USGS
science for a changing world

Prepared in cooperation with the Yellowstone River Conservation District Council and the U.S. Army Corps of Engineers

Streamflow Statistics for Unregulated and Regulated Conditions for Selected Locations on the Yellowstone, Tongue, and Powder Rivers, Montana, 1928–2002

Scientific Investigations Report 2013–5173
Version 1.1, June 2014

U.S. Department of the Interior
U.S. Geological Survey

Cover photograph: Yellowstone River south of Billings, Montana, looking downstream from South Billings Boulevard (photograph by the U.S. Geological Survey, September 29, 2005).

Streamflow Statistics for Unregulated and Regulated Conditions for Selected Locations on the Yellowstone, Tongue, and Powder Rivers, Montana, 1928–2002

By Katherine J. Chase

Prepared in cooperation with the Yellowstone River Conservation District Council
and the U.S. Army Corps of Engineers

Scientific Investigations Report 2013–5173
Version 1.1, June 2014

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
SALLY JEWELL, Secretary

U.S. Geological Survey
Suzette M. Kimball, Acting Director

U.S. Geological Survey, Reston, Virginia: 2013
Revised: June 2014

For more information on the USGS—the Federal source for science about the Earth, its natural and living resources, natural hazards, and the environment, visit *http://www.usgs.gov* or call 1–888–ASK–USGS.

For an overview of USGS information products, including maps, imagery, and publications, visit *http://www.usgs.gov/pubprod*

To order this and other USGS information products, visit *http://store.usgs.gov*

Suggested citation:
Chase, K.J., 2013, Streamflow statistics for unregulated and regulated conditions for selected locations on the Yellowstone, Tongue, and Powder Rivers, Montana, 1928–2002 (ver. 1.1, June 23, 2014): U.S. Geological Survey Scientific Investigations Report 2013–5173, 183 p., *http://dx.doi.org/10.3133/sir20135173*.

Contents

Figures

Tables

Conversion Factors, Datum, Abbreviations, and Definitions for Streamflow Terminology

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
acre	4,047	square meter (m^2)
acre	0.4047	hectare (ha)
acre	0.4047	square hectometer (hm^2)
acre	0.004047	square kilometer (km^2)
square mile (mi^2)	259.0	hectare (ha)
square mile (mi^2)	2.590	square kilometer (km^2)
acre-foot (acre-ft)	1,233	cubic meter (m^3)
kilo acre-foot (KAF)	1,233,000	cubic meter (m^3)
	Flow rate	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

°C = (°F-32)/1.8

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Abbreviations

CES	Cumulative-effects study
MOVE.1	Maintenance of Variance Extension, Type 1, curve-fitting procedure
OLS	ordinary least-squares
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
YRCDC	Yellowstone River Conservation District Council

Definitions for Streamflow Terminology

Annual mean streamflow	arithmetic mean of all daily mean streamflows for a single specified year
Annual instantaneous peak flow	maximum instantaneous streamflow that occurred during a single specified year
Daily mean streamflow	arithmetic mean streamflow for a single specified day
Mean annual streamflow	arithmetic mean of all annual mean streamflows for the period of record or a specific period of multiple years
Mean daily streamflow	arithmetic mean of all daily mean streamflows for a specified day for the period of record or for a specific period of multiple years
Mean monthly streamflow	arithmetic mean of all monthly mean streamflows for a specified month for the period of record or for a specific period of multiple years
Monthly mean streamflow	arithmetic mean of all daily mean streamflows for a single specified month in a single specified year

Acknowledgments

Special thanks are given to Steven K. Sando (U.S. Geological Survey Montana Water Science Center) and Daniel D. Driscoll (U.S. Geological Survey South Dakota Water Science Center) for helpful peer reviews. The assistance of Peter M. McCarthy (U.S. Geological Survey Montana Water Science Center) also is gratefully acknowledged.

The author also appreciates the assistance of Douglas J. Clemetson and Roger L. Kay (U.S. Army Corps of Engineers).

Streamflow Statistics for Unregulated and Regulated Conditions for Selected Locations on the Yellowstone, Tongue, and Powder Rivers, Montana, 1928–2002

By Katherine J. Chase

Abstract

Major floods in 1996 and 1997 on the Yellowstone River in Montana intensified public debate over the effects of human activities on the Yellowstone River. In 1999, the Yellowstone River Conservation District Council was formed to address conservation issues on the river. The Yellowstone River Conservation District Council partnered with the U.S. Army Corps of Engineers to conduct a cumulative-effects study on the main stem of the Yellowstone River. The cumulative-effects study is intended to provide a basis for future management decisions in the watershed. Streamflow statistics, such as flow-frequency and flow-duration data calculated for unregulated and regulated streamflow conditions, are a necessary component of the cumulative effects study.

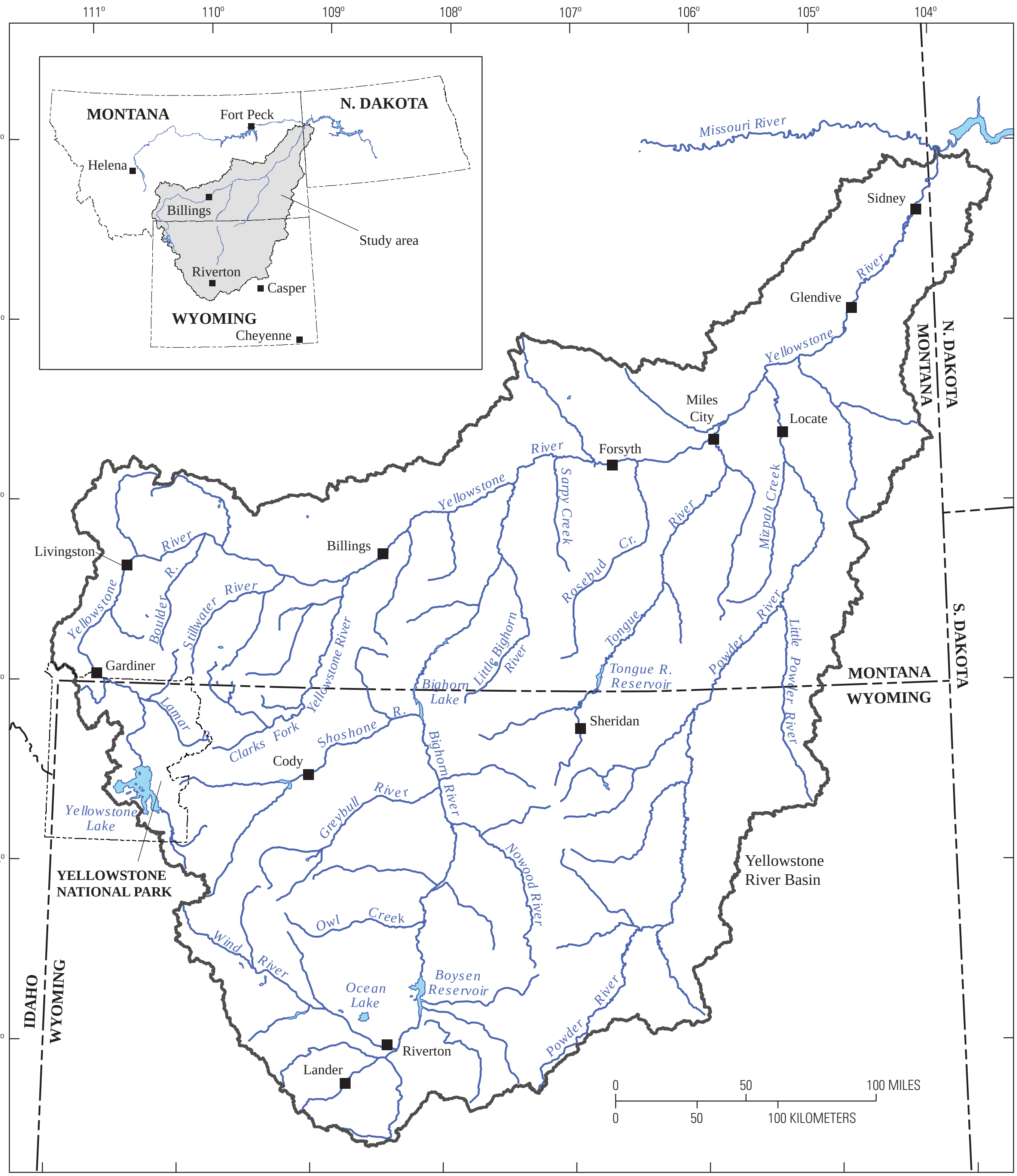
The U.S. Geological Survey, in cooperation with the Yellowstone River Conservation District Council and the U.S. Army Corps of Engineers, calculated streamflow statistics for unregulated and regulated conditions for the Yellowstone, Tongue, and Powder Rivers for the 1928–2002 study period. Unregulated streamflow represents flow conditions that might have occurred during the 1928–2002 study period if there had been no water-resources development in the Yellowstone River Basin. Regulated streamflow represents estimates of flow conditions during the 1928–2002 study period if the level of water-resources development existing in 2002 was in place during the entire study period. Peak-flow frequency estimates for regulated and unregulated streamflow were developed using methods described in Bulletin 17B. High-flow frequency and low-flow frequency data were developed for regulated and unregulated streamflows from the annual series of highest and lowest (respectively) mean flows for specified *n*-day consecutive periods within the calendar year. Flow-duration data, and monthly and annual streamflow characteristics, also were calculated for the unregulated and regulated streamflows.

Introduction

The Yellowstone River is one of the longest free-flowing rivers in the lower 48 States, draining about 70,000 square miles (mi^2) as it flows more than 600 miles (mi) from its origin east of Yellowstone National Park, Wyoming, through Montana to the confluence with the Missouri River in North Dakota (Jean and Crispin, 2001; U.S. Geological Survey, 2010; fig. 1). The Yellowstone River supports a wide variety of agricultural, domestic, industrial, and recreational uses, and in some areas of Montana, is a blue-ribbon trout stream.

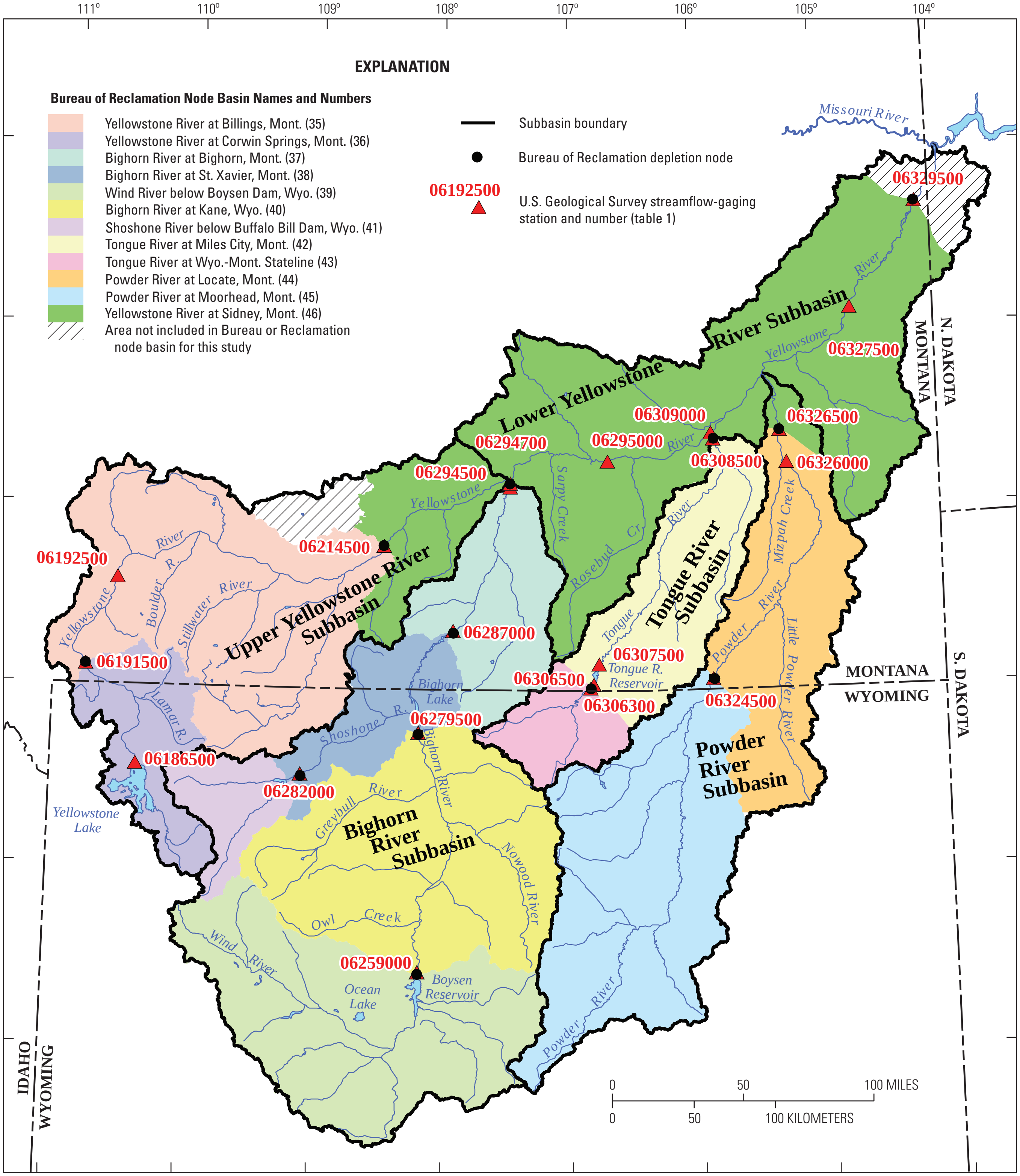
Major floods in 1996 and 1997 intensified public debate over the effects of human activities on the Yellowstone River and led to multidisciplinary efforts to understand the river's response to flood control, channel stabilization, and construction along the Yellowstone River corridor. In 1999 the Yellowstone River Conservation District Council (YRCDC) was formed to address conservation issues on the river. The YRCDC partnered with the U.S. Army Corps of Engineers (USACE) to conduct a cumulative-effects study (CES) on the Yellowstone River main stem. The CES is intended to provide a basis for future management decisions in the watershed. Streamflow statistics for unregulated and regulated conditions along the Yellowstone River main stem are a necessary component of the CES.

In a previous study, the USACE calculated streamflow statistics for unregulated and regulated streamflow conditions for the Yellowstone River main stem in the Upper Yellowstone River Subbasin and for the Bighorn River (fig. 2; U.S. Army Corps of Engineers, 2011a, b). To supplement that work, the U.S. Geological Survey (USGS), in cooperation with the YRCDC and the USACE, began a study that would calculate streamflow statistics for unregulated and regulated streamflow conditions for the Yellowstone River main stem in the Lower Yellowstone River Subbasin (fig. 2). At the request of the USACE and the YRCDC's Technical Advisory Committee, streamflow statistics for unregulated and regulated streamflow conditions for the Tongue and Powder Rivers also were included, although those Yellowstone River tributaries are not specifically part of the CES of the Yellowstone River main stem.



Base modified from U.S. Geological Survey Digital Line Graph (DLG), 1:2,000,000, 1973, Lambert Conformal Conic Projection
Standard parallels 45°00' and 49°00' central meridian –109°30'
North American Datum of 1983 (NAD 83).

Figure 1. Yellowstone River Basin in Montana, Wyoming, and North Dakota.



Base modified from U.S. Geological Survey Digital Line Graph (DLG), 1:2,000,000, 1973, Lambert Conformal Conic Projection
Standard parallels 45°00' and 49°00' central meridian –109°30'
North American Datum of 1983 (NAD 83).

Figure 2. Study area subbasins in Montana, Wyoming, and North Dakota, and Bureau of Reclamation node basins and streamflow-gaging stations in Montana and Wyoming.

Purpose and Scope

The purpose of this report is to present streamflow statistics for selected locations on the Yellowstone, Tongue, and Powder Rivers for the 1928–2002 (calendar year) study period. These statistics include basic summary statistics and flow-frequency data, and flow-duration data for two streamflow conditions: "unregulated," where effects of streamflow regulation and water use have been removed, and "regulated," where streamflows are adjusted to represent near-present-day (based on 2002 data) levels of development. Streamflow data, from these regulated and unregulated conditions, are intended for use in management and development of main-stem Yellowstone River resources. Information for selected streamflow-gaging stations on the Yellowstone, Bighorn, Tongue, and Powder Rivers is summarized in table 1; locations of selected streamflow-gaging stations in the Yellowstone River Basin are shown on figure 2. To facilitate the data analyses, the Yellowstone River Basin was divided into five subbasins (fig. 2): (1) Upper Yellowstone River Subbasin, (2) Bighorn River Subbasin, (3) Lower Yellowstone River Subbasin, (4) Tongue River Subbasin, and (5) Powder River Subbasin. Though the Yellowstone River Basin extends into Wyoming and North Dakota, streamflow statistics only were calculated for locations in Montana.

Table 1. Information for selected streamflow-gaging stations in the Yellowstone River Basin, Montana and Wyoming[1].

Station number	Station name	Drainage area (square miles)	Contributing drainage area (square miles)[2]	Period of record (through 2010)
06186500	Yellowstone River at Yellowstone Lake Outlet, Yellowstone National Park, Wyoming	991		1922–82, 1983–86, 1988–2010
06191500	Yellowstone River at Corwin Springs, Mont.	2,619		1889–93, 1910–2010
06192500	Yellowstone River near Livingston, Mont.	3,551		1897–1905, 1928–32, 1937–2010
06214500	Yellowstone River at Billings, Mont.	11,805	11,408	1904–05, 1928–2010
06294500	Bighorn River above Tullock Creek near Bighorn, Mont.	22,414		1945–55, 1956–2010
06295000	Yellowstone River at Forsyth, Mont.	40,146	39,455	1921–23, 1977–2010
06309000	Yellowstone River at Miles City, Mont.	48,253		1922–23, 1928–2010
06327500	Yellowstone River at Glendive, Mont.	66,739		1897–1910, 1931–34
06329500	Yellowstone River near Sidney, Mont.	69,083	68,392	1910–31, 1933–2010
06306300	Tongue River at State Line near Decker, Mont.	1,453		1960–2010
06306500	Tongue River near Decker, Mont.	1,585		1928–1938
06307500	Tongue River at Tongue River Dam, near Decker, Mont.	1,770		1939–2010
06308500	Tongue River at Miles City, Mont.	5,397		1938–42, 1946–2010
06324500	Powder River at Moorhead, Mont.	8,086		1929–72, 1974–2010
06326000	Powder River at Mizpah, Mont.	12,132		1928–1933
06326500	Powder River near Locate, Mont.	13,068		1938–2010

[1]U.S. Geological Survey (2010).

[2]Contributing area only specified for selected streamflow-gaging stations in U.S. Geological Survey (2010).

Description of the Study Area

The headwaters of the Yellowstone River are in northern Wyoming, east of Yellowstone National Park. The river enters Montana near the town of Gardiner and flows north and east across 500 mi of Montana to its confluence with the Missouri River in North Dakota (fig. 1). Elevations in the drainage basin range from about 13,780 feet (ft; above NAVD 88) in the mountains south of Yellowstone National Park to 1,850 ft at the mouth of the Yellowstone River (Zelt and others, 1999). Major tributaries to the Yellowstone River include the Bighorn, Tongue, and Powder Rivers (table 1, fig. 1).

Generally, the climate is semiarid with cold winters and warm summers. Based on climatic data for 1971–2000, monthly mean temperatures at Yellowstone Lake, Wyo. (fig. 1; elevation 7,870 ft), ranged from –3.1 °F in January to 70.4 °F in July, and monthy mean temperatures at Sidney, Mont. (in the eastern part of the basin, elevation 1,920 ft), ranged from 2.7 °F in January to 86.3 °F in July (National Oceanic and Atmospheric Administration, 2002). The mean annual precipitation of 20.40 inches (in.) at Yellowstone Lake, Wyo. was distributed fairly evenly throughout the year, whereas about 58 percent of the mean annual precipitation (14.31 in.) at Sidney, Mont., fell from May to August.

The typical annual flow pattern for the Yellowstone River downstream from Billings, Mont., consists of a lowland snowmelt peak during the late winter/early spring followed by a peak from the mountain snowmelt during the late spring/early summer (Zelt and others, 1999). Several short- to moderate-duration rainstorm peaks typically augment the spring/summer snowmelt peaks and the summer base flows.

Methods for Calculating Streamflow Statistics for Unregulated and Regulated Conditions

Observed daily streamflow records from USGS streamflow-gaging stations served as the basis for calculating the streamflow statistics. Daily mean streamflows (referred to herein as daily streamflows) were retrieved and analyzed using methods developed by the USACE and the USGS. The USACE retrieved daily streamflows for selected USGS streamflow-gaging stations (U.S. Geological Survey, 2010) and organized the data into a USACE Hydrologic Engineering Center Data Storage System database using the computer program HEC-DSSvue (U.S. Army Corps of Engineers, 2009a; Douglas J. Clemetson, P.E., Chief, Hydrology Section, U.S. Army Corps of Engineers, written commun., November 2009). Missing daily streamflows for ungaged periods were synthesized to develop a complete set of daily streamflows for the selected streamflow-gaging stations for the 1928–2002 study period. This study period was chosen because the USACE desired a 75-year study period and U.S. Department of the Interior Bureau of Reclamation (Reclamation) depletion data (necessary to estimate unregulated and regulated streamflows) were only available for 1929–2002. The daily streamflows were modified to represent unregulated and regulated streamflow conditions, respectively. Statistical summaries were calculated for each set of conditions.

Synthesis of Missing Streamflow Records

In order to develop a complete set of daily streamflows for the 1928–2002 study period, monthly mean streamflows (referred to herein as monthly streamflows) for periods of missing records were synthesized using the Maintenance of Variance Extension, Type 1 (MOVE.1) curve-fitting procedure described by Hirsch (1982) and Alley and Burns (1983) and discussed below in the section "Synthesis of Monthly Mean Streamflows." The synthesized monthly streamflows were used to synthesize daily streamflows.

Synthesis of Monthly Mean Streamflows

Monthly streamflows for the Lower Yellowstone River (or the part of the Yellowstone River in the Lower Yellowstone River Subbasin; fig. 2), Tongue River, and Powder River were synthesized using MOVE.1. The MOVE.1 procedure is based on correlation of streamflow records for a target station (that is, a streamflow-gaging station needing estimation of missing records) with concurrent streamflow records for one or more index stations. The MOVE.1 procedure is analogous to ordinary least-squares (OLS) regression, except that MOVE.1 results in a synthesized flow record with a variance comparable to that of the observed flow record (Cary and Parrett, 1996). This mixed-station procedure can be applied to cases for which an appropriate index station has a shorter record length than the target station (Sando and others, 2008). Selected information about MOVE.1 analyses for synthesizing monthly streamflows at streamflow-gaging stations for this study is presented in table 2.

Yellowstone River Streamflow-Gaging Stations

For the streamflow-gaging stations on the Yellowstone River, monthly streamflows were synthesized for less than 1.0 percent (06309000, Yellowstone River at Miles City) to 96 percent (06327500, Yellowstone River at Glendive) of the study period (table 2). Pearson correlation coefficients calculated for the concurrent data for the target and index stations ranged from 0.87 to 1.0, indicating a strong positive correlation (Hirsch and others, 1993). Values of the standard error of prediction in percent (SEP; as discussed in Alley and Burns, 1983) ranged from 5.2–9.3 percent; these relatively small (less than 10 percent) values of SEP indicate that the results from the MOVE.1 analyses are reliable.

Tongue and Powder River Streamflow-Gaging Stations

For the Tongue and Powder Rivers, monthly streamflows were synthesized for 19 and 14 percent of the study period, respectively (table 2). Pearson correlation coefficients calculated for concurrent data for the target and index stations generally were lower than coefficients associated with synthesized Yellowstone streamflows, ranging from 0.25 to 0.98. The SEPs were 55 and 56 percent for the Tongue and Powder River streamflow-gaging stations, respectively. The monthly streamflows synthesized for the Tongue and Powder Rivers are, therefore, less reliable than monthly streamflows synthesized for the Yellowstone River. Given that less than 20 percent of the monthly streamflows for the study period were synthesized, however, and that the Tongue and Powder Rivers are not specifically part of the cumulative effects study, the synthesized monthly streamflows are sufficient for purposes of this study.

Table 2. Selected information about Maintenance of Variance Extension, Type 1 (MOVE.1) analyses for synthesizing monthly mean streamflows at selected Yellowstone River Basin streamflow-gaging stations, Montana, during the study period January 1928 through December 2002.

[All stations located in Montana except for Lamar River near Tower Falls Range Station, YNP, Wyoming. Abbreviations: SEP, standard error of prediction, in percent; YNP, Yellowstone National Park; R, River; bl, below; Cr, Creek]

Target station for which monthly mean streamflows were synthesized						Index station(s) used in synthesis of monthly mean streamflows					
Station name	Station number	Drainage area[1], in square miles	Period of systematic monthly recordin thestudy period	Ungaged period requiring synthesis of monthly mean streamflows	Percent missing monthly mean stream-flows	Station name	Station number	Drainage area[1], in square miles	Number of monthly mean streamflows synthesized based on this station	Pearson correlation coefficient for concurrent data for target and index station	SEP of MOVE.1 analysis
Yellowstone River at Forsyth	06295000	40,146	10/1977–12/2002 (303 months)	1/1928–9/1977 (597 months)	66	Yellowstone River at Miles City	06309000	48,253	565	0.97–0.99	5.2
						Yellowstone River near Sidney	06329500	69,083	8	0.90–0.99	
						Yellowstone River near Miles City	06296120	42,847	24	1.00	
Yellowstone River at Miles City	06309000	48,253	9/1928–12/2002 (892 months)	1/1928–8/1928 (8 months)	0.89	Yellowstone River near Sidney	06329500	69,083	8	0.91–0.99	8.1
Yellowstone River at Glendive	06327500	66,739	10/1931–9/1934; 10/2002–12/2002 (39 months)	1/1928–9/1931; 10/1934–9/2002 (861 months)	96	Yellowstone River near Sidney	06329500	69,083	8	0.97–0.98	7.0
						Yellowstone River at Miles City	06309000	48,253	811	0.87–1.00	
						Yellowstone River at Billings	06214500	11,805	42	0.93	
Yellowstone River near Sidney	06329500	69,083	1/1928–12/1931; 10/1933–12/2002 (879 months)	1/1932–9/1933 (21 months)	2.3	Yellowstone River at Miles City	6309000	48,253	13	0.95–0.99	9.3
						Yellowstone River at Glendive	06327500	66,739	8	0.97–0.98	

Table 2. Selected information about Maintenance of Variance Extension, Type 1 (MOVE.1) analyses for synthesizing monthly mean streamflows at selected Yellowstone River Basin streamflow-gaging stations, Montana, during the study period January 1928 through December 2002.—Continued

[All stations located in Montana except for Lamar River near Tower Falls Range Station, YNP, Wyoming. Abbreviations: SEP, standard error of prediction, in percent; YNP, Yellowstone National Park; R, River; bl, below; Cr, Creek]

Target station for which monthly mean streamflows were synthesized						Index station(s) used in synthesis of monthly mean streamflows					
Station name	Station number	Drainage area[1], in square miles	Period of systematic monthly record in the study period	Ungaged period requiring synthesis of monthly mean streamflows	Percent missing monthly mean stream-flows	Station name	Station number	Drainage area[1], in square miles	Number of monthly mean streamflows synthesized based on this station	Pearson correlation coefficient for concurrent data for target and index station	SEP of MOVE.1 analysis
Tongue River at Miles City	06308500	5,397	4/1938–4/1942; 4/1946–12/2002 (730 months)	1/1928–3/1938; 5/1942–3/1946 (170 months)	19	Clarks Fork Yellowstone near Belfry	06207500	1,154	14	0.25–0.53	55
						Lamar River near Tower Falls Ranger Station, YNP, Wyo.	06188000	660	8	0.31–0.67	
						Shields River at Clyde Park	06193500	543	21	0.55–0.74	
						Powder River at Moorhead	06324500	8,086	81	0.27–0.88	
						Tongue River at Tongue River Dam, near Decker	06307500	1,770	30	0.79–0.96	
						Little Bighorn R bl Pass Cr near Wyola	06290500	428	8	0.81–0.88	
						Powder River near Locate	06326500	13,068	4	0.81	
						Bighorn River near St. Xavier	06287000	19,667	4	0.45	
Powder River near Locate	06326500	13,068	4/1938–12/2002 (777 months)	1/1928–3/1938 (123 months)	14	Clarks Fork Yellowstone near Belfry	06207500	1,154	16	0.26–0.56	56
						Powder River at Moorhead	06324500	8,086	107	0.70–0.98	

[1]Drainage areas from U.S. Geological Survey (2010).

Synthesis of Daily Mean Streamflows

Daily streamflows were synthesized by distributing the synthesized monthly streamflows to daily streamflows by using ratios of daily to monthly streamflows (referred to herein as daily/monthly ratios) developed from appropriate index stations. Selected information about daily/monthly ratio analyses for synthesizing daily mean streamflows is presented in table 3. Errors associated with the synthesized daily streamflows include the errors associated with the monthly streamflows and additional errors resulting from the monthly-to-daily distribution. Therefore, the errors associated with synthesis of daily streamflows likely are higher than errors associated with synthesis of monthly streamflow values.

Yellowstone River Streamflow-Gaging Stations

Daily streamflows for each of the four Yellowstone River streamflow-gaging stations were synthesized using daily/monthly ratios from the Yellowstone River near Sydney and/or the Yellowstone River at Miles City streamflow-gaging stations (table 3). Daily/monthly ratios from the Yellowstone River at Forsyth and Yellowstone River at Glendive were not used because those streamflow-gaging stations had much shorter periods of record during the study period (table 1).

Daily streamflows were synthesized for the entire study period (1928–2002). Initially, the synthesized daily streamflows were compared with observed daily streamflows to determine the effect of travel-time between the target and index streamflow-gaging stations. For three of the target/index streamflow-gaging station pairs, the series of daily/monthly ratios was shifted backward (when the index station was downstream from the target station) or forward (when the index station was upstream from the target station) in order to achieve better agreement between synthesized and observed daily streamflows (table 3).

Tongue and Powder River Streamflow-Gaging Stations

Missing daily streamflows for the Tongue River at Miles City for the 1920s and 1930s were synthesized using two types of data (table 3). Long-term mean daily/monthly ratios from the Tongue River at Miles City (calculated from the observed streamflows for the streamflow-gaging station period of record concurrent with the study period) were used for the period from January 1, 1928, to April 19, 1928, because no data were available from appropriate index stations for that period. Daily/monthly ratios from the Tongue River near Decker were used for the period from April 20, 1928, to April 1, 1938.

Daily streamflows for the Tongue River at Miles City for the period from May 1, 1943 to March 31, 1946 were synthesized by using weighted averages of daily/monthly ratios for the Tongue River at Tongue River Dam, near Decker (weighting of 33 percent) and the Powder River near Locate (weighting of 67 percent). Weighted averages of data from the two streamflow gages were used (instead of data exclusively from either streamflow gage) to account for regulation effects that the Tongue River Dam may have on the synthesized daily streamflows. Daily streamflow data were not available for this same period for the Tongue River at State line, near Decker, Mont., which is upstream from the Tongue River Reservoir and, therefore, is unaffected by reservoir regulation. Using data exclusively from the Tongue River at Tongue River Dam (which drains about 33 percent of the Tongue River at Miles City drainage area) for estimating daily/monthly ratios might result in synthesized daily streamflows that are overly affected by stream regulation. Even though the Powder River Subbasin is adjacent to the Tongue River Subbasin (fig. 2), and the topography, vegetation, and climate for both Subbasins are similar, using data exclusively from the Powder River near Locate as an index station might result in synthesized daily streamflows with no representation of the regulation effects of the Tongue River Dam. The streamflows synthesized for the Tongue River at Miles City are less reliable than the daily streamflows synthesized for the Yellowstone and Powder Rivers because of the uncertainties associated with the weighted-average analyses. Less than 7 percent of the record, however, was synthesized in this manner; therefore, the synthesized daily streamflows are acceptable for the purposes of this study.

Synthesized streamflows for the Tongue River at Miles City include a daily streamflow of 12,320 cubic feet per second (ft^3/s) for June 20, 1944, which is larger than any observed daily streamflow for that streamflow-gaging station and is smaller than the largest known annual instantaneous peak streamflow of 13,300 ft^3/s (Parrett and Johnson, 2004), which occurred June 15, 1962 (U.S. Geological Survey, 2010). That large synthesized daily streamflow (12,320 ft^3/s) appears to be reasonable, because the second largest observed daily streamflow on the Powder River at Locate (23,500 ft^3/s) also occurred on the same date, and climate stations in the vicinity received extremely large amounts of precipitation on and just before June 20, 1944 (Robb, 1944).

Missing daily streamflows for the Powder River near Locate mostly were synthesized using daily/monthly ratios from two index stations; the Powder River near Mizpah and the Powder River at Moorhead (table 3). Similar to the synthesis for the Tongue River at Miles City, long-term mean daily/monthly ratios from the Powder River near Locate (calculated from the observed streamflows for the streamflow-gaging station period of record concurrent with the study period) were used from January 1, 1928, to August 28, 1928, because no data were available from appropriate index stations for that period.

Streamflow Conditions Analysis

Streamflow datasets were synthesized for two hypothetical streamflow conditions: unregulated and regulated. These datasets are more homogenous than the observed streamflow datasets because effects of changing water use practices were removed (for the unregulated dataset) or modified to be uniform through the study period (for the regulated dataset). Data homogeneity is an important assumption for the procedures used in the statistical analyses (U.S. Interagency Advisory Council on Water Data, 1982).

Unregulated conditions represent estimates of streamflows during the 1928–2002 study period assuming there was no water-resources development in the Yellowstone River Basin. Water-resources development includes irrigation operations, reservoir operations, and other human-caused changes to the amount and timing of streamflow. Historical depletions estimated by Reclamation (U.S. Department of the Interior Bureau of Reclamation, 1999 and 2005) and described in the section "Depletion Estimates", account for changes to streamflow caused by water-resources development throughout the Yellowstone River Basin. Unregulated streamflows were estimated by adding the historical depletions estimated by Reclamation to the observed streamflows.

Regulated streamflows represent estimates of streamflows that might have occurred during the 1928–2002 study period assuming a uniform level of water-resources development existing in 2002 and applied throughout the entire study period. Regulated streamflows were estimated by subtracting the "2002-level depletions" (described in the section "Depletion Estimates") from the respective unregulated streamflows.

Depletion Estimates

The Bureau of Reclamation developed estimates of historical and 2002-level depletions for the entire Missouri River Basin (U.S. Department of the Interior Bureau of Reclamation, 2005) for water years 1929–2002. Depletion estimates were developed for 118 node basins in the Missouri River Basin, which included 12 node basins (fig. 2) in the Yellowstone River Basin. The node basin boundaries do not necessarily correspond with the subbasin boundaries (fig. 2). For example, the lower part of the Powder River Subbasin is included in the Yellowstone River at Sidney, Mont. node basin. Also a small part (approximately 690 mi^2) of the Upper Yellowstone River Subbasin northwest of the Yellowstone River at Billings, Mont. streamflow-gaging station (06214500) was not included in any node basins within the Yellowstone River Basin; this area corresponds with the non-contributing drainage area of 691 mi^2 at the Yellowstone River at Forsyth, Mont. streamflow gaging station (06295000; table 1; difference between drainage area and non-contributing drainage area). In addition, the part of the Lower Yellowstone River Subbasin downstream from the Yellowstone River near Sidney, Mont. streamflow-gaging station (0629500) is not included in any node basin considered for this study.

The term "depletion" refers to changes to natural streamflows that result from water-resources development. In almost all cases, water-resources development results in net decreases in streamflow over periods of one to multiple years. Some water-resources development (for example, reservoir and irrigation operations), however, can result in decreases in streamflow (relative to natural conditions) during specific times of the year and increases in streamflow during other times of the year. In unusual cases, such as construction of a reservoir and the associated increase in water surface area in a region where precipitation exceeds evaporation, water-resources development can result in net increases in streamflow over relatively long periods. Thus, the term "depletion" as used by Reclamation (U.S. Department of the Interior, Bureau of Reclamation, 2005) and in this report does not imply a decrease in streamflow, especially on a seasonal basis. Positive depletions indicate decreases in streamflow relative to natural conditions, and conversely, negative depletions indicate increases in streamflow relative to natural conditions.

The historical depletions determined by Reclamation (U.S. Department of the Interior, Bureau of Reclamation, 2005) included estimates of irrigation operations, reservoir operations, and other water uses that existed each year during 1929–2002. Those estimates were based on climatological records, the irrigation methods in use and number of irrigated acres, and municipal and industrial water uses for each year. The 2002-level depletions determined by Reclamation were based upon estimates of irrigation operations, reservoir operations, and municipal and industrial water uses that existed in 2002, which then were applied to each year during 1929–2002. Applying the 2002-level depletions to each year accounts for effects of interannual climatic variability on water demand and consumptive use. Because Reclamation did not develop depletion estimates for 1928, monthly depletions for 1928 (this study) were estimated from the monthly averages for the years 1929 to 1933 for the historical and 2002-level depletions. The Reclamation 1929-2002 depletion data and 1928 estimates from this study are presented in Appendix 1 of this report.

Lower Yellowstone River Subbasin Depletion Estimates

Monthly historical and 2002-level depletions at each gage along the Yellowstone River main stem in the Lower Yellowstone River Subbasin were apportioned according to the number of irrigated acres upstream from the gage relative to the total irrigated acres in each Reclamation node basin. The U.S. Army Corps of Engineers (2011b) modified the monthly depletions calculated by Reclamation for the Bighorn River Subbasin. Those modified monthly depletions for the Bighorn River Subbasin and the monthly depletions for the Upper Yellowstone River Subbasin were added to the monthly depletions calculated for each streamflow-gaging station in the Lower Yellowstone River Subbasin. The monthly depletions were distributed to daily depletions assuming a constant value for each day of each month. To be consistent with the USACE approach for the Bighorn Subbasin and the Upper Yellowstone River Basin (Douglas J. Clemetson, Hydrology Section, U.S. Army Corps of Engineers, written commun., 2010), when subtraction of daily depletions from observed daily streamflows resulted in negative unregulated daily streamflows, those negative streamflows were set to zero.

Table 3. Selected information about daily mean streamflow to monthly mean streamflow ratio (daily/monthly ratio) analyses for synthesizing daily mean streamflows at selected Yellowstone River Basin streamflow-gaging stations, Montana, during the study period, January 1928 through December 2002.

[All stations located in Montana. Abbreviations: NA, not applicable]

Information about target stations for which daily mean streamflows were synthesized						Information about index station(s) used in devleoping daily/monthly ratios for synthesis of daily mean streamflows						
Station name	Station number	Drainage area, in square miles	Period of systematic record in study period	Ungaged period requiring synthesis of daily mean streamflows	Percent of missing daily mean streamflows	Station name and supplemental analysis information	Station number	Drainage area, in square miles	Period of synthesized daily mean streamflows based on this station	Percent of study period represented by synthesized daily mean streamflows	Length of intervening reach between target and index station (miles)	Shift[1] (in days) applied to approximately account for travel time between the target and index station
Yellowstone River at Forsyth	06295000	40,146	10/1/1977–12/31/2002	1/1/1928–9/30/1977	66	Yellowstone River near Sidney	06329500	69,083	1/1/1928–8/27/1928	0.87	209	–2
						Yellowstone River at Miles City	06309000	48,253	8/28/1928–9/30/1977	65	54	0
Yellowstone River at Miles City	06309000	48,253	8/28/1928–12/31/2002	1/1/1928–8/27/1928	0.89	Yellowstone River near Sidney	06329500	69,083	1/1/1928–8/27/1928	0.89	155	–1
Yellowstone River at Glendive	06327500	66,739	10/1/1931–9/30/1934	1/1/1928–9/30/1931; 10/1/1934–12/31/2002	96	Yellowstone River near Sidney	06329500	69,083	1/1/1928–9/30/1931; 10/1/1934–9/30/2002	96.0	63.2	0
Yellowstone River near Sidney	06329500	69,083	1/1/1928–12/31/1931; 10/1/1933–12/31/2002	1/1/1932–9/30/1933	2.3	Yellowstone River at Miles City	06309000	48,253	1/1/1932–9/30/1933	2.3	155	+1
Tongue River at Miles City	06308500	5,397	4/2/1938–4/30/1942; 4/1/1946–12/31/2002	1/1/1928–4/1/1938; 5/1/1942–3/31/1946	19	Tongue River at Miles City (long-term mean daily/monthly ratio[2])	06308500	5,397	1/1/1928–4/19/1928	0.40	NA	NA
						Tongue River near Decker	06306500	1,585	4/20/1928–4/1/1938	13	189.2	+1
						Tongue River at Tongue River Dam combined with Powder River near Locate (weighted average)[3]: Tongue River at Tongue River Dam (weighing of 33 percent)	06307500	1,770	5/1/1942–3/31/1946	5	180	+1
						Powder River near Locate (weighting of 67 percent)	06326500	13,068			NA	NA
Powder River near Locate	06326500	13,068	3/26/1938–12/31/2002	1/1/1928–3/25/1938	14	Powder River near Locate (long-term mean daily/monthly ratio[2])	06326500	13,068	1/1/1928–8/28/1928	0.88	NA	0
						Powder River near Mizpah	06326200	12,132	8/29/1928–3/31/1933	6.1	19	0
						Powder River at Moorhead	06324500	8,086	4/1/1933–3/25/1938	6.6	181.3	+2

[1]After applying the daily/monthly ratios, the synthesized daily mean streamflows were shifted backward (negative values) or forward (positive values) to approximately account for travel time between the target and index station.

[2]For periods when appropriate index stations were not available, the long-term mean daily/monthy ratio for the given month was used to synthesize daily mean streamflows.

[3]Weighted averages of daily/monthly rates from the two streamflow gaging stations were used to account for effects of the Tongue River Reservoir on daily streamflow estimates.

Tongue and Powder River Subbasin Depletion Estimates

Monthly depletions estimated by Reclamation for the Tongue River Subbasin (fig. 2) were totaled to estimate the depletions at the streamflow-gaging station at the Tongue River at Miles City (06308500). Likewise, monthly depletions for the Powder River Subbasin were totaled to estimate the depletions at Powder River near Locate (06326500). Initially, the monthly depletions were distributed to daily depletions assuming a constant value for each day of each month. When subtraction of daily depletions from observed streamflows resulted in negative unregulated daily streamflows for a given month, the daily depletions for that given month were recalculated assuming a pattern similar to the daily streamflow hydrograph. After that recalculation, unregulated daily streamflows for a few days in October remained negative for some years; in those cases, all negative unregulated streamflows were set to zero. The intermediate step of redistributing depletions based on the daily streamflow hydrograph to decrease the number of negative unregulated streamflow values was applied to the Tongue and Powder streamflows because (1) negative streamflows occurred for more days for the Tongue and Powder Rivers than for the Yellowstone River, and (2) consistency with the USACE approach was not as critical for the Tongue and Powder Rivers because the USACE did not calculate streamflow statistics for the Tongue and Powder Rivers.

Tongue River Reservoir Depletion Estimates

The Tongue River just below the Tongue River Dam has a drainage area of 1,770 mi^2, which is about 33 percent of the Tongue River Subbasin as measured at the Tongue River at Miles City, Mont. streamflow-gaging station (06308500; U.S. Geological Survey, 2010). The Tongue River Dam was constructed in 1940 and has an active storage capacity at the spillway crest of 79,071 acre-ft (Montana Department of Natural Resources and Conservation, 2004). Most of the stored water is released into the Tongue River for irrigation downstream to the confluence of the Tongue and Yellowstone Rivers at Miles City (Montana Department of Natural Resources and Conservation, 2004). Overall effects of the Tongue River reservoir and other small (less than 200,000 acre-ft) reservoirs were included in the “Other Depletions” category in the Reclamation depletion estimates (U.S. Department of the Interior Bureau of Reclamation, 1999) in a general manner that, according to Reclamation (U.S. Department of the Interior Bureau of Reclamation, 1999), likely accounted only for reservoir evaporation. The “Other Depletions” category also included conservation tillage practices, farm ponds, and livestock, municipal, energy, industrial, and rural-domestic uses. “Other Depletions” for node basins in a large part of the Missouri River Basin (that is, the approximately 280,000 mi^2 upstream from Gavins Point Dam on the South Dakota–Nebraska border and including the Tongue River Subbasin) were roughly estimated to be 7 percent of the annual irrigation depletions in the respective node basins. Because of the general manner used to estimate overall small-reservoir depletions, Reclamation “Other Depletions” estimates were examined closely to determine whether such estimates accounted adequately for Tongue River Reservoir depletions to meet the objectives of this study.

Depletions for the Tongue River Reservoir were calculated by the USGS by subtracting reservoir outflows, as measured at the streamflow-gaging station at the Tongue River at Tongue River Dam, near Decker, Mont., (06307500), from reservoir inflows (as measured at the streamflow-gaging station at the Tongue River at State line, near Decker, Mont. 06306300) for the period 1960–2002, when data from both gages were available (table 1). The mean annual calculated reservoir depletion for 1960–2002 was 30 acre-ft, which is substantially smaller than the mean annual total depletions for the Tongue River Subbasin (5,500 acre-ft) and the mean annual total depletions for the Yellowstone River Basin upstream from Miles City (7,482,000 acre-ft) that were estimated by Reclamation for the same period (U.S. Department of the Interior Bureau of Reclamation, 1999). Also, the calculated mean monthly depletions for the Tongue River Reservoir (this study) are small compared to the mean monthly total depletions for the Yellowstone River Basin at Miles City that were estimated by Reclamation. The ratio of the mean monthly depletions for the Tongue River Reservoir (this study) to the mean monthly total depletions for the Yellowstone River Basin at Miles City that were estimated by Reclamation is 5 percent or less for every month except March (which was 14 percent).

Calculated reservoir depletions were compared to Reclamation “Other Depletions” estimates (U.S. Department of the Interior, Bureau of Reclamation, 1999), and differences were apparent (fig. 3). In May and June, the calculated mean monthly reservoir depletions were 82 and 75 percent (respectively) greater than the Reclamation “Other Depletions” estimates. In July, August, and September, the calculated mean monthly reservoir depletions were negative (indicating reservoir outflows were greater than reservoir inflows) and 130, 110, and 110 percent (respectively) less than the Reclamation “Other Depletions” estimates, which were slightly positive.

The effect of such differences between the calculated reservoir depletions and Reclamation “Other Depletions” estimates on determinations of the unregulated streamflows for the Tongue River at Miles City was examined. Mean monthly unregulated streamflows for Tongue River at Miles City were determined by two methods: (1) adding the calculated reservoir depletions to Reclamation “Other Depletions” estimates; and (2) using the Reclamation “Other Depletions” estimates alone. Differences between unregulated streamflows for Tongue River at Miles City determined using methods 1 and 2 generally were small (fig. 4). Generally the largest differences occur in May and August. In May, the Reclamation estimates (method 2) result in higher mean monthly streamflows for a difference between the two methods of +214 ft^3/s, or 17 percent. In August, Reclamation estimates (method 2) result in lower mean monthly streamflow for a difference

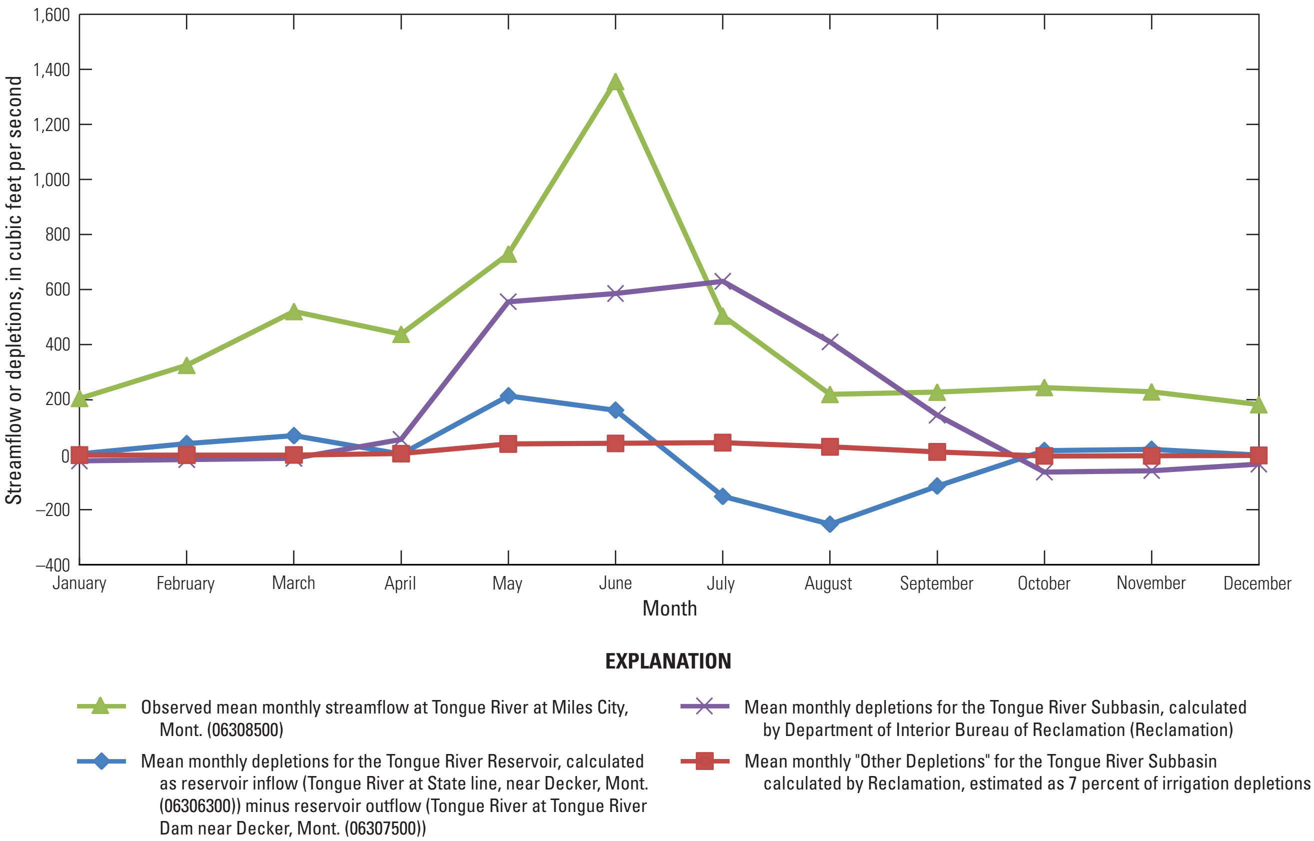


Figure 3. Mean monthly observed streamflow at Tongue River at Miles City, Mont. (streamflow-gaging station 06308500) and mean monthly depletion estimates, 1960–2002.

between the two methods of –253 ft^3/s, or –40 percent. To provide a perspective on the effect of these differences on Yellowstone River main-stem streamflows (the primary focus of the CES), 214 ft^3/s is about 1 percent of the May mean monthly streamflow (17,200 ft^3/s), and 253 ft^3/s is about 3 percent of the August mean monthly streamflow (7,970 ft^3/s) for the Yellowstone River at Miles City, based on observed streamflow records from 1922 to 2010 (U.S. Geological Survey, 2010).

