962	30333	87	1911	22701	132	1934	11164
43	1928	30283	88	2001	22537	133	1931	10701
44	1969	30122	89	1991	22330			
45	1944	29726	90	1957	22079			

Table E-4. March – July Runoff Volume Rankings.

Rank	Year	Annual Runoff KAF	Rank	Year	Annual Runoff KAF	Rank	Year	Annual Runoff KAF
1	2011	48380	46	2008	19633	91	2005	13697
2	2019	43139	47	1913	19415	92	1956	13504
3	1881	39660	48	1929	19365	93	2012	13293
4	1997	36565	49	1906	19318	94	1966	13198
5	1978	31430	50	1951	19288	95	1933	13093
6	2018	31089	51	2017	19254	96	2003	12928
7	1952	27694	52	1942	19111	97	1946	12720
8	2010	27649	53	1904	19056	98	1939	12695
9	1927	27358	54	1925	19036	99	1981	12530
10	1995	27063	55	1924	18933	100	1989	12283
11	1975	26862	56	1914	18814	101	1954	12278
12	1899	25728	57	1953	18773	102	1955	12264
13	1909	25688	58	1976	18460	103	1930	12135
14	1986	25162	59	1922	18316	104	2006	11985
15	1917	24964	60	1901	18094	105	1980	11879
16	1996	24629	61	1983	17981	106	1958	11866
17	1907	24401	62	1921	17776	107	1990	10970
18	2009	24393	63	1949	17618	108	2000	10954
19	1993	24337	64	1964	17499	109	1985	10791
20	1916	24124	65	1910	17209	110	1935	10595
21	1967	23813	66	1900	17082	111	1937	10563
22	1943	23790	67	1994	16986	112	2004	10404
23	2014	23731	68	2015	16811	113	2002	10331
24	1908	23681	69	2001	16665	114	1936	10262
25	1972	23523	70	1974	16542	115	1992	9449
26	1982	23144	71	1903	16337	116	1941	9420
27	1962	22940	72	1998	16229	117	1977	9391
28	1969	22913	73	1991	16102	118	1919	9275
29	1920	22754	74	1945	15915	119	1988	8355
30	1944	22686	75	2013	15905	120	1940	8028
31	1965	22657	76	1957	15796	121	1934	7301
32	1928	22531	77	1938	15641	122	1961	7058
33	1971	22496	78	2007	15227	123	1931	6353
34	1999	22024	79	1960	15146			
35	1948	21997	80	2016	15044			
36	1898	21954	81	1968	14970			
37	1950	21946	82	1932	14724			
38	1979	21764	83	1902	14552			
39	1912	21761	84	1911	14481			
40	1984	21608	85	1905	14360			
41	1947	21188	86	1987	14326			
42	1915	21000	87	1973	14196			
43	1970	20026	88	1926	14043			
44	1918	19821	89	1963	14005			
45	1923	19647	90	1959	13698			