The Reclamation "Other Depletions" estimates (with no additional accounting for Tongue River Reservoir depletions) were determined the most suitable for estimating unregulated and regulated streamflows at Tongue River at Miles City based on the following factors: (1) adding the calculated Tongue River Reservoir depletions to the Reclamation "Other Depletions" estimates for the period 1960–2002 did not have a substantial effect on estimated unregulated streamflows at Tongue River at Miles City (fig. 4) for most months; (2) because reservoir inflow data for 1939–59 are not available, reservoir depletions for that period would have to be estimated by using reservoir models, reservoir storage data, and/or other procedures; (3) incorporating the reservoir depletions into the regulated streamflow calculations would entail using 2002-level depletions by assuming 2002 reservoir operating procedures and historical-climatic data; (4) calculated mean annual reservoir depletions for 1960–2002 were very small compared to Reclamation total depletions estimates for the Tongue River Subbasin and the Yellowstone River Basin upstream from Miles City; and (5) the Tongue River Subbasin is not specifically part of the CES.

Peak-Flow Frequency Analysis

Procedures described in Bulletin 17B, "Guidelines for Determining Flood Flow Frequency" (U.S. Interagency Advisory Council on Water Data, 1982; hereinafter referred to as Bulletin 17B), were used for developing peak-flow frequency data for unregulated and regulated flows. Annual instantaneous peak flows for the unregulated and regulated datasets were estimated for each year by multiplying the estimated annual maximum daily streamflows for both streamflow conditions by the ratios of annual instantaneous peak flow to annual maximum daily streamflow computed from observed records. For periods of missing records for a given streamflow-gaging station, the annual maximum daily streamflows were multiplied by the ratios of annual instantaneous peak flow to annual maximum daily streamflow for nearby streamflow-gaging stations that were hydrologically similar. The computer program HEC-SSP (U.S. Army Corps of Engineers, 2009b) was used to calculate the frequency analysis by using standard Bulletin 17B default procedures for fitting the log-Pearson III

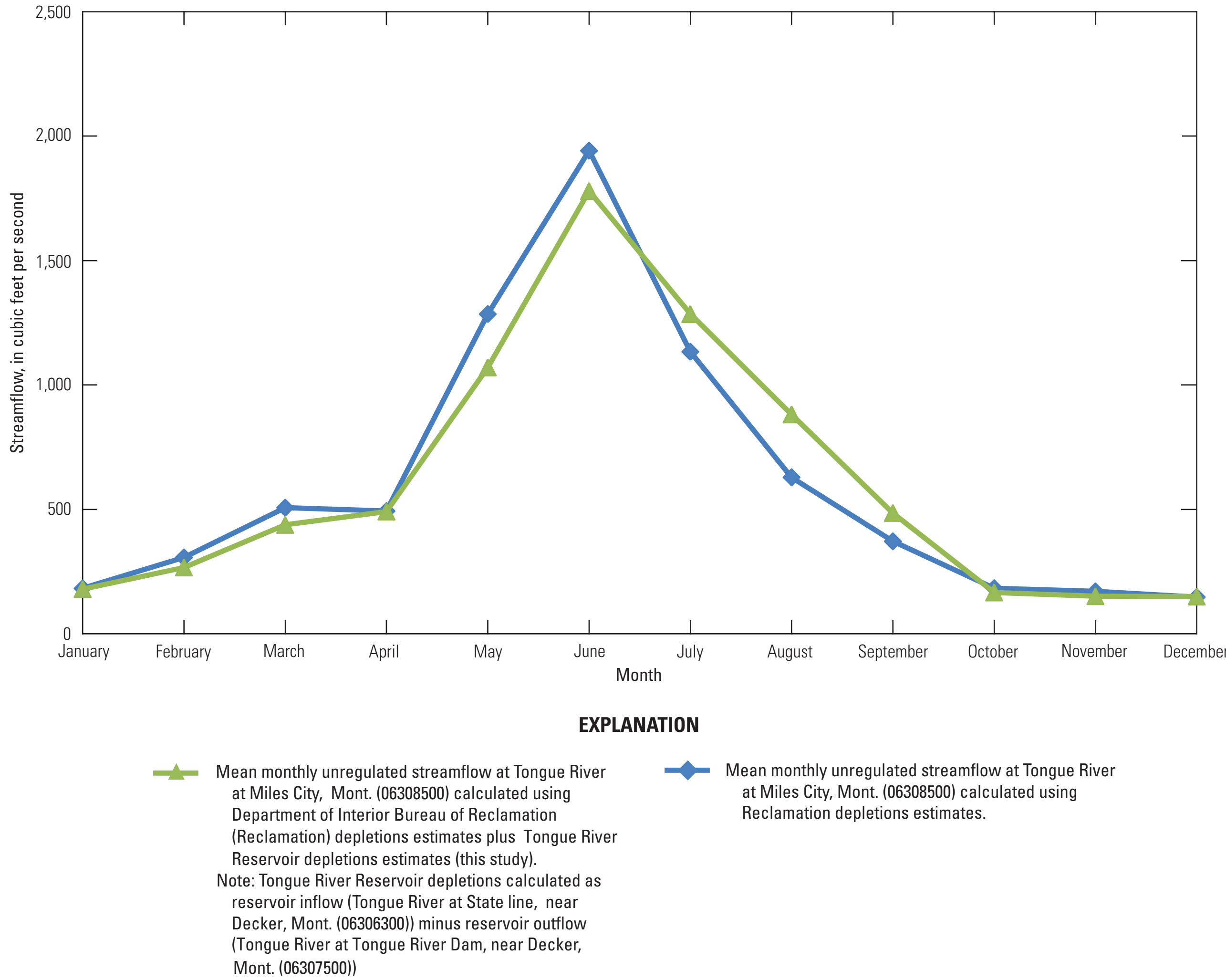


Figure 4. Mean monthly unregulated streamflows at Tongue River at Miles City, Mont. (streamflow-gaging station 06308500), 1960–2002.

distribution to the estimated unregulated and regulated annual instantaneous peak flows. Peak-flow frequency data were developed for recurrence intervals of 1.5, 2, 5, 10, 25, 50, 100, 200, and 500 years. Peak-flow data for the 200- and 500-year recurrence intervals are included in this study, as is done in many other peak-flow frequency studies (for example, Sando and others, 2008; Parrett and Johnson, 2004), because they are necessary for flood-plain mapping.

As recommended in Bulletin 17B (U.S. Interagency Advisory Council on Water Data, 1982), procedures for calculating the skew coefficient and for accounting for low outliers were applied for this study. A weighted skew coefficient was calculated by using the skew of the log series of the systematic record (commonly termed the "station skew") and a generalized skew coefficient. The generalized skew coefficient was determined by using the nationwide generalized skew map (presented in Bulletin 17B, plate 1) as discussed in Parrett and Johnson (2004). The station skew coefficient was weighted based on systematic record length, and the generalized skew coefficient was weighted based on a mean-square error of 0.64 when applying the nationwide generalized skew map in Montana (Parrett and Johnson, 2004). Procedures from Bulletin 17B were used for determining low-outlier thresholds based on the mean and standard deviation of the log series of peak flows as described by Grubbs and Beck (1972).

Effects of ice-jam releases were not accounted for in the peak-flow frequency analysis. This approach is consistent with recommendations in a hydrology study for the Yellowstone and Tongue Rivers at Miles City by the U.S. Army Corps of Engineers (2007). The USACE estimated peak-flow frequencies for an "ice-affected season" (January 1–April 15) and for an "open-water-affected season" (April 16–January 1) and then combined the two curves in a "combined discharge-frequency analysis." Next, the combined discharge-frequency analyses were compared with the "all-seasons" discharge-frequency analyses. Finally, the all-seasons discharge frequency analyses were recommended because the resulting flood-frequency data most closely matched observed historical streamflow data. In addition, the flood-frequency data from the combined analyses were similar to the flood-frequency data from the all-seasons analyses. For this study, the USGS conducted a similar analysis for the Yellowstone River at Sidney. A single frequency curve adequately represented all of the peak flows; therefore separate analyses for ice-affected seasons were not necessary.

High-Flow Frequency Analysis

Annual *n*-day high-flow frequency data were developed from annual series of the highest daily streamflows for specified *n*-day consecutive periods within the calendar year. For example, an annual series of 3-day high flows consists of the highest mean flow that occurs over any 3-day consecutive period during each year of record (McCarthy, 2004).

The computer program HEC-SSP (U.S. Army Corps of Engineers, 2009b) was used to calculate high-flow frequency relationships for the *n*-day datasets for the unregulated and regulated streamflow conditions. The log-Pearson III distribution along with the station skew was used to estimate high-flow frequency data for consecutive periods of 1, 3, 7, 15, 30, 60, 90, 120, and 183 days for recurrence intervals of 2, 5, 10, 25, 50, and 100 years. The 200- and 500-year high-flow frequency data were not estimated because the study period includes only 75 years of data, and USGS guidelines recommend limiting analyses to twice the period of record (Parrett, 1997; Walter Hofmann, U.S. Geological Survey, written commun., 1973), except where peak-flow data are necessary for flood insurance studies, as noted in the “Peak-Flow Frequency Analysis” section.

Low-Flow Frequency Analysis

Annual *n*-day low-flow frequency data were developed from an annual series of the lowest daily streamflows for *n*-day consecutive periods within each climatic year, from April 1–March 31 (Riggs, 1972, reprinted 1982). For example, an annual series of 7-day low flows consists of the lowest mean flow that occurred over any 7-day consecutive period during each year of record. In addition, seasonal low-flow frequency data were developed from the annual series of the lowest daily streamflows for 7-day and 30-day consecutive periods for the winter (January–March), spring (April–June), summer (July–September), and fall (October–December) seasons, and monthly low-flow frequency data were developed from the annual series of the lowest daily streamflows for 7-day consecutive periods for each month.

The computer program HEC-SSP (U.S. Army Corps of Engineers, 2009b) was used to calculate the low-flow frequency relationships for *n*-day datasets for unregulated and regulated streamflow conditions. The log-Pearson III distribution was applied (in a manner similar to the analysis described in the “High-Flow Frequency Analysis” section) to estimate low-flow frequency data for consecutive periods of 7 and 30 days for recurrence intervals of 2, 5, 10, 25, 50, and 100 years. Non-exceedance probabilities were calculated using only non-zero flows, and then a conditional adjustment probability was used to refine the non-exceedance probability for the zero flows in the record. If the log-Pearson III distribution did not fit the data, then a Pearson III distribution was applied. If neither the log-Pearson III nor the Pearson III distribution fit the data, then a graphical curve was fit through the data.

Flow-Duration Analysis

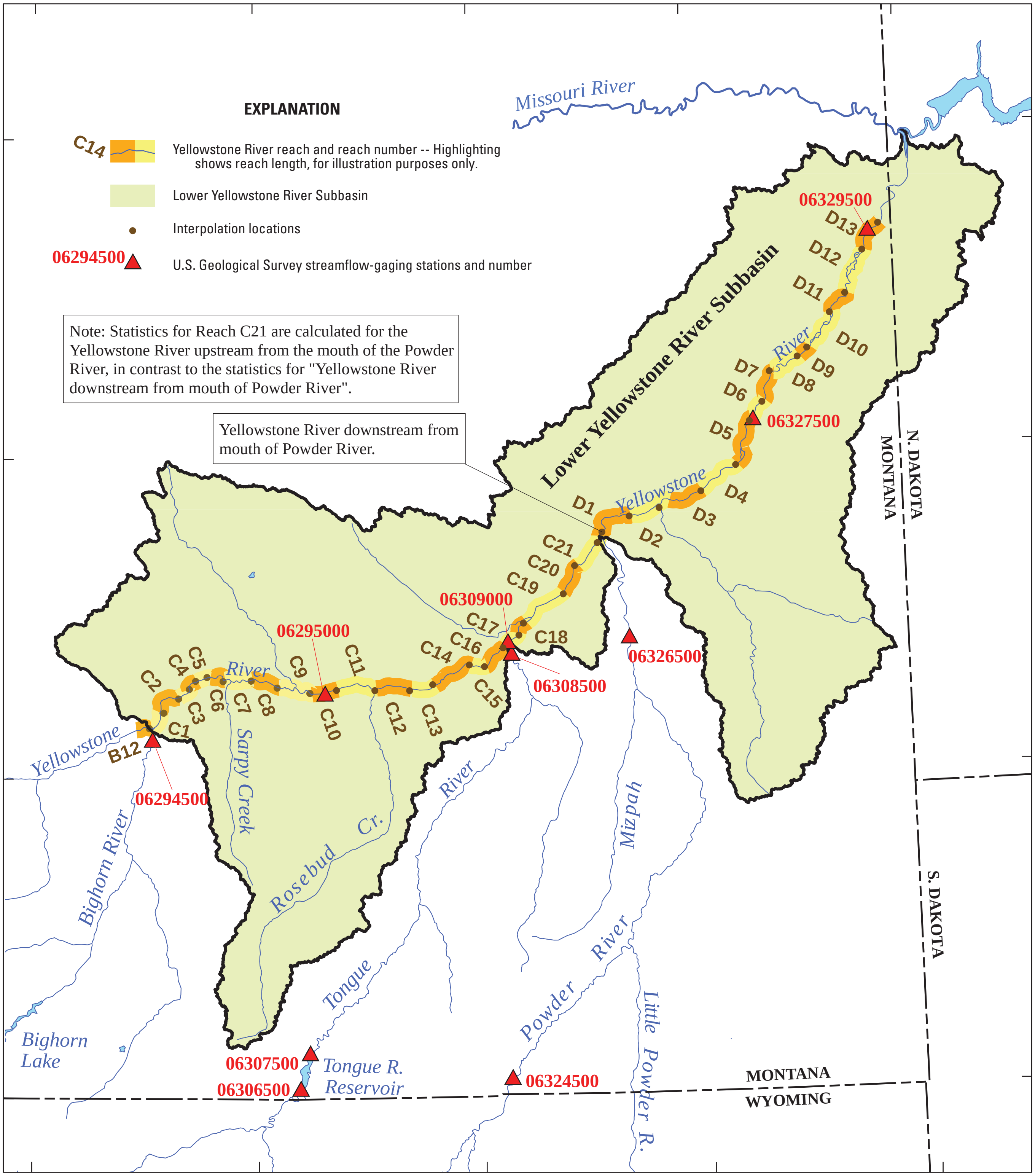
Annual and seasonal flow-duration data were developed for unregulated and regulated streamflow conditions using the computer program HEC-DSSvue (U.S. Army Corps of Engineers, 2009a) for the Tongue River. As the analyses progressed, version 2.0 of HEC-SSP was released, which included the capability to calculate flow-duration data, so the computer program HEC-SSP, version 2.0, (U.S. Army Corps of Engineers, 2010) was used to calculate flow-duration data for the Yellowstone and Powder Rivers. The flow-duration calculation routines in HEC-DSSvue and HEC-SSP produce identical results. The flow-duration characteristic is defined as a daily streamflow that has been equaled or exceeded a specific percentage of days during the period of record. Flow-duration data were developed from daily streamflows over the entire period of record; those data, however, are not related to the sequence of flow events. For example, the streamflow value on a flow-duration table that corresponds to a 10-percent exceedance is the value that was exceeded by 10 percent of the flow record without regard to when those days of exceedance occurred. The days of exceedance might not have been consecutive and might have occurred either in a single year or during several years (McCarthy, 2004; Ludwig, 1992).

Monthly and Annual Streamflow Characteristics

Maxima, minima, and mean monthly and annual streamflows were calculated using HEC-DSSvue (U.S. Army Corps of Engineers, 2009a). The standard deviation of both the mean monthly streamflows and the mean annual streamflows also were calculated.

Interpolation of Streamflow Statistics for Selected Study Reaches

The Yellowstone River was divided into several study reaches for the cumulative-effects study (fig. 5). For study reaches C10, C17, D6, and D13, the statistics calculated at the streamflow-gaging stations that are located within each reach represent the study-reach statistics. For the rest of the selected study reaches downstream from the Yellowstone River/Bighorn River confluence, peak-flow frequency, high-flow frequency, low-flow frequency, and flow-duration statistics were interpolated linearly between streamflow-gaging stations (fig. 5). Monthly and annual streamflow characteristics are not reported for the selected study reaches because some of these statistics (including maximum and minimum values with associated months of occurrence) cannot be determined accurately by interpolation.



Base modified from U.S. Geological Survey Digital Line Graph (DLG), 1:2,000,000, 1973, Lambert Conformal Conic Projection
Standard parallels 45°00' and 49°00' central meridian –109°30'
North American Datum of 1983 (NAD 83).

0 25 50 MILES
0 25 50 KILOMETERS

Figure 5. Selected reaches along the Yellowstone River, Mont. (modified from Bryan Swindell, DTM Consulting, Inc., written commun., 2011).

Streamflow statistics for selected study reaches downstream from the Yellowstone River at Forsyth, Mont. streamflow-gaging station (06295000) were interpolated linearly on the basis of approximate drainage area at the downstream end of each study reach relative to the drainage areas of the bracketing streamflow-gaging stations. In many cases, changes in streamflow statistics between different locations on a river channel do not vary linearly with proportional changes in drainage area. In fact, at some locations a given streamflow statistic decreased between one streamflow-gaging station and the next downstream streamflow gaging station. In those locations, interpolation on the basis of drainage areas resulted in unrealistically large decreases in the streamflow statistic in reaches containing a large tributary (such as the Powder River). Because this study was largely focused on calculation of streamflow statistics at gaging stations, and because streamflow data to improve interpolation are unavailable, the interpolated data are presented with those unrealistic decreases.

Drainage areas were estimated using digital elevation models (cell size 689 square meters) provided by the USACE (Douglas J. Clemetson, Hydrology Section, U.S. Army Corps of Engineers, written commun., 2009). In some instances, the drainage areas estimated for the streamflow-gaging stations using the digital elevation models were different (by up to 1 percent of total contributing drainage area) than the drainage areas reported in U.S. Geological Survey (2010), probably due to differences in the resolution of the elevation data and methods used to delineate the drainage area boundaries.

Because study reach C21 includes the confluence of the Yellowstone and Powder Rivers, and because a streamflow-gaging station does not exist on the Yellowstone River just downstream from the Yellowstone/Powder River confluence, streamflow statistics also were interpolated for the additional location “Yellowstone River downstream from the mouth of the Powder River.” In addition to the statistics for the gaging stations included in this report, peak-flow data and the drainage area for reach B12, upstream from the Yellow-stone River/Bighorn River confluence, were included in U.S. Army Corps of Engineers (2011b). These data were used to interpolate streamflow statistics for study reaches C1-C9. High-flow frequency, low-flow frequency, and flow-duration statistics were not included in U.S. Army Corps of Engineers (2011b), therefore those statistics were not interpolated for reaches C1-C9.

Streamflow Statistics for Unregulated and Regulated Conditions for Selected Locations on the Yellowstone, Tongue, and Powder Rivers

Streamflow statistics for the period 1928–2002 were calculated for unregulated and regulated conditions using methods described in the preceding sections “Peak-Flow Frequency Analysis,” “High-Flow Frequency Analysis,” “Low-Flow Frequency Analysis,” “Flow-Duration Analysis,” and “Monthly and Annual Streamflow Characteristics” for four streamflow-gaging stations on the Yellowstone River, one streamflow gaging station on the Tongue River, and one streamflow-gaging station on the Powder River. In addition, peak-flow frequency data were interpolated for 31 locations between streamflow-gaging stations; and annual *n*-day high-flow frequency data, annual *n*-day low-flow frequency data, and annual and seasonal flow-duration data were interpolated for 22 locations on the Yellowstone River between streamflow gaging stations.

Streamflow statistics for the six streamflow-gaging stations are presented in tables and figures contained in appendix 2. The tables and graphs summarize annual *n*-day high-flow frequency data; annual, seasonal and monthly *n*-day low-flow frequency data; annual and seasonal flow-duration data; and maxima, minima, and mean monthly and annual streamflow data. Instantaneous peak-flow data for each of these stations also are presented in table 4.

Interpolated streamflow statistics for the Yellowstone River are presented in Excel spreadsheets (appendixes 3–6). Interpolated annual instantaneous peak-flow data for 31 locations between streamflow-gaging stations, as well as for reach B12, upstream from the Yellowstone River/Bighorn River confluence (fig. 5; calculated by the U.S. Army Corps of Engineers, 2011b) and the four streamflow-gaging stations on the Yellowstone River, are presented in appendix 3. Interpolated annual *n*-day high-flow frequency data for 22 locations between streamflow-gaging stations, as well as calculated data for the four streamflow-gaging stations, are presented in appendix 4. Interpolated annual *n*-day low-flow frequency data for 22 locations between streamflow-gaging stations, as well as calculated data for the four streamflow-gaging stations, are presented in appendix 5. Interpolated annual and seasonal flow-duration data for 22 locations between streamflow-gaging stations, as well as calculated data for the four streamflow-gaging stations, are presented in appendix 6.

Table 4. Annual instantaneous peak-flow data for selected streamflow-gaging stations on the Yellowstone, Tongue, and Powder Rivers, Montana, for unregulated and regulated streamflow conditions, 1928–2002.

[Abbreviations: ft³/s, cubic feet per second. Symbol: %, percent]

Station number	Station name	Streamflow condition	Annual instantaneous peak flow, in ft³/s, for: recurrence interval, in years , and annual exceedance probability, in percent								
			1.5 67%	2 50%	5 20%	10 10%	25 4%	50 2%	100 1%	200 0.5%	500 0.2%
06295000	Yellowstone River at Forsyth, Mont.[1]	Unregulated	54,700	61,300	77,300	87,900	101,000	111,000	121,000	131,000	145,000
		Regulated	41,100	46,900	61,300	70,700	82,700	91,600	101,000	110,000	122,000
06309000	Yellowstone River at Miles City, Mont.[1]	Unregulated	56,700	63,400	78,900	88,600	100,000	109,000	117,000	125,000	136,000
		Regulated	41,700	48,200	62,700	71,300	81,200	88,000	94,400	100,000	108,000
06327500	Yellowstone River at Glendive, Mont.[1]	Unregulated	61,300	69,400	89,400	103,000	120,000	133,000	146,000	159,000	177,000
		Regulated	46,000	54,200	74,000	86,800	103,000	114,000	125,000	136,000	151,000
06329500	Yellowstone River near Sidney, Mont.[1]	Unregulated	61,400	69,900	90,500	104,000	120,000	132,000	143,000	155,000	170,000
		Regulated	46,000	54,300	75,100	89,100	107,000	120,000	134,000	147,000	166,000
06308500	Tongue River at Miles City, Mont.	Unregulated	3,260	4,140	6,740	8,790	11,800	14,200	17,000	20,000	24,400
		Regulated	2,860	3,760	6,410	8,480	11,400	13,900	16,500	19,400	23,500
06326500	Powder River near Locate, Mont.[2]	Unregulated	5,030	7,390	14,600	20,200	27,900	33,800	39,900	46,100	54,400
		Regulated	4,650	6,990	14,300	20,100	27,900	34,000	40,300	46,700	55,200

[1]Peak flows decrease in the downstream direction between stations 06295000 and 06309000 and between stations 06327500 and 06329500 for lower annual exceedance-probability flows. The decrease is relatively small and probably is within the error of the frequency analysis. A decrease in peak flows in the downstream direction could be due to attenuation of these larger peak flows. A similar decrease in peak flows between station numbers 06295000 and 06309000 is reported in Parrett and Johnson (2004, table 2).

[2]In general, regulated streamflows should not be higher than unregulated streamflows for the 0.2-, 0.5-, 1-, and 2-percent annual exceedance-probability flows. The regulated flows for the Powder River near Locate, Mont., are less than about 1 percent higher than unregulated streamflows for these exceedance probability flows; this discrepancy is well within the error of the statistical analyses.

Summary

The Yellowstone River is one of the longest free-flowing rivers in the lower 48 States. The river supports a wide variety of agricultural, domestic, industrial, and recreational uses, and in some areas of Montana, is a blue-ribbon trout stream. Major floods in 1996 and 1997 intensified public debate over the effects of human activities on the Yellowstone River. In 1999, the Yellowstone River Conservation District Council (YRCDC) was formed to address conservation issues on the river. The YRCDC partnered with the U.S. Army Corps of Engineers (USACE) to conduct a cumulative-effects study (CES) on the main stem of the Yellowstone River. The CES is intended to provide a basis for future management decisions in the watershed. Streamflow statistics, such as flow-frequency and flow-duration data calculated for unregulated and regulated streamflow conditions, are necessary for many aspects of that cumulative-effects study.

The U.S. Geological Survey, in cooperation with the YRCDC and the USACE, calculated streamflow statistics for unregulated and regulated streamflow conditions for the Yellowstone, Tongue and Powder Rivers for the 1928–2002 study period (calendar year). These statistics include basic summary statistics and flow-frequency data, and flow-duration data for two streamflow conditions: “unregulated,” where effects of streamflow regulation and water use have been removed, and “regulated,” where streamflows are adjusted to represent near-present-day (based on 2002 data) levels of development.

Missing daily streamflows for ungaged periods were synthesized to develop a complete set of daily streamflow data for all of the streamflow-gaging stations for the 1928–2002 study period. Monthly mean streamflows for periods of missing records were synthesized using the Maintenance of Variance Extension, Type 1 (MOVE.1) curve-fitting procedure. Daily mean streamflows were synthesized by distributing monthly mean streamflows to daily mean streamflows by using ratios of daily mean to monthly mean streamflows developed from appropriate index stations.

Unregulated and regulated daily streamflows were estimated from the observed and synthesized daily streamflows and Bureau of Reclamation depletions data, and then statistical summaries were calculated for the unregulated and regulated daily streamflow datasets. Unregulated streamflows were estimated by adding historical depletions to the observed streamflows (or to synthesized streamflows for periods of missing records). Regulated streamflows were estimated by subtracting the 2002-level depletions from the unregulated streamflows. Peak-flow frequency estimates for unregulated and regulated streamflow conditions were developed using methods described in the U.S. Interagency Advisory Council on Water Data Bulletin 17B. High-flow frequency and low-flow frequency data were developed from the respective annual series of highest and lowest mean flows for specified *n*-day consecutive periods within the calendar year, for unregulated and regulated conditions. Flow-duration data and monthly and annual streamflow characteristics also were calculated for unregulated and regulated streamflows and are presented in tabular and graphic form in this report.

References Cited

Alley, W.M., and Burns, A.W., 1983, Mixed station extension of monthly streamflow records: Journal of Hydraulic Engineering, American Society of Civil Engineers, v. 109, no. 10, p. 1,272–1,284.

Cary, L.E., and Parrett, Charles, 1996, Synthesis of natural flows at selected sites in the upper Missouri River basin, Montana, 1928–89: U.S. Geological Survey Water-Resources Investigations Report 95–1461, 109 p.

Grubbs, F.E., and Beck, Glenn, 1972, Extension of sample sizes and percentage points for significance tests of outlying observations: Technometrics, v. 14, no. 4, p. 847–854.

Helsel, D.R., and Hirsch, R.M., 2002, Statistical methods in water resources: Techniques of Water-Resources Investigations of the U.S. Geological Survey, book 4, chapter A3, 522 pages.

Hirsch, R.M., 1982, A comparison of four streamflow record extension techniques: Water Resources Research, v. 18, no. 4, p. 1,081–1,088.

Hirsch, R.M., Helsel, D.R., Cohn, T.A., and Gilroy, E.J., 1993, Statistical analysis of hydrologic data, *in* Maidment, D. R., Handbook of Hydrology: San Francisco, Calif., McGraw Hill, Inc., p. 17.1–17.55.

Jean, C., and Crispin, S., 2001, Inventory of important biological resources in the Upper Yellowstone River Watershed: Report to the Environmental Protection Agency, Montana Natural Heritage Program, Helena Montana, 26 p., plus appendixes.

Ludwig, A.H., 1992, Flow duration and low-flow characteristics of selected Arkansas streams: U.S. Geological Survey Water-Resources Investigations Report 92–4026, 57 p.

McCarthy, P.M., 2004, Statistical summaries of streamflow in Montana and adjacent areas, water years 1900 through 2002: U.S. Geological Survey Scientific Investigations Report 2004–5266, 317 p.

Montana Department of Natural Resources and Conservation, 2004, Tongue River dam manual for operation and maintenance: Helena, Mont., State Water Projects Bureau, Water Resources Division, Montana Department of Natural Resources and Conservation, P.O. Box 210601, Helena, MT 59620, variously paginated.

National Oceanic and Atmospheric Administration, 2002, Monthly station normals of temperature, precipitation, and heating and cooling degree days 1971–2000, Montana: Asheville, N.C., National Environmental Satellite, Data, and Information Service, National Climatic Data Center, Climatography of the United States, no. 81, 51 p., accessed May 10, 2011, at *http://hurricane.ncdc.noaa.gov/climatenormals/clim81/MTnorm.pdf*.

Parrett, Charles, 1997, Regional analyses of annual precipitation maxima in Montana: U.S. Geological Survey Water-Resources Investigations Report 97–4004, 51 p.

Parrett, Charles, and Johnson, D.R., 2004, Methods for estimating flood frequency in Montana based on data through water year 1998: U.S. Geological Survey Water-Resources Investigations Report 03–4308, 101 p.

Riggs, H.C., 1972 [reprinted 1982], Low-flow investigations: Techniques of Water-Resources Investigations of the United States Geological Survey, book 4, chap. B1, 18 p.

Robb, A.D., 1944, Climatological data, Montana section, year 1944: Helena, Mont., U.S. Department of Commerce, Weather Bureau, v. XLVII, 8 p.

Sando, S.K., Driscoll, D.G., and Parrett, Charles, 2008, Peak-flow frequency estimates based on data through water year 2011 for selected streamflow-gaging stations in South Dakota: U.S. Geological Survey Scientific Investigations Report 2008–5104, 42 p. [with online only appendixes and tables]. Also available online at *http://pubs.usgs.gov/sir/2008/5104/*.

U.S. Army Corps of Engineers, 2007, Miles City, Mont., hydrologic analysis: Omaha, Neb., U.S. Army Corps of Engineers Omaha District, 28 p., [revised 2007].

U.S. Army Corps of Engineers, 2009a, Hydrologic Engineering Center data storage system HEC-DSSVue visual utility engine user's manual: Davis, Calif., U.S. Army Corps of Engineers Hydrologic Engineering Center, 490 p.

U.S. Army Corps of Engineers, 2009b, Hydrologic Engineering Center statistical software package HEC-SSP, version 1.1: Davis, Calif., U.S. Army Corps of Engineers Hydrologic Engineering Center, 214 p.

U.S. Army Corps of Engineers, 2010, Hydrologic Engineering Center statistical software package HEC-SSP, version 2.0: Davis, Calif., U.S. Army Corps of Engineers Hydrologic Engineering Center, 313 p.

U.S. Army Corps of Engineers, 2011a, Yellowstone River corridor study, Lower Bighorn River hydrology: Omaha, Nebraska, U.S. Army Corps of Engineers Engineering Division, Hydrologic Engineering Branch, Hydrology Section, Final Report, 22 p.

U.S. Army Corps of Engineers, 2011b, Yellowstone River corridor study, Upper Yellowstone River hydrology: Omaha, Nebraska, U.S. Army Corps of Engineers Engineering Division, Hydrologic Engineering Branch, Hydrology Section, Final Report, 63 p.

U.S. Department of the Interior, Bureau of Reclamation, 1999, A study to determine the historic and present-level streamflow depletions in the Missouri River basin above Hermann, Missouri,-Appendix F-C *of* Upper Mississippi River system flow frequency study: Billings, Mont., U.S. Department of the Interior, Bureau of Reclamation, Water Resources Service Group, Great Plains Regional Office, variously paged.

U.S. Department of the Interior, Bureau of Reclamation, 2005, A study to determine the historic and present-level streamflow depletions in the Missouri River basin for the period 1929 to 2002: Billings, Mont., U.S. Department of the Interior, Bureau of Reclamation, Water Resources Service Group, Great Plains Regional Office, variously paged.

U.S. Geological Survey, 2010, Water data for the Nation, surface water: U.S. Geological Survey database, accessed November 4, 2010, at *http://waterdata.usgs.gov*.

U.S. Interagency Advisory Council on Water Data, 1982, Guidelines for determining flood flow frequency—Bulletin 17B of the Hydrology Subcommittee: U.S. Geological Survey, Office of Water Data Coordination, 183 p.

Zelt, R.B., Boughton, G.K, Miller, K.A., Mason, J.P., and Gianakos, L.M., 1999, Environmental setting of the Yellowstone River basin, Montana, North Dakota, and Wyoming: U.S. Geological Survey Water-Resources Investigations Report 98–4269, 112 p.

Publishing support provided by:
Denver Publishing Service Center

For more information concerning this publication, contact:
Center Director, USGS Wyoming-Montana Water Science Center
3162 Bozeman Ave.
Helena, MT 59601
(406) 457-5900

Or visit the Montana Water Science Center Web site at:
http://mt.water.usgs.gov/

Appendixes

The Bureau of Reclamation depletions data (appendix 1), annual instantaneous peak-flow data at and between streamflow-gaging stations (appendix 3), annual *n*-day high-flow frequency data at and between streamflow-gaging stations (appendix 4), annual *n*-day low-flow frequency data at and between streamflow-gaging stations (appendix 5) and annual and seasonal flow-duration data at and between streamflow-gaging stations (appendix 6) are presented in Excel spreadsheets. Additionally, the streamflow statistics for selected streamflow-gaging stations (appendix 2) are included as part of this report.

Appendix 1. Depletion Data for the Yellowstone River Basin, Mont., and Wyo., 1928–2002

Appendix 1 contains historical and 2002-level depletion data from the Bureau of Reclamation (2005) for selected Bureau of Reclamation node basins. The excel file is named *sir2013-5173_APP_1_depletion.xlsx*. Locations of node basins are shown on figure 2 (main report).

Appendix 2. Statistics for Selected Streamflow-Gaging Stations on the Yellowstone, Tongue, and Powder Rivers, Mont., for Unregulated and Regulated Streamflow Conditions, 1928–2002

Appendix 2 contains tables and figures showing statistics for six selected streamflow-gaging stations. Locations of the streamflow-gaging stations are shown in figure 2 (main report).

Appendix 2–1. Statistics for Streamflow-Gaging Station 06295000 (Yellowstone River at Forsyth, Mont.)

Table 2-1-1. Annual *n*-day high-flow frequency data for streamflow-gaging station 06295000 (Yellowstone River at Forsyth, Mont.) for unregulated and regulated streamflow conditions, 1928–2002.

[Abbreviations: ft^3/s, cubic feet per second. Symbol: %, percent]

n, period of consecutive days	Streamflow, in ft^3/s, for indicated recurrence interval, in years, and exceedance probability, in percent						
	2 50%	5 20%	10 10%	20 5%	25 4%	50 2%	100 1%
Unregulated							
1	59,900	75,100	84,600	93,400	96,100	104,000	113,000
3	58,100	72,430	81,100	88,900	91,300	98,500	105,000
7	54,700	68,300	76,500	83,900	86,200	92,900	99,400
15	50,400	62,700	70,200	76,900	79,000	85,200	91,200
30	45,600	56,400	62,800	68,500	70,200	75,400	80,400
60	38,500	46,800	51,600	55,900	57,200	61,000	64,500
90	32,700	39,100	42,700	45,800	46,800	49,500	52,100
120	28,000	33,200	36,100	38,600	39,400	41,600	43,600
183	21,600	25,400	27,500	29,300	29,900	31,400	32,900
Regulated							
1	45,900	60,100	68,600	76,200	78,500	85,500	92,000
3	44,000	57,400	65,200	72,100	74,200	80,200	85,900
7	41,000	53,800	61,300	67,700	69,700	75,400	80,600
15	37,600	49,200	55,900	61,800	63,500	68,600	73,300
30	33,500	43,800	49,700	54,800	56,300	60,600	64,600
60	27,300	35,900	40,800	45,100	46,400	50,200	53,600
90	22,500	29,300	33,200	36,600	37,600	40,500	43,200
120	19,000	24,500	27,700	30,400	31,200	33,500	35,700
183	15,324	19,300	21,500	23,500	24,100	25,800	27,400

Table 2-1-2. Annual, seasonal, and monthly *n*-day low-flow frequency data for streamflow-gaging station 06295000 (Yellowstone River at Forsyth, Mont.) for unregulated and regulated streamflow conditions, 1928–2002.

[Abbreviations: ft³/s, cubic feet per second. Symbol: % percent]

n, period of consecutive days (month, for monthly frequency data)	Unregulated						
	Streamflow, in ft³/s, for indicated recurrence interval, in years, and exceedance probability, in percent						
	2 50%	5 20%	10 10%	20 5%	25 4%	50 2%	100 1%
Annual							
7	1,920	1,210	927	732	681	551	452
30	3,410	2,620	2,250	1,960	1,880	1,660	1,480
Winter (January–March)							
7	2,560	1,690	1,320	1,060	994	815	676
30	3,820	2,840	2,380	2,040	1,950	1,700	1,490
Spring (April–June)							
7	7,280	5,510	4,700	4,100	3,940	3,500	3,130
30	8,620	6,610	5,720	5,060	4,880	4,400	3,990
Summer (July–September)							
7	7,600	5,710	4,730	3,960	3,750	3,170	2,690
30	8,750	7,010	6,140	5,450	5,260	4,720	4,260
Fall (October–December)							
7	2,490	1,470	1,080	826	760	596	474
30	4,190	3,260	2,830	2,500	2,400	2,150	1,940
Monthly							
7 (January)	2,840	1,830	1,400	1,100	1,020	820	664
7 (February)	3,650	2,570	2,100	1,760	1,670	1,430	1,240
7 (March)	4,770	3,520	2,990	2,600	2,490	2,210	1,980
7 (April)	7,280	5,510	4,700	4,100	3,940	3,500	3,130
7 (May)	17,500	14,100	12,500	11,300	10,900	10,000	9,220
7 (June)	33,100	26,000	22,700	20,400	19,700	17,900	16,400
7 (July)	20,000	15,700	13,900	12,500	12,100	11,100	10,200
7 (August)	11,400	9,630	8,820	8,210	8,040	7,570	7,170
7 (September)	7,600	5,710	4,730	3,960	3,750	3,170	2,690
7 (October)	5,700	4,230	3,550	3,040	2,900	2,530	2,220
7 (November)	4,820	3,110	2,270	1,670	1,520	1,120	835
7 (December)	2,750	1,650	1,210	914	838	648	508

Table 2-1-2. Annual, seasonal, and monthly *n*-day low-flow frequency data for streamflow-gaging station 06295000 (Yellowstone River at Forsyth, Mont.) for unregulated and regulated streamflow conditions, 1928–2002.—Continued

[Abbreviations: ft^3/s, cubic feet per second. Symbol: % percent]

	Regulated						
n, period of consecutive days (month, for monthly frequency data)	Streamflow, in ft^3/s, for indicated recurrence interval, in years, and exceedance probability, in percent						
	2 50%	5 20%	10 10%	20 5%	25 4%	50 2%	100 1%
Annual							
7	3,350	2,650	2,340	2,110	2,050	1,880	1,740
30	4,480	3,550	3,090	2,730	2,630	2,360	2,130
Winter (January–March)							
7	3,900	3,100	2,750	2,480	2,405	2,207	2,041
30	5,000	4,050	3,610	3,270	3,180	2,920	2,710
Spring (April–June)							
7	5,400	4,040	3,460	3,040	2,920	2,620	2,370
30	6,620	4,980	4,280	3,770	3,640	3,270	2,970
Summer (July–September)							
7	5,130	3,660	3,020	2,560	2,440	2,110	1,840
30	5,890	4,160	3,420	2,890	2,740	2,360	2,060
Fall (October–December)							
7	4,050	3,040	2,630	2,330	2,250	2,036	1,863
30	5,550	4,490	3,970	3,570	3,460	3,140	2,880
Monthly							
7 (January)	4,240	3,320	2,910	2,600	2,510	2,275	2,080
7 (February)	4,820	3,750	3,270	2,900	2,800	2,530	2,300
7 (March)	5,630	4,370	3,820	3,410	3,310	3,010	2,760
7 (April)	5,410	4,050	3,470	3,050	2,930	2,630	2,380
7 (May)	8,730	6,260	5,200	4,440	4,230	3,690	3,240
7 (June)	22,700	15,900	13,000	10,900	10,400	8,900	7,730
7 (July)	10,700	6,550	4,980	3,950	3,680	3,010	2,500
7 (August)	5,500	3,790	3,110	2,630	2,510	2,180	1,920
7 (September)	5,570	4,000	3,320	2,820	2,690	2,340	2,050
7 (October)	6,780	5,220	4,480	3,910	3,750	3,320	2,960
7 (November)	6,180	4,580	3,790	3,190	3,020	2,570	2,200
7 (December)	4,270	3,230	2,780	2,450	2,360	2,130	1,930

Table 2-1-3. Annual and seasonal flow-duration data for streamflow-gaging station 06295000 (Yellowstone River at Forsyth, Mont.) for unregulated and regulated streamflow conditions, 1928–2002.

[Abbreviations: ft^3/s, cubic feet per second. Symbol: %, percent]

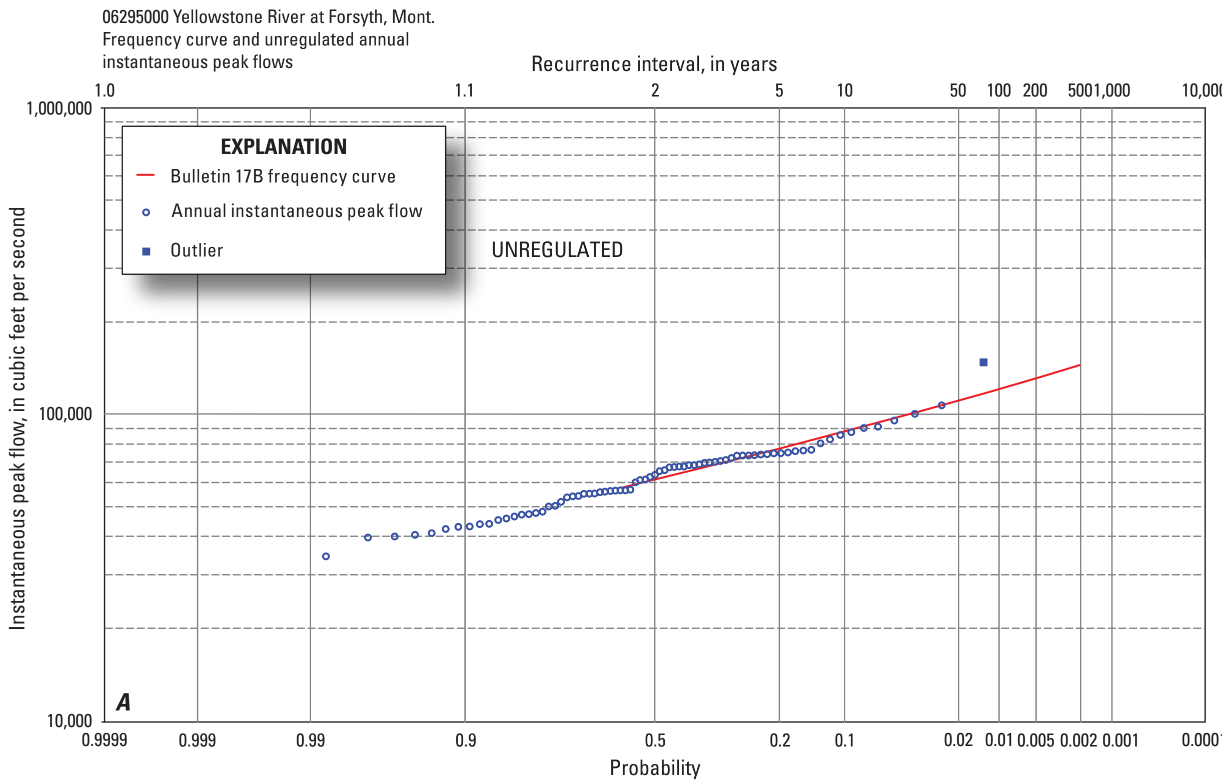
Streamflow condition	Streamflow, in ft^3/s, which was equaled or exceeded for indicated percent of time																		
	1%	2%	5%	10%	15%	20%	25%	30%	40%	50%	60%	70%	75%	80%	85%	90%	95%	98%	99%
	Annual																		
Unregulated	64,000	56,600	44,900	33,600	26,100	20,600	16,400	13,400	9,890	7,770	6,470	5,530	5,110	4,650	4,130	3,550	2,760	1,910	1,490
Regulated	50,100	43,800	33,800	24,200	17,300	13,200	11,000	9,770	8,220	7,280	6,520	5,820	5,430	5,040	4,630	4,200	3,580	2,900	2,540
	Winter (January–March)																		
Unregulated	19,000	15,100	11,400	8,700	7,680	7,040	6,490	6,100	5,370	4,850	4,410	3,930	3,660	3,360	3,010	2,620	1,990	1,540	1,250
Regulated	19,800	15,700	12,000	9,660	8,650	7,860	7,430	7,030	6,430	5,940	5,470	5,020	4,770	4,510	4,200	3,830	3,230	2,770	2,520
	Spring (April–June)																		
Unregulated	75,700	68,900	60,000	52,000	45,800	41,300	37,200	33,600	27,500	22,400	17,600	12,700	10,600	9,440	7,780	6,840	5,930	5,100	4,580
Regulated	61,100	54,500	46,500	39,600	34,300	30,200	26,700	23,400	17,600	13,600	10,800	8,180	7,310	6,430	5,810	5,080	4,330	3,760	3,430
	Summer (July–September)																		
Unregulated	60,200	52,100	42,100	33,600	28,000	24,100	20,900	18,500	15,200	13,200	11,500	10,100	9,490	8,910	8,320	7,530	6,150	5,230	4,510
Regulated	46,600	40,100	32,200	25,000	19,700	15,900	13,200	11,500	9,530	8,230	7,170	6,090	5,610	5,120	4,580	4,090	3,320	2,660	2,350
	Fall (October–December)																		
Unregulated	11,200	10,300	9,030	8,070	7,410	6,970	6,650	6,360	5,850	5,460	5,060	4,510	4,160	3,790	3,450	2,990	2,280	1,400	1,110
Regulated	12,100	11,400	10,400	9,400	8,910	8,450	8,040	7,720	7,240	6,800	6,340	5,790	5,420	5,030	4,650	4,200	3,590	2,830	2,520

Table 2-1-4. Monthly and annual streamflow characteristics for streamflow-gaging station 06295000 (Yellowstone River at Forsyth, Mont.) for unregulated and regulated streamflow conditions, 1928–2002.

[Abbreviations: ft³/s, cubic feet per second]

Period	Unregulated					
	Streamflow, in ft³/s, or year, for indicated streamflow characteristic					
	Maximum monthly mean and maximum annual mean streamflow	Year of maximum monthly mean and maximum annual mean streamflow	Minimum monthly mean and minimum annual mean streamflow	Year of minimum monthly mean and minimum annual mean streamflow	Mean monthly and mean annual streamflow	Standard deviation of mean monthly and mean annual streamflow
January	7,090	1983	1,570	1937	4,210	1,206
February	15,100	1971	1,850	1932	5,180	2,098
March	17,600	1929	2,850	2002	7,270	2,853
April	16,400	1943	3,410	1961	8,970	2,687
May	44,300	1928	13,660	1953	25,580	5,807
June	78,100	1997	20,389	1934	43,760	11,650
July	55,900	1975	12,101	1934	29,010	10,040
August	22,100	1997	8,120	1934	13,631	3,137
September	13,500	1968	4,010	1934	8,760	2,007
October	11,500	1941	2,860	2001	6,570	2,000
November	8,520	1982	2,900	1931	5,510	1,400
December	7,310	1982	2,240	1932	4,440	1,151
Annual	20,800	1997	8,750	2001	13,500	2,549

Period	Regulated					
	Streamflow, in ft³/s, or year, for indicated streamflow characteristic					
	Maximum monthly mean and maximum annual mean streamflow	Year of maximum monthly mean and maximum annual mean streamflow	Minimum monthly mean and minimum annual mean streamflow	Year of minimum monthly mean and minimum annual mean streamflow	Mean monthly and mean annual streamflow	Standard deviation of mean monthly and mean annual streamflow
January	8,340	1968	2,800	1937	5,520	1,210
February	15,600	1971	3,040	1932	6,220	2,020
March	18,600	1929	3,220	2002	8,010	2,820
April	13,300	1997	2,450	1961	7,070	2,360
May	35,300	1928	7,040	1961	16,300	4,970
June	64,100	1997	11,700	1934	32,200	10,600
July	43,700	1967	3,820	1934	19,400	9,720
August	17,800	1997	2,540	1934	7,910	3,450
September	13,400	1941	2,740	2001	6,960	2,380
October	12,800	1941	3,570	2001	7,620	2,050
November	10,600	1982	4,030	1934	7,020	1,610
December	8,970	1982	3,430	1934	5,850	1,220
Annual	18,200	1997	5,680	1934	10,800	2,720



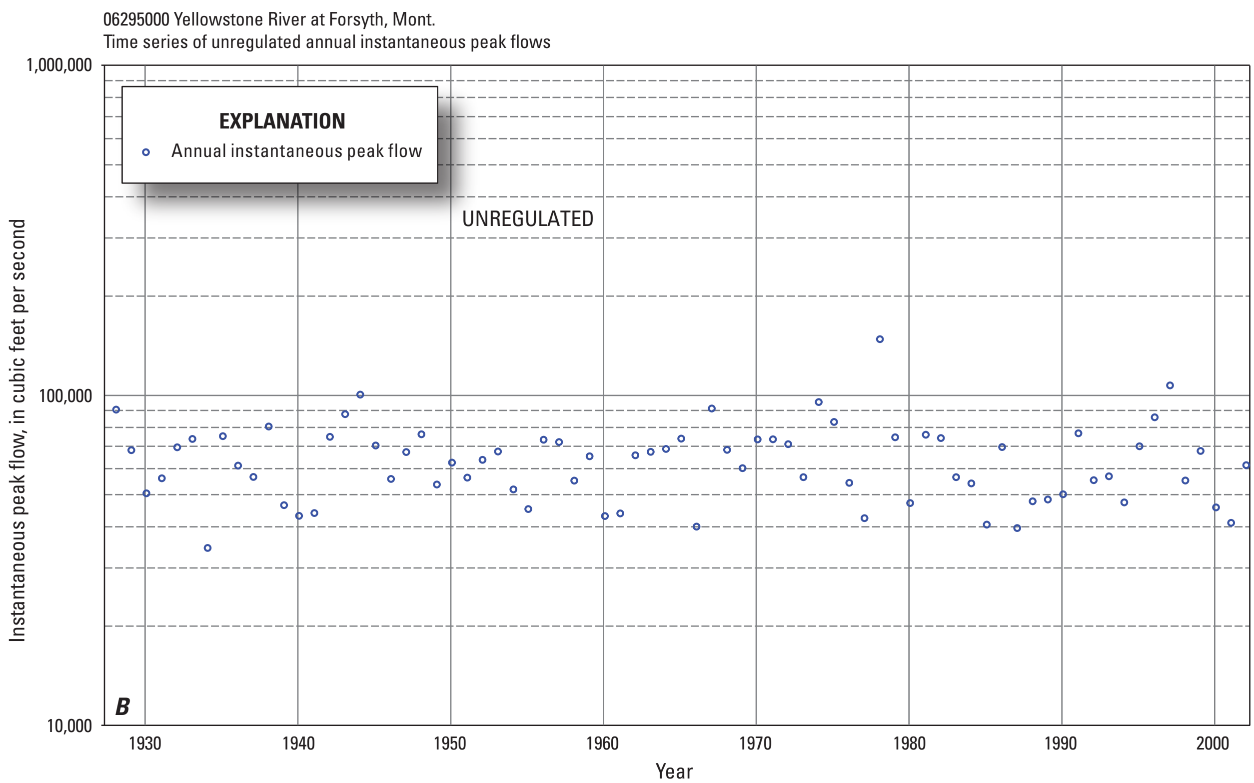
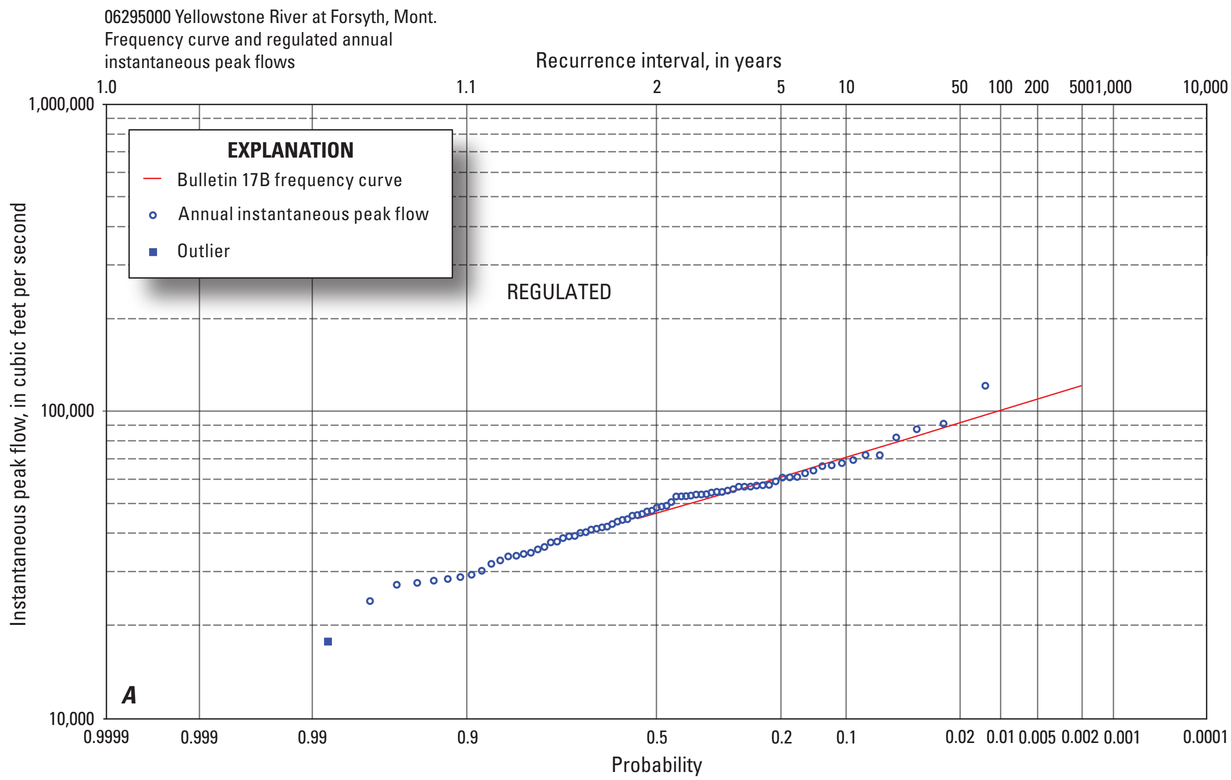


Figure 2-1-1. Annual instantaneous peak-flow data for streamflow-gaging station 06295000 (Yellowstone River at Forsyth, Mont.) for unregulated streamflow conditions, 1928–2002. *A*, Frequency curve and unregulated annual instantaneous peak flows. *B*, Time series of unregulated annual instantaneous peak flows. [Bulletin 17B: U.S. Interagency Advisory Council on Water Data, 1982]



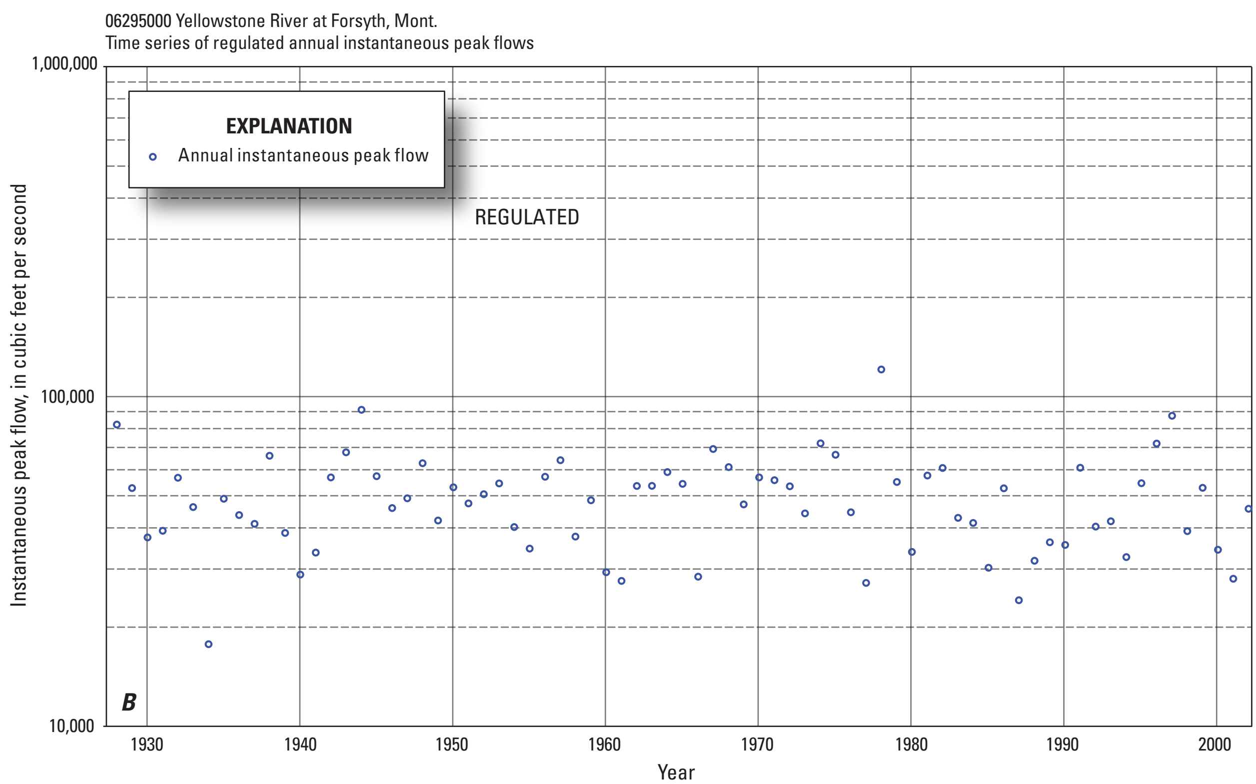


Figure 2-1-2. Annual instantaneous peak-flow data for streamflow-gaging station 06295000 (Yellowstone River at Forsyth, Mont.) for regulated streamflow conditions, 1928–2002. *A*, Frequency curve and regulated annual instantaneous peak flows. *B*, Time series of regulated annual instantaneous peak flows. [Bulletin 17B: U.S. Interagency Advisory Council on Water Data, 1982]

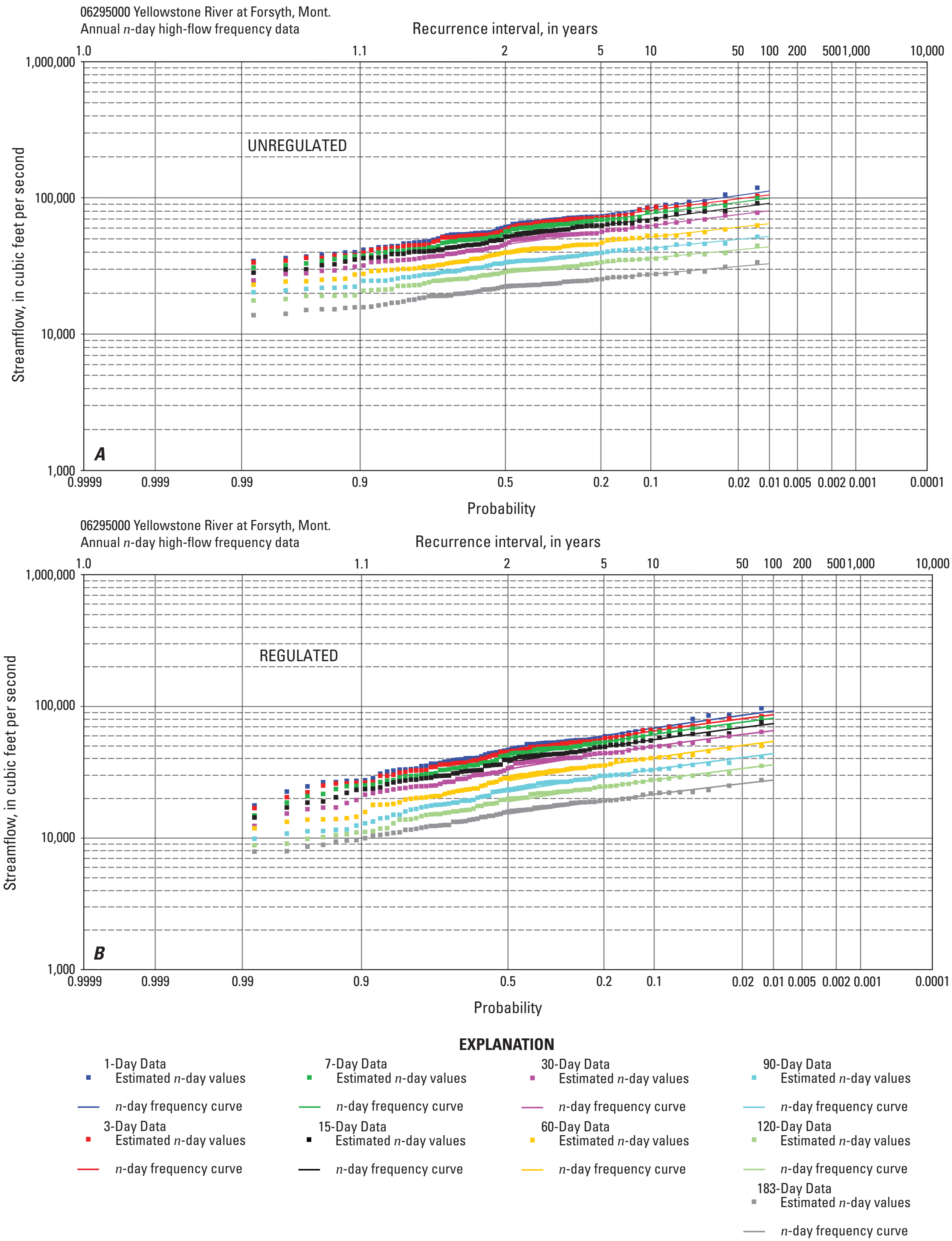


Figure 2-1-3. Annual *n*-day high-flow frequency data for streamflow-gaging station 06295000 (Yellowstone River at Forsyth, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

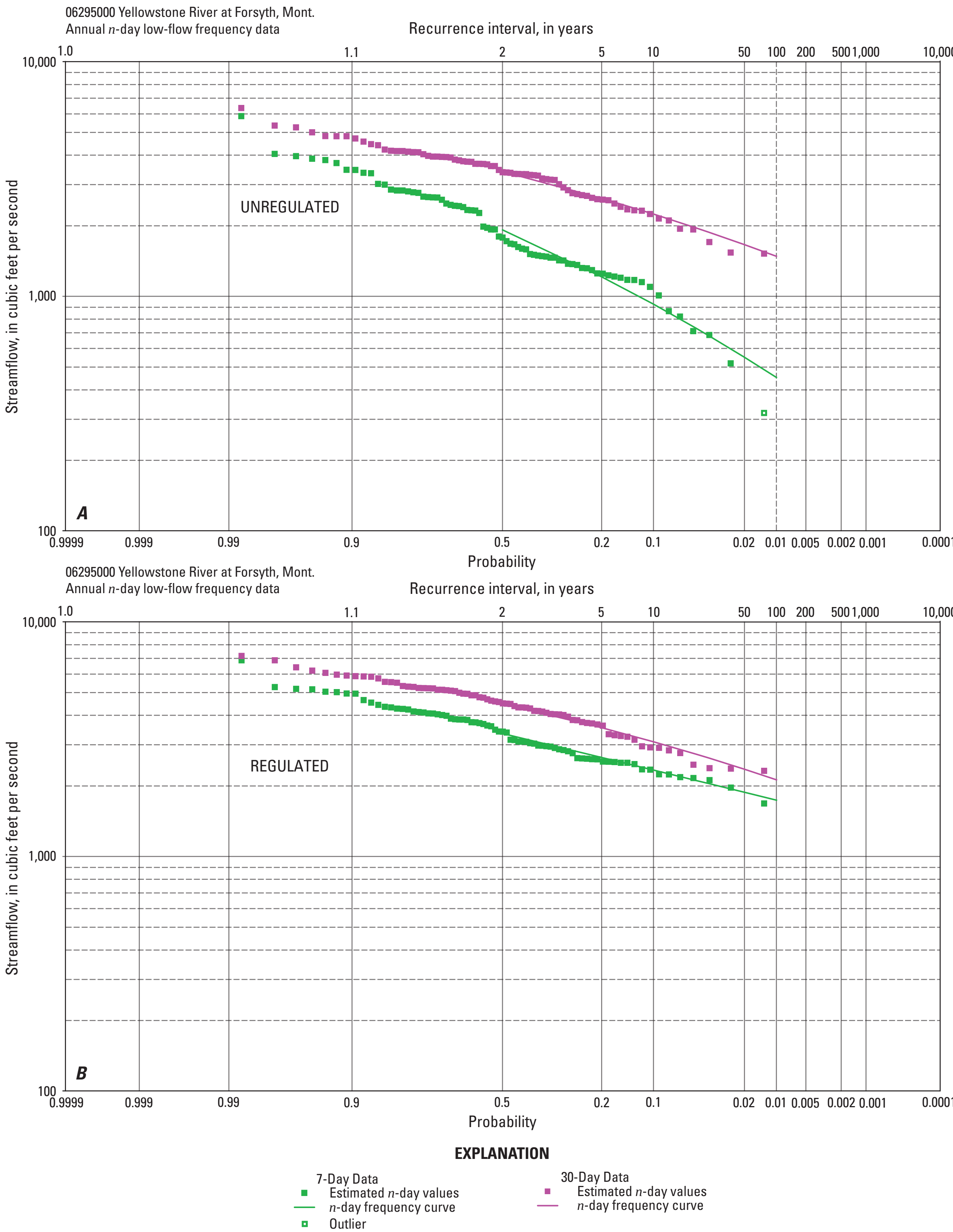


Figure 2-1-4. Annual *n*-day low-flow frequency data for streamflow-gaging station 06295000 (Yellowstone River at Forsyth, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

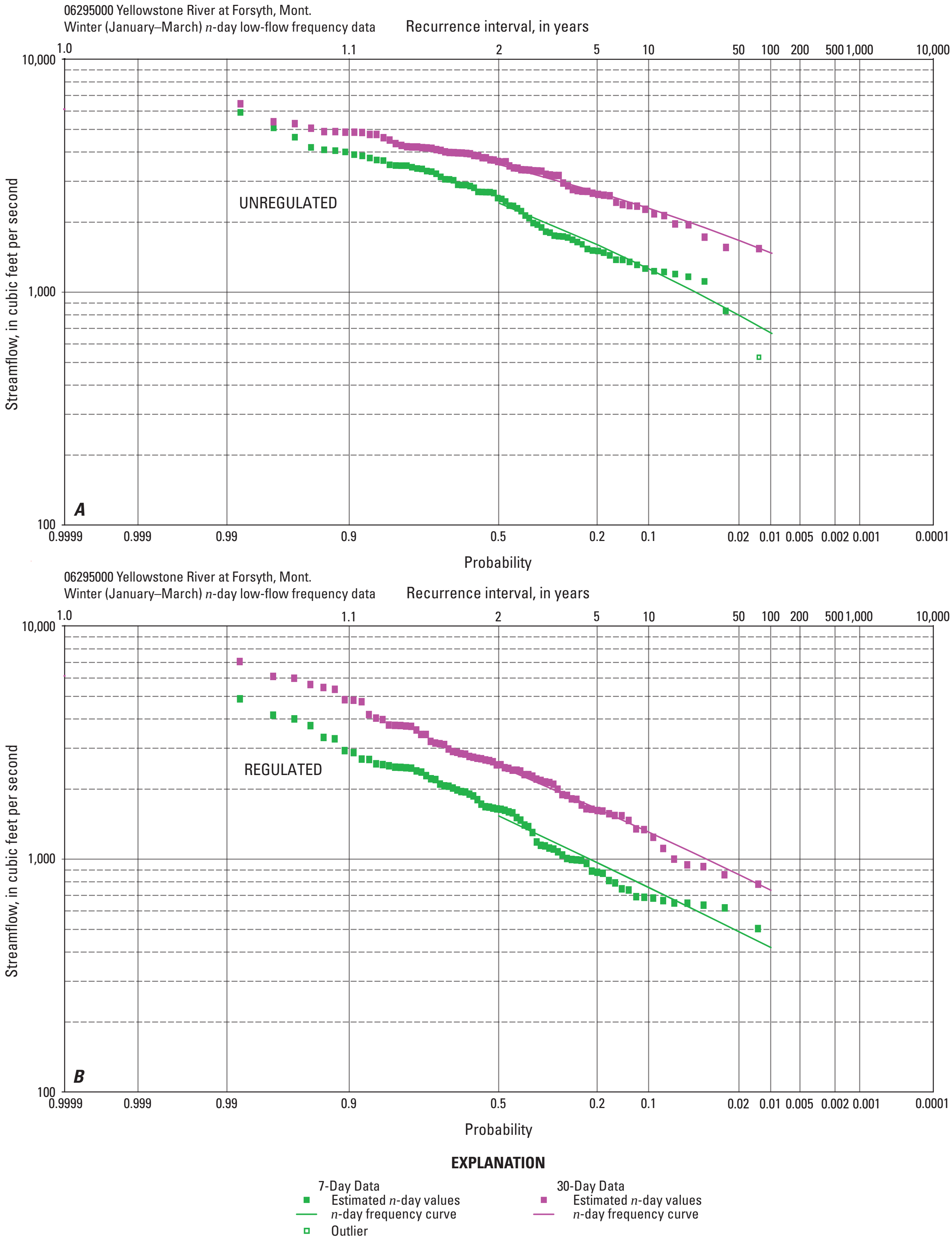


Figure 2-1-5. Winter (January–March) *n*-day low-flow frequency data for streamflow-gaging station 06295000 (Yellowstone River at Forsyth, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

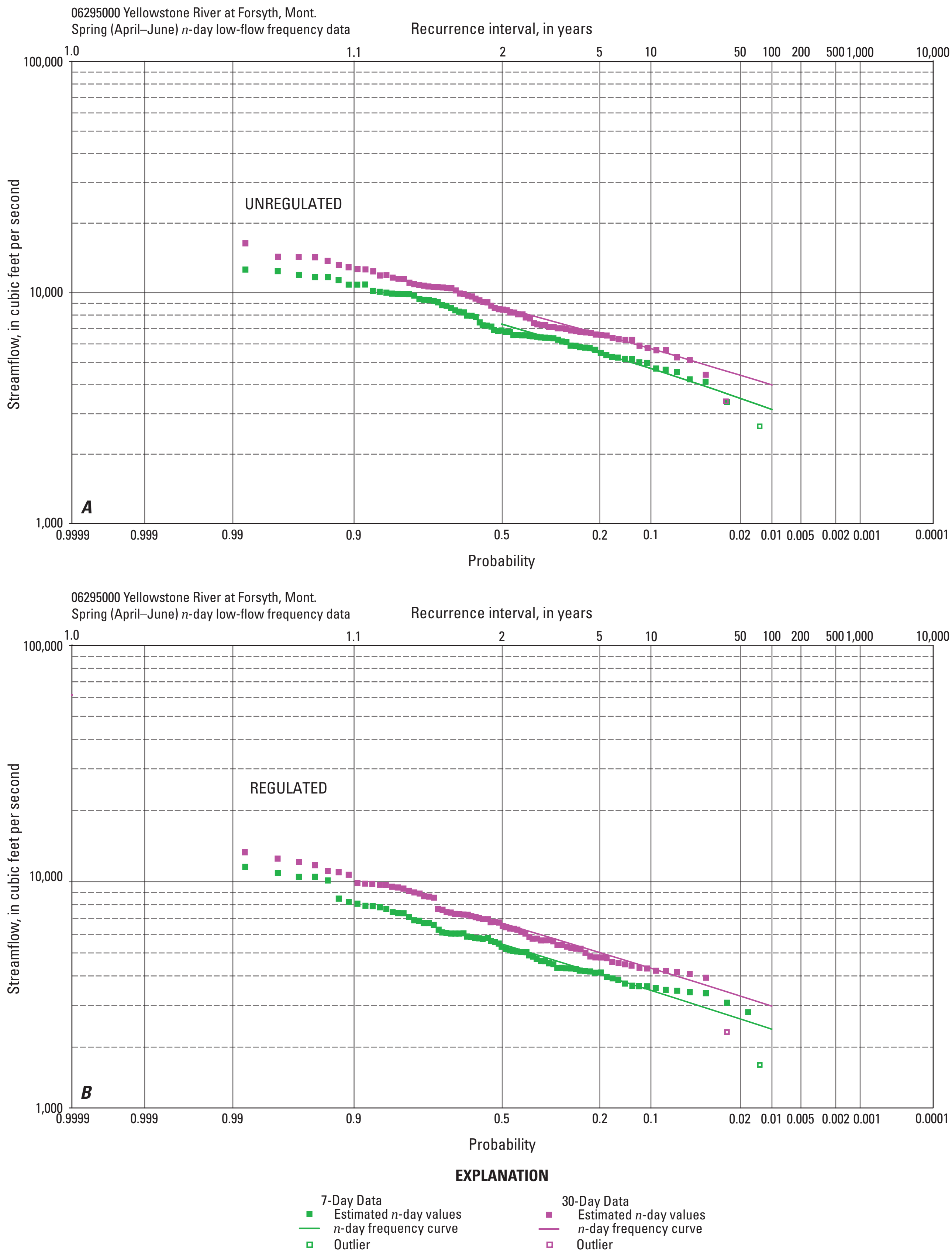


Figure 2-1-6. Spring (April–June) *n*-day low-flow frequency data for streamflow-gaging station 06295000 (Yellowstone River at Forsyth, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.

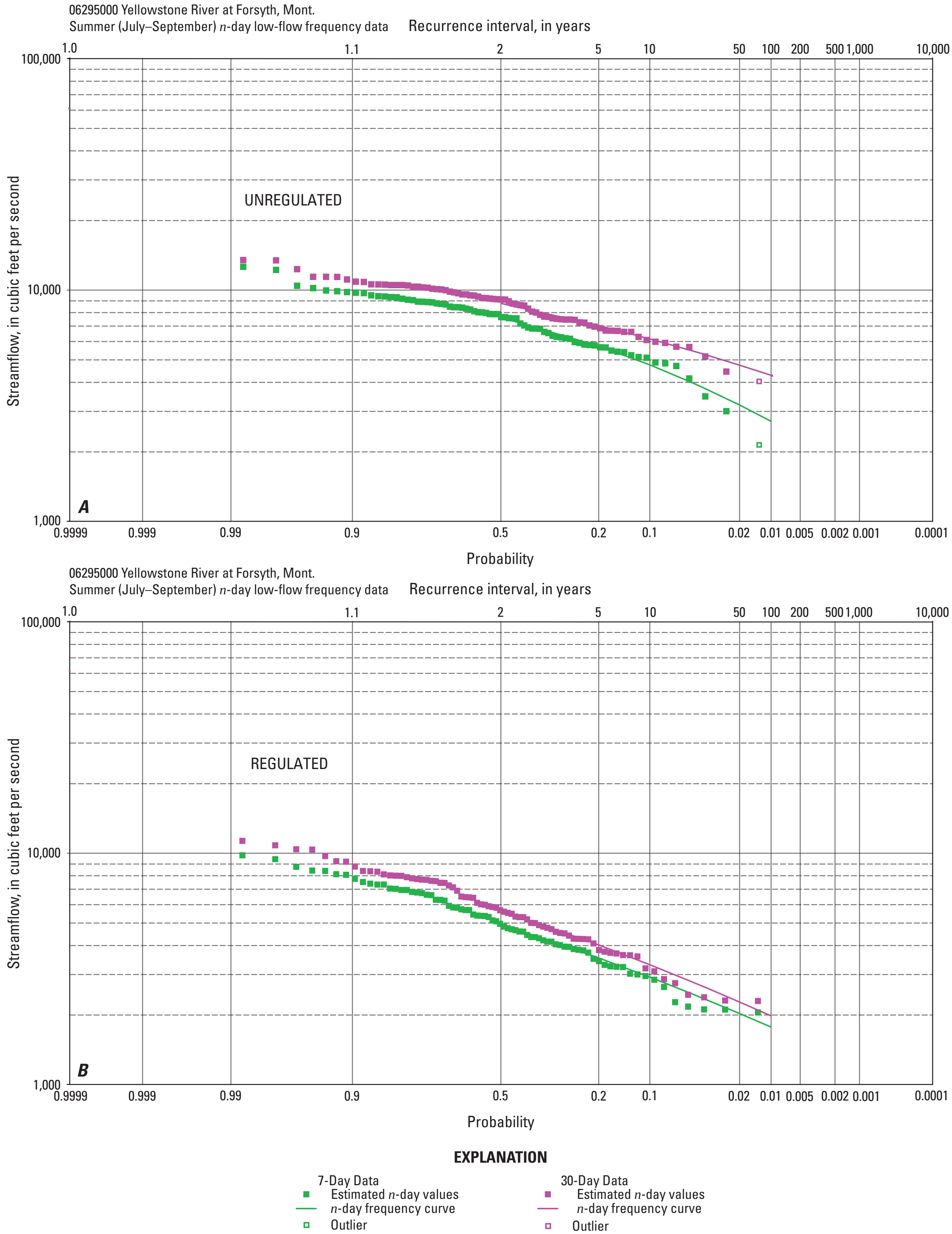


Figure 2-1-7. Summer (July–September) *n*-day low-flow frequency data for streamflow-gaging station 06295000 (Yellowstone River at Forsyth, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

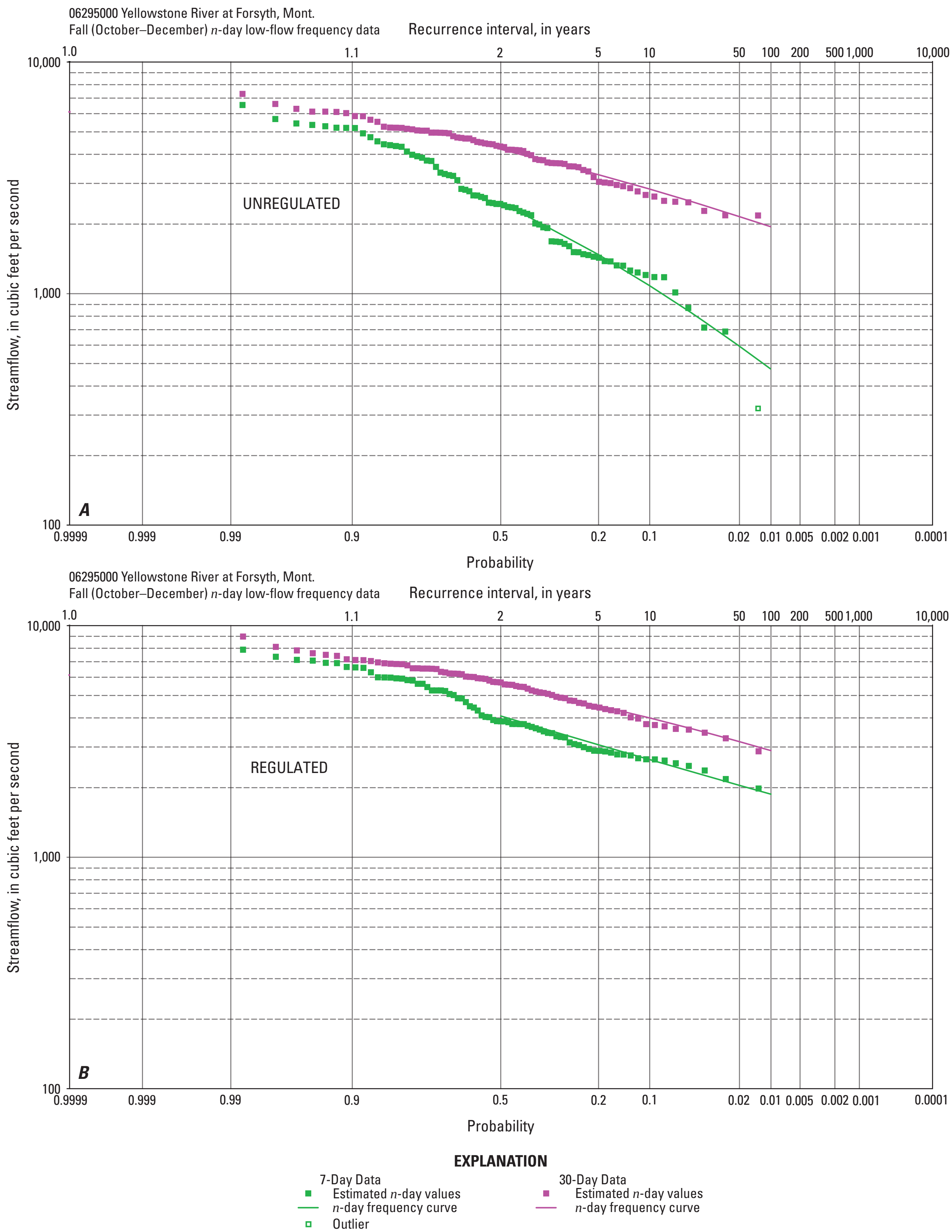


Figure 2-1-8. Fall (October–December) *n*-day low-flow frequency data for streamflow-gaging station 06295000 (Yellowstone River at Forsyth, Mont.) for *A*, unregulated and *B,* regulated streamflow conditions, 1928–2002.

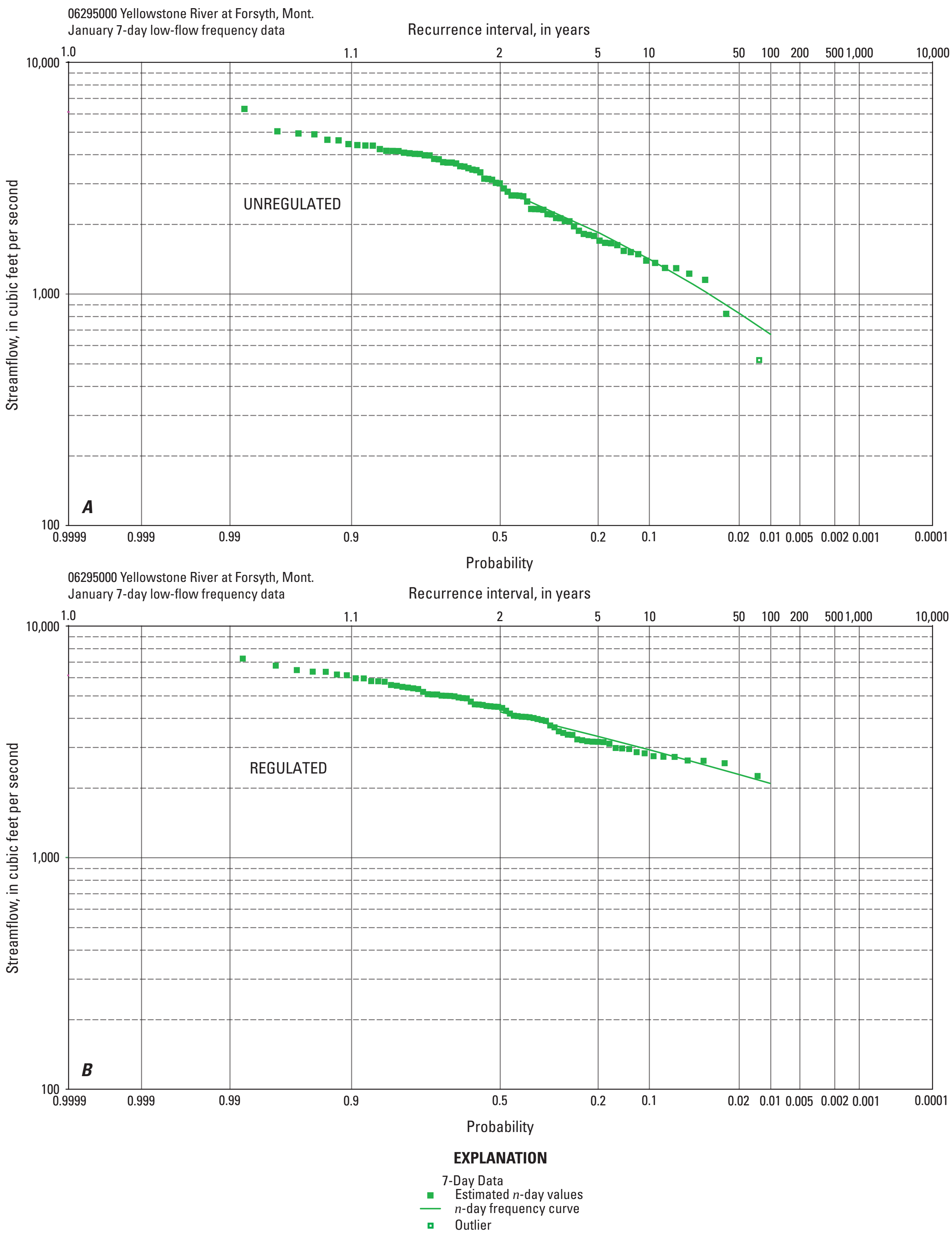


Figure 2-1-9. January 7-day low-flow frequency data for streamflow-gaging station 06295000 (Yellowstone River at Forsyth, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

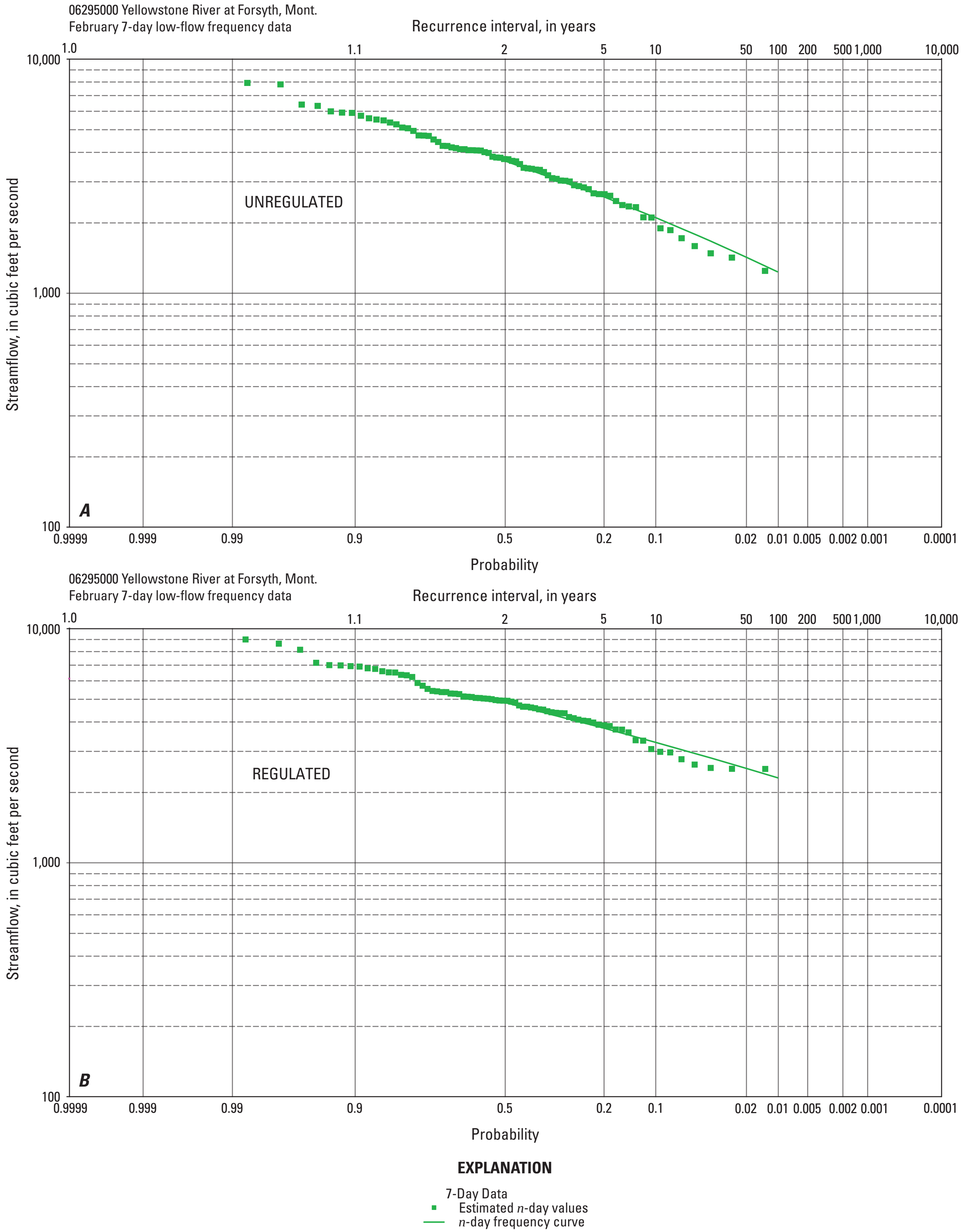


Figure 2-1-10. February 7-day low-flow frequency data for streamflow-gaging station 06295000 (Yellowstone River at Forsyth, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.

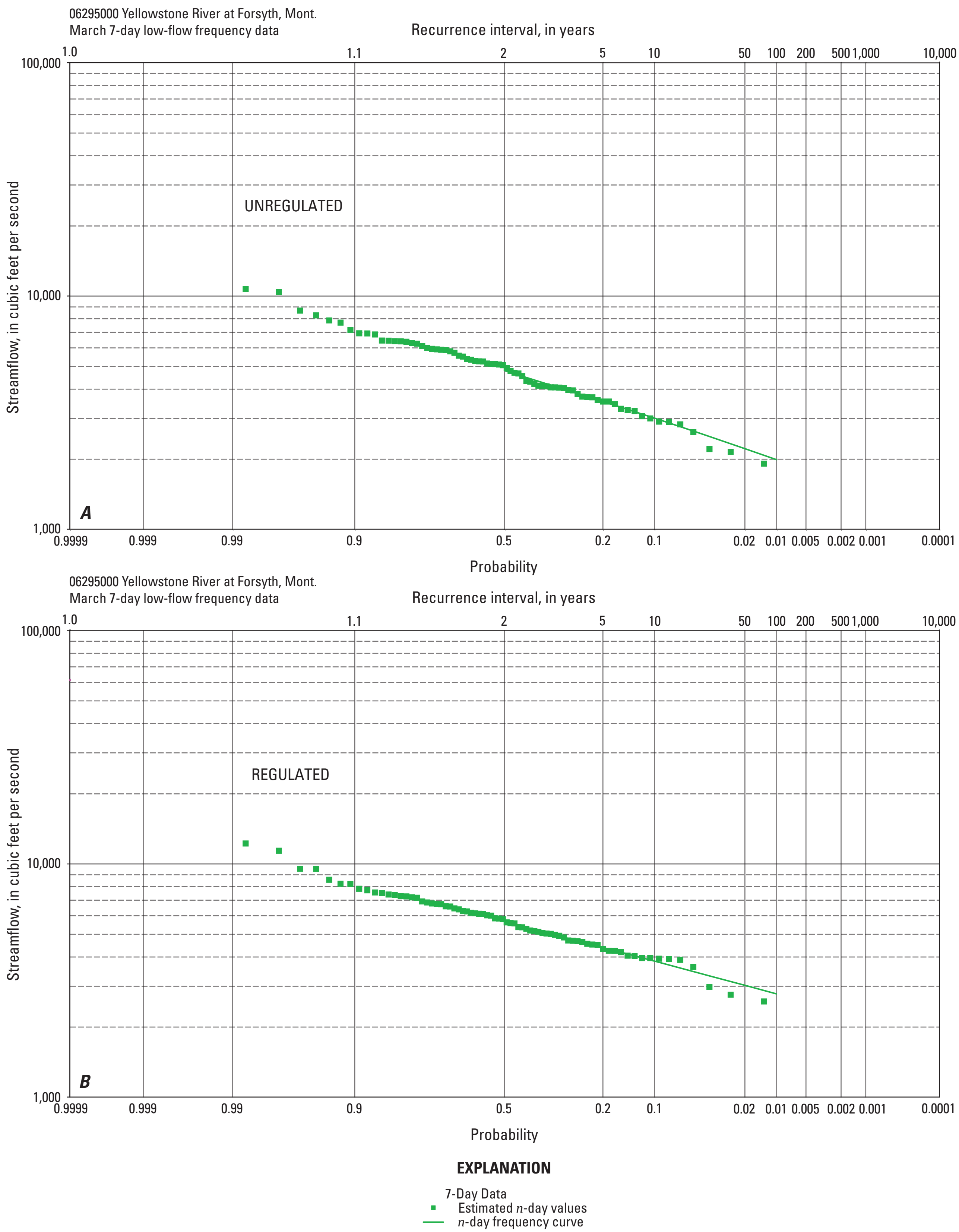


Figure 2-1-11. March 7-day low-flow frequency data for streamflow-gaging station 06295000 (Yellowstone River at Forsyth, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

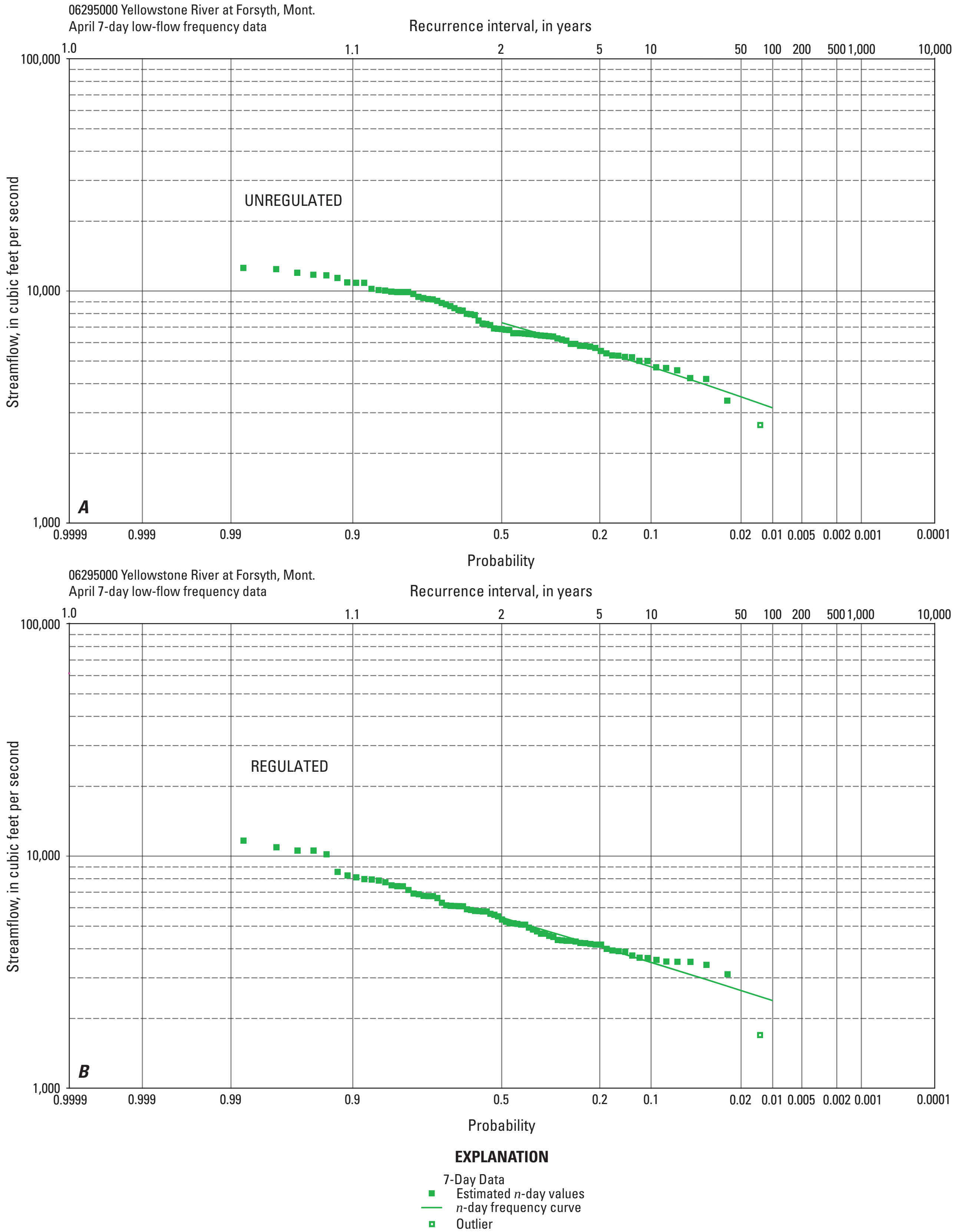


Figure 2-1-12. April 7-day low-flow frequency data for streamflow-gaging station 06295000 (Yellowstone River at Forsyth, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.

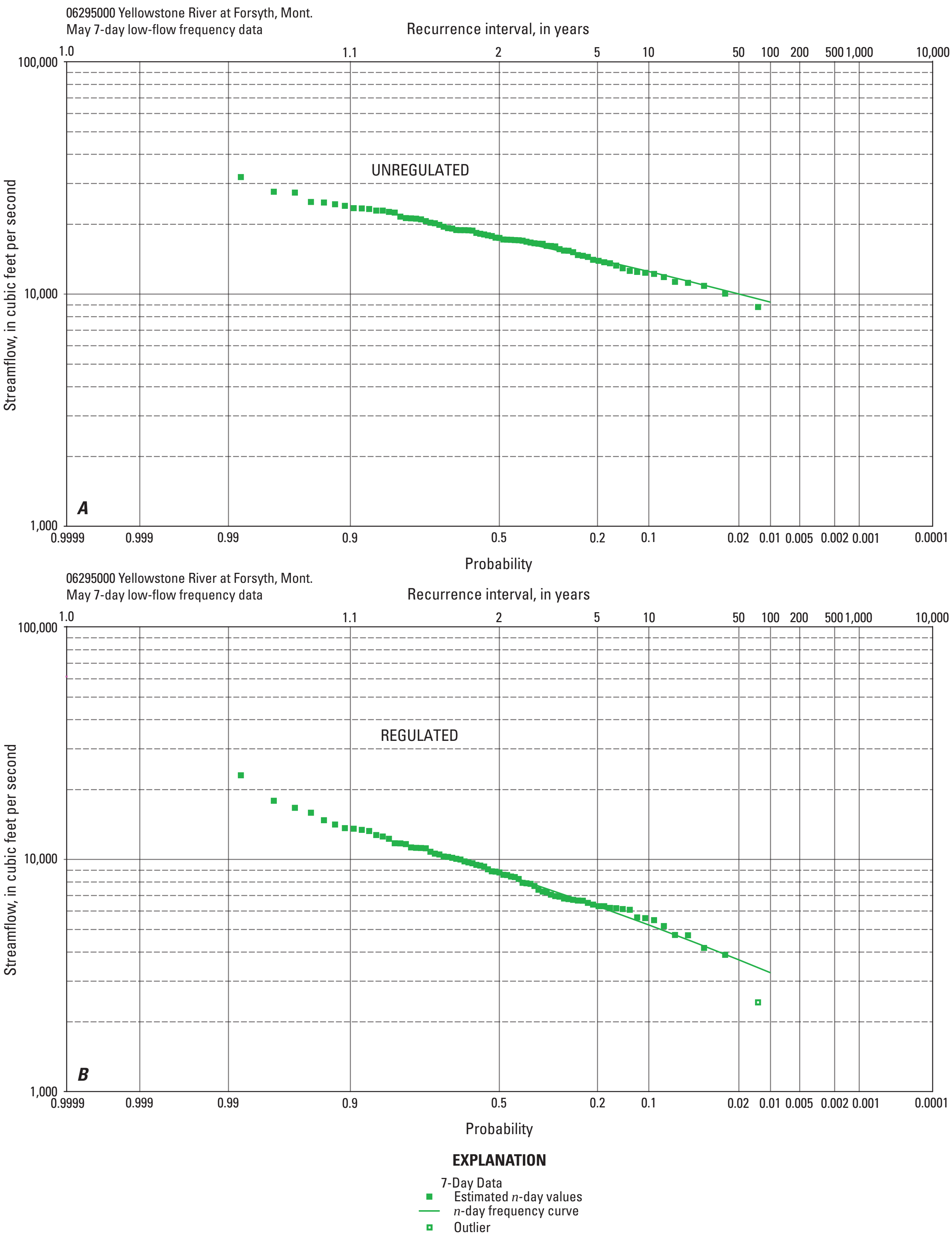


Figure 2-1-13. May 7-day low-flow frequency data for streamflow-gaging station 06295000 (Yellowstone River at Forsyth, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

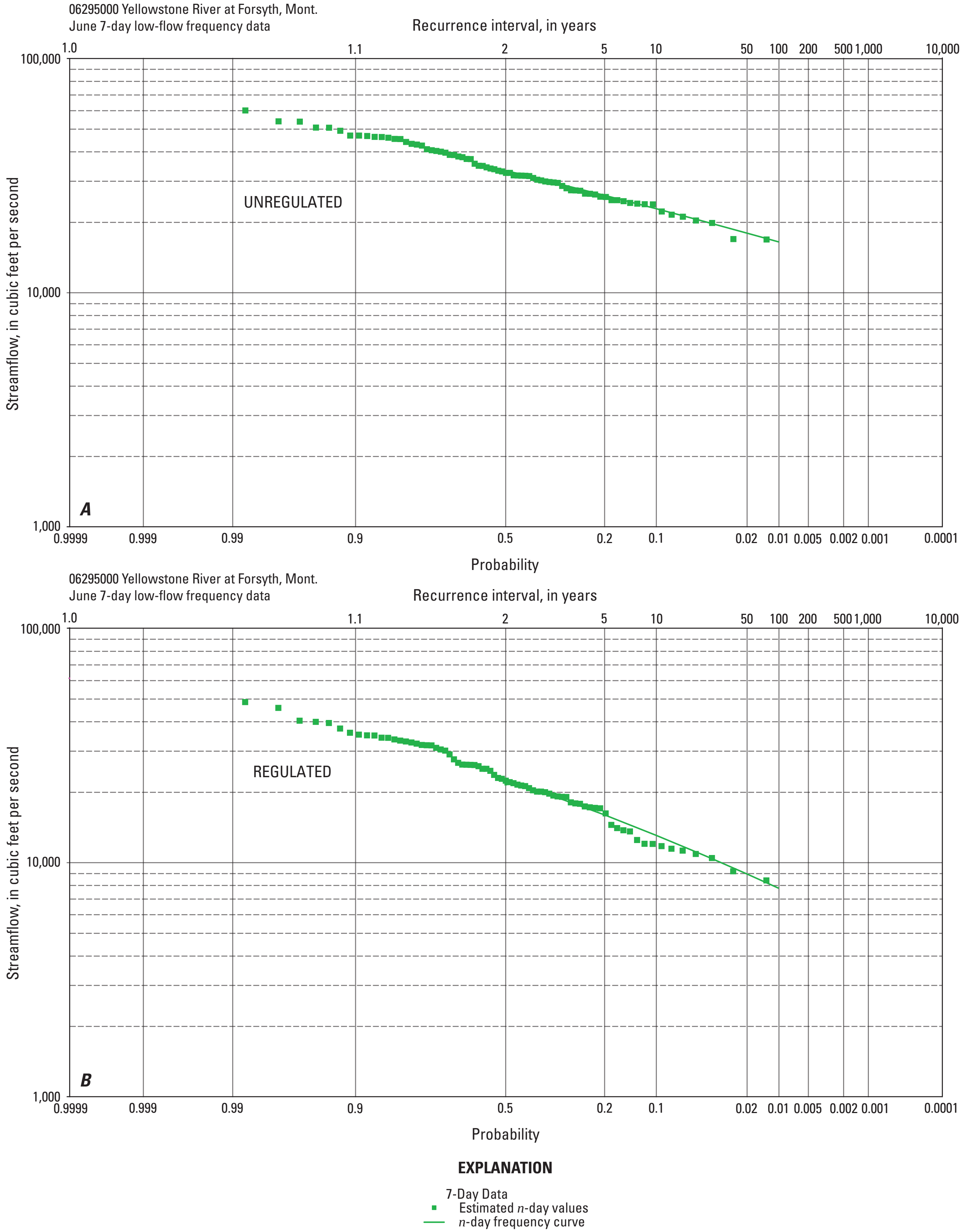
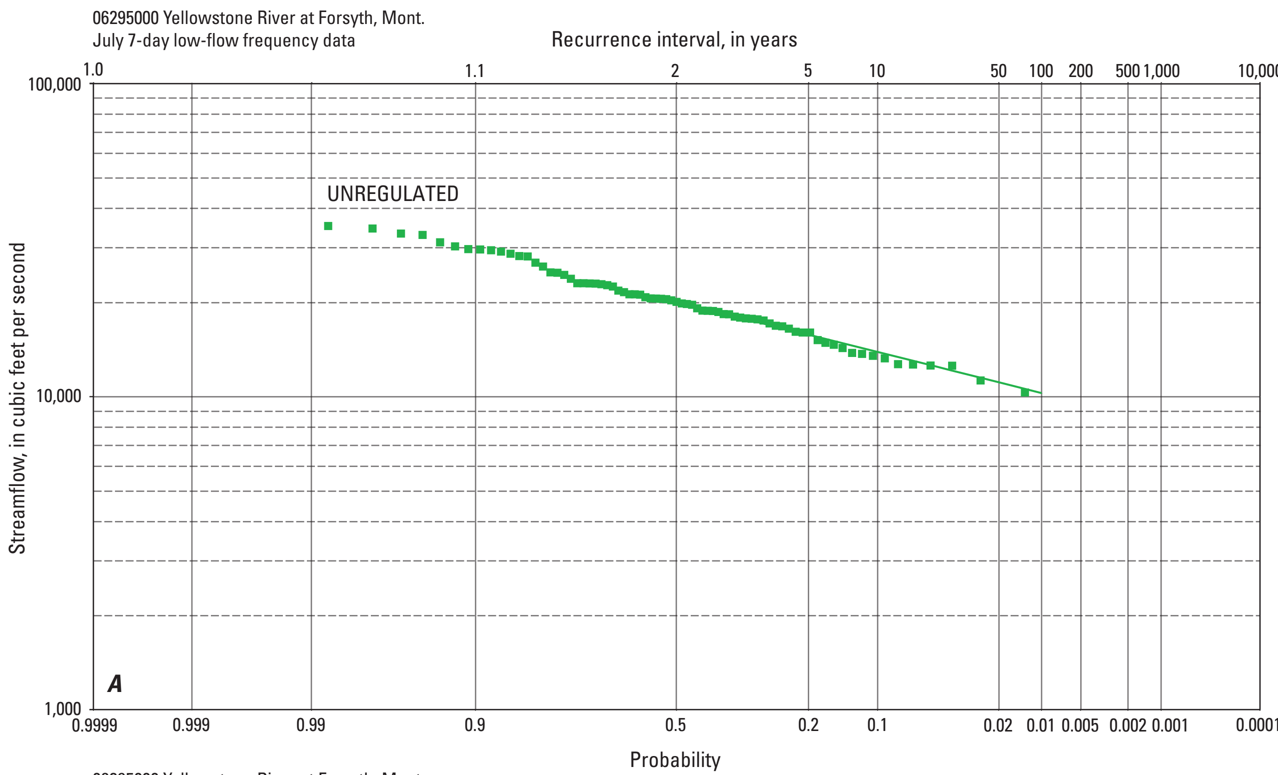
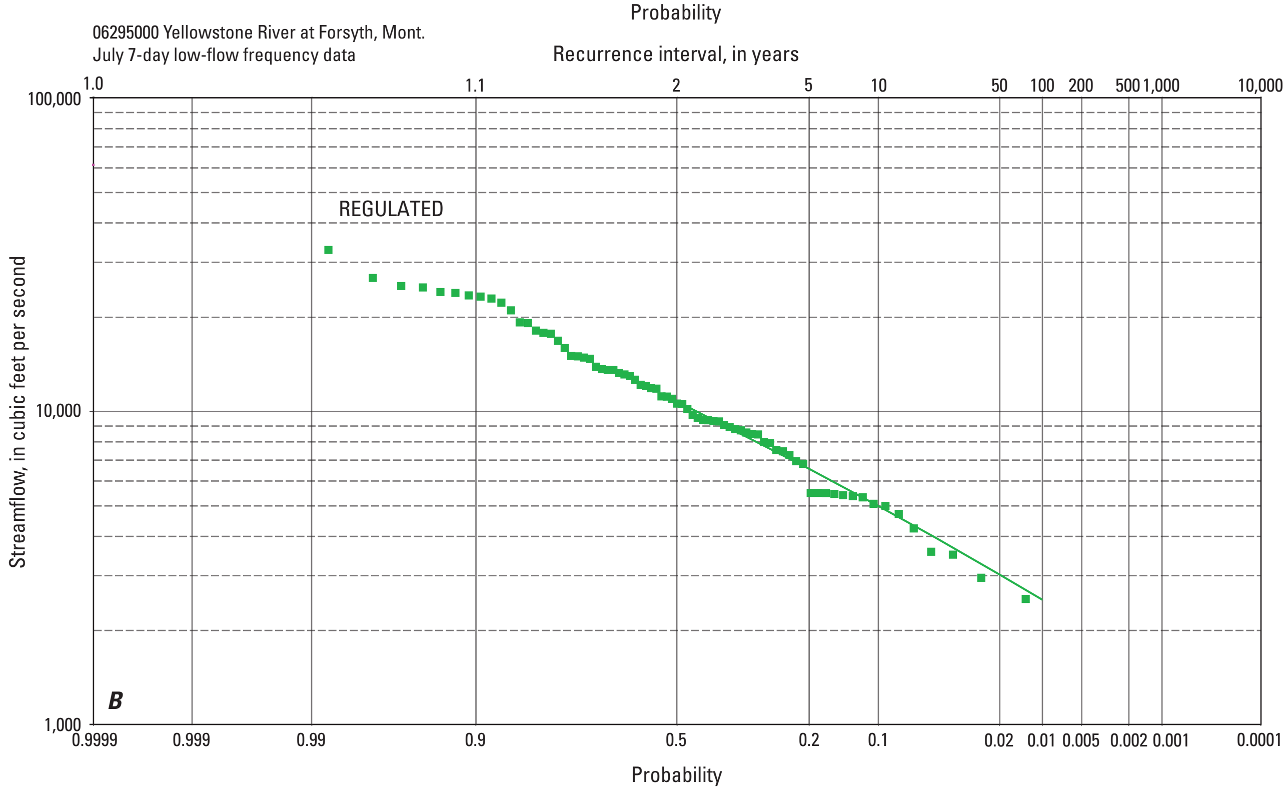


Figure 2-1-14. June 7-day low-flow frequency data for streamflow-gaging station 06295000 (Yellowstone River at Forsyth, Mont.) for *A*, unregulated and *B,* regulated streamflow conditions, 1928–2002.

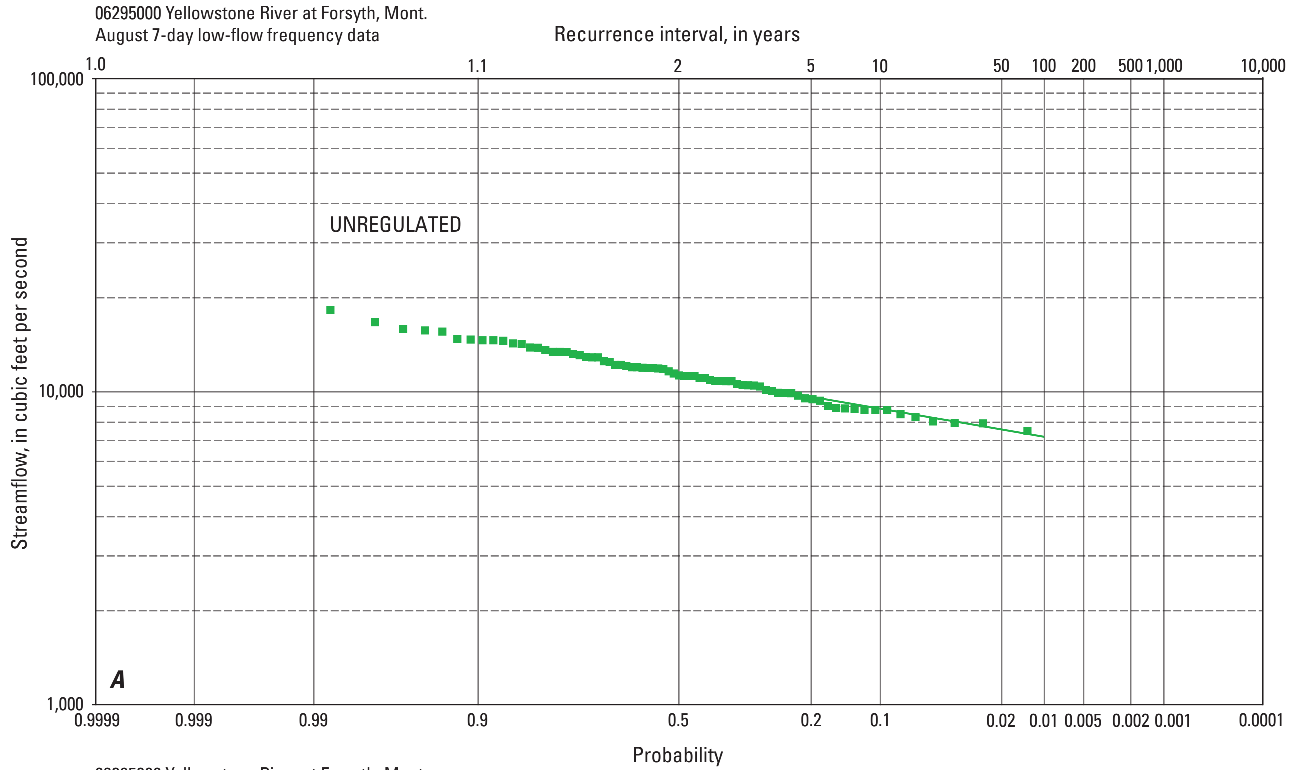




EXPLANATION

7-Day Data
Estimated *n*-day values
n-day frequency curve

Figure 2-1-15. July 7-day low-flow frequency data for streamflow-gaging station 06295000 (Yellowstone River at Forsyth, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.



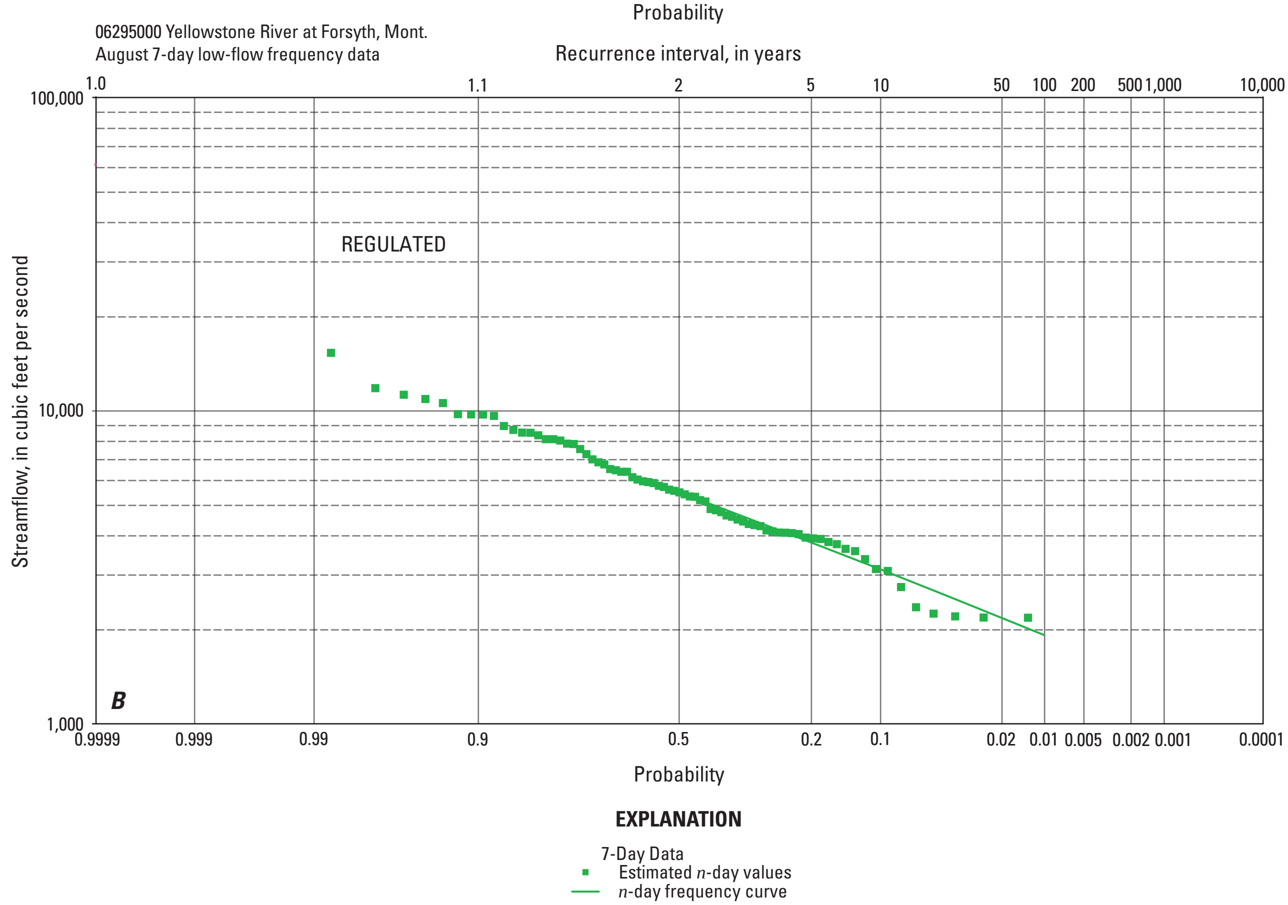


Figure 2-1-16. August 7-day low-flow frequency data for streamflow-gaging station 06295000 (Yellowstone River at Forsyth, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.

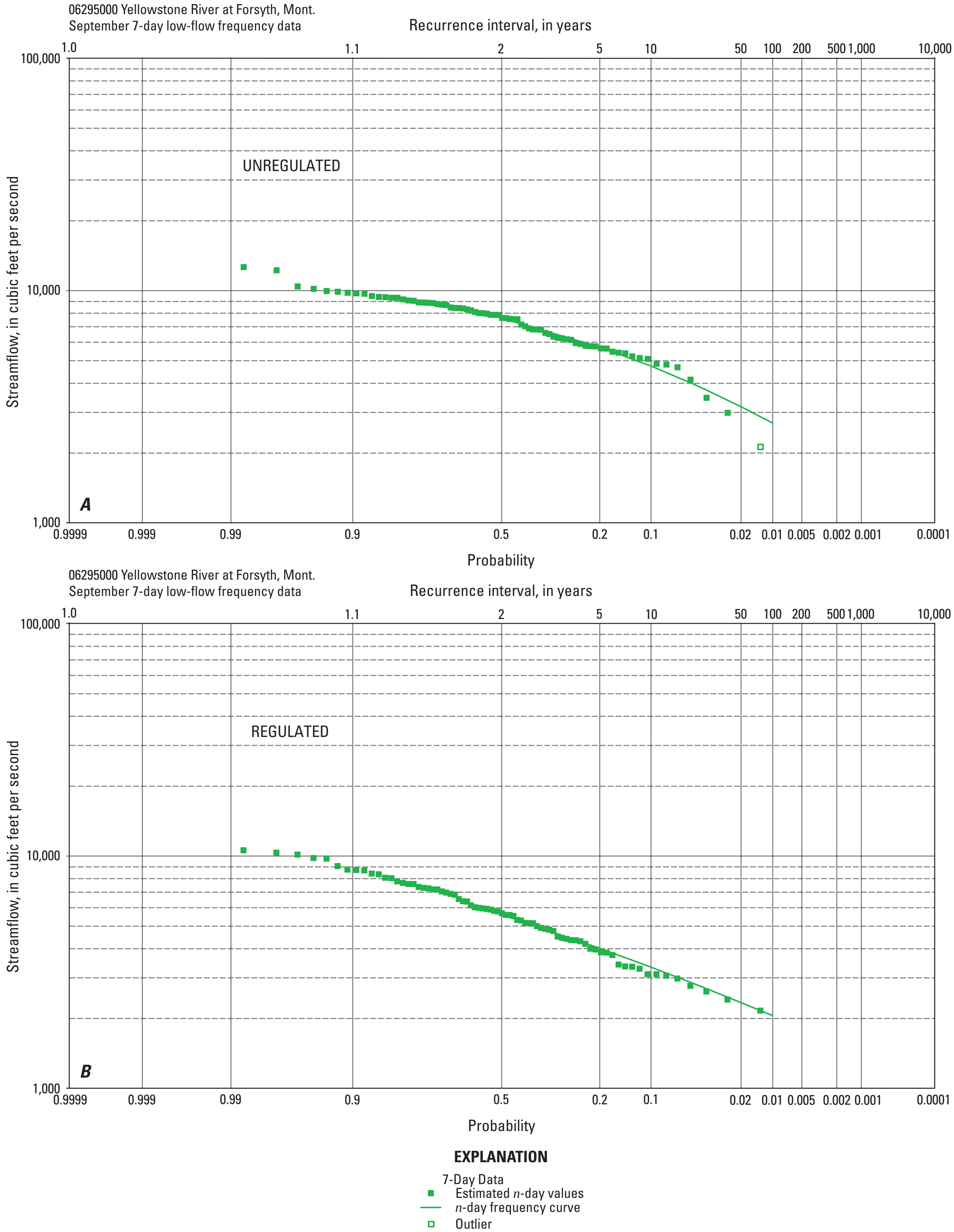


Figure 2-1-17. September 7-day low-flow frequency data for streamflow-gaging station 06295000 (Yellowstone River at Forsyth, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

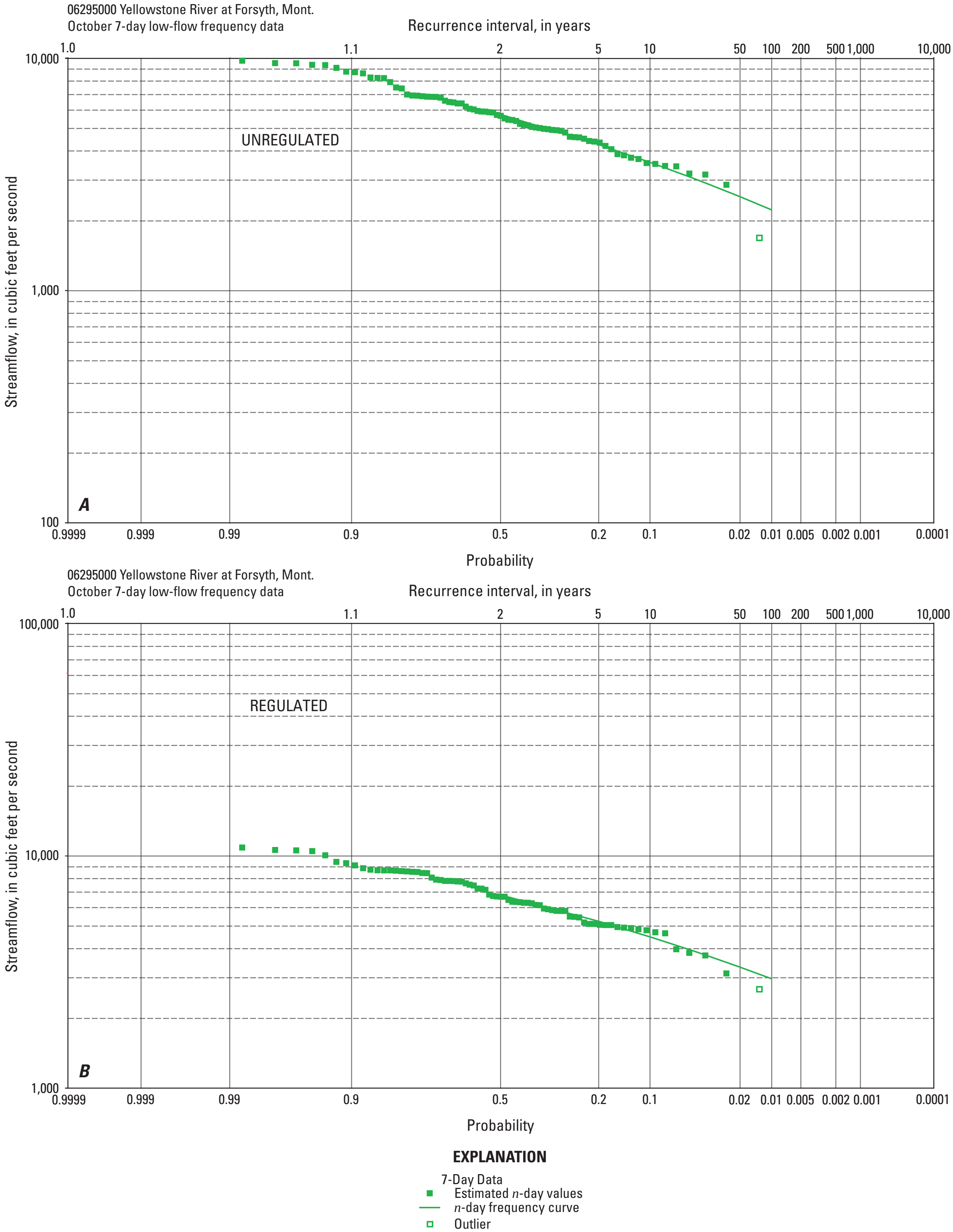


Figure 2-1-18. October 7-day low-flow frequency data for streamflow-gaging station 06295000 (Yellowstone River at Forsyth, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.

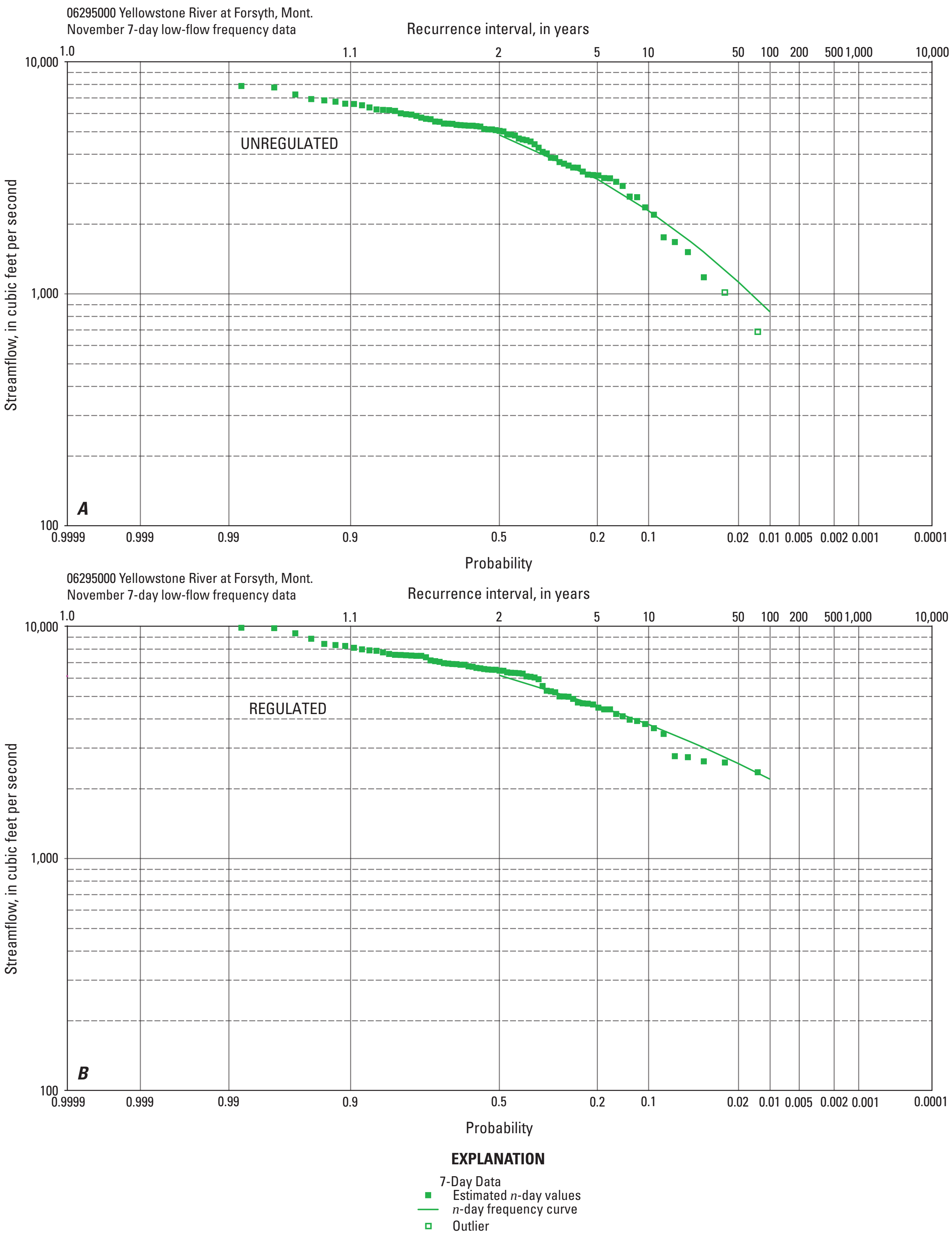


Figure 2-1-19. November 7-day low-flow frequency data for streamflow-gaging station 06295000 (Yellowstone River at Forsyth, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

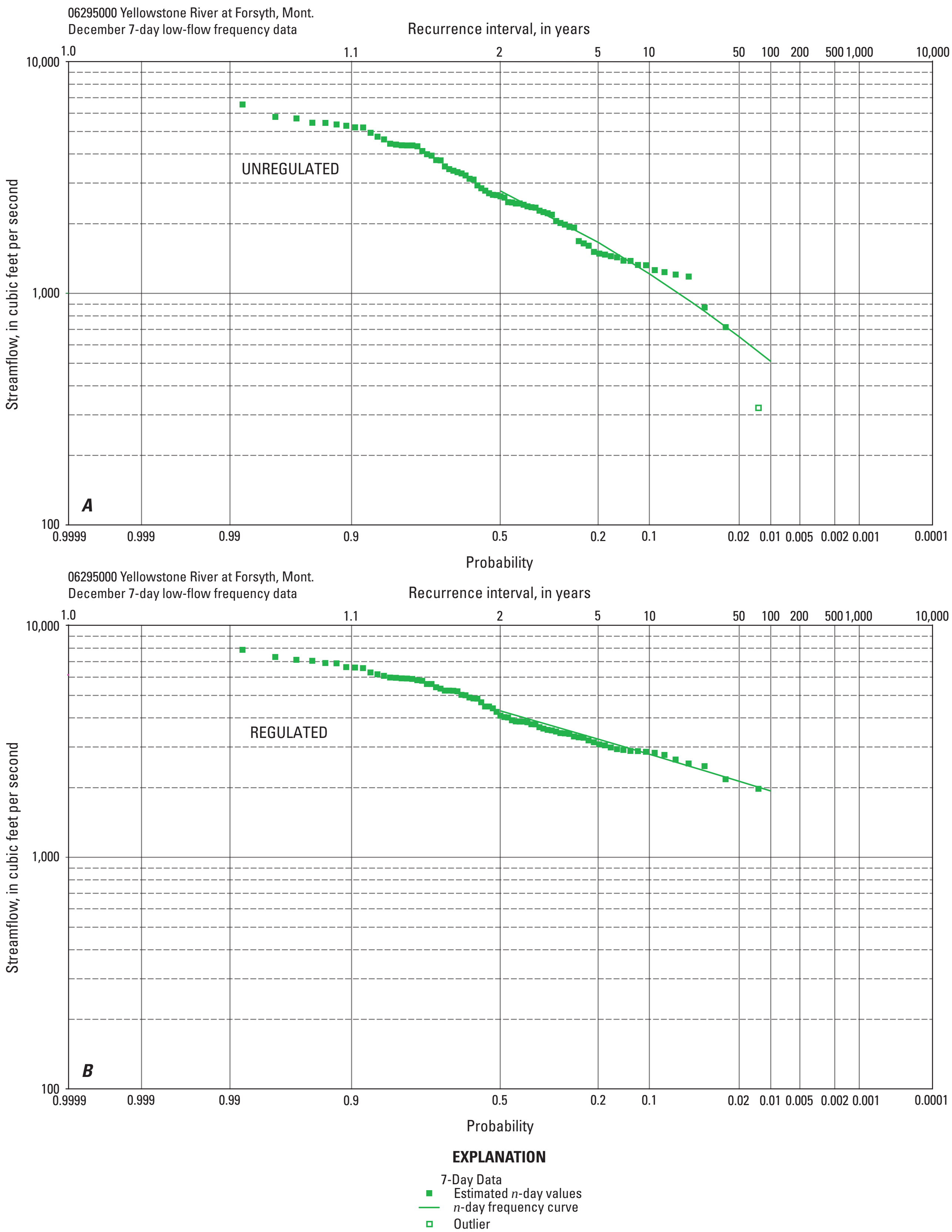
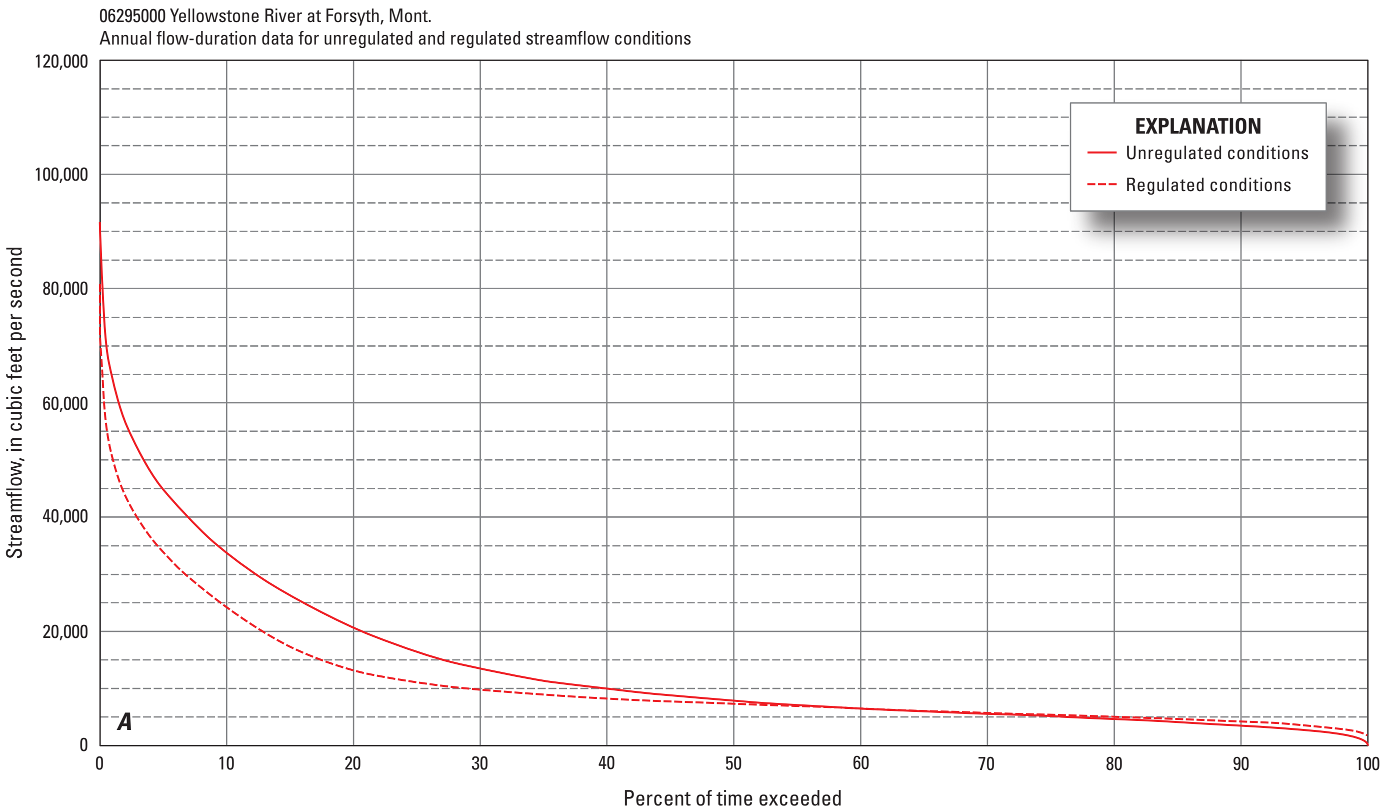


Figure 2-1-20. December 7-day low-flow frequency data for streamflow-gaging station 06295000 (Yellowstone River at Forsyth, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.



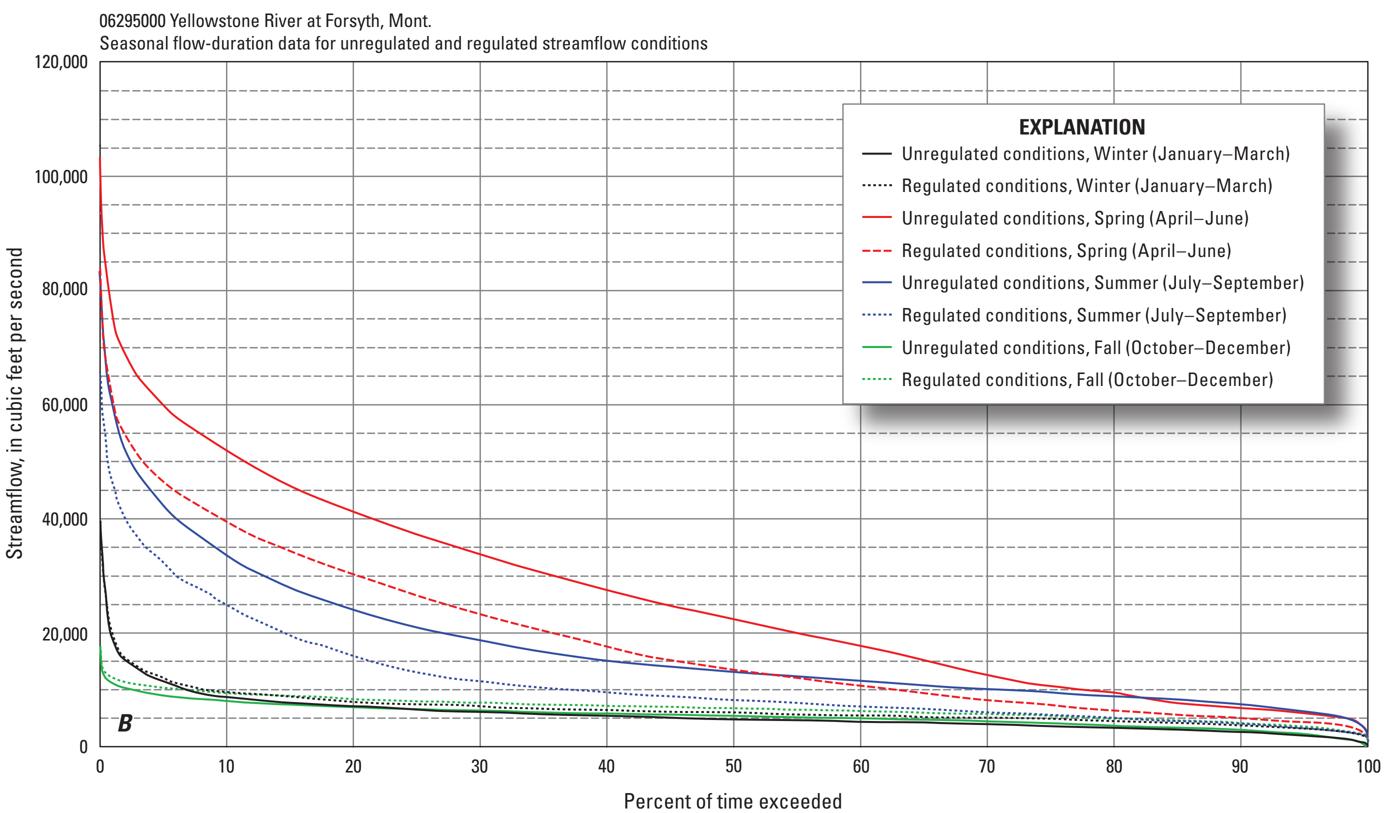


Figure 2-1-21. *A,* Annual and *B,* seasonal flow-duration data for streamflow-gaging station 06295000 (Yellowstone River at Forsyth, Mont.) for unregulated and regulated streamflow conditions, 1928–2002.

Appendix 2–2. Statistics for Streamflow-Gaging Station 06309000 (Yellowstone River at Miles City, Mont.)

Table 2-2-1. Annual *n*-day high-flow frequency data for streamflow-gaging station 06309000 (Yellowstone River at Miles City, Mont.) for unregulated and regulated streamflow conditions, 1928–2002.

[Abbreviations: ft^3/s, cubic feet per second. Symbol: %, percent]

n, period of consecutive days	Streamflow, in ft^3/s, for indicated recurrence interval, in years, and exceedance probability, in percent						
	2 50%	5 20%	10 10%	20 5%	25 4%	50 2%	100 1%
Unregulated							
1	61,800	76,600	85,500	93,400	95,800	103,000	110,000
3	59,900	74,600	83,300	91,100	93,500	101,000	107,000
7	56,600	70,400	78,600	86,000	88,200	94,800	101,000
15	52,300	64,800	72,300	79,000	81,000	87,000	92,800
30	47,300	58,400	64,900	70,600	72,400	77,500	82,400
60	40,000	48,600	53,600	58,000	59,300	63,200	66,800
90	34,000	40,700	44,400	47,700	48,700	51,500	54,200
120	29,200	34,600	37,700	40,300	41,100	43,400	45,500
183	22,700	26,600	28,800	30,700	31,300	32,900	34,400
Regulated							
1	46,900	60,900	68,800	75,700	77,800	83,700	89,200
3	44,900	58,700	66,700	73,600	75,700	81,800	87,400
7	42,000	55,200	62,700	69,100	71,100	76,600	81,700
15	38,600	50,600	57,400	63,200	64,900	69,900	74,400
30	34,400	45,100	51,100	56,200	57,700	62,100	66,000
60	28,000	36,900	42,100	46,600	47,900	51,800	55,400
90	23,000	30,200	34,300	37,900	38,900	42,000	44,800
120	19,500	25,300	28,600	31,400	32,300	34,700	37,000
183	15,900	20,000	22,300	24,400	25,000	26,800	28,400

Table 2-2-2. Annual, seasonal, and monthly *n*-day low-flow frequency data for streamflow-gaging station 06309000 (Yellowstone River at Miles City, Mont.) for unregulated and regulated conditions, 1928–2002.

[Abbreviations: ft³/s, cubic feet per second. Symbol: %, percent]

	Unregulated						
***n*, period of consecutive days (month, for monthly frequency data)**	**Streamflow, in ft³/s, for indicated recurrence interval, in years, and exceedance probability, in percent**						
	2 50%	**5 20%**	**10 10%**	**20 5%**	**25 4%**	**50 2%**	**100 1%**
			Annual				
7	1,920	1,230	962	775	727	602	505
30	3,530	2,720	2,340	2,050	1,980	1,760	1,580
			Winter (January–March)				
7	2,590	1,730	1,370	1,120	1,050	881	745
30	3,980	2,960	2,500	2,160	2,060	1,810	1,600
			Spring (April–June)				
7	7,950	5,990	5,110	4,450	4,270	3,780	3,380
30	9,330	7,120	6,140	5,410	5,220	4,680	4,240
			Summer (July–September)				
7	8,200	6,180	5,100	4,260	4,020	3,370	2,840
30	9,380	7,550	6,620	5,880	5,670	5,090	4,600
			Fall (October–December)				
7	2,510	1,490	1,110	850	790	624	503
30	4,360	3,370	2,910	2,560	2,470	2,200	1,980
			Monthly				
7 (January)	2,900	1,890	1,460	1,150	1,080	870	710
7 (February)	3,790	2,660	2,180	1,840	1,750	1,510	1,310
7 (March)	5,140	3,780	3,190	2,750	2,640	2,330	2,070
7 (April)	7,950	5,990	5,110	4,450	4,270	3,780	3,380
7 (May)	18,550	14,820	13,050	11,690	11,310	10,270	9,390
7 (June)	34,620	27,110	23,720	21,180	20,480	18,580	17,000
7 (July)	21,200	16,730	14,750	13,290	12,890	11,800	10,900
7 (August)	12,190	10,340	9,470	8,800	8,610	8,100	7,660
7 (September)	8,200	6,180	5,100	4,260	4,020	3,370	2,840
7 (October)	5,870	4,440	3,810	3,340	3,210	2,870	2,590
7 (November)	4,970	3,140	2,260	1,640	1,480	1,080	793
7 (December)	2,790	1,680	1,240	951	877	688	546

Table 2-2-2. Annual, seasonal, and monthly *n*-day low-flow frequency data for streamflow-gaging station 06309000 (Yellowstone River at Miles City, Mont.) for unregulated and regulated conditions, 1928–2002.—Continued

[Abbreviations: ft³/s, cubic feet per second. Symbol: %, percent]

Regulated							
***n*, period of consecutive days (month, for monthly frequency data)**	**Streamflow, in ft³/s, for indicated recurrence interval, in years, and exceedance probability, in percent**						
	2 50%	**5 20%**	**10 10%**	**20 5%**	**25 4%**	**50 2%**	**100 1%**
Annual							
7	3,390	2,710	2,420	2,210	2,150	2,000	1,880
30	4,680	3,700	3,220	2,850	2,740	2,460	2,220
Winter (January–March)							
7	3,990	3,170	2,820	2,560	2,490	2,300	2,140
30	5,220	4,210	3,750	3,400	3,300	3,030	2,800
Spring (April–June)							
7	5,950	4,420	3,760	3,280	3,150	2,810	2,520
30	7,210	5,370	4,570	4,000	3,840	3,430	3,090
Summer (July–September)							
7	5,360	3,830	3,180	2,710	2,580	2,240	1,970
30	6,150	4,350	3,580	3,020	2,870	2,470	2,160
Fall (October–December)							
7	4,140	3,120	2,690	2,380	2,300	2,080	1,900
30	5,690	4,570	4,030	3,620	3,510	3,190	2,920
Monthly							
7 (January)	4,330	3,400	2,990	2,680	2,590	2,360	2,170
7 (February)	5,000	3,880	3,390	3,030	2,930	2,660	2,430
7 (March)	6,020	4,630	4,010	3,560	3,430	3,090	2,810
7 (April)	5,980	4,440	3,780	3,300	3,170	2,820	2,540
7 (May)	8,940	6,310	5,170	4,350	4,130	3,550	3,080
7 (June)	23,400	16,320	13,300	11,140	10,560	9,030	7,810
7 (July)	11,050	6,700	5,080	4,010	3,740	3,050	2,520
7 (August)	5,660	3,930	3,230	2,750	2,620	2,280	2,020
7 (September)	5,890	4,280	3,580	3,070	2,930	2,570	2,270
7 (October)	7,060	5,530	4,810	4,260	4,110	3,700	3,350
7 (November)	6,460	4,750	3,900	3,250	3,070	2,590	2,200
7 (December)	4,380	3,290	2,830	2,490	2,400	2,160	1,960

Table 2-2-3. Annual and seasonal flow-duration data for streamflow-gaging station 06309000 (Yellowstone River at Miles City, Mont.) for unregulated and regulated streamflow conditions, 1928–2002.

[Abbreviations: ft³/s, cubic feet per second. Symbol: %, percent]

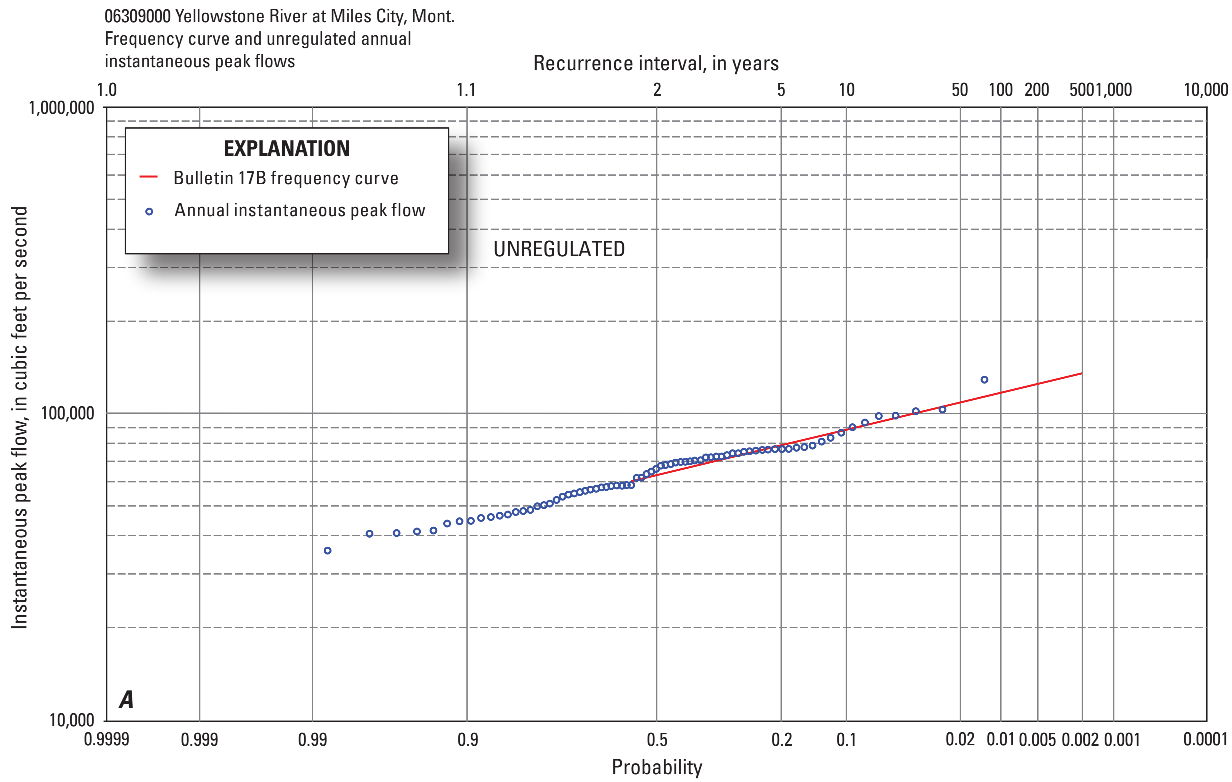
Streamflow condition	Streamflow, in ft³/s, which was equaled or exceeded for indicated percent of time																		
	1%	2%	5%	10%	15%	20%	25%	30%	40%	50%	60%	70%	75%	80%	85%	90%	95%	98%	99%
Annual																			
Unregulated	66,100	58,800	46,700	35,100	27,300	21,600	17,400	14,300	10,600	8,300	6,870	5,860	5,420	4,910	4,330	3,670	2,870	1,960	1,540
Regulated	51,600	45,300	34,900	24,800	17,800	13,800	11,600	10,230	8,640	7,640	6,880	6,110	5,710	5,290	4,860	4,370	3,740	3,010	2,670
Winter (January–March)																			
Unregulated	21,700	16,600	12,400	9,430	8,290	7,540	6,960	6,470	5,730	5,170	4,680	4,130	3,820	3,500	3,150	2,710	2,080	1,600	1,320
Regulated	21,500	17,100	13,100	10,400	9,250	8,430	7,910	7,500	6,830	6,240	5,800	5,250	4,990	4,690	4,400	4,000	3,330	2,890	2,620
Spring (April–June)																			
Unregulated	77,600	71,000	62,000	53,800	47,500	42,800	38,600	35,000	28,600	23,300	18,600	13,400	11,500	10,200	8,350	7,410	6,430	5,470	4,880
Regulated	62,000	55,500	47,800	40,600	35,400	31,000	27,200	23,800	17,800	13,900	11,200	8,640	7,790	6,860	6,220	5,470	4,640	4,070	3,630
Summer (July–September)																			
Unregulated	63,000	54,500	44,200	35,400	29,400	25,400	22,000	19,600	16,100	14,000	12,300	10,800	10,200	9,550	8,880	8,050	6,730	5,670	4,980
Regulated	48,600	41,200	33,300	25,700	20,400	16,400	13,700	12,000	9,950	8,550	7,460	6,390	5,840	5,310	4,760	4,200	3,530	2,820	2,570
Fall (October–December)																			
Unregulated	11,700	10,800	9,390	8,460	7,790	7,300	6,940	6,650	6,120	5,740	5,300	4,670	4,320	3,930	3,540	3,040	2,340	1,400	1,110
Regulated	12,600	11,900	10,800	9,950	9,380	8,850	8,410	8,090	7,560	7,100	6,640	6,050	5,650	5,260	4,840	4,350	3,750	2,890	2,590

Table 2-2-4. Monthly and annual streamflow characteristics for streamflow-gaging station 06309000 (Yellowstone River at Miles City, Mont.) for unregulated and regulated streamflow conditions, 1928–2002.

[Abbreviations: ft³/s, cubic feet per second]

Unregulated						
	Streamflow, in ft³/s, or year, for indicated streamflow characteristic					
Period	Maximum monthly mean and maximum annual mean streamflow	Year of maximum monthly mean and maximum annual mean streamflow	Minimum monthly mean and minimum annual mean streamflow	Year of minimum monthly mean and minimum annual mean streamflow	Mean monthly and mean annual streamflow	Standard deviation of mean monthly and mean annual streamflow
January	7,790	1983	1,660	1937	4,410	1,259
February	15,800	1971	1,970	1932	5,530	2,247
March	18,300	1929	2,640	2002	7,880	3,060
April	18,100	1943	3,610	1961	9,730	2,984
May	45,400	1928	13,692	1953	26,540	6,191
June	77,300	1997	21,187	2001	45,330	11,894
July	58,800	1975	12,995	1934	30,490	10,540
August	21,600	1997	8,690	1934	14,500	3,263
September	14,200	1968	4,230	1934	9,380	2,114
October	11,900	1941	3,260	1935	6,870	2,074
November	8,670	1982	2,930	1931	5,740	1,500
December	7,680	1982	2,290	1932	4,630	1,231
Annual	21,000	1997	9,280	2001	14,200	2,661

Regulated						
	Streamflow, in ft³/s, or year, for indicated streamflow characteristic					
Period	Maximum monthly mean and maximum annual mean streamflow	Year of maximum monthly mean and maximum annual mean streamflow	Minimum monthly mean and minimum annual mean streamflow	Year of minimum monthly mean and minimum annual mean streamflow	Mean monthly and mean annual streamflow	Standard deviation of mean monthly and mean annual streamflow
January	8,680	1968	2,920	1937	5,750	1,270
February	16,200	1971	3,180	1932	6,600	2,160
March	19,300	1929	3,030	2002	8,630	3,010
April	14,700	1996	2,620	1961	7,730	2,640
May	35,700	1928	6,640	1961	16,500	5,370
June	62,300	1997	12,100	1934	33,000	10,900
July	45,800	1967	3,950	1934	20,000	10,190
August	16,800	1997	2,620	1961	8,190	3,560
September	14,000	1941	3,080	1940	7,370	2,510
October	13,400	1941	4,280	1934	8,000	2,110
November	11,100	1972	4,150	1934	7,340	1,700
December	9,380	1982	3,540	1934	6,100	1,300
Annual	18,100	1997	5,900	1934	11,200	2,850



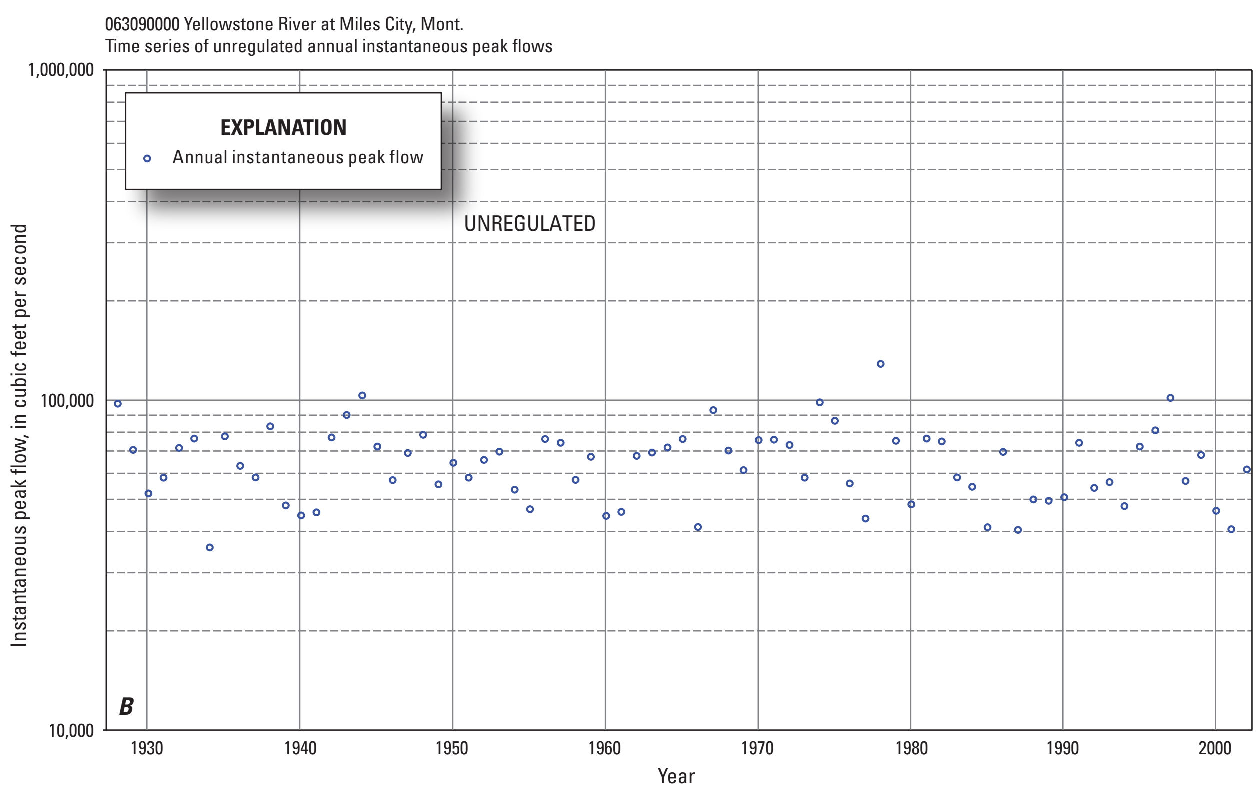
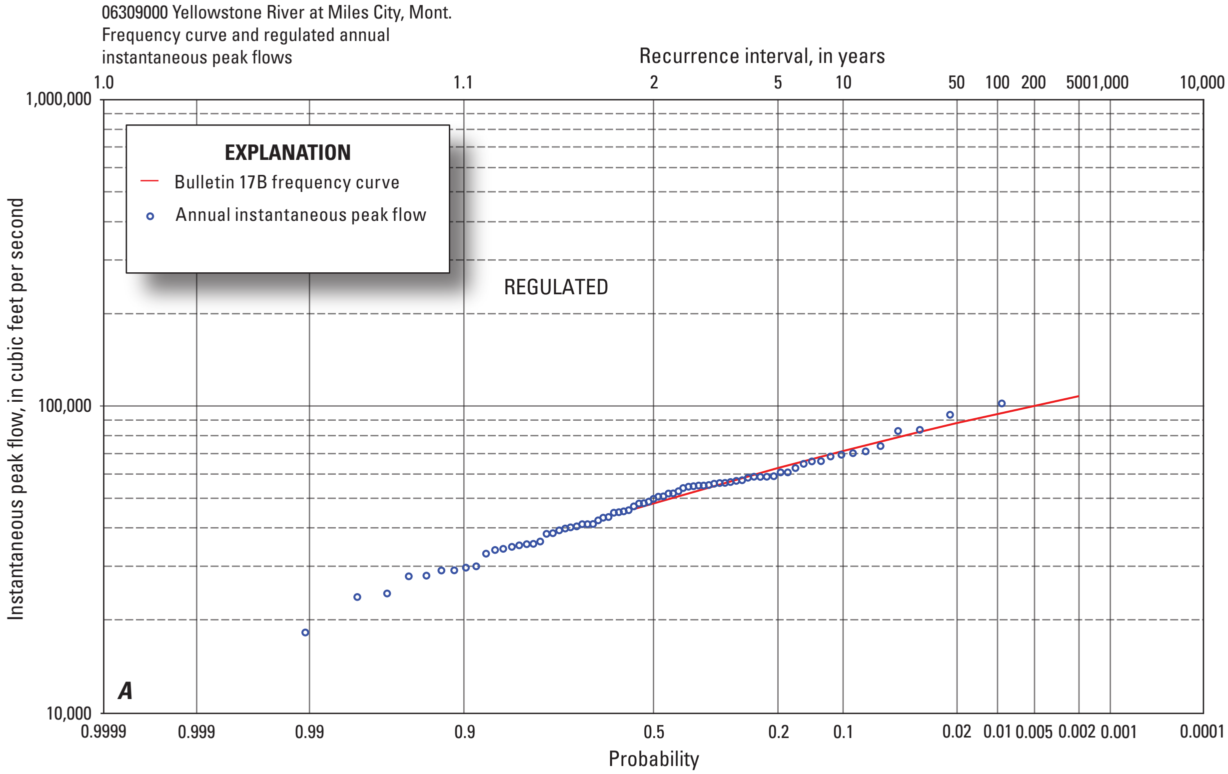


Figure 2-2-1. Annual instantaneous peak-flow data for streamflow-gaging station 06309000 (Yellowstone River at Miles City, Mont.) for unregulated streamflow conditions, 1928–2002. *A*, Frequency curve and unregulated annual instantaneous peak flows. *B*, Time series of unregulated annual instantaneous peak flows. [Bulletin 17B: U.S. Interagency Advisory Council on Water Data, 1982]



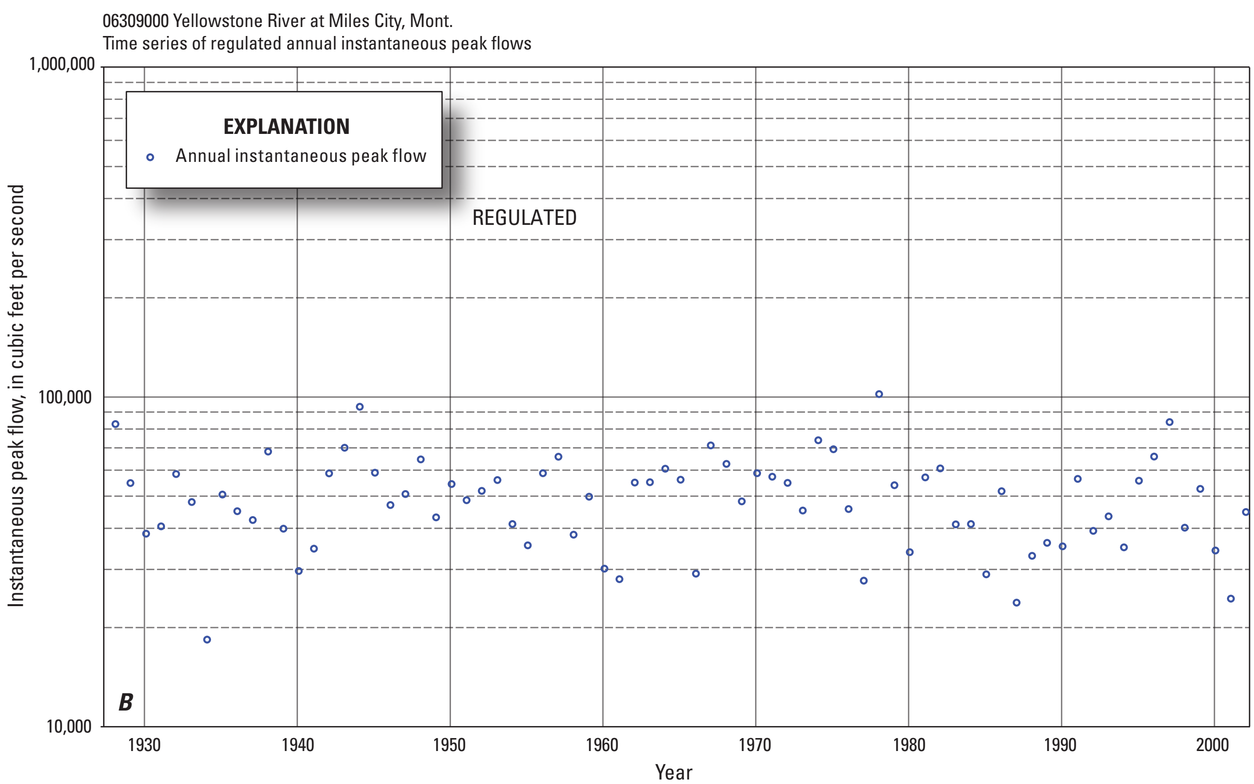


Figure 2-2-2. Annual instantaneous peak-flow data for streamflow-gaging station 06309000 (Yellowstone River at Miles City, Mont.) for regulated streamflow conditions, 1928–2002. *A*, Frequency curve and regulated annual instantaneous peak flows. *B*, Time series of regulated annual instantaneous peak flows. [Bulletin 17B: U.S. Interagency Advisory Council on Water Data, 1982]

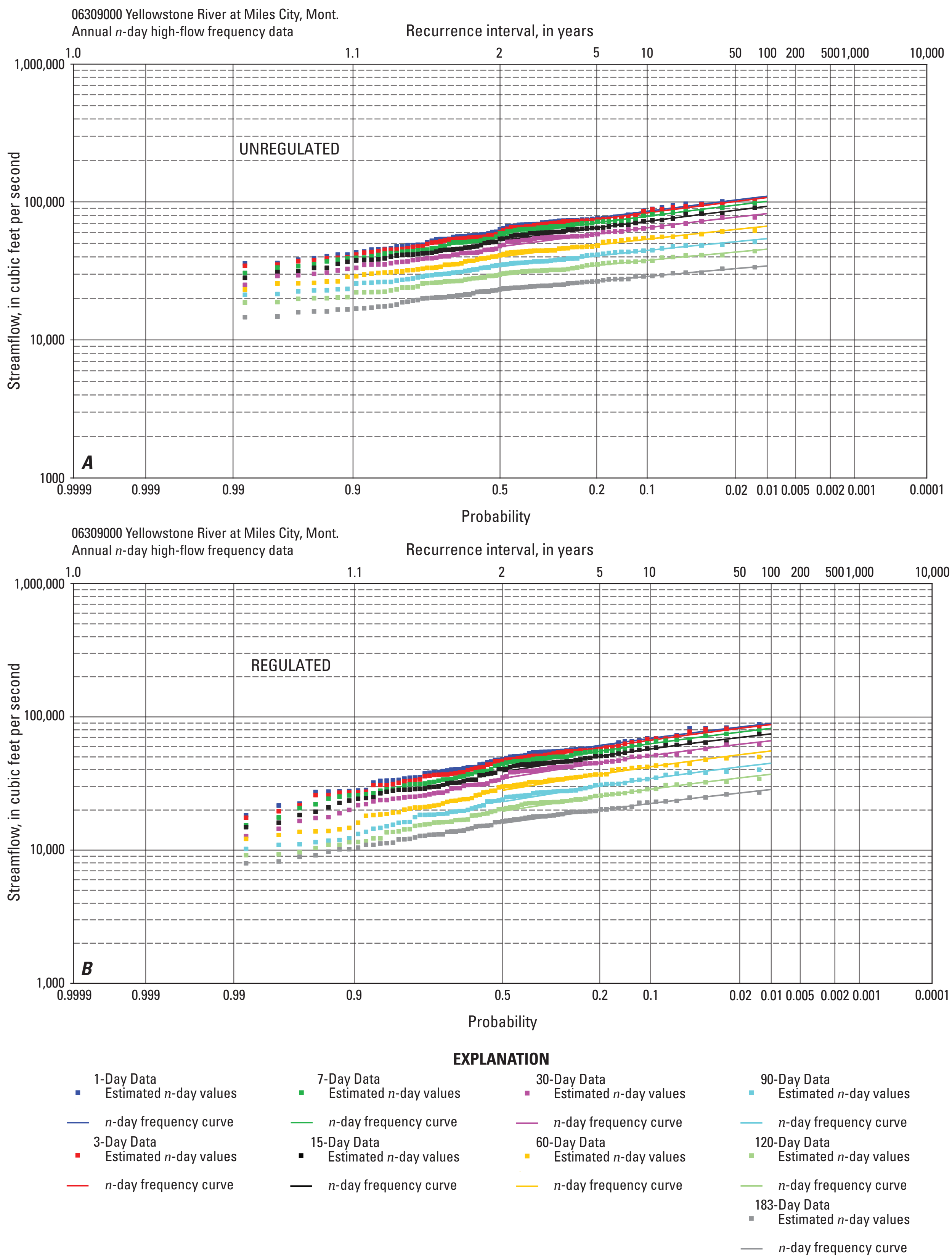


Figure 2-2-3. Annual *n*-day high-flow frequency data for streamflow-gaging station 06309000 (Yellowstone River at Miles City, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

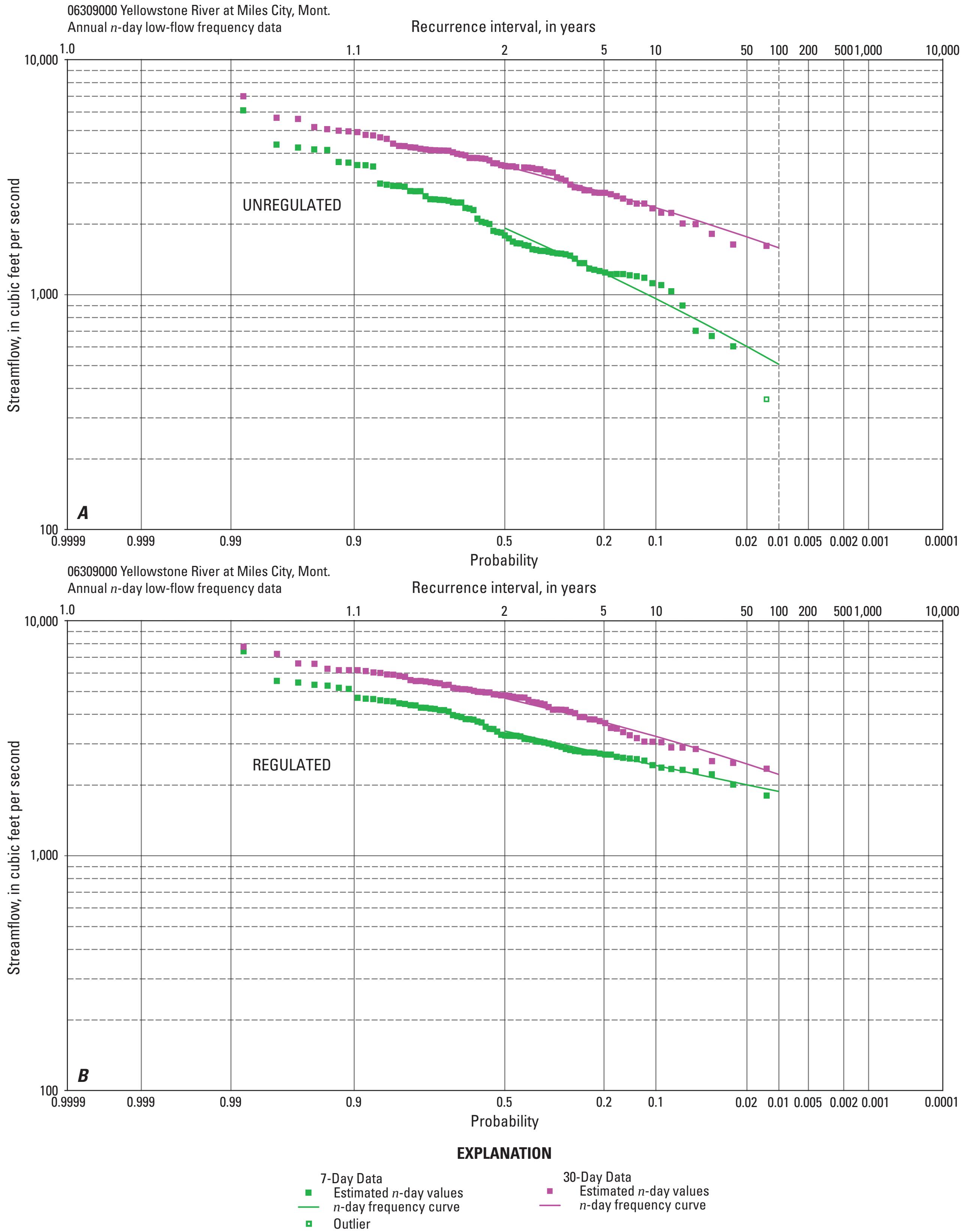


Figure 2-2-4. Annual *n*-day low-flow frequency data for streamflow-gaging station 06309000 (Yellowstone River at Miles City, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.

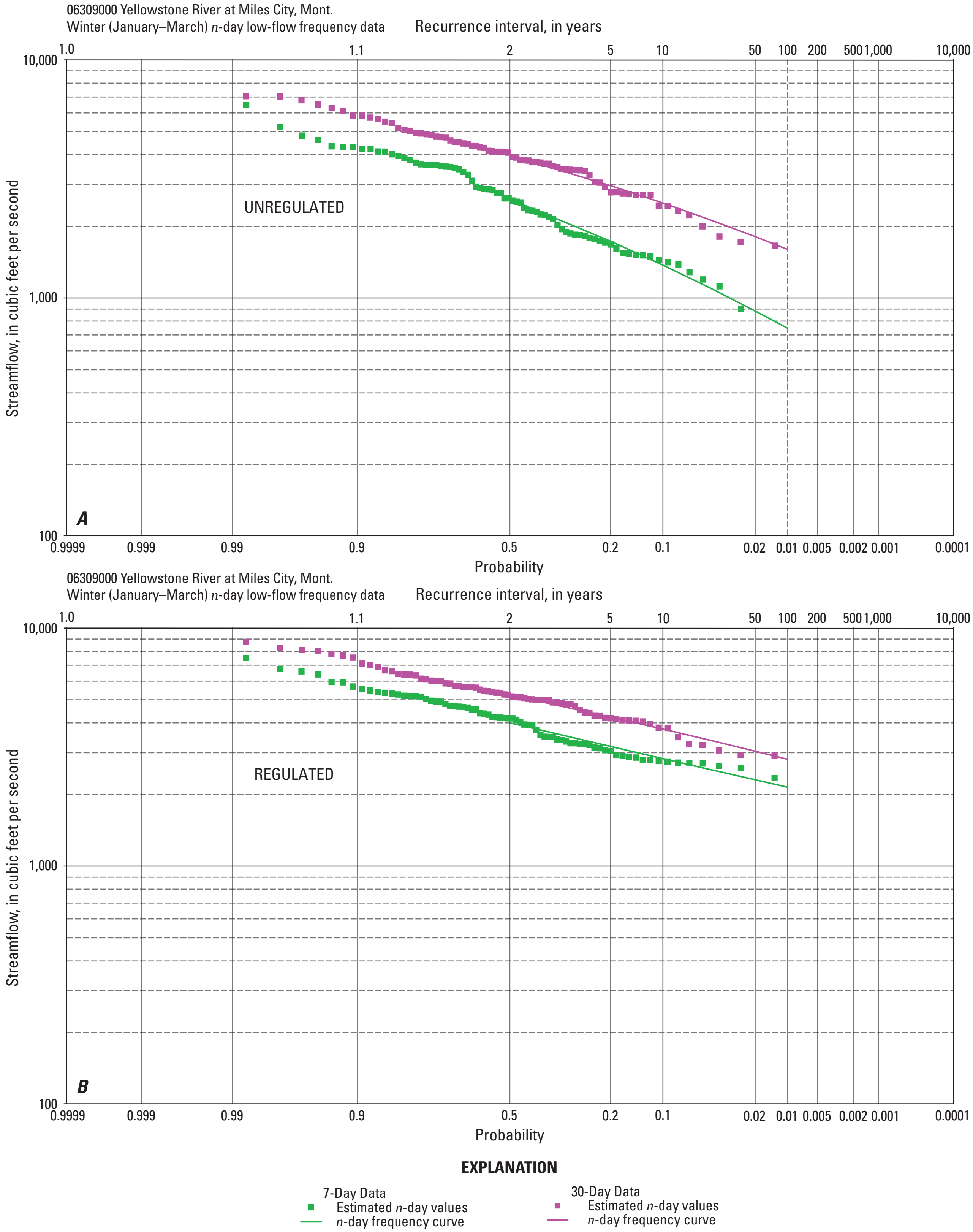


Figure 2-2-5. Winter (January–March) *n*-day low-flow frequency data for streamflow-gaging station 06309000 (Yellowstone River at Miles City, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

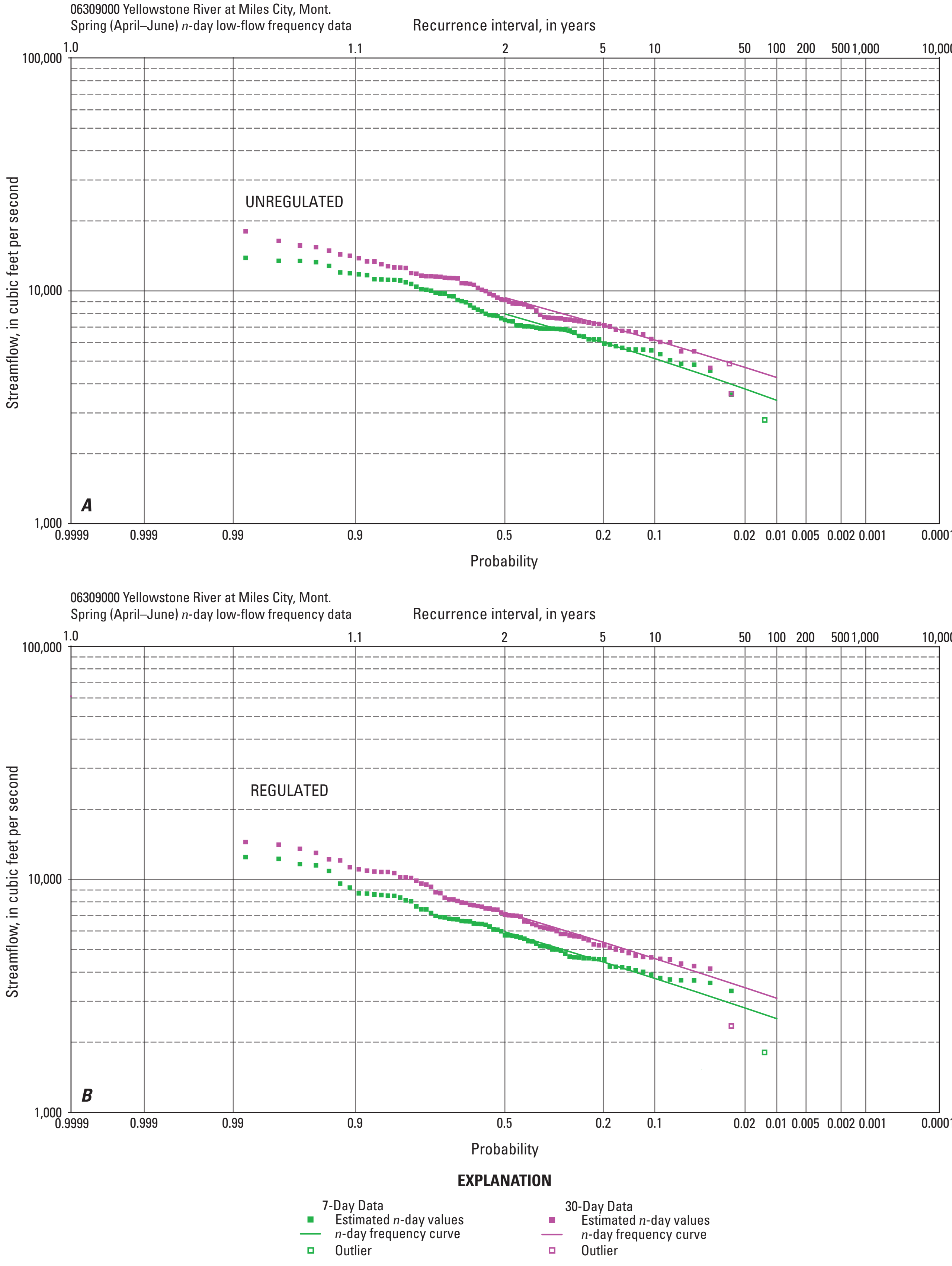


Figure 2-2-6. Spring (April–June) *n*-day low-flow frequency data for streamflow-gaging station 06309000 (Yellowstone River at Miles City, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.

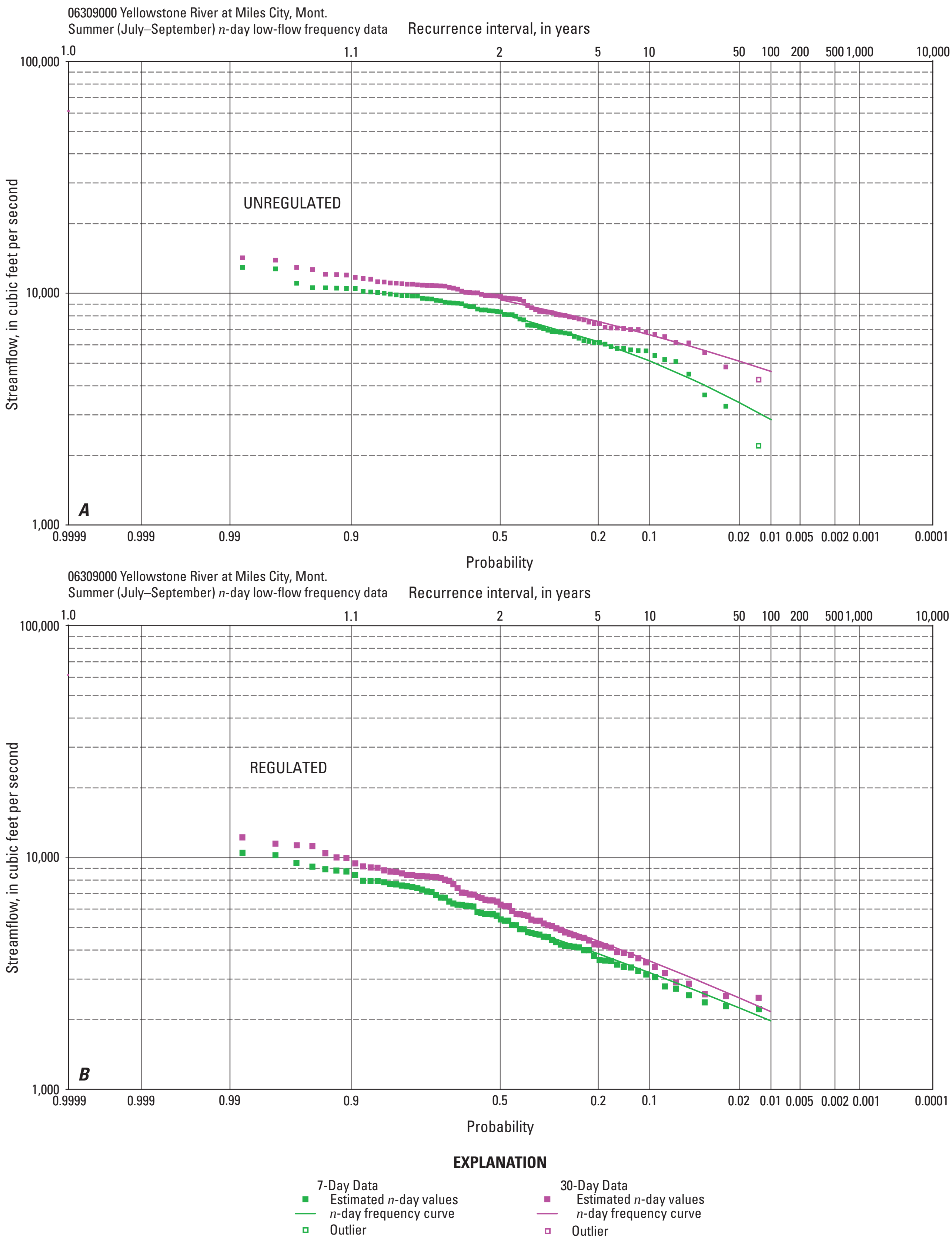


Figure 2-2-7. Summer (July–September) *n*-day low-flow frequency data for streamflow-gaging station 06309000 (Yellowstone River at Miles City, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

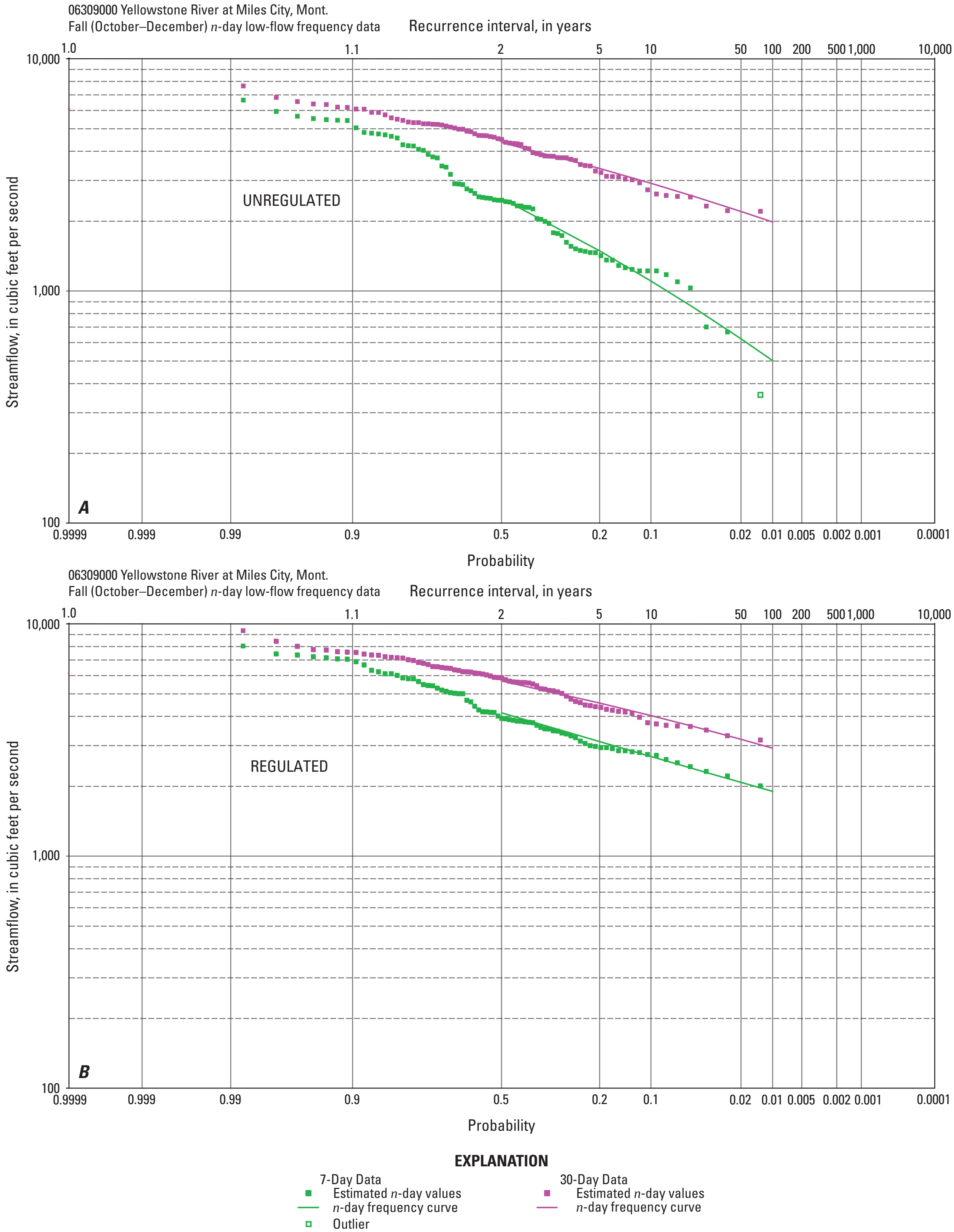


Figure 2-2-8. Fall (October–December) *n*-day low-flow frequency data for streamflow-gaging station 06309000 (Yellowstone River at Miles City, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.

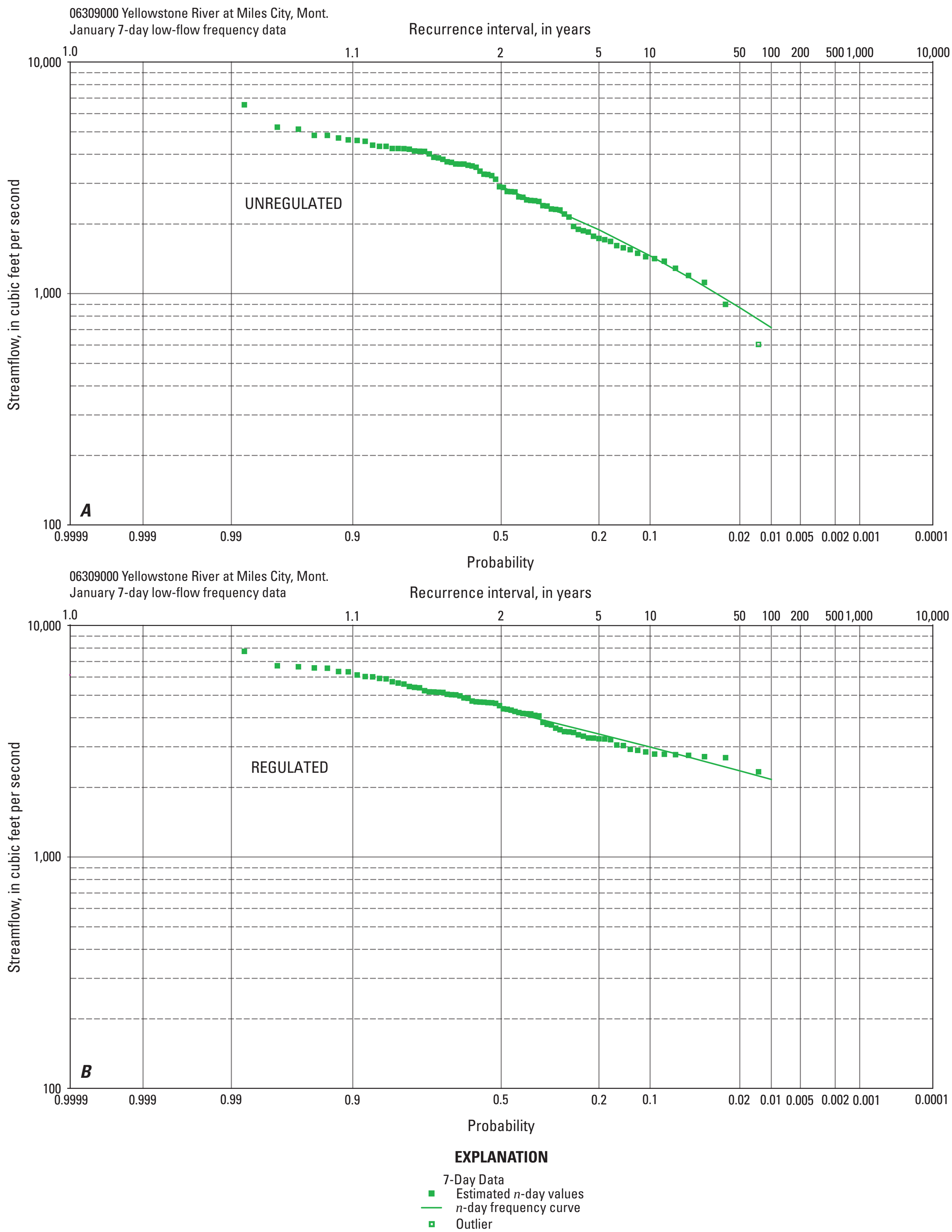


Figure 2-2-9. January 7-day low-flow frequency data for streamflow-gaging station 06309000 (Yellowstone River at Miles City, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

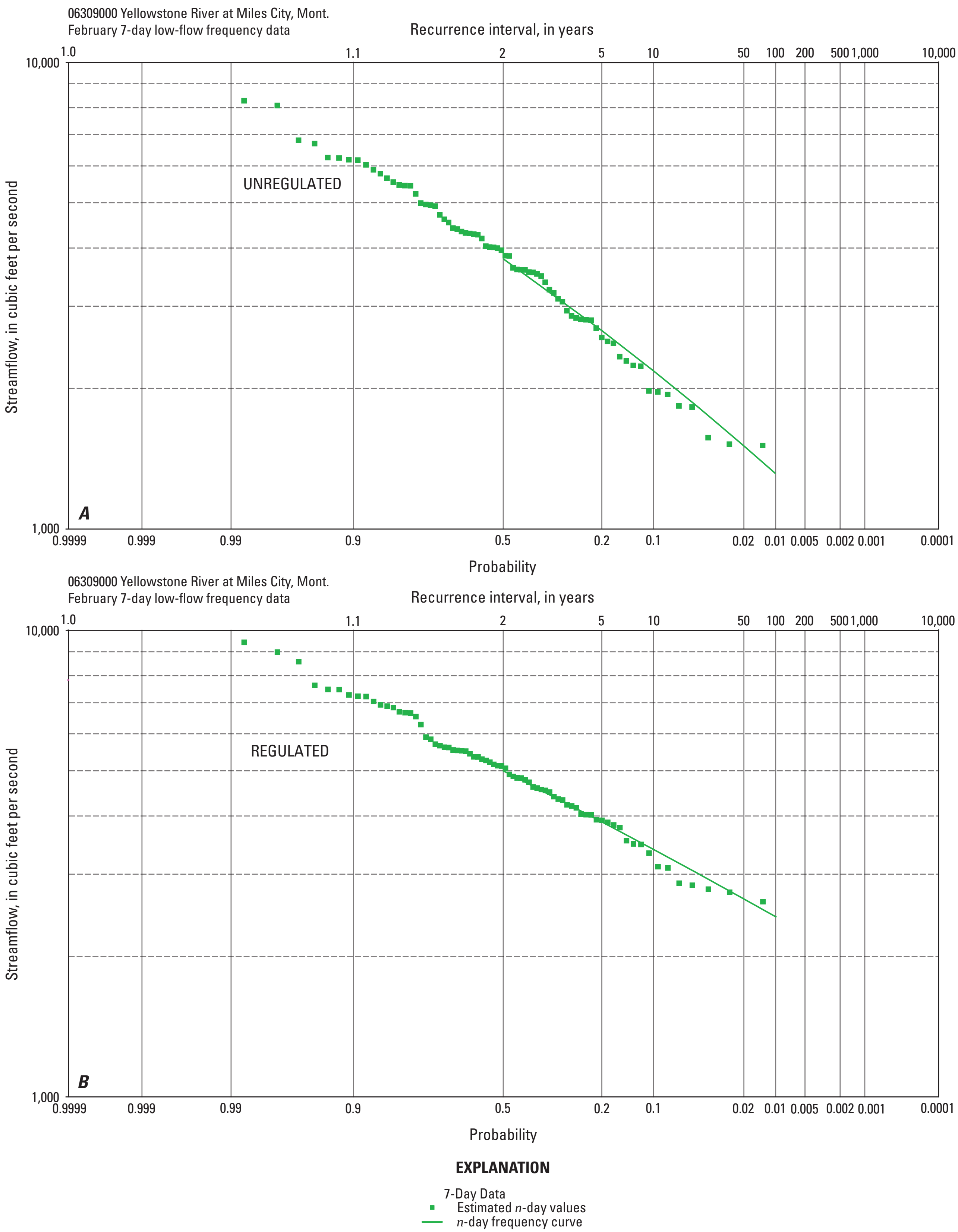
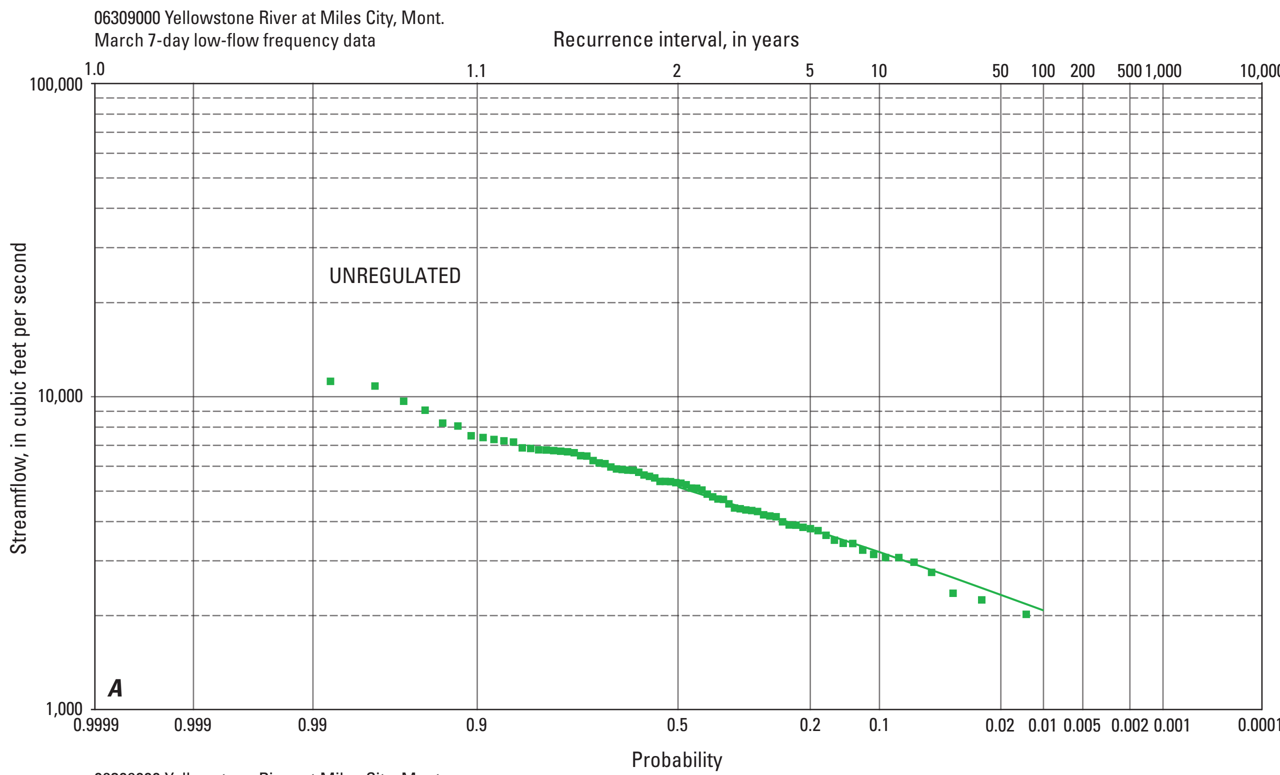
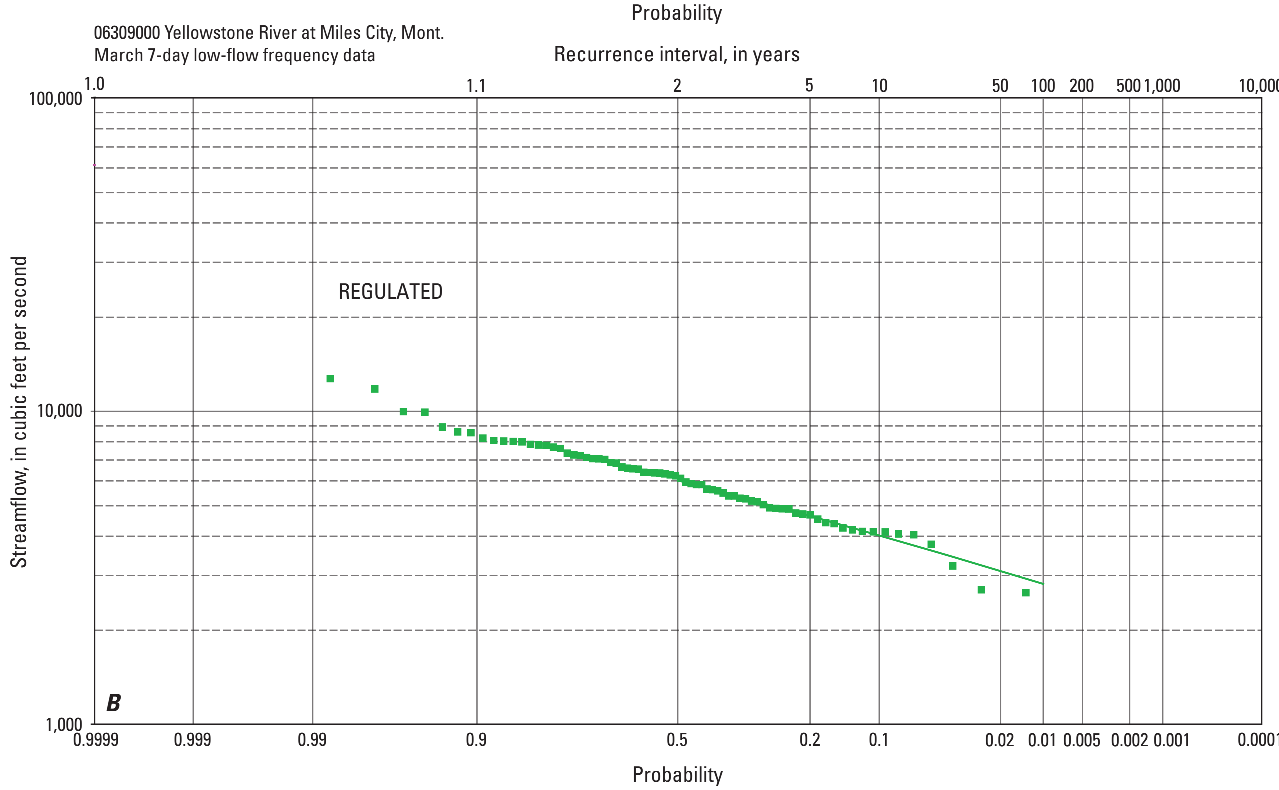


Figure 2-2-10. February 7-day low-flow frequency data for streamflow-gaging station 06309000 (Yellowstone River at Miles City, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.





EXPLANATION

7-Day Data
Estimated *n*-day values
n-day frequency curve

Figure 2-2-11. March 7-day low-flow frequency data for streamflow-gaging station 06309000 (Yellowstone River at Miles City, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

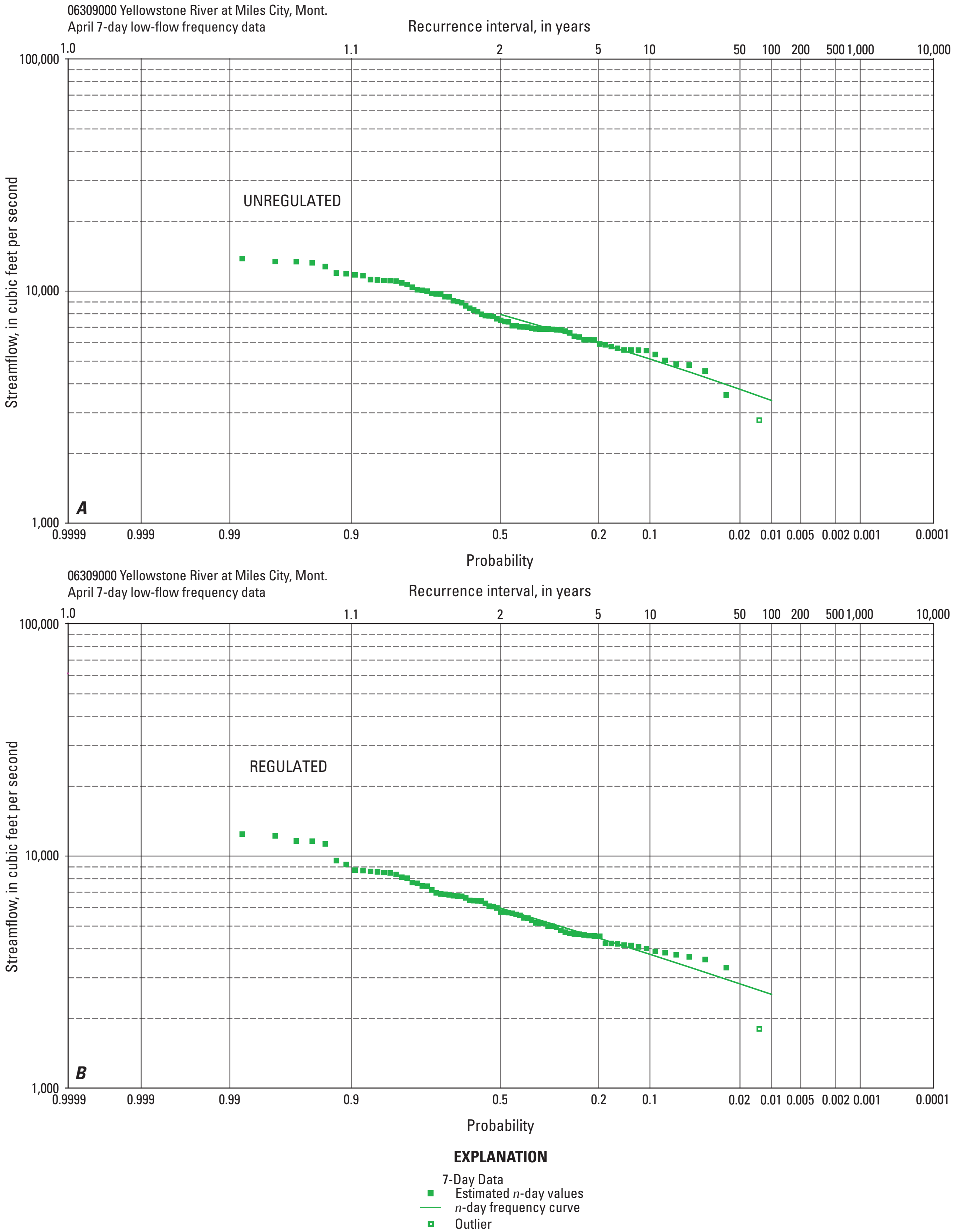


Figure 2-2-12. April 7-day low-flow frequency data for streamflow-gaging station 06309000 (Yellowstone River at Miles City, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.

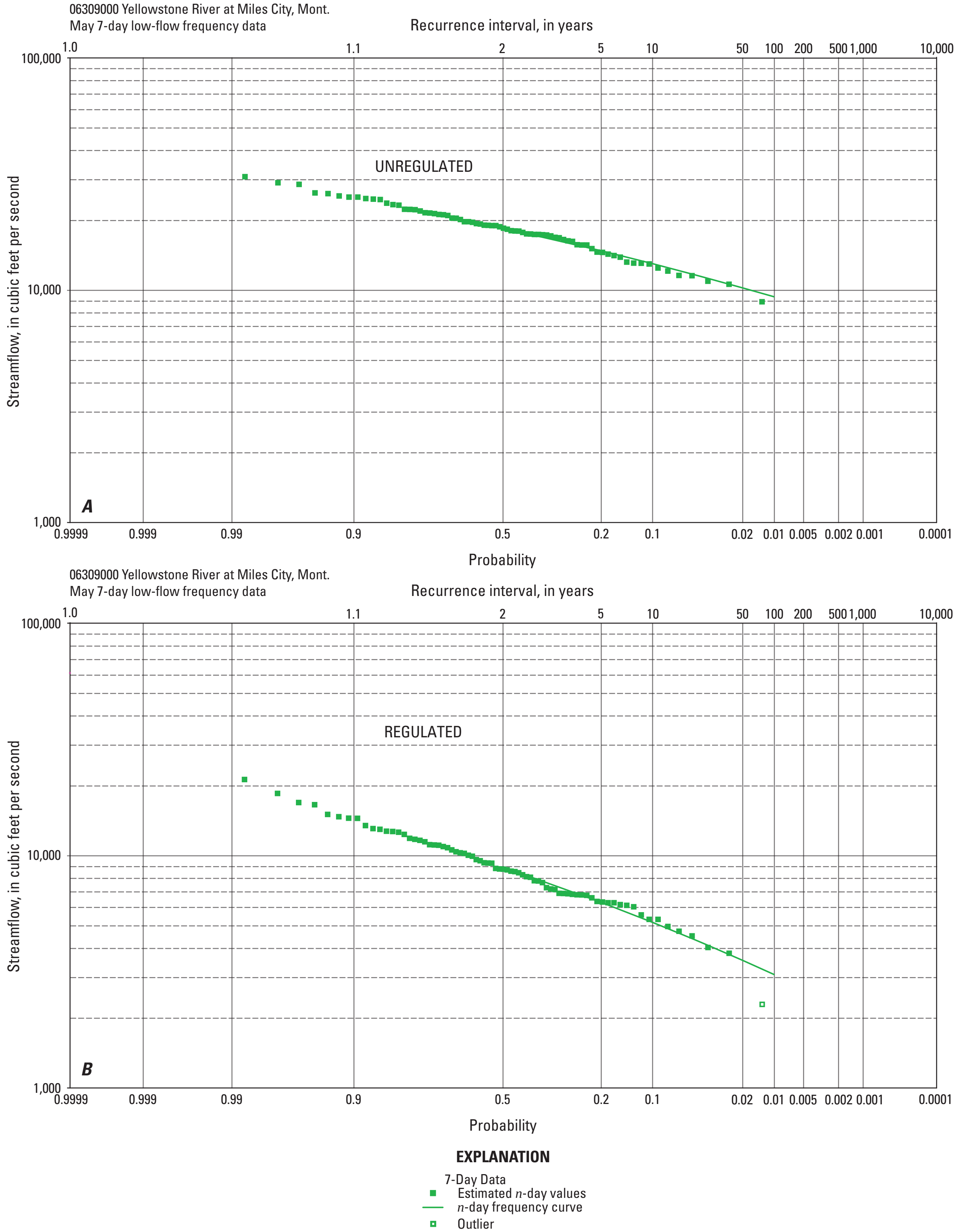


Figure 2-2-13. May 7-day low-flow frequency data for streamflow-gaging station 06309000 (Yellowstone River at Miles City, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

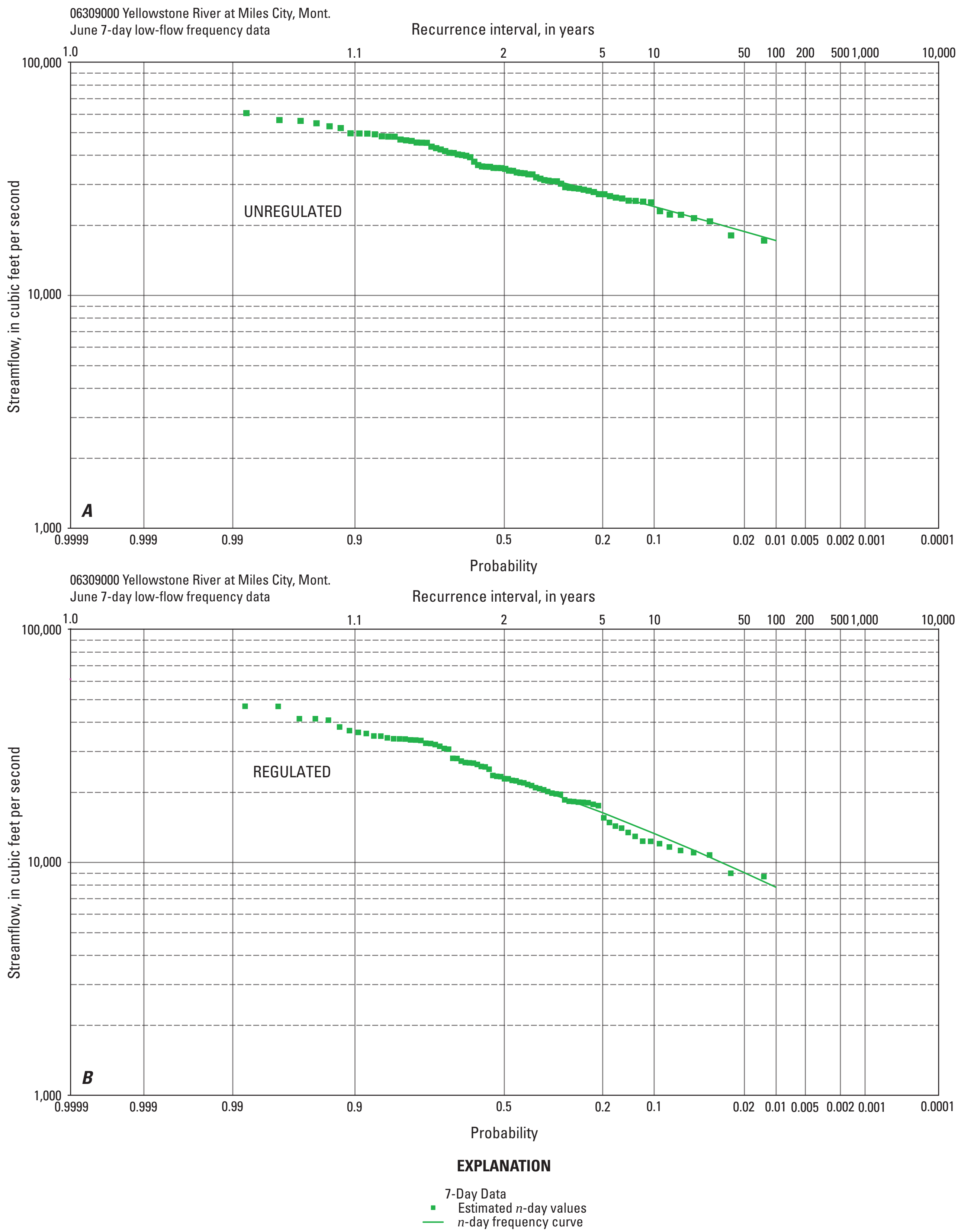
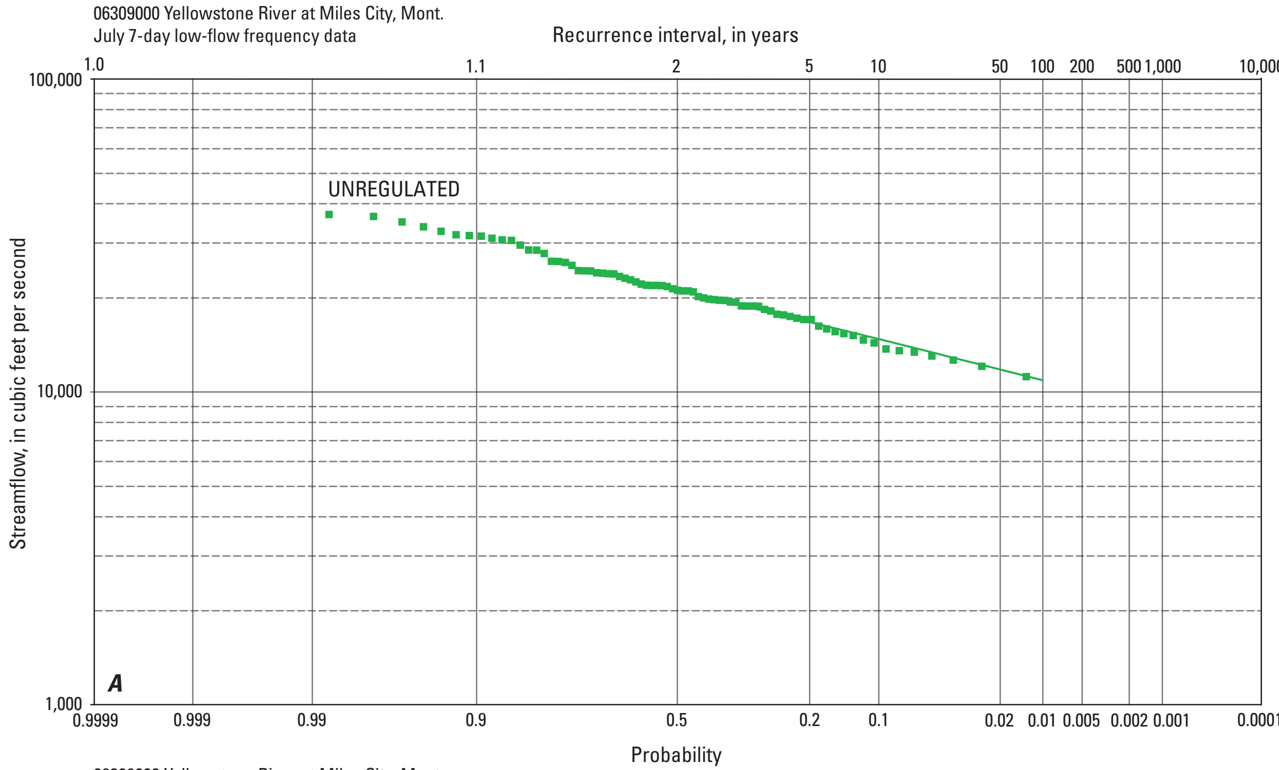


Figure 2-2-14. June 7-day low-flow frequency data for streamflow-gaging station 06309000 (Yellowstone River at Miles City, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.



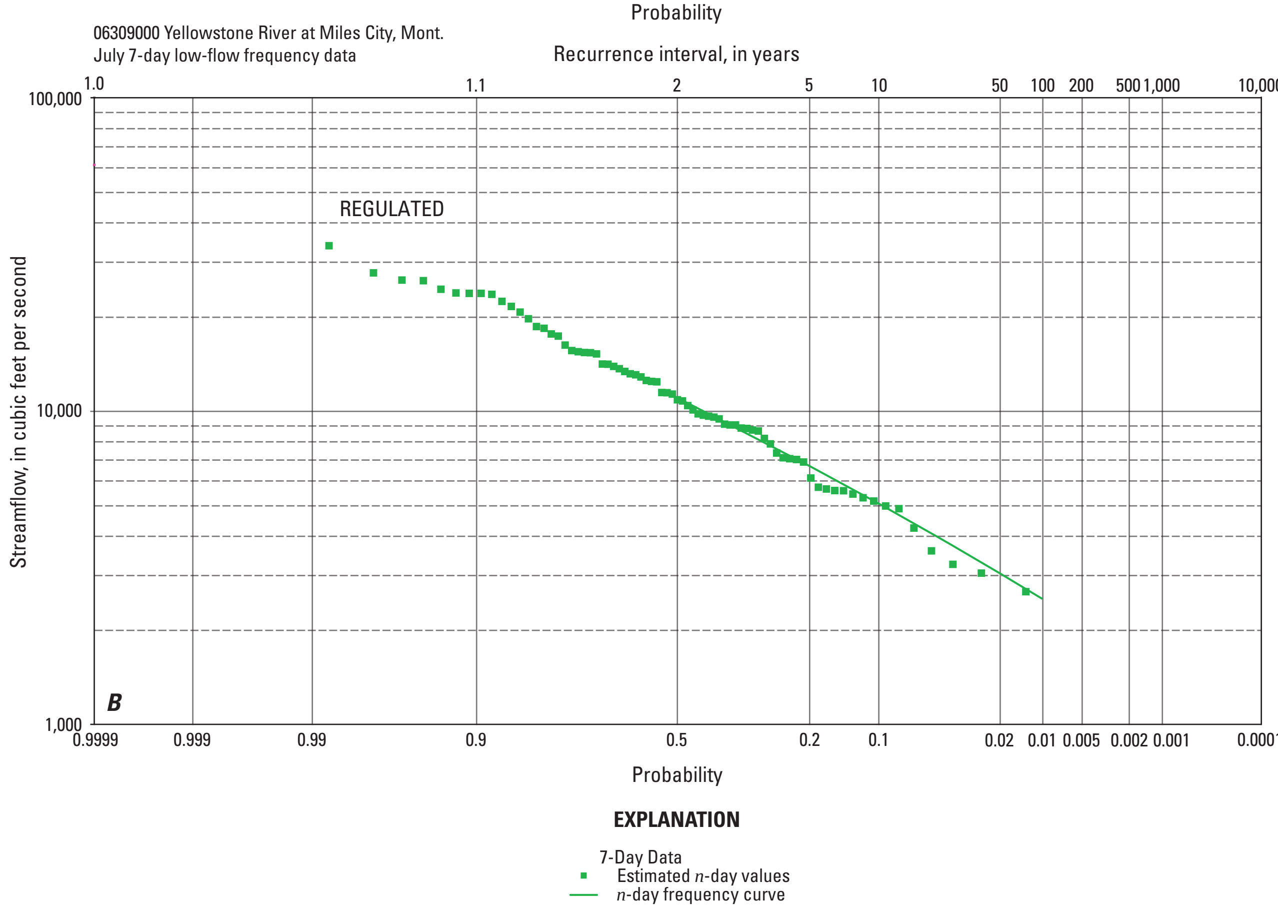


Figure 2-2-15. July 7-day low-flow frequency data for streamflow-gaging station 06309000 (Yellowstone River at Miles City, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

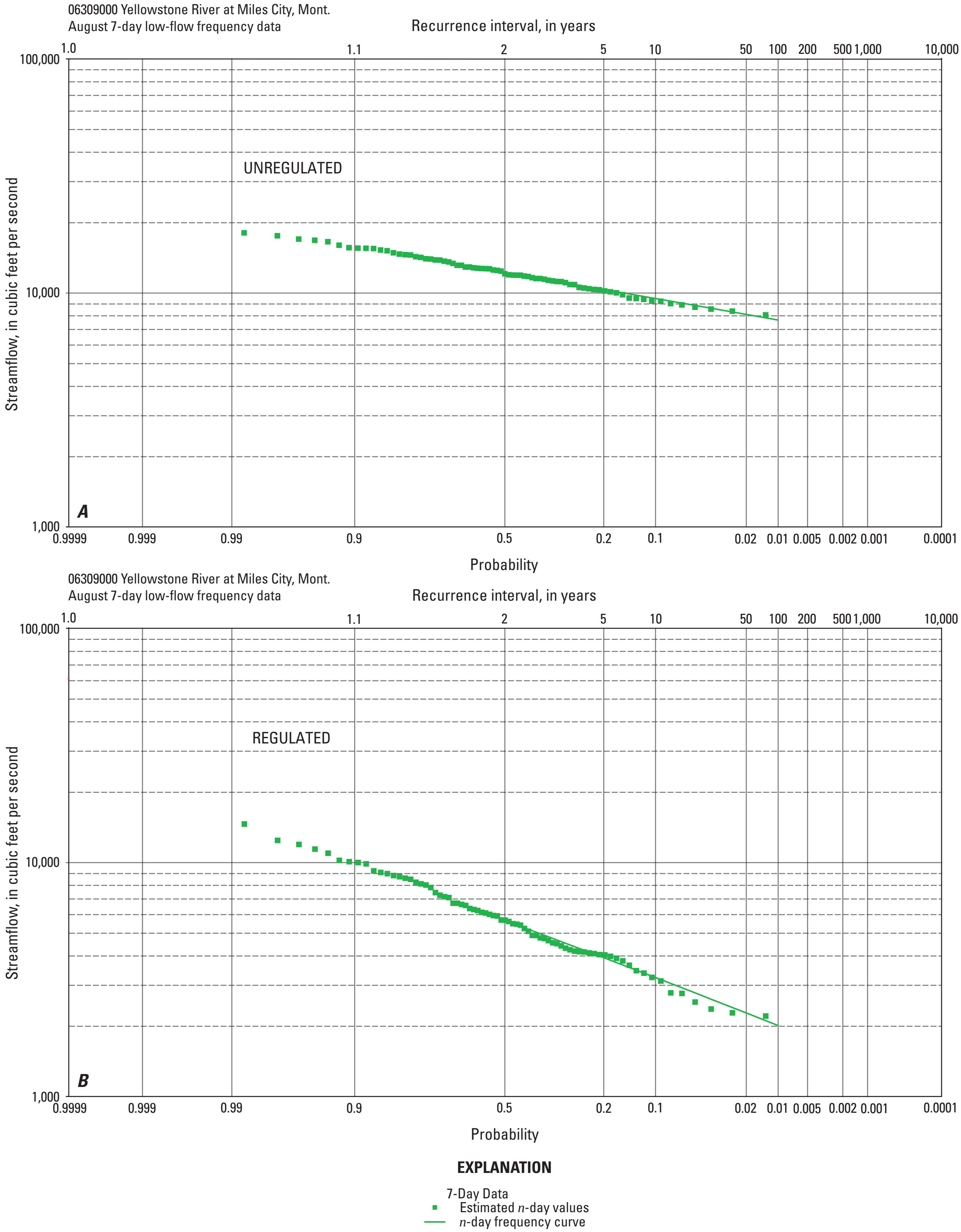
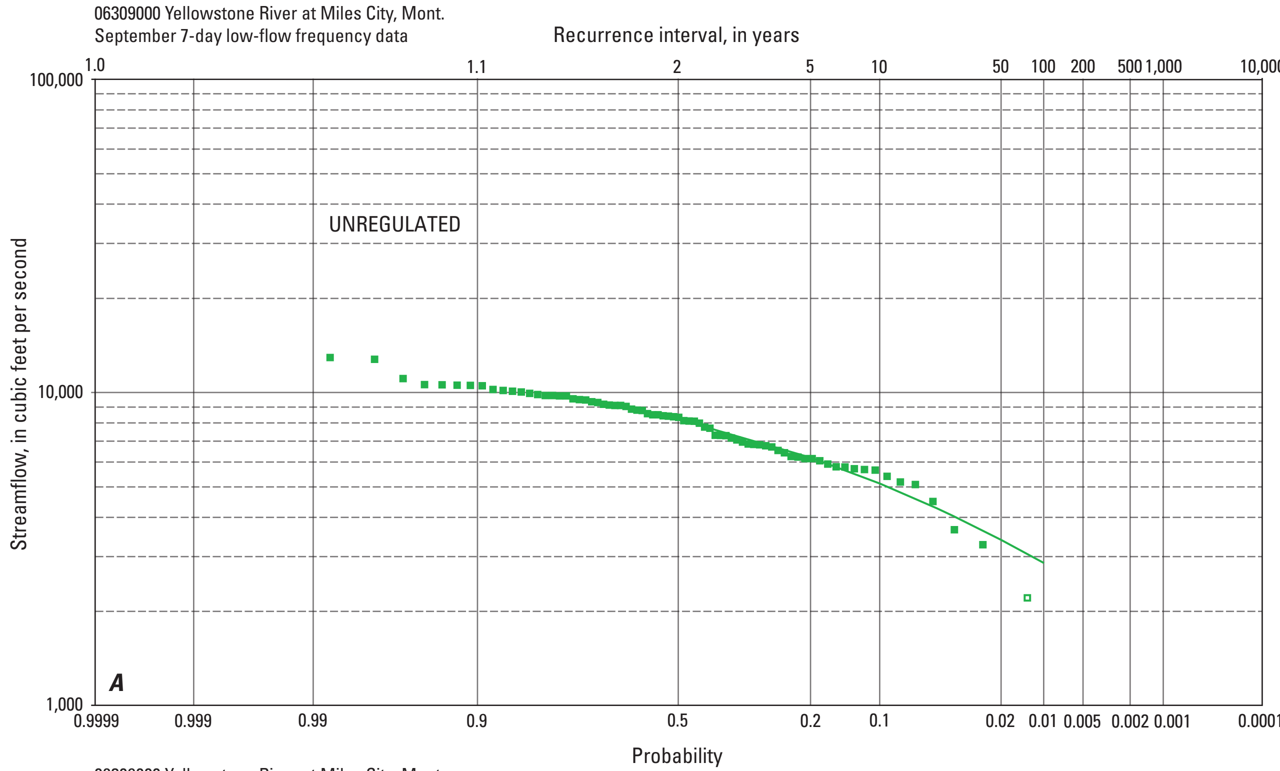


Figure 2-2-16. August 7-day low-flow frequency data for streamflow-gaging station 06309000 (Yellowstone River at Miles City, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.



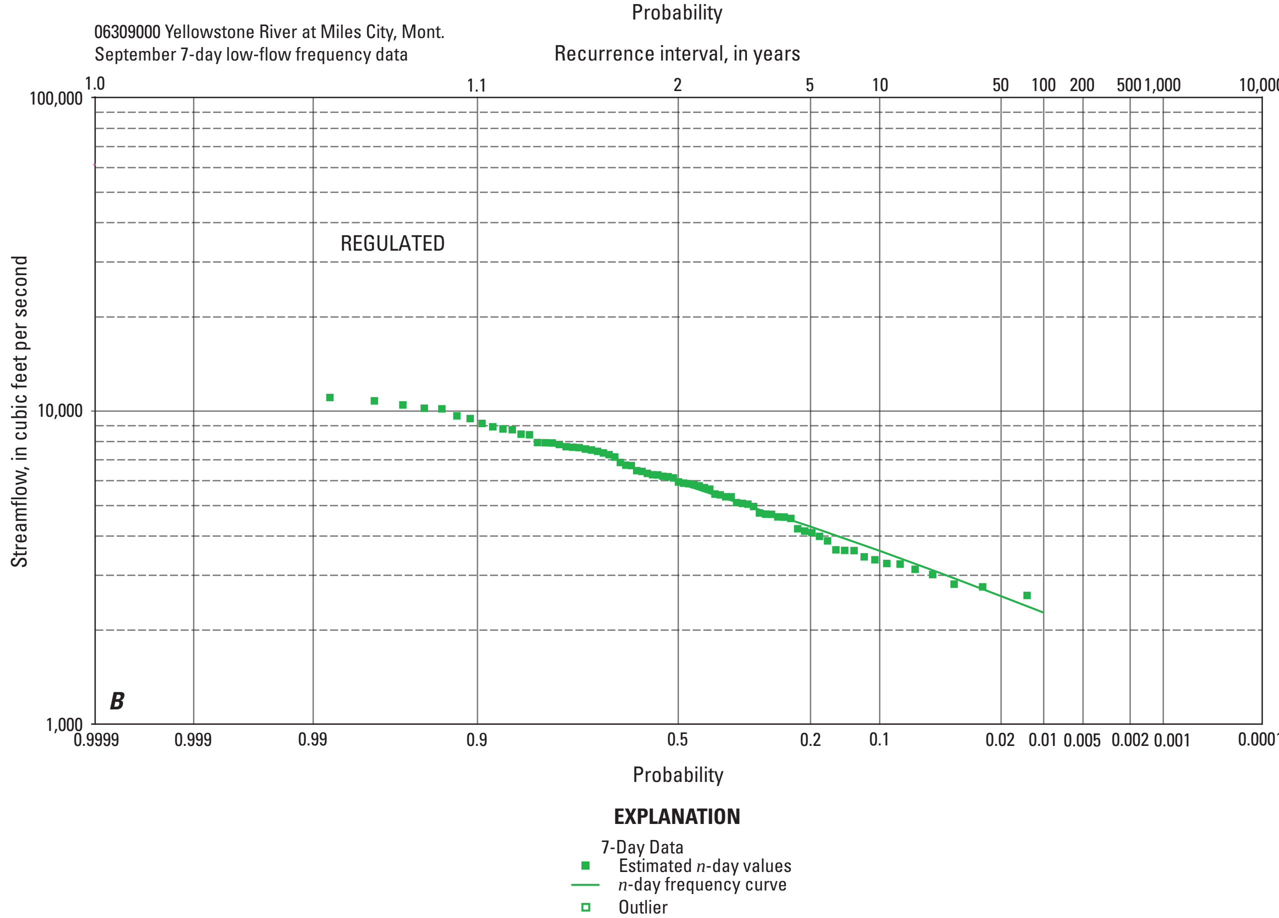


Figure 2-2-17. September 7-day low-flow frequency data for streamflow-gaging station 06309000 (Yellowstone River at Miles City, Mont.) for *A,* unregulated and *B*, regulated streamflow conditions, 1928–2002.

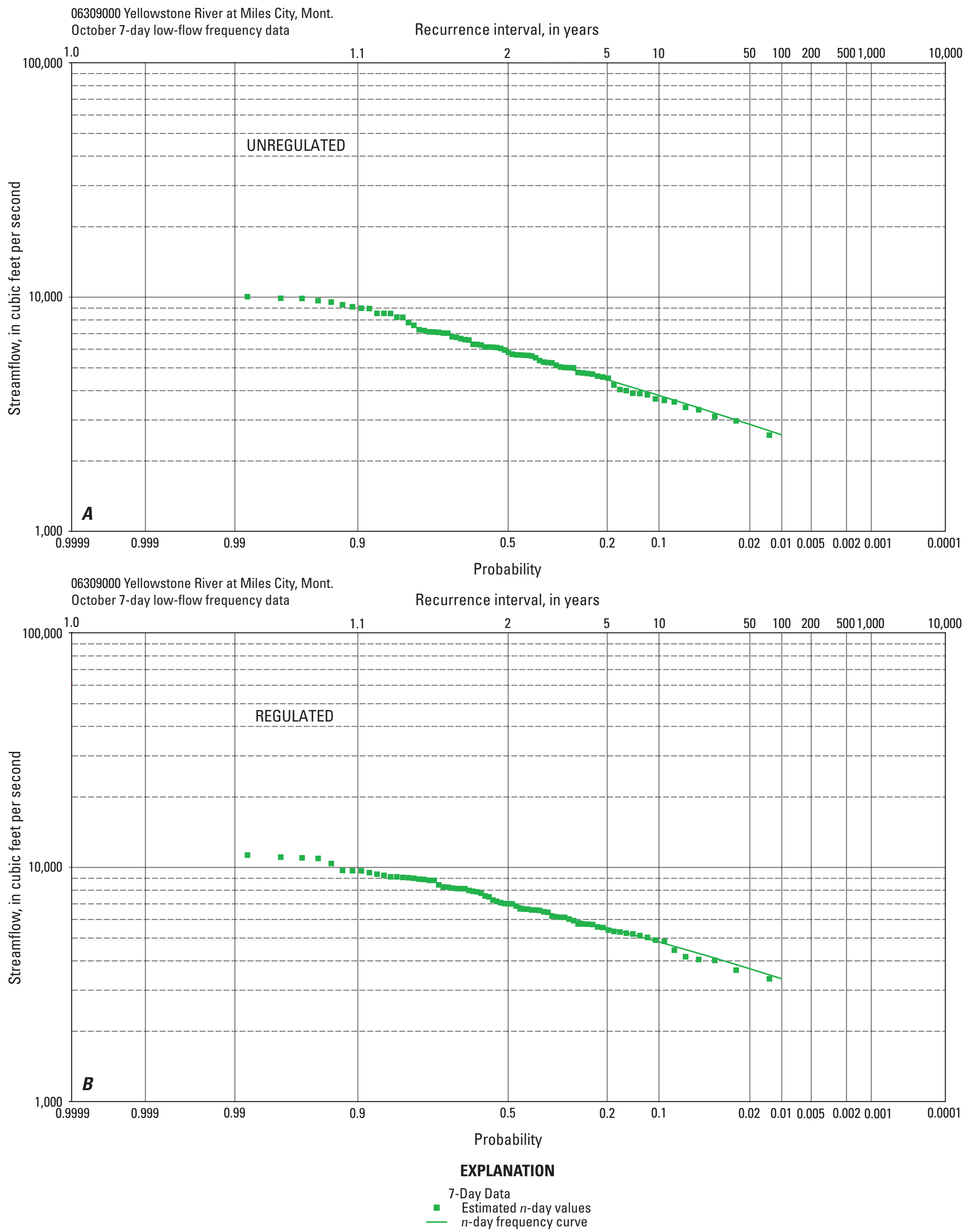


Figure 2-2-18. October 7-day low-flow frequency data for streamflow-gaging station 06309000 (Yellowstone River at Miles City, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.

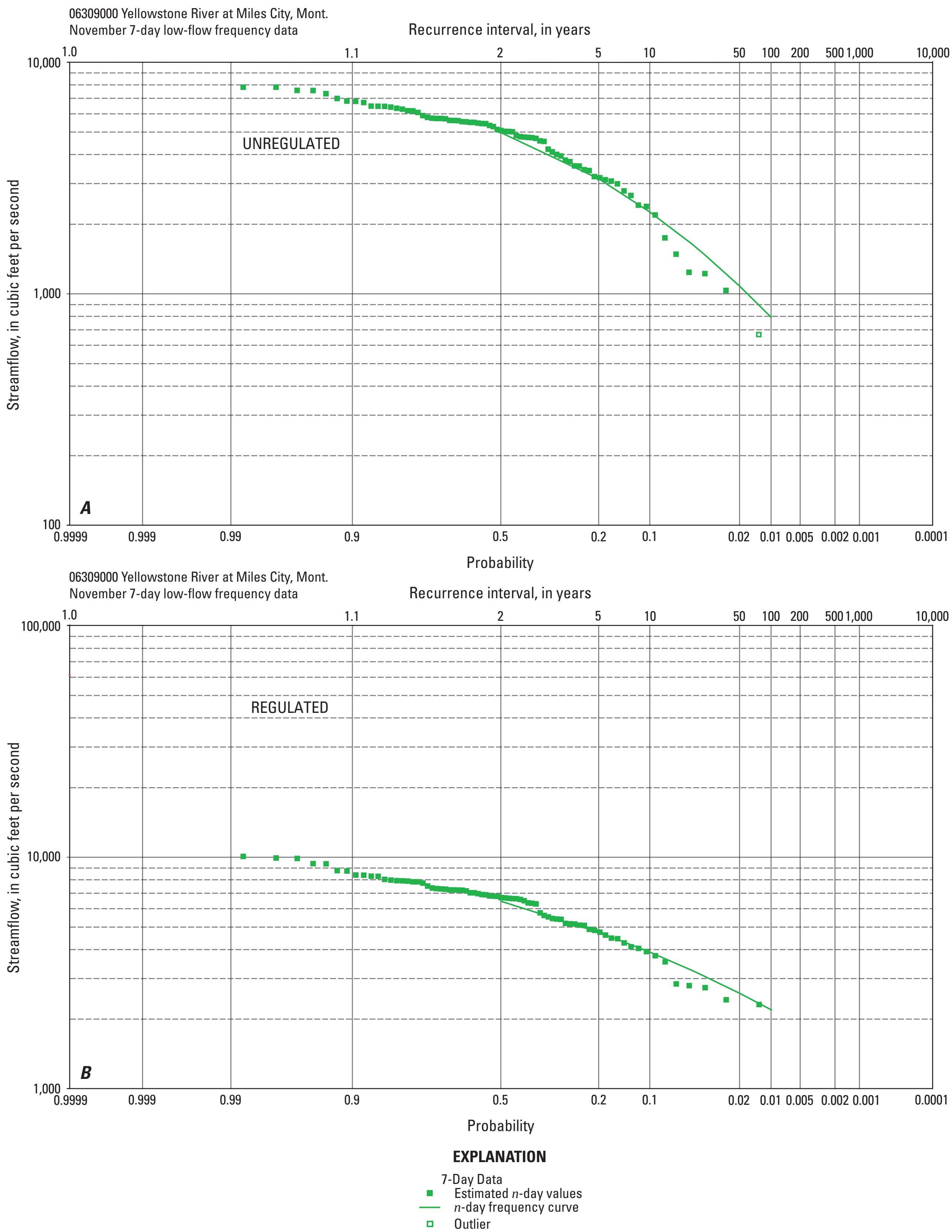


Figure 2-2-19. November 7-day low-flow frequency data for streamflow-gaging station 06309000 (Yellowstone River at Miles City, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

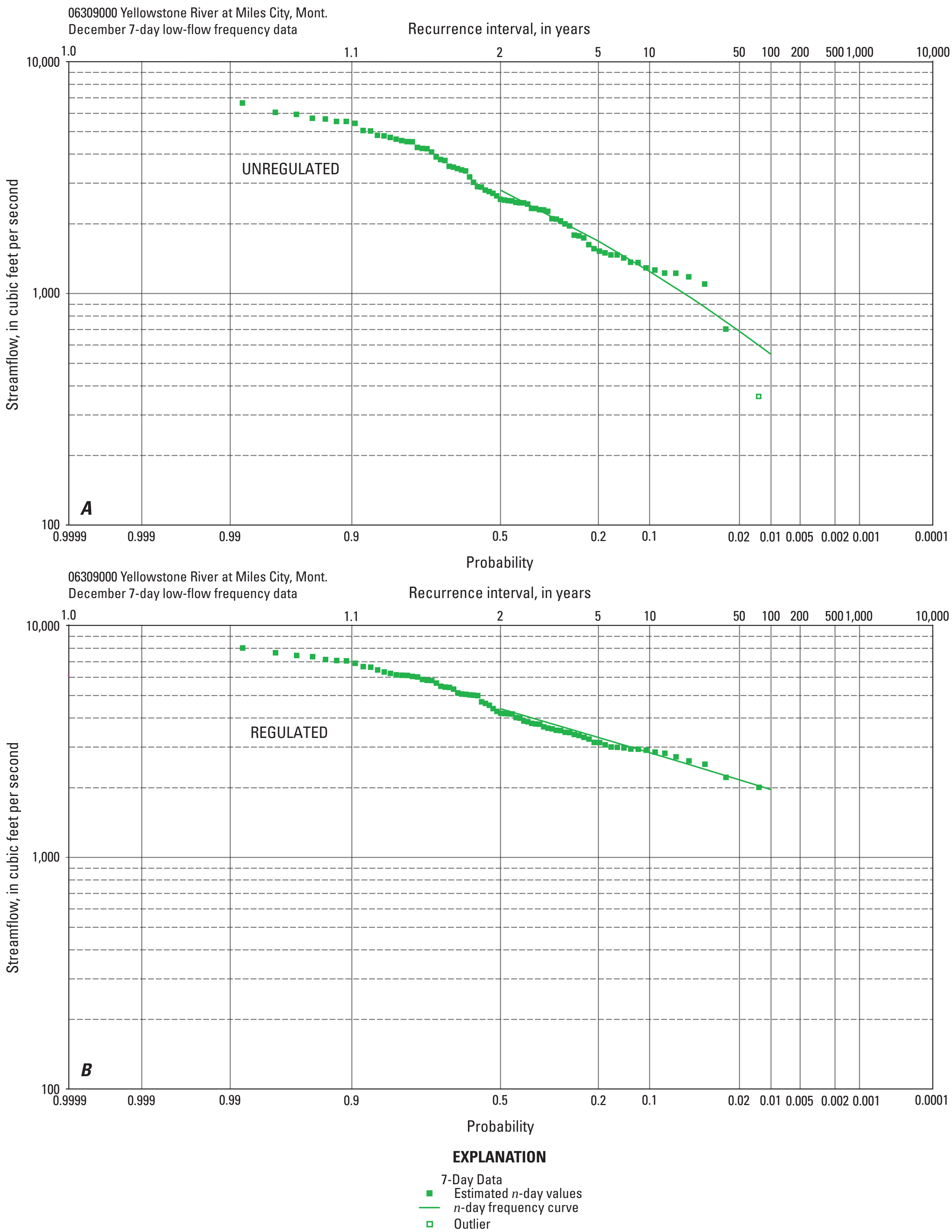
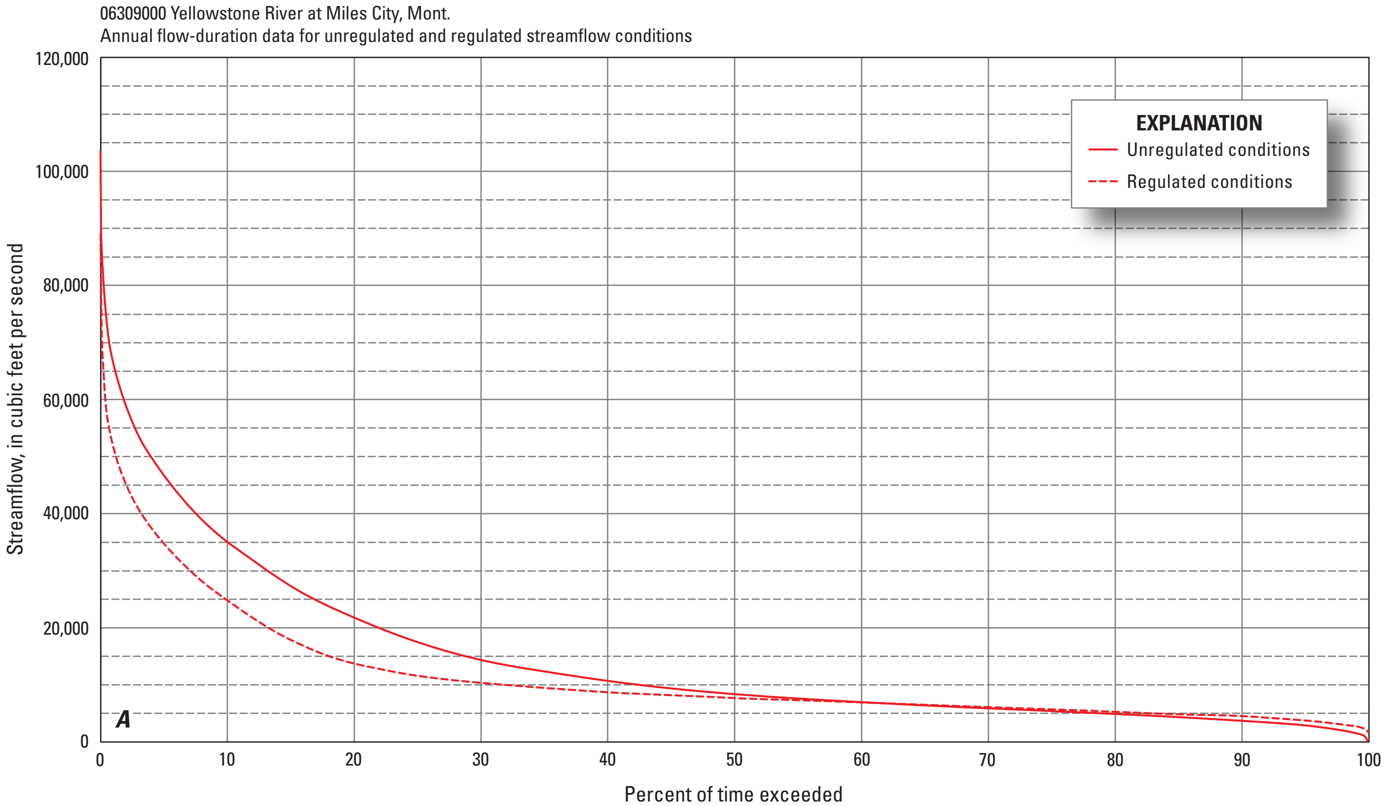


Figure 2-2-20. December 7-day low-flow frequency data for streamflow-gaging station 06309000 (Yellowstone River at Miles City, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.



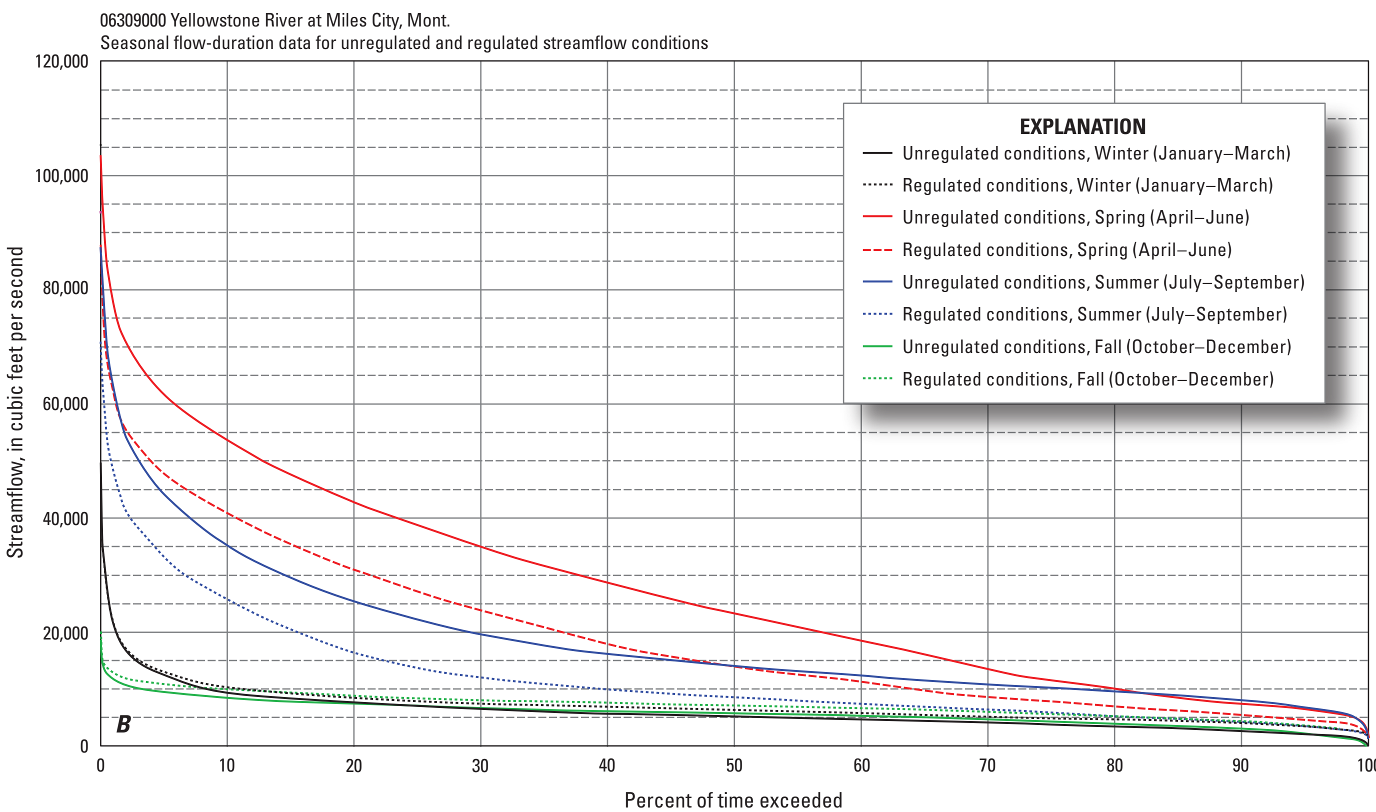


Figure 2-2-21. *A,* Annual and *B,* seasonal flow-duration data for streamflow-gaging station 06309000 (Yellowstone River at Miles City, Mont.) for unregulated and regulated streamflow conditions, 1928–2002.

Appendix 2–3. Statistics for Streamflow-Gaging Station 06327500 (Yellowstone River at Glendive, Mont.)

Table 2-3-1. Annual *n*-day high-flow frequency data for streamflow-gaging station 06327500 (Yellowstone River at Glendive, Mont.) for unregulated and regulated streamflow conditions, 1928–2002.

[Abbreviations: ft^3/s, cubic feet per second. Symbol: %, percent]

Unregulated							
n, period of consecutive days	Streamflow, in ft^3/s, for indicated recurrence interval, in years, and exceedance probability, in percent						
	2 50%	5 20%	10 10%	20 5%	25 4%	50 2%	100 1%
1	67,200	85,100	96,500	107,000	110,000	121,000	131,000
3	64,800	80,900	90,700	99,600	102,000	110,000	118,000
7	60,800	76,300	85,700	94,200	96,800	105,000	112,000
15	56,000	69,900	78,200	85,800	88,100	95,000	102,000
30	50,600	62,800	70,100	76,600	78,600	84,500	90,100
60	42,700	52,100	57,600	62,500	64,000	68,400	72,600
90	36,400	43,600	47,800	51,400	52,500	55,700	58,700
120	31,300	37,100	40,500	43,400	44,300	46,800	49,200
183	24,300	28,600	31,100	33,200	33,800	35,600	37,300
Regulated							
n, period of consecutive days	Streamflow, in ft^3/s, for indicated recurrence interval, in years, and exceedance probability, in percent						
	2 50%	5 20%	10 10%	20 5%	25 4%	50 2%	100 1%
1	52,200	69,600	80,800	91,400	94,800	105,000	115,000
3	49,900	65,100	74,300	82,400	84,900	92,200	99,100
7	45,400	59,900	68,600	76,500	78,900	86,100	92,900
15	41,400	54,900	62,700	69,300	71,300	77,000	82,200
30	36,800	48,900	55,700	61,400	63,100	68,000	72,400
60	29,700	39,600	45,300	50,300	51,900	56,300	60,300
90	24,400	32,300	36,800	40,800	42,000	45,400	48,500
120	20,900	27,100	30,600	33,700	34,600	37,200	39,600
183	16,900	21,400	24,000	26,200	26,900	28,900	30,700

Table 2-3-2. Annual, seasonal, and monthly *n*-day low-flow frequency data for streamflow-gaging station 06327500 (Yellowstone River at Glendive, Mont.) for unregulated and regulated steamflow conditions, 1928–2002.

[Abbreviations: ft^3/s, cubic feet per second. Symbol: %, percent]

	Unregulated						
***n*, period of consecutive days (month, for monthly frequency data)**	**Streamflow, in ft^3/s, for indicated recurrence interval, in years, and exceedance probability, in percent**						
	2 50%	**5 20%**	**10 10%**	**20 5%**	**25 4%**	**50 2%**	**100 1%**
Annual							
7	1,820	936	567	343	292	177	107
30	3,450	2,630	2,270	2,000	1,920	1,720	1,560
Winter (January–March)							
7	2,390	1,560	1,230	1,010	949	798	681
30	3,860	2,930	2,530	2,240	2,160	1,950	1,780
Spring (April–June)							
7	8,440	6,390	5,450	4,750	4,560	4,040	3,610
30	10,100	7,740	6,630	5,800	5,570	4,940	4,420
Summer (July–September)							
7	9,050	6,450	4,790	3,490	3,140	2,250	1,600
30	10,000	8,030	6,990	6,160	5,930	5,280	4,730
Fall (October–December)							
7	2,280	1,130	737	498	442	309	219
30	4,460	3,350	2,830	2,440	2,330	2,040	1,800
Monthly							
7 (January)	2,780	1,720	1,300	1,020	948	762	622
7 (February)	3,580	2,520	2,080	1,760	1,680	1,460	1,280
7 (March)	5,190	3,740	3,140	2,710	2,600	2,300	2,060
7 (April)	8,440	6,390	5,450	4,750	4,560	4,040	3,610
7 (May)	20,600	16,500	14,500	13,000	12,600	11,400	10,400
7 (June)	36,000	28,200	24,700	22,200	21,500	19,500	17,900
7 (July)	22,300	17,400	15,300	13,700	13,300	12,100	11,100
7 (August)	12,700	10,700	9,760	9,060	8,860	8,330	7,870
7 (September)	9,070	6,460	4,790	3,490	3,140	2,250	1,600
7 (October)	5,850	4,460	3,840	3,380	3,260	2,920	2,650
7 (November)	5,360	3,070	1,870	1,100	925	532	302
7 (December)	2,510	1,350	937	680	617	463	353

Table 2-3-2. Annual, seasonal, and monthly *n*-day low-flow frequency data for streamflow-gaging station 06327500 (Yellowstone River at Glendive, Mont.) for unregulated and regulated steamflow conditions, 1928–2002.—Continued

[Abbreviations: ft^3/s, cubic feet per second. Symbol: %, percent]

n, period of consecutive days (month, for monthly frequency data)	Regulated						
	Streamflow, in ft^3/s, for indicated recurrence interval, in years, and exceedance probability, in percent						
	2 50%	5 20%	10 10%	20 5%	25 4%	50 2%	100 1%
				Annual			
7	3,180	2,440	2,130	1,900	1,840	1,670	1,530
30	4,750	3,630	3,070	2,630	2,500	2,160	1,880
				Winter (January–March)			
7	3,870	3,030	2,670	2,410	2,330	2,140	1,980
30	5,130	4,210	3,820	3,540	3,460	3,260	3,090
				Spring (April–June)			
7	6,400	4,630	3,830	3,250	3,090	2,670	2,330
30	7,850	5,830	4,930	4,260	4,080	3,590	3,180
				Summer (July–September)			
7	5,070	3,400	2,710	2,220	2,090	1,750	1,490
30	6,010	4,040	3,200	2,620	2,460	2,060	1,740
				Fall (October–December)			
7	4,000	2,880	2,430	2,120	2,030	1,810	1,630
30	5,930	4,770	4,220	3,790	3,670	3,340	3,060
				Monthly			
7 (January)	4,330	3,270	2,800	2,460	2,360	2,110	1,900
7 (February)	4,850	3,830	3,380	3,060	2,970	2,730	2,530
7 (March)	6,100	4,680	4,090	3,670	3,560	3,250	3,010
7 (April)	6,360	4,650	3,910	3,360	3,210	2,820	2,500
7 (May)	10,300	7,100	5,600	4,400	4,100	3,300	2,700
7 (June)	24,000	16,500	13,300	11,000	10,400	8,800	7,600
7 (July)	11,000	6,250	4,500	3,380	3,100	2,400	1,890
7 (August)	5,380	3,540	2,820	2,340	2,210	1,880	1,620
7 (September)	5,970	4,130	3,330	2,750	2,600	2,190	1,870
7 (October)	7,200	5,640	4,910	4,340	4,190	3,760	3,400
7 (November)	6,560	4,770	3,890	3,230	3,050	2,560	2,170
7 (December)	4,270	3,030	2,520	2,150	2,050	1,800	1,590

Table 2-3-3. Annual and seasonal flow-duration data for streamflow-gaging station 06327500 (Yellowstone River at Glendive, Mont.) for unregulated and regulated streamflow conditions, 1928–2002.

[Abbreviations: ft³/s, cubic feet per second. Symbol: %, percent]

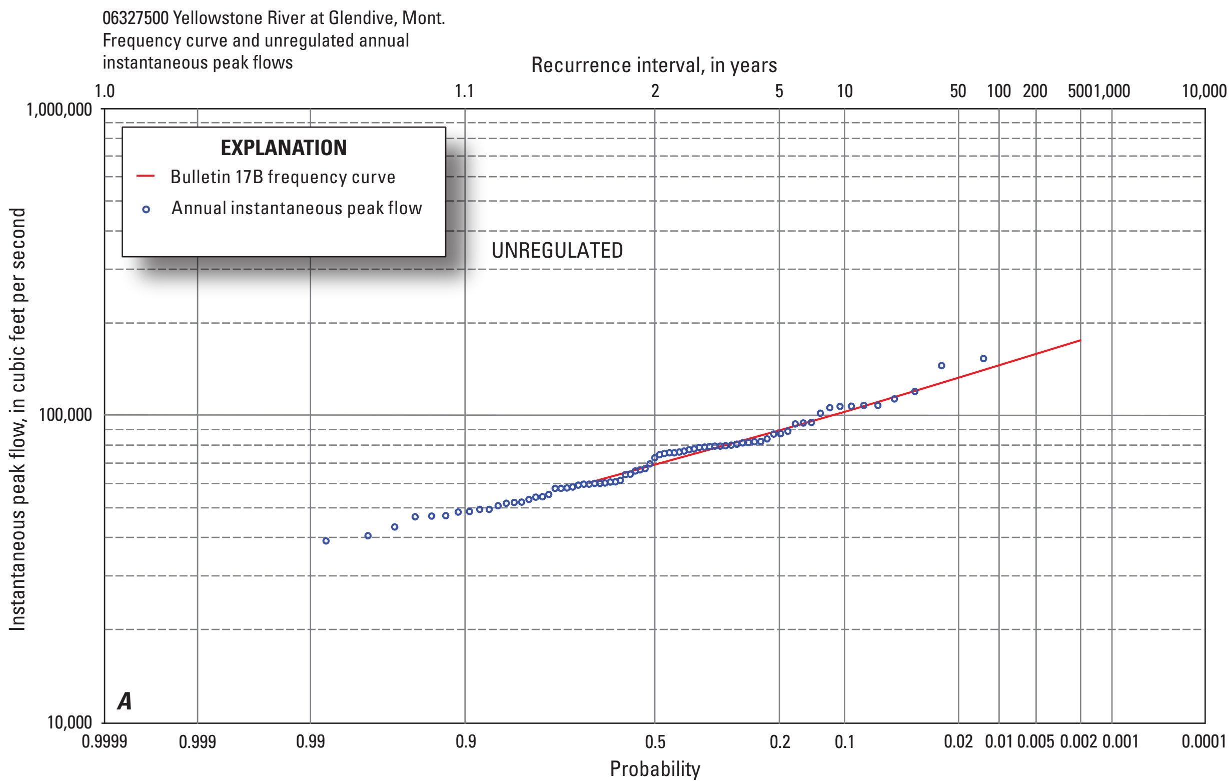
Streamflow condition	Streamflow, in ft³/s, which was equaled or exceeded for indicated percent of time																		
	1%	2%	5%	10%	15%	20%	25%	30%	40%	50%	60%	70%	75%	80%	85%	90%	95%	98%	99%
Annual																			
Unregulated	72,000	64,200	49,900	37,500	29,400	23,400	19,000	15,500	11,400	8,920	7,240	6,110	5,620	5,050	4,400	3,730	2,820	1,870	1,290
Regulated	56,800	49,200	37,200	26,300	19,000	14,800	12,300	10,900	9,170	8,020	7,210	6,380	5,940	5,450	4,980	4,450	3,650	2,850	2,450
Winter (January–March)																			
Unregulated	27,600	21,100	14,500	10,900	9,310	8,320	7,430	6,820	5,940	5,330	4,740	4,140	3,830	3,530	3,190	2,730	2,110	1,410	1,090
Regulated	28,000	21,900	15,100	11,600	10,300	9,300	8,440	7,850	7,090	6,500	5,920	5,320	5,060	4,800	4,420	3,980	3,430	2,810	2,520
Spring (April–June)																			
Unregulated	85,700	76,600	67,500	57,700	50,900	45,400	40,900	37,100	30,600	25,200	20,400	14,400	12,400	10,700	9,200	7,980	6,910	5,940	5,290
Regulated	69,300	60,700	52,100	43,800	37,600	32,700	28,500	25,000	18,800	15,000	12,100	9,280	8,320	7,490	6,820	6,020	5,050	4,180	3,570
Summer (July–September)																			
Unregulated	69,100	60,300	47,200	37,700	31,400	27,000	23,400	20,800	17,300	14,900	13,100	11,500	10,800	10,100	9,440	8,520	6,990	5,850	4,530
Regulated	53,700	46,100	35,200	27,300	21,600	17,100	14,300	12,600	10,400	8,930	7,640	6,490	5,970	5,350	4,760	4,140	3,210	2,560	2,140
Fall (October–December)																			
Unregulated	11,800	11,000	9,770	8,770	8,080	7,610	7,250	6,950	6,380	5,960	5,500	4,830	4,440	4,010	3,640	3,080	2,030	1,170	689
Regulated	12,900	12,200	11,200	10,300	9,730	9,250	8,820	8,480	7,920	7,450	6,950	6,280	5,890	5,440	4,960	4,470	3,580	2,810	2,330

Table 2-3-4. Monthly and annual streamflow characteristics for streamflow-gaging station 06327500 (Yellowstone River at Glendive, Mont.) for unregulated and regulated streamflow conditions, 1928–2002.

[Abbreviations: ft^3/s, cubic feet per second]

Unregulated						
	Streamflow, in ft^3/s, or year, for indicated streamflow characteristic					
Period	Maximum monthly mean and maximum annual mean streamflow	Year of maximum monthly mean and maximum annual mean streamflow	Minimum monthly mean and minimum annual mean streamflow	Year of minimum monthly mean and minimum annual mean streamflow	Mean monthly and mean annual streamflow	Standard deviation of mean monthly and mean annual streamflow
January	8,410	1983	1,600	1940	4,580	1,430
February	16,900	1971	2,880	2001	5,610	2,430
March	19,600	1929	2,750	2002	9,210	3,290
April	19,300	1943	3,760	1961	10,530	3,090
May	49,100	1928	15,050	1953	28,900	6,520
June	84,000	1997	22,100	2001	48,300	13,100
July	63,000	1975	14,000	1934	32,600	11,480
August	23,100	1997	9,330	1977	15,400	3,480
September	15,300	1968	4,230	1934	10,050	2,290
October	11,900	1982	3,510	1935	7,050	2,000
November	8,800	1982	3,130	1931	5,920	1,470
December	8,230	1982	2,160	1931	4,840	1,390
Annual	22,400	1997	9,570	1934	15,200	2,850

Regulated						
	Streamflow, in ft^3/s, or year, for indicated streamflow characteristic					
Period	Maximum monthly mean and maximum annual mean streamflow	Year of maximum monthly mean and maximum annual mean streamflow	Minimum monthly mean and minimum annual mean streamflow	Year of minimum monthly mean and minimum annual mean streamflow	Mean monthly and mean annual streamflow	Standard deviation of mean monthly and mean annual streamflow
January	9,400	1968	3,010	1937	5,960	1,440
February	17,400	1971	3,730	2001	6,710	2,330
March	20,700	1929	3,170	2002	9,990	3,240
April	15,700	1996	2,740	1961	8,440	2,720
May	38,400	1928	7,430	1961	17,800	5,660
June	67,800	1997	12,000	1934	35,000	12,100
July	49,000	1967	3,950	1934	21,100	11,110
August	17,700	1997	2,560	1961	8,390	3,780
September	15,000	1941	3,120	1934	7,810	2,700
October	13,400	1941	4,610	1934	8,270	2,040
November	11,200	1972	4,450	1934	7,610	1,670
December	9,980	1982	3,510	2002	6,360	1,460
Annual	19,300	1997	5,800	1934	11,900	3,060



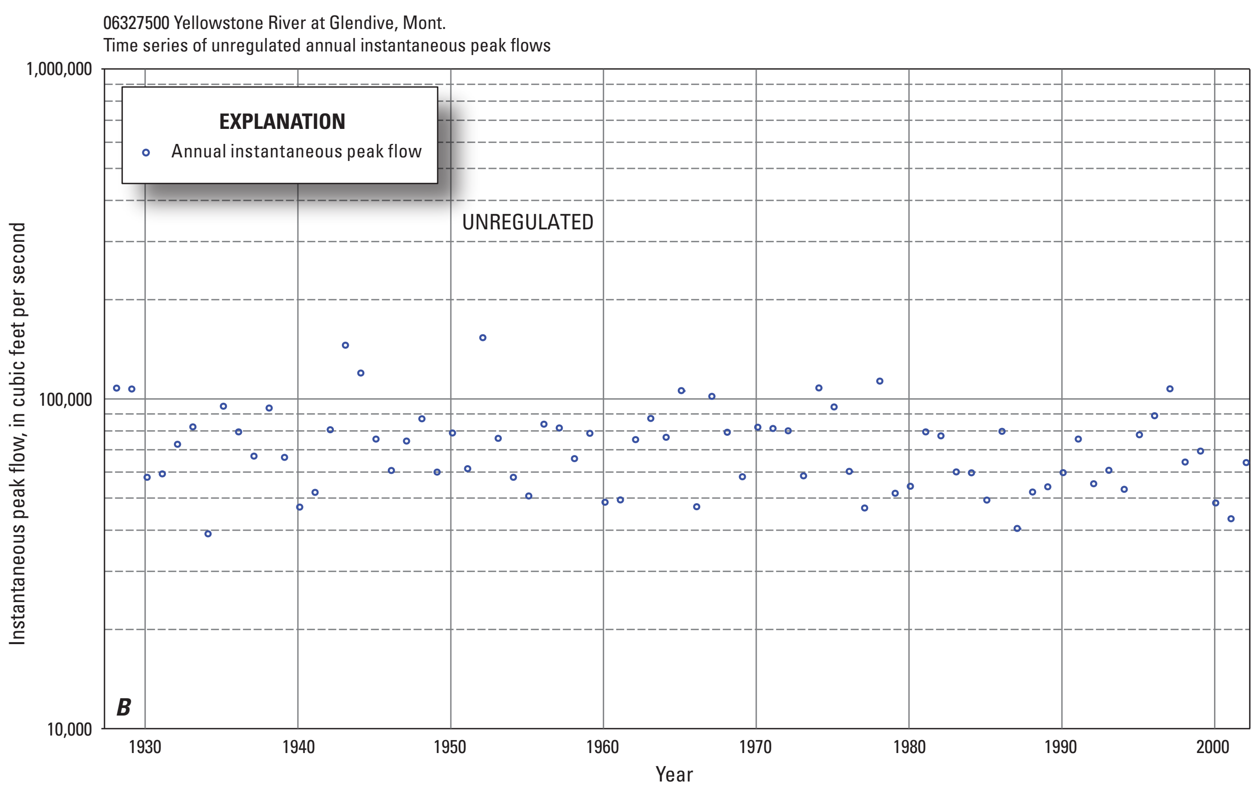
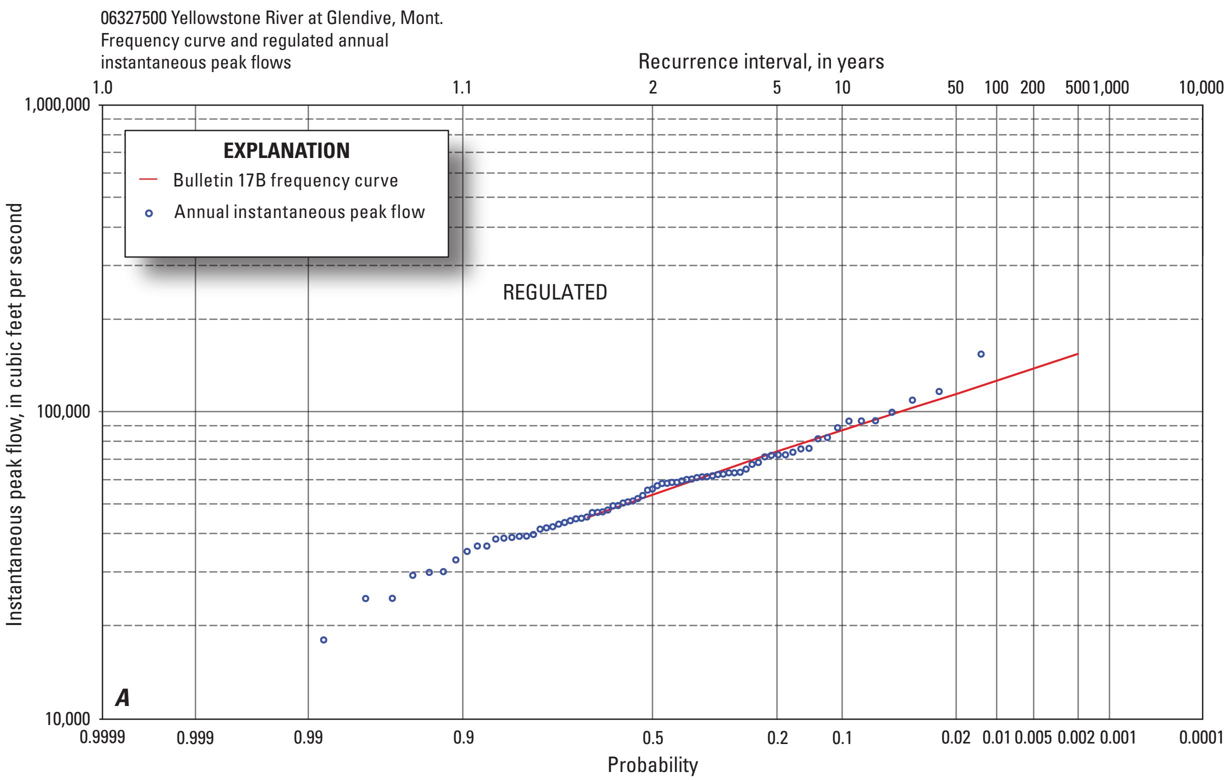


Figure 2-3-1. Annual instantaneous peak-flow data for streamflow-gaging station 06327500 (Yellowstone River at Glendive, Mont.) for unregulated streamflow conditions, 1928–2002. *A*, Frequency curve and unregulated annual instantaneous peak flows. *B*, Time series of unregulated annual instantaneous peak flows. [Bulletin 17B: U.S. Interagency Advisory Council on Water Data, 1982]



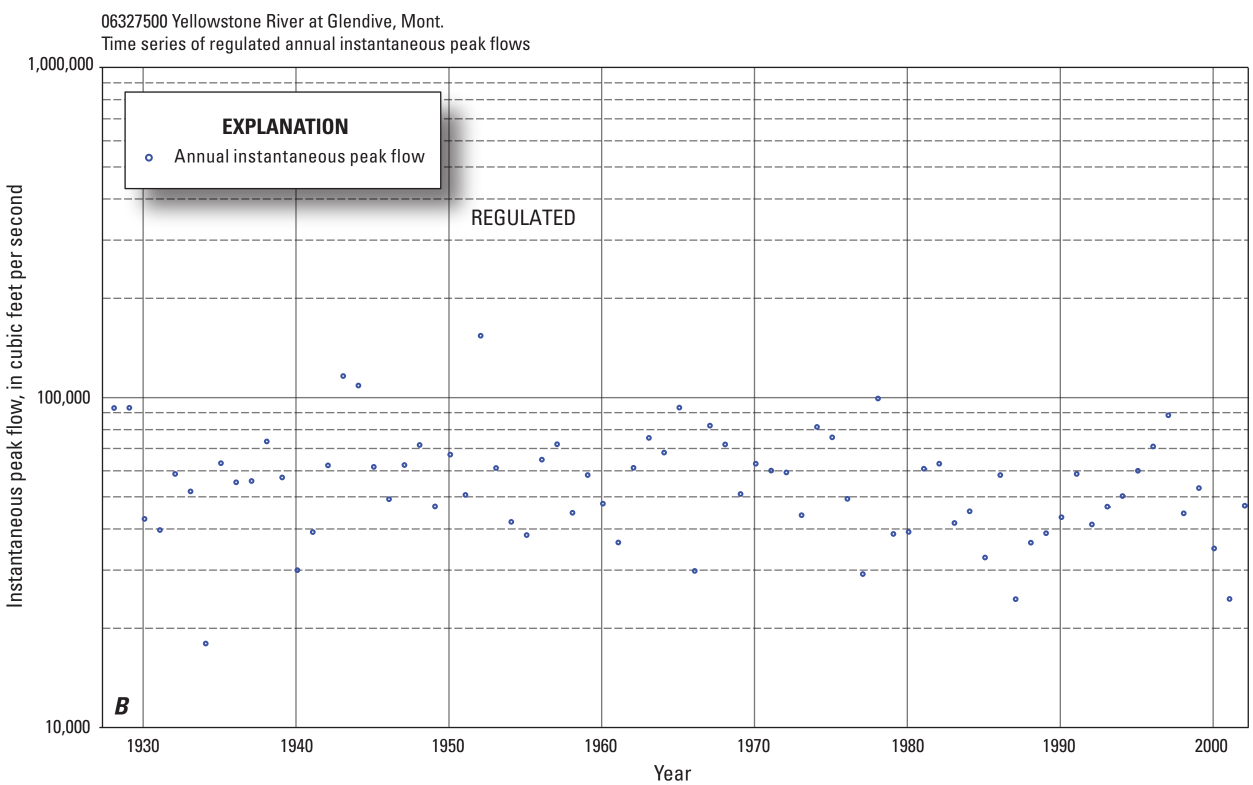
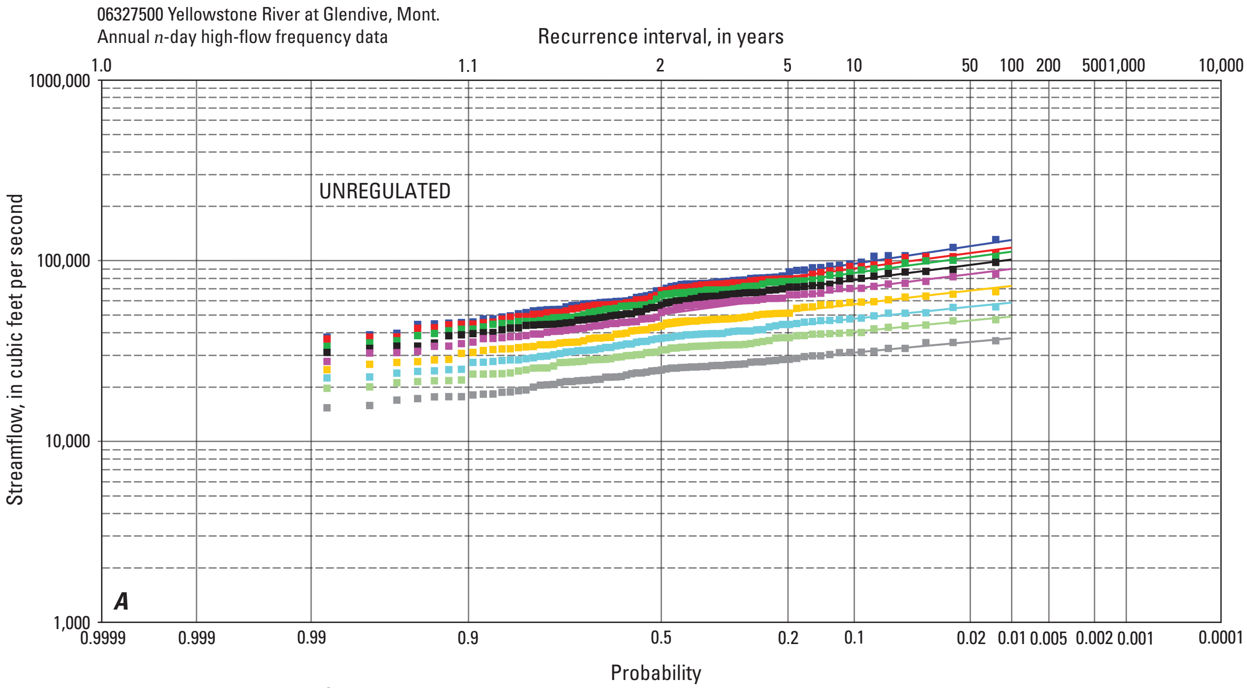
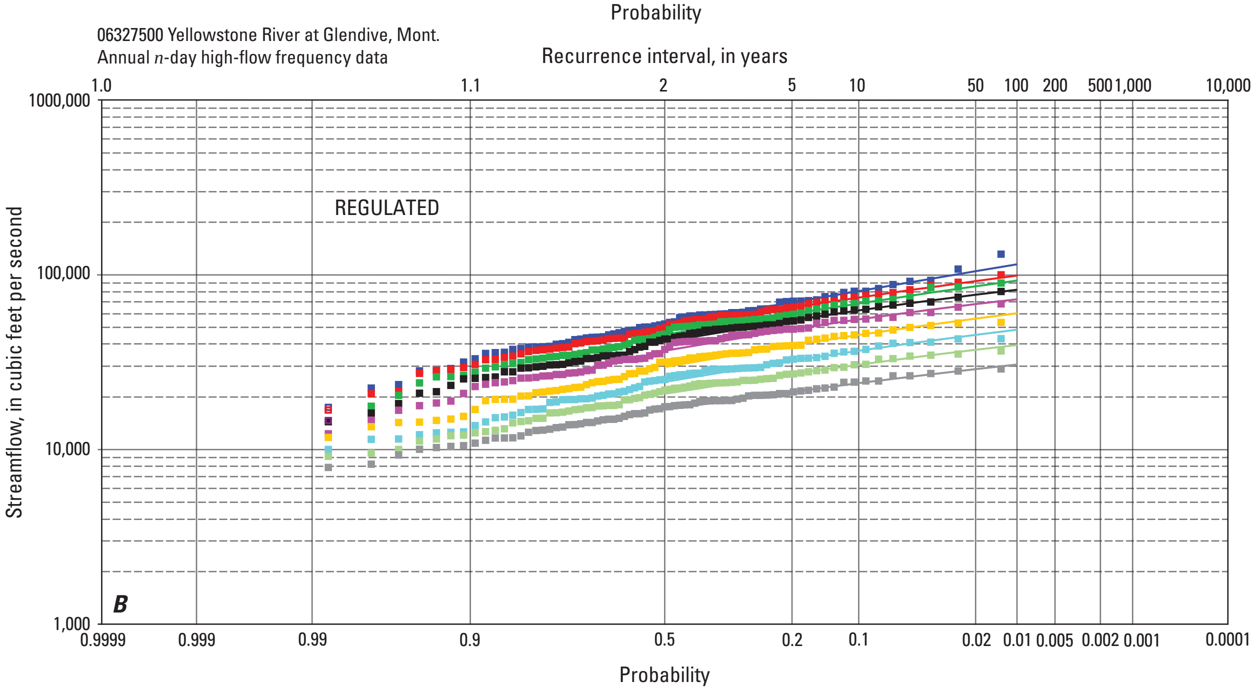


Figure 2-3-2. Annual instantaneous peak-flow data for streamflow-gaging station 06327500 (Yellowstone River at Glendive, Mont.) for regulated streamflow conditions, 1928–2002. *A*, Frequency curve and regulated annual instantaneous peak flows. *B*, Time series of regulated annual instantaneous peak flows. [Bulletin 17B: U.S. Interagency Advisory Council on Water Data, 1982]





EXPLANATION

1-Day Data
Estimated *n*-day values
n-day frequency curve

3-Day Data
Estimated *n*-day values
n-day frequency curve

7-Day Data
Estimated *n*-day values
n-day frequency curve

15-Day Data
Estimated *n*-day values
n-day frequency curve

30-Day Data
Estimated *n*-day values
n-day frequency curve

60-Day Data
Estimated *n*-day values
n-day frequency curve

90-Day Data
Estimated *n*-day values
n-day frequency curve

120-Day Data
Estimated *n*-day values
n-day frequency curve

183-Day Data
Estimated *n*-day values
n-day frequency curve

Figure 2-3-3. Annual *n*-day high-flow frequency data for streamflow-gaging station 06327500 (Yellowstone River at Glendive, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

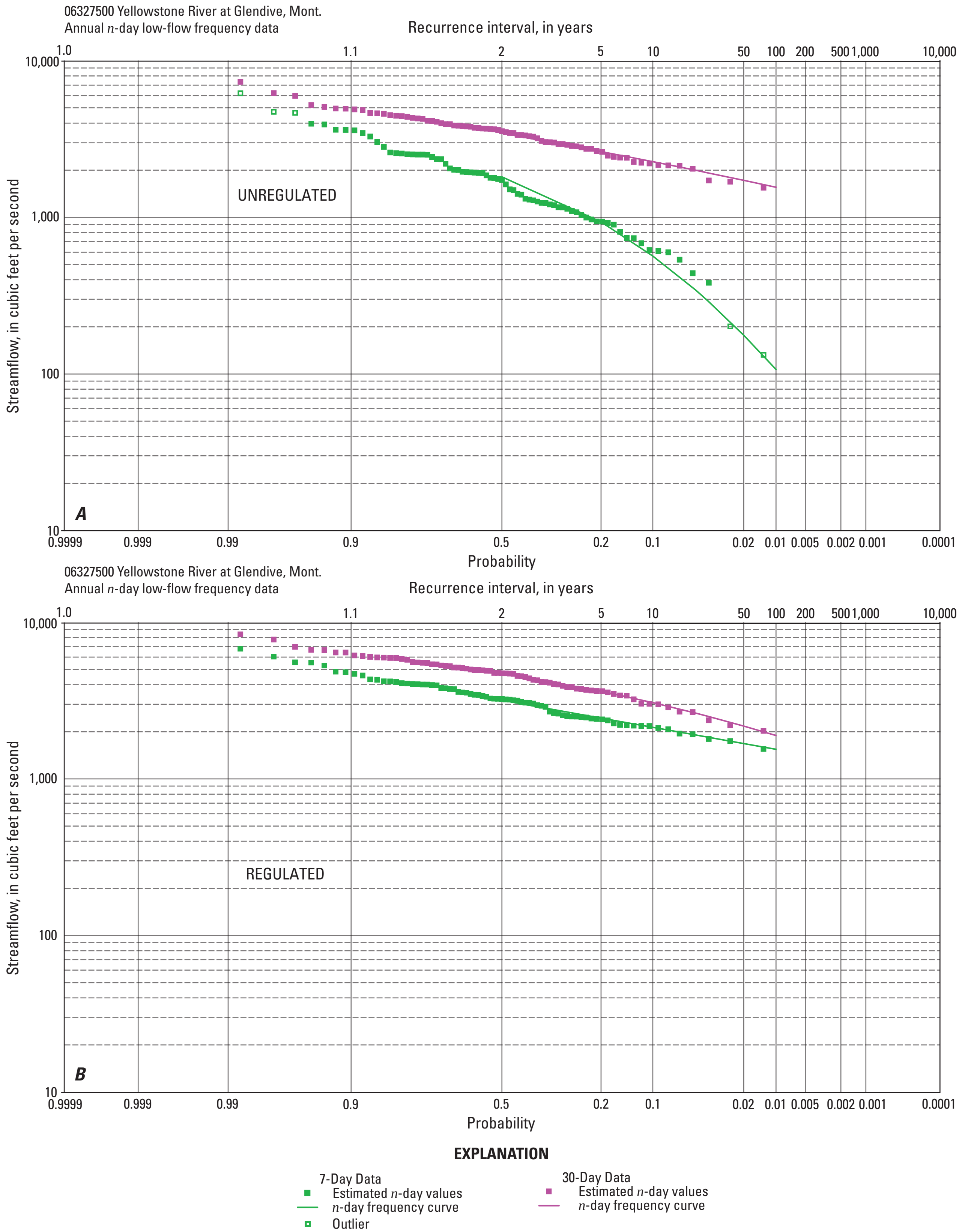


Figure 2-3-4. Annual *n*-day low-flow frequency data for streamflow-gaging station 06327500 (Yellowstone River at Glendive, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.

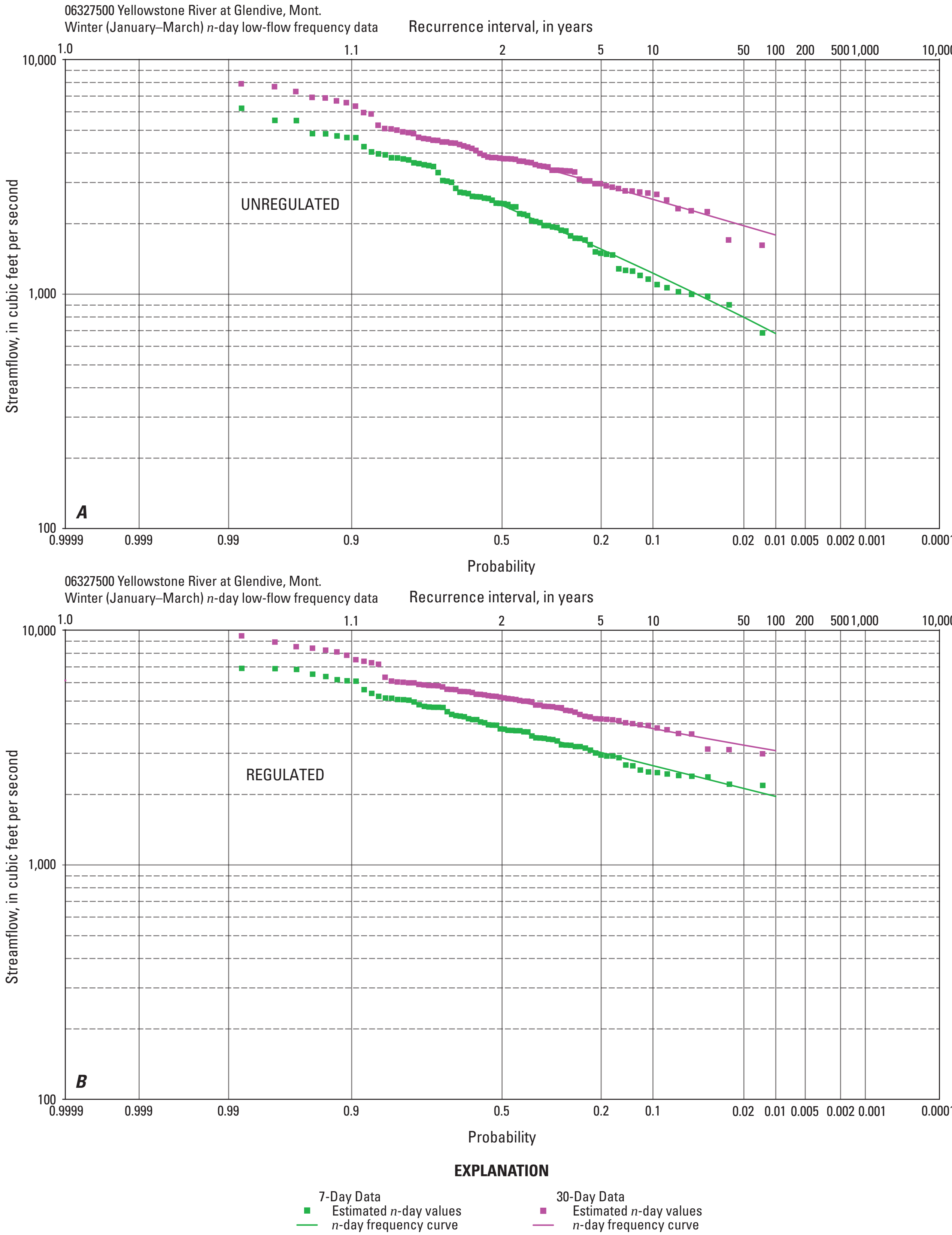


Figure 2-3-5. Winter (January–March) *n*-day low-flow frequency data for streamflow-gaging station 06327500 (Yellowstone River at Glendive, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

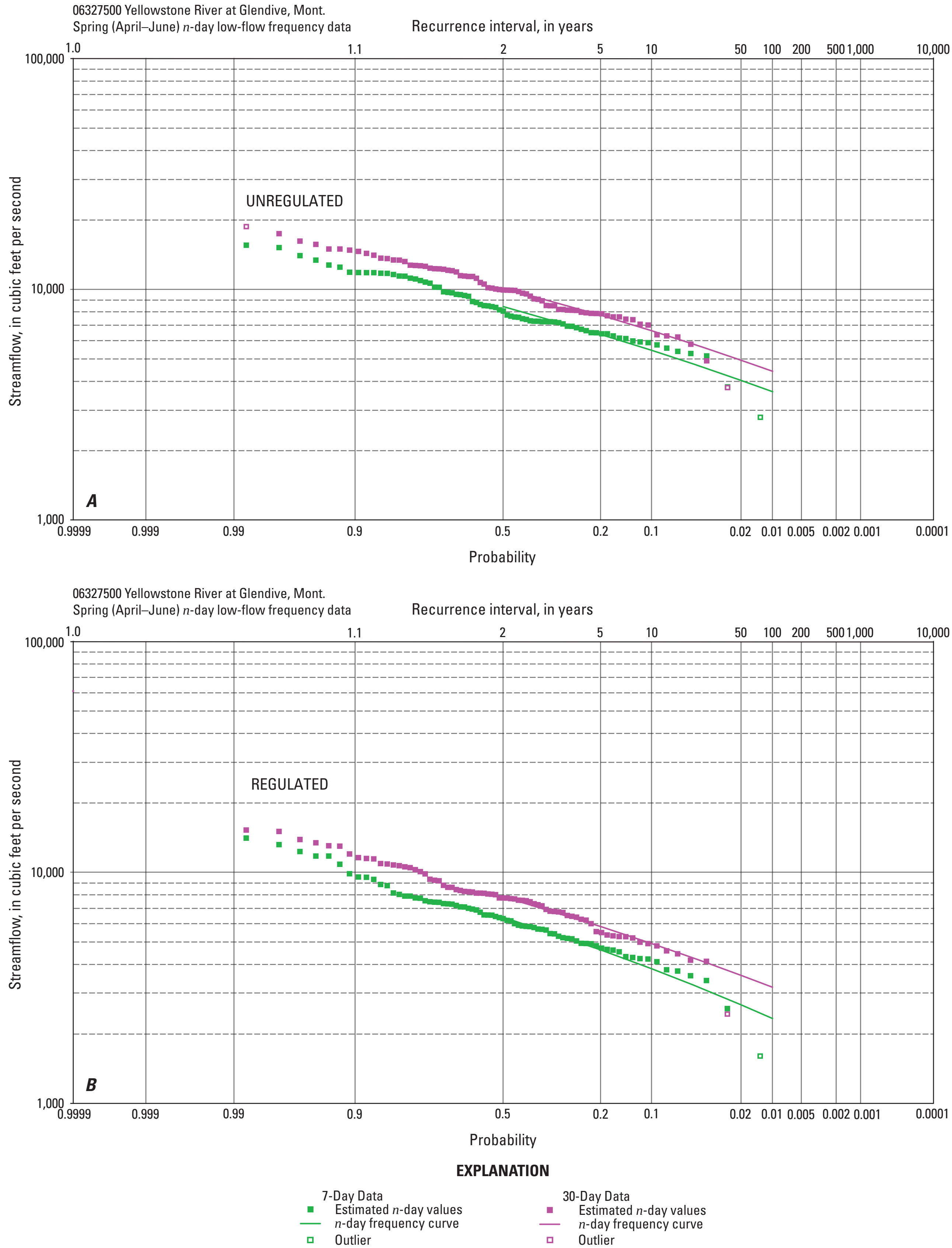


Figure 2-3-6. Spring (April–June) *n*-day low-frequency data for streamflow-gaging station 06327500 (Yellowstone River at Glendive, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.

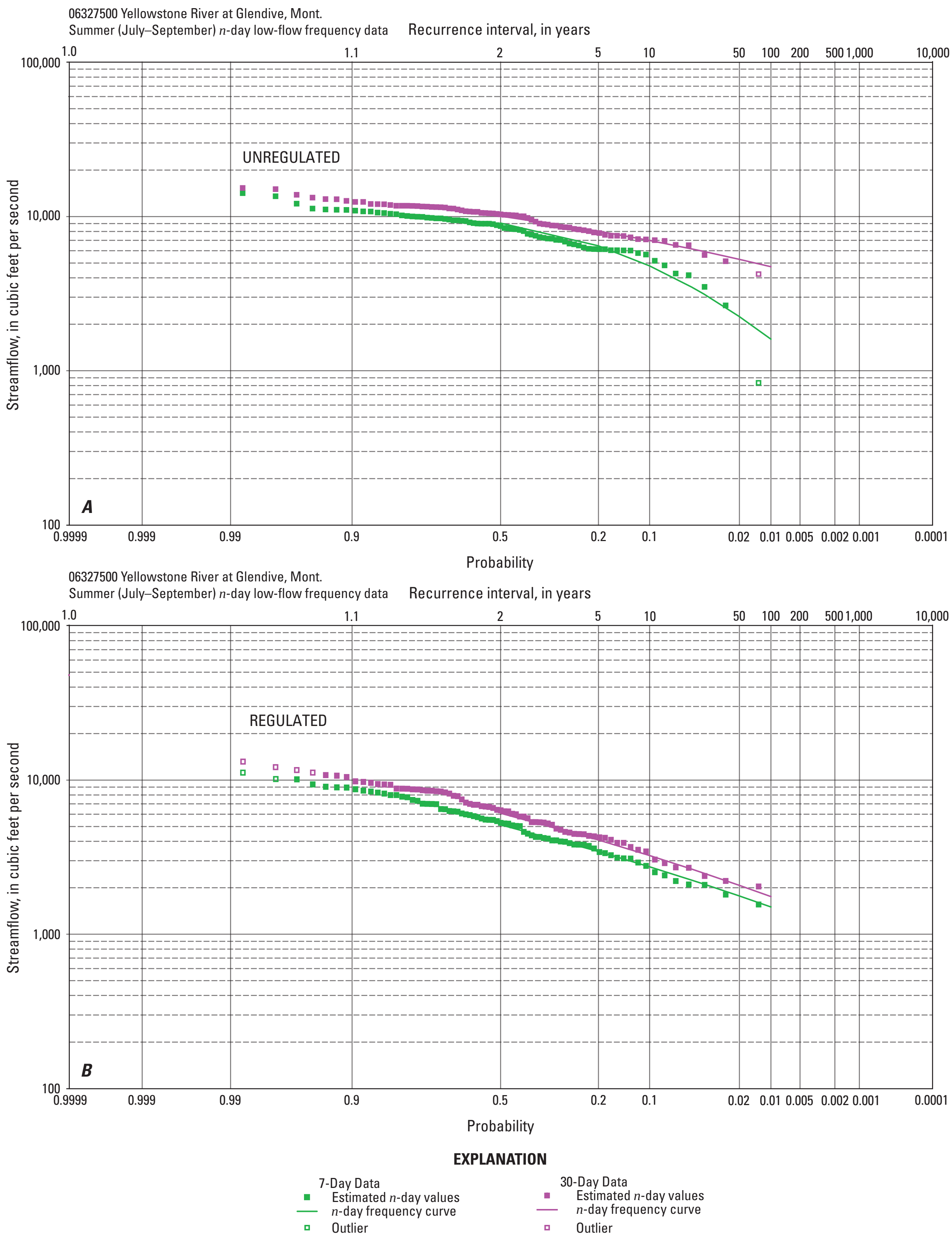


Figure 2-3-7. Summer (July–September) *n*-day low-frequency data for streamflow-gaging station 06327500 (Yellowstone River at Glendive, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

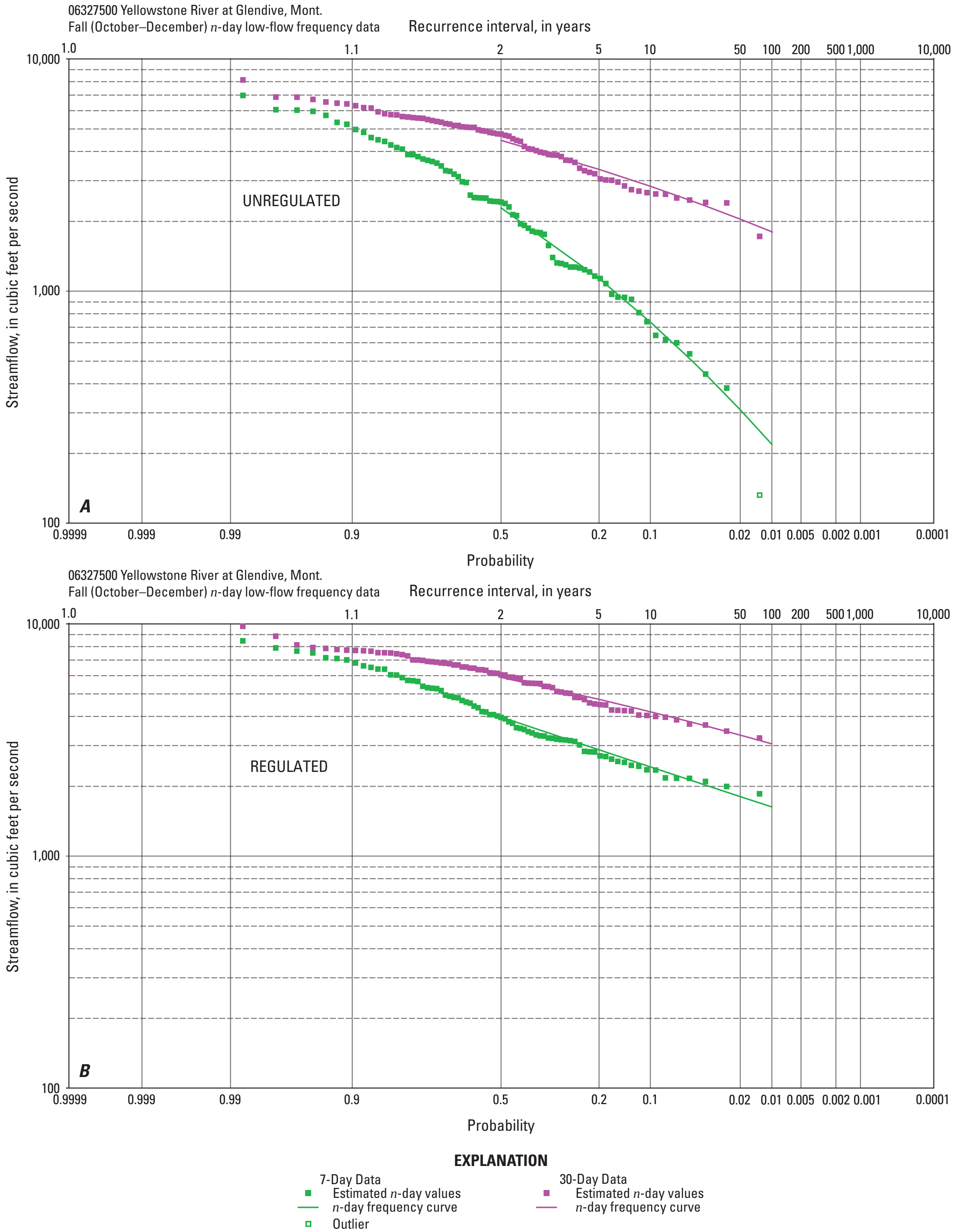


Figure 2-3-8. Fall (October–December) *n*-day low-flow frequency data for streamflow-gaging station 06327500 (Yellowstone River at Glendive, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.

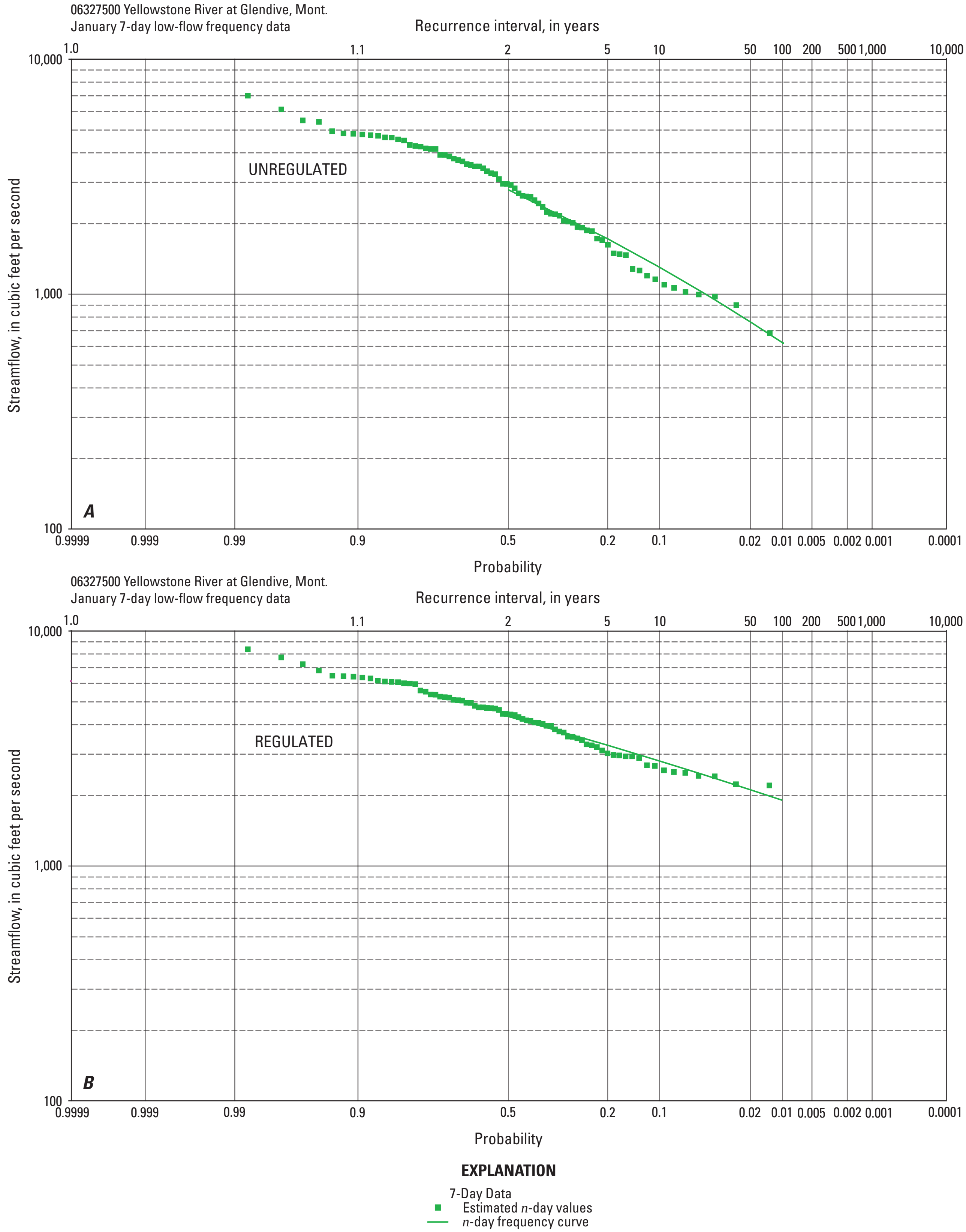


Figure 2-3-9. January 7-day low-flow frequency data for streamflow-gaging station 06327500 (Yellowstone River at Glendive, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

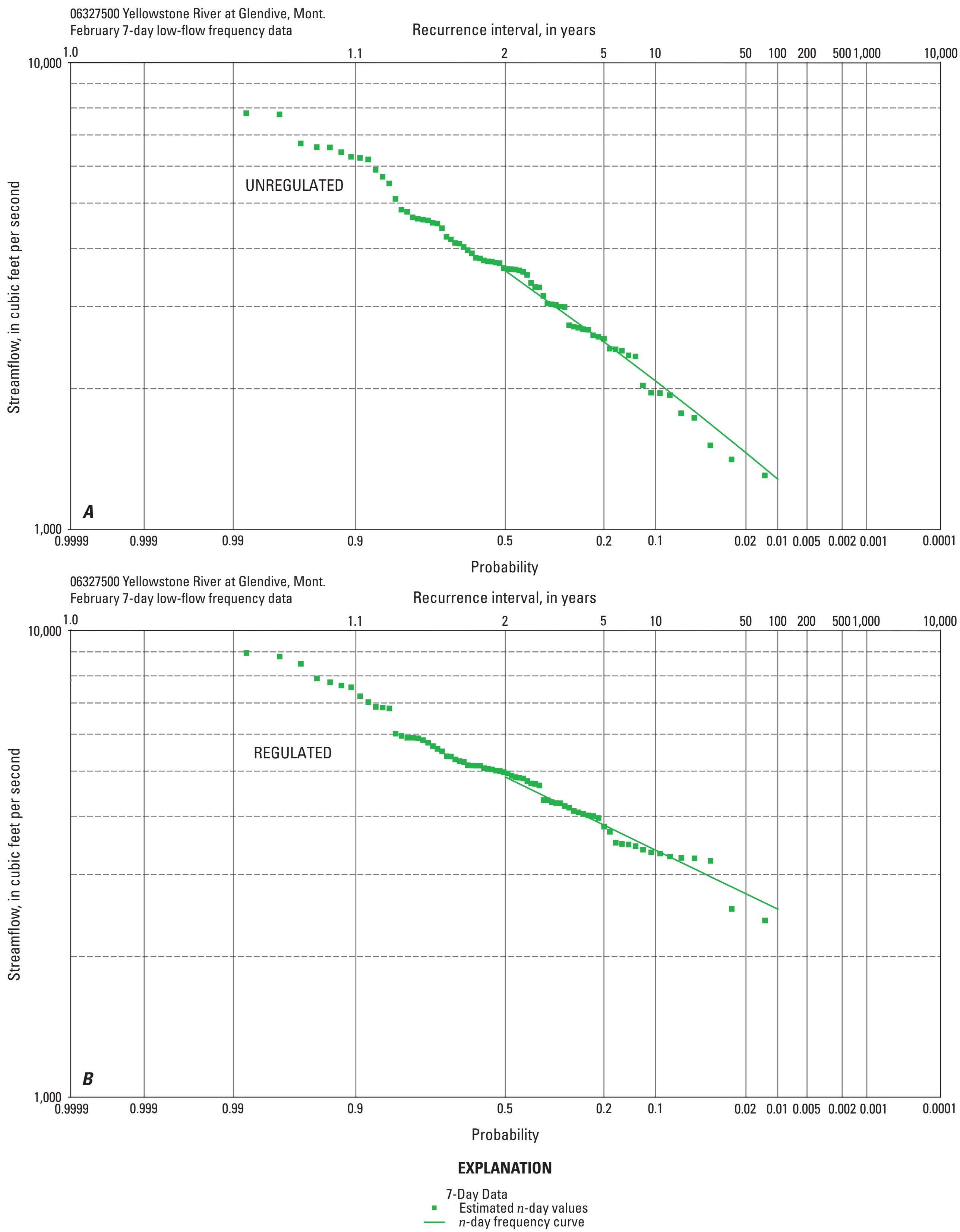


Figure 2-3-10. February 7-day low-flow frequency data for streamflow-gaging station 06327500 (Yellowstone River at Glendive, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.

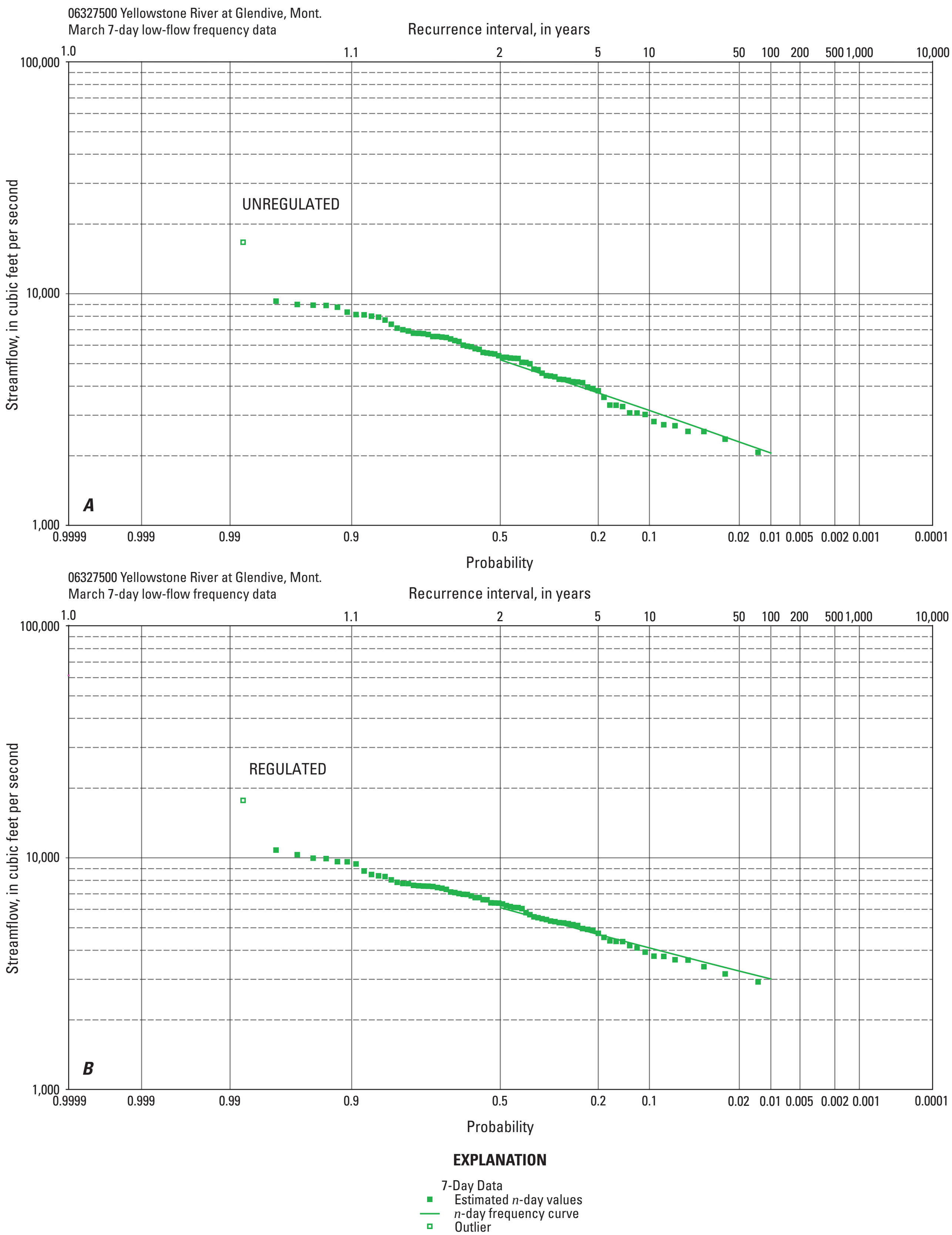


Figure 2-3-11. March 7-day low-flow frequency data for streamflow-gaging station 06327500 (Yellowstone River at Glendive, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

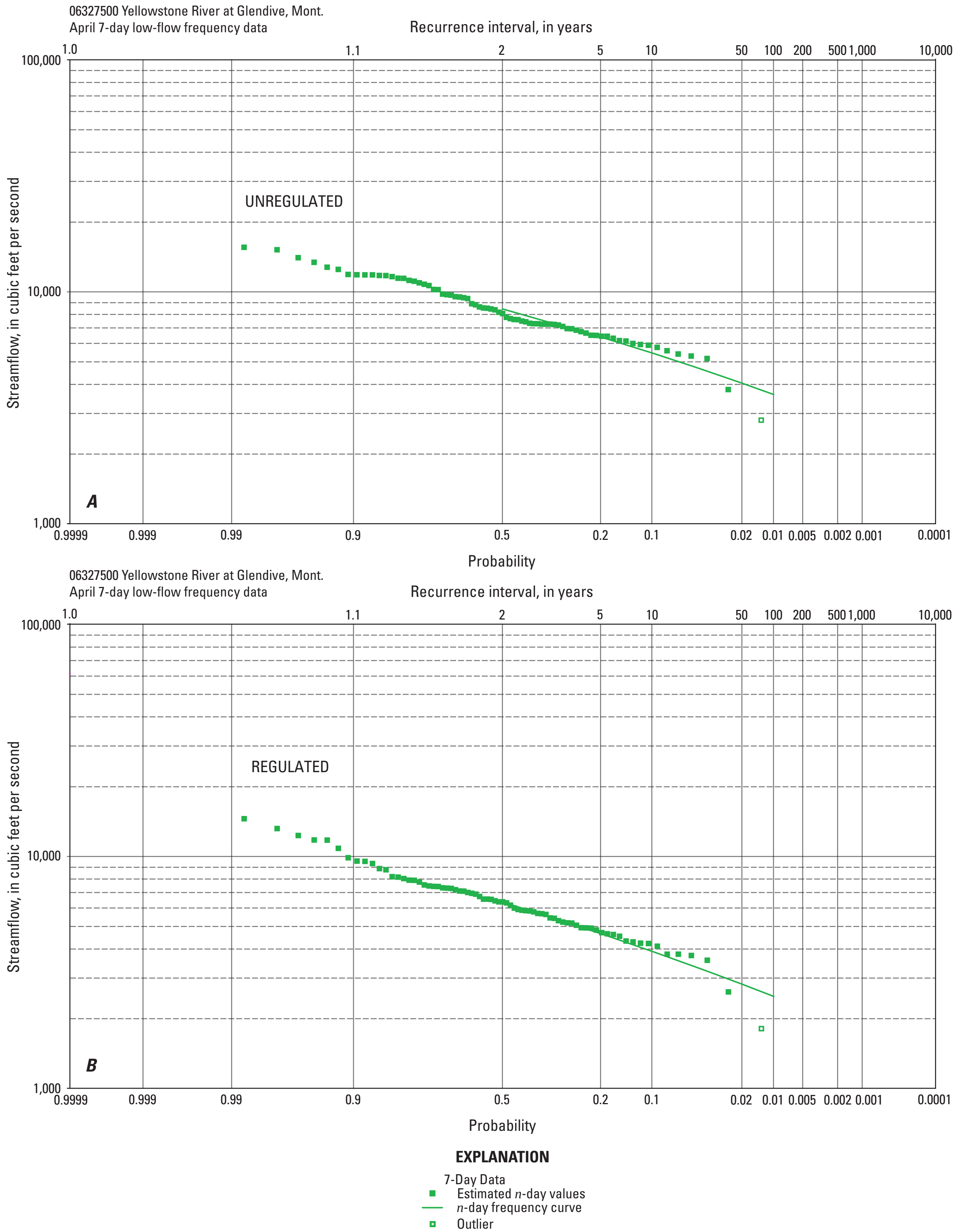


Figure 2-3-12. April 7-day low-flow frequency data for streamflow-gaging station 06327500 (Yellowstone River at Glendive, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.

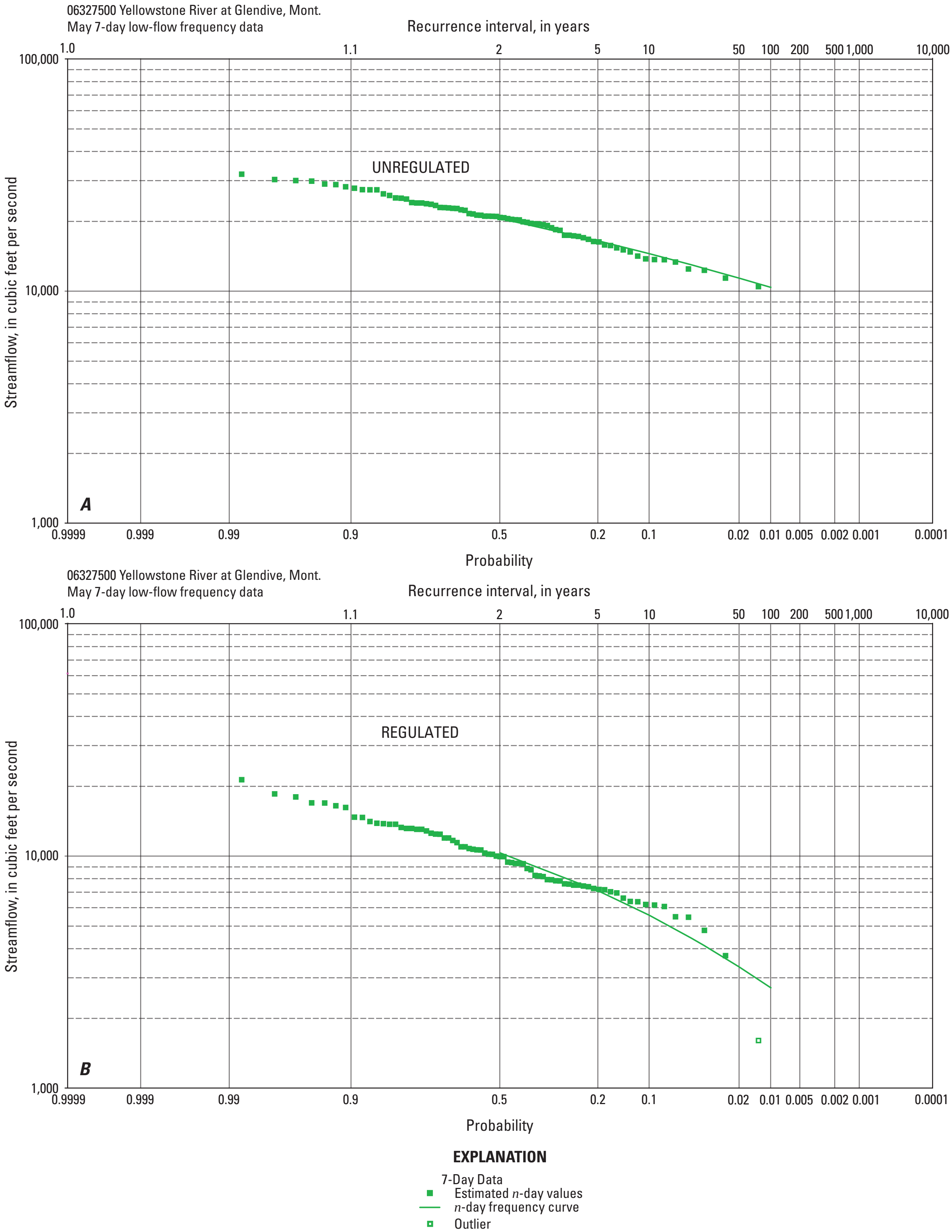
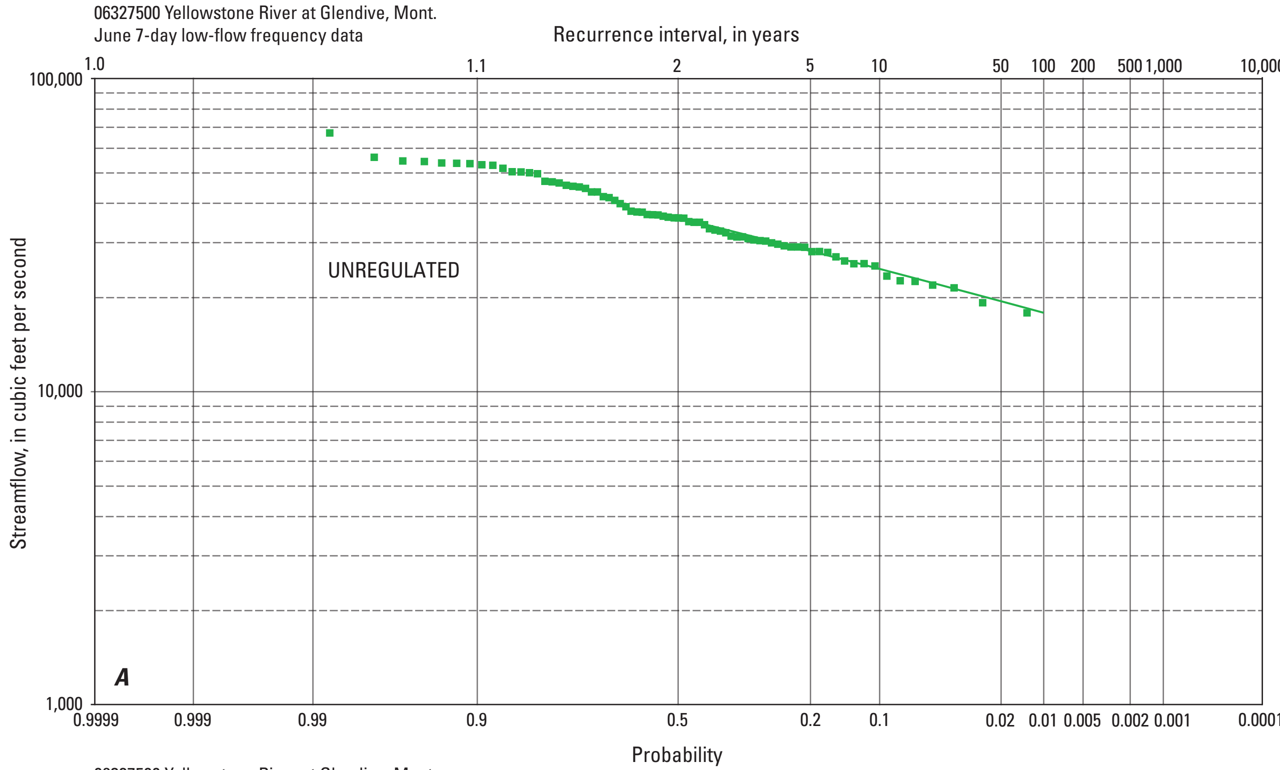


Figure 2-3-13. May 7-day low-flow frequency data for streamflow-gaging station 06327500 (Yellowstone River at Glendive, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.



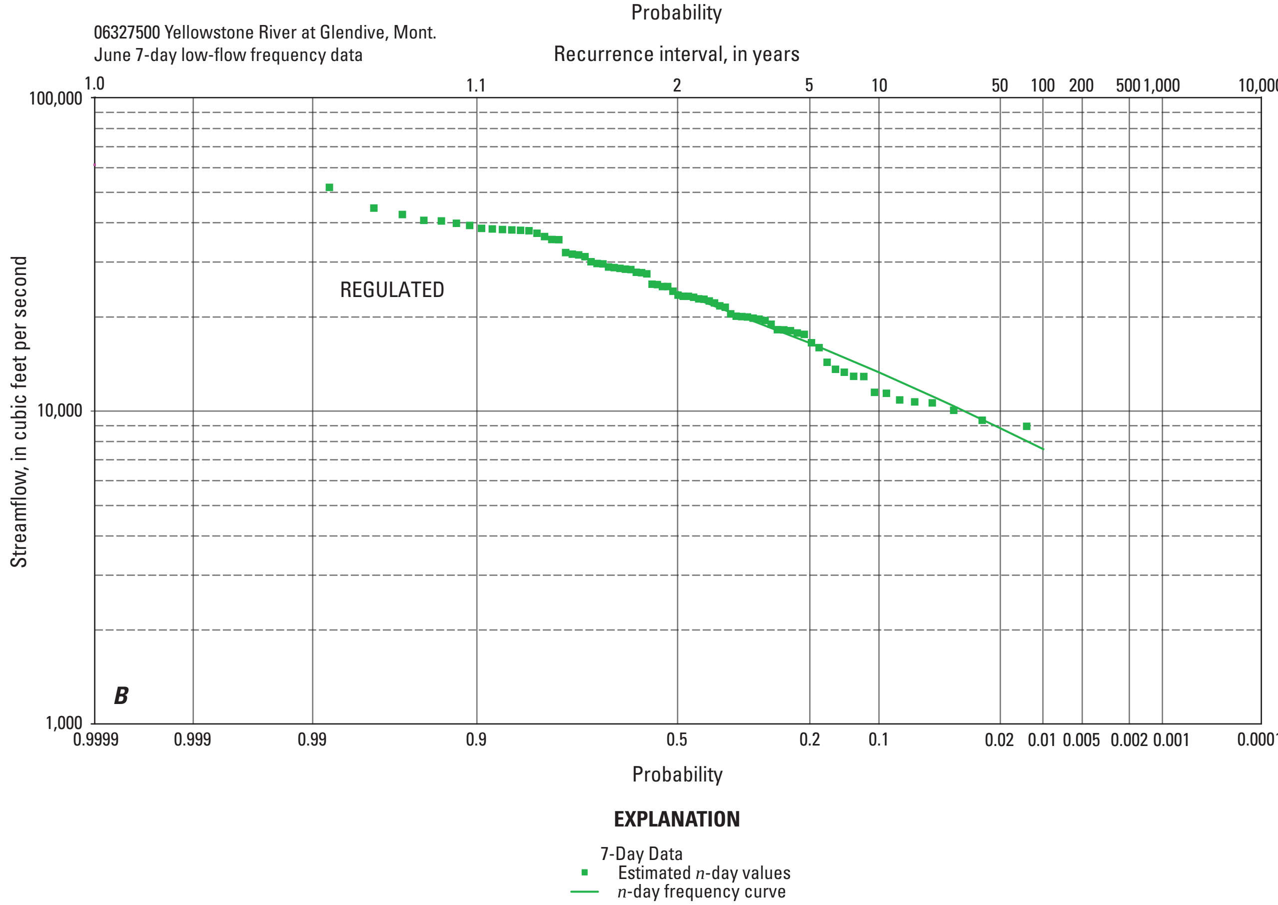


Figure 2-3-14. June 7-day low-flow frequency data for streamflow-gaging station 06327500 (Yellowstone River at Glendive, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.

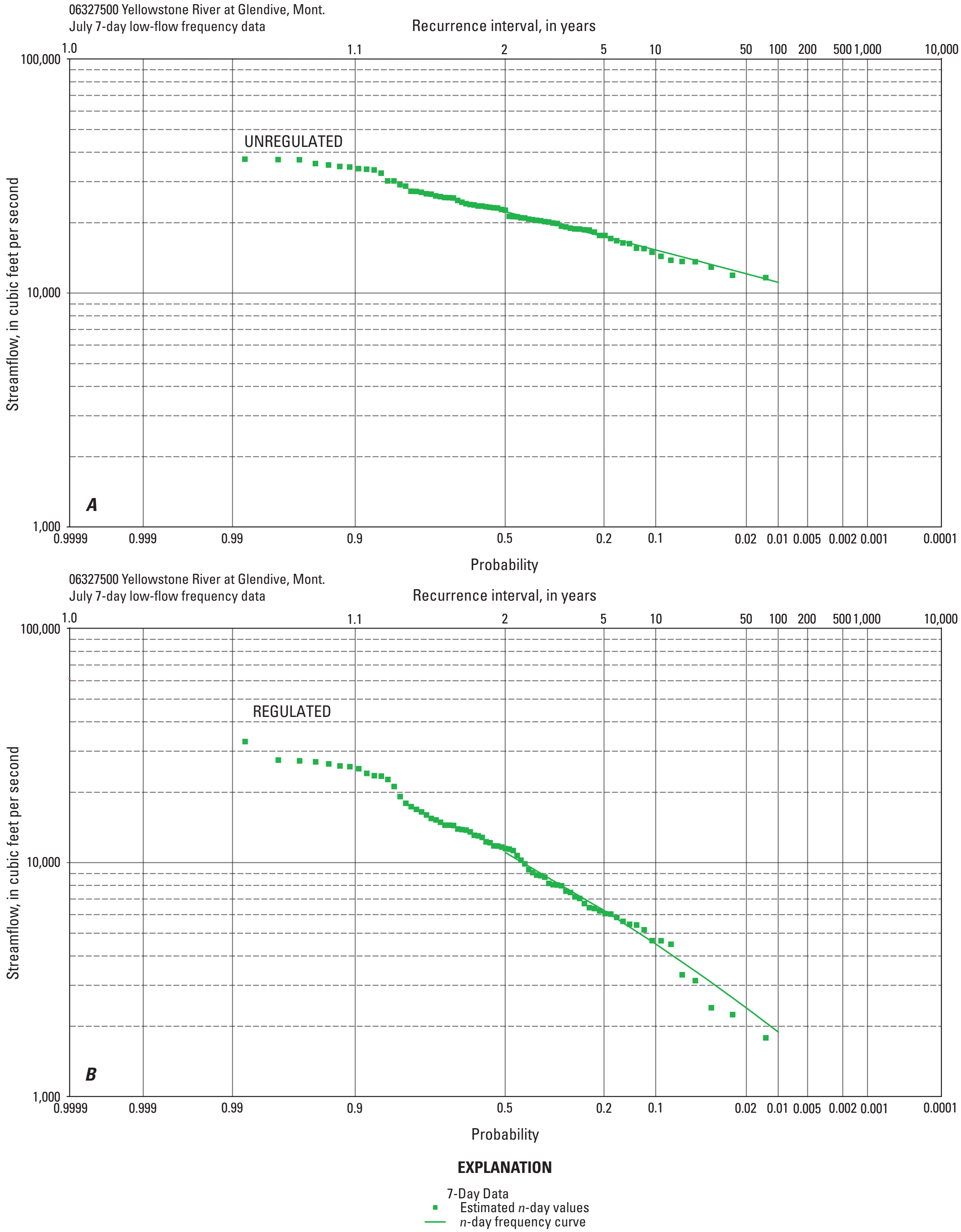


Figure 2-3-15. July 7-day low flow frequency data for streamflow-gaging station 06327500 (Yellowstone River at Glendive, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

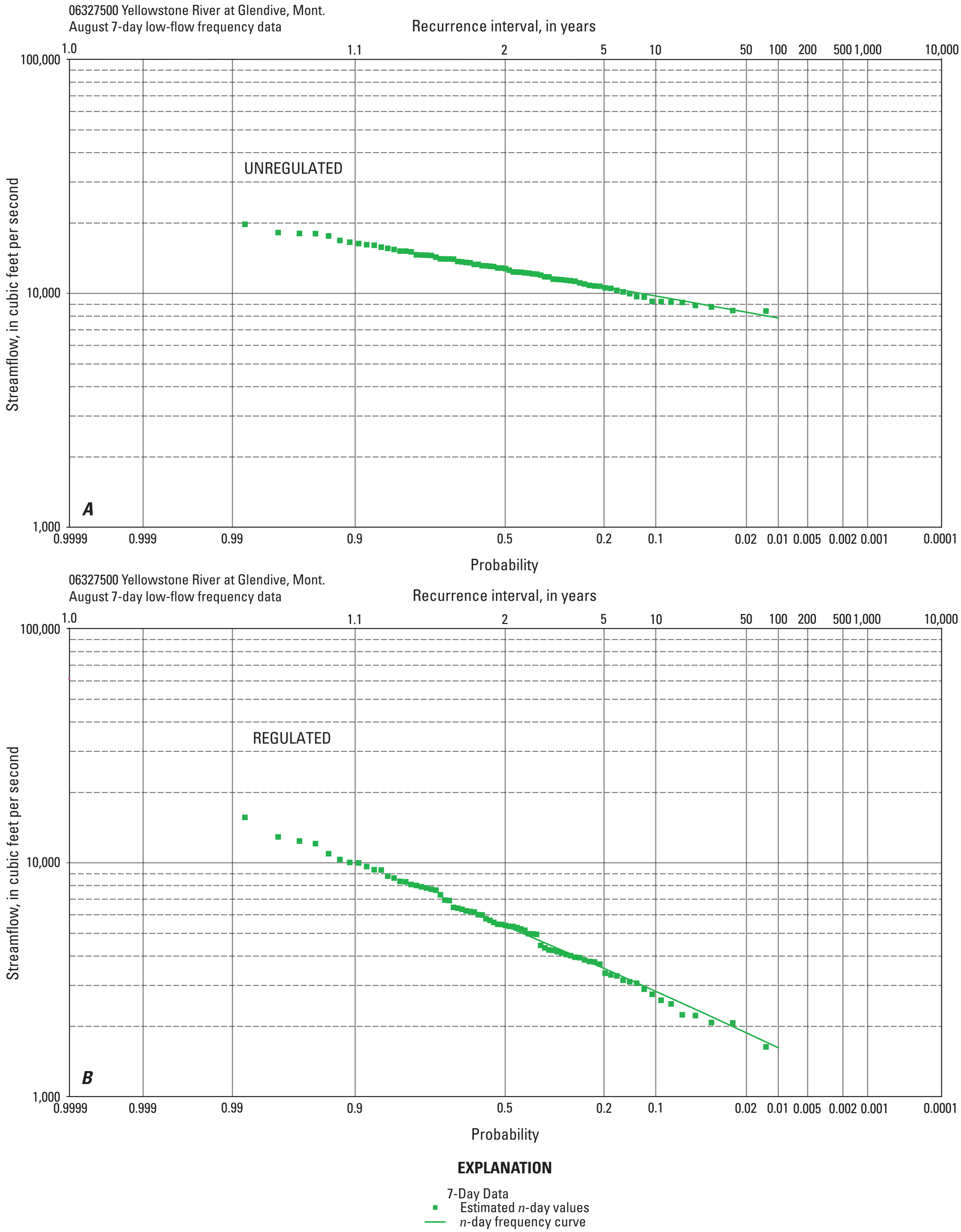
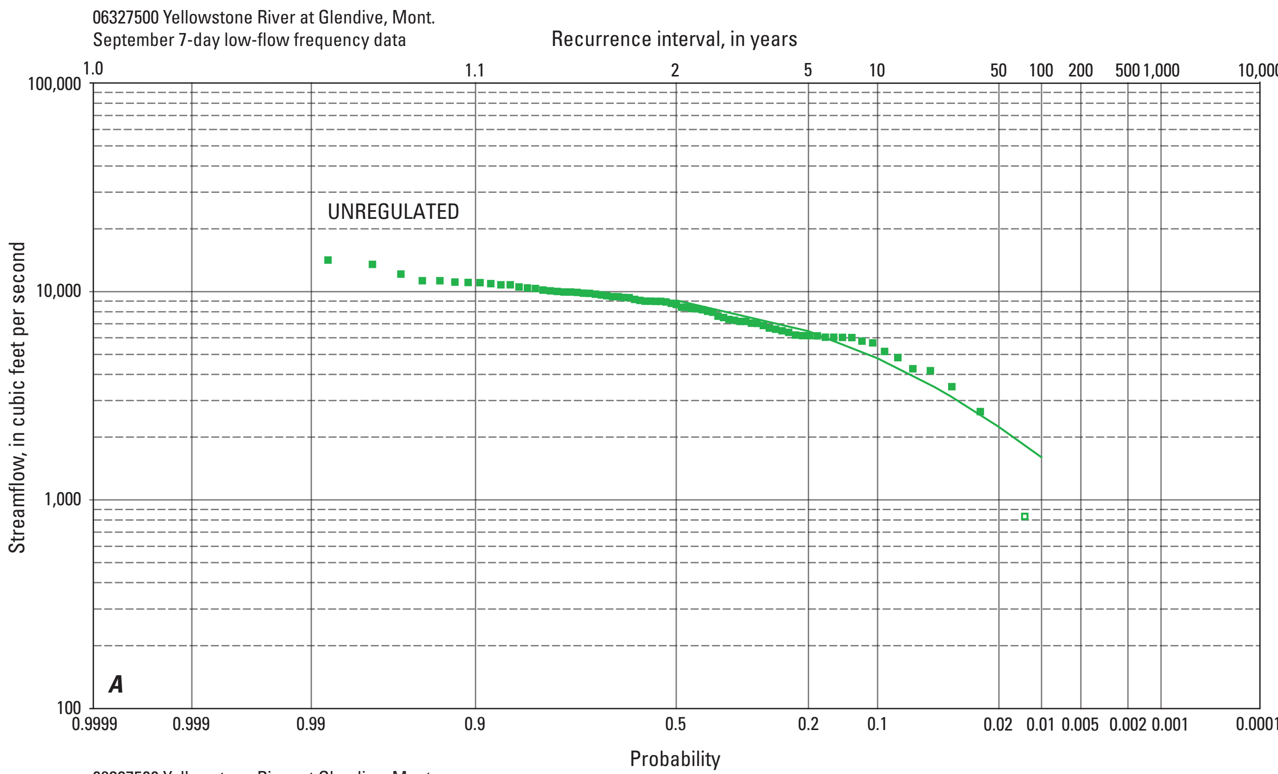


Figure 2-3-16. August 7-day low-flow frequency data for streamflow-gaging station 06327500 (Yellowstone River at Glendive, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.



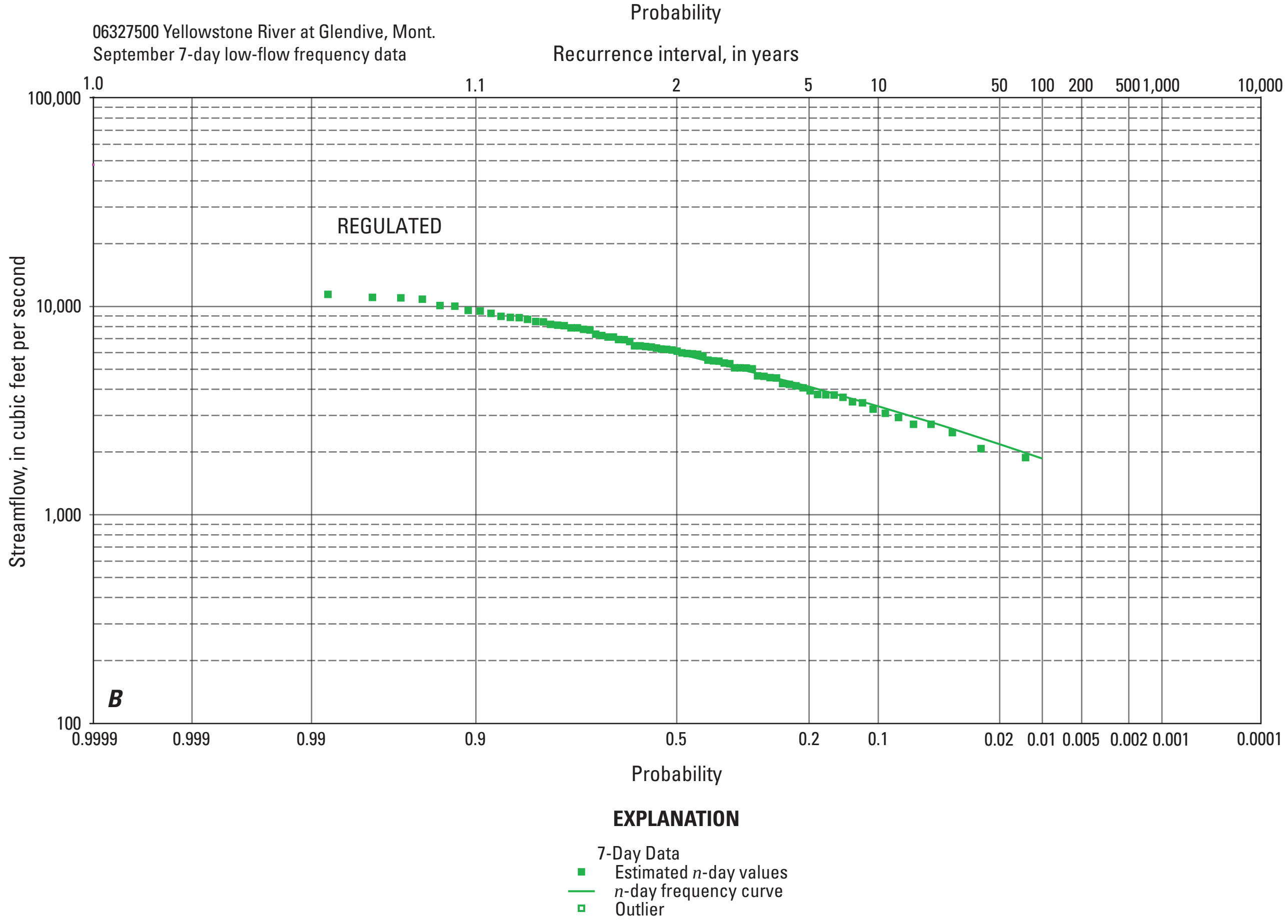


Figure 2-3-17. September 7-day low-flow frequency data for streamflow-gaging station 06327500 (Yellowstone River at Glendive, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

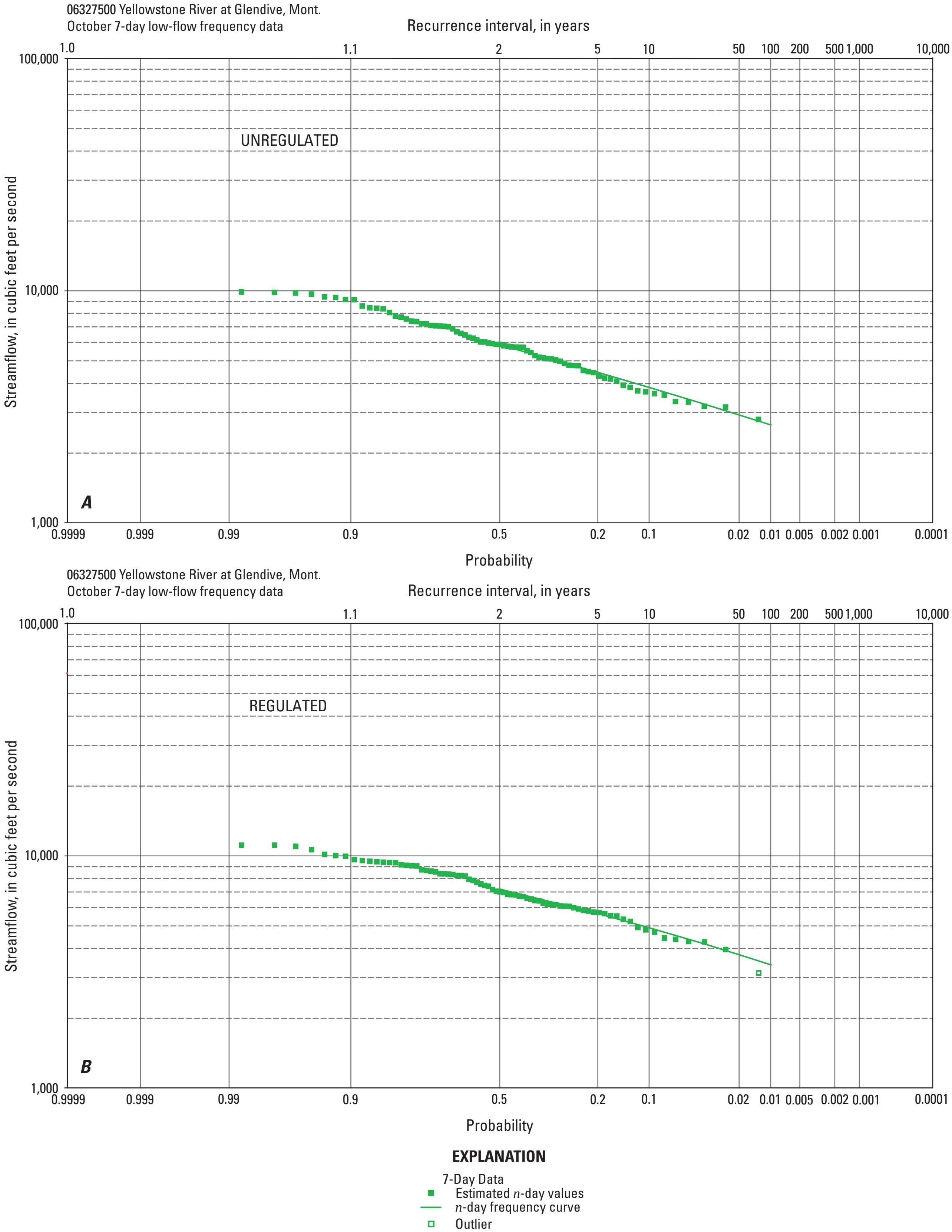
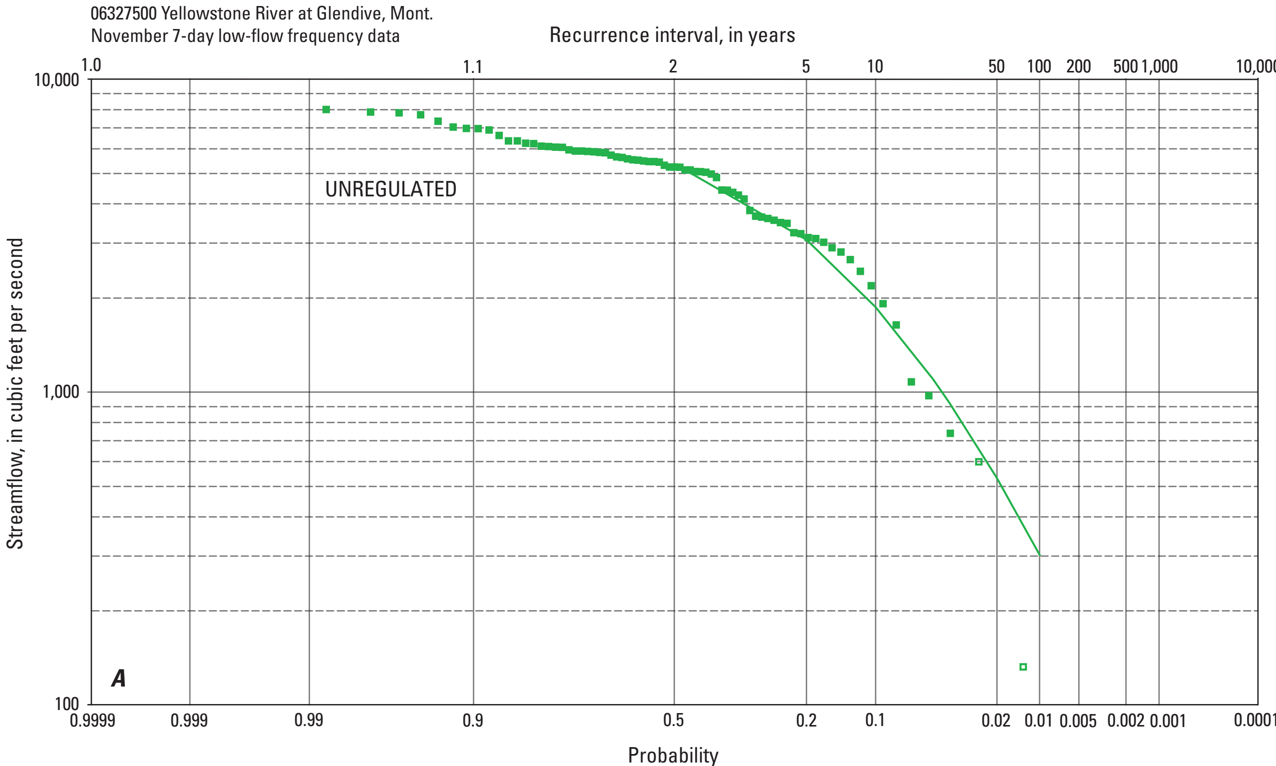


Figure 2-3-18. October 7-day low-flow frequency data for streamflow-gaging station 06327500 (Yellowstone River at Glendive, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.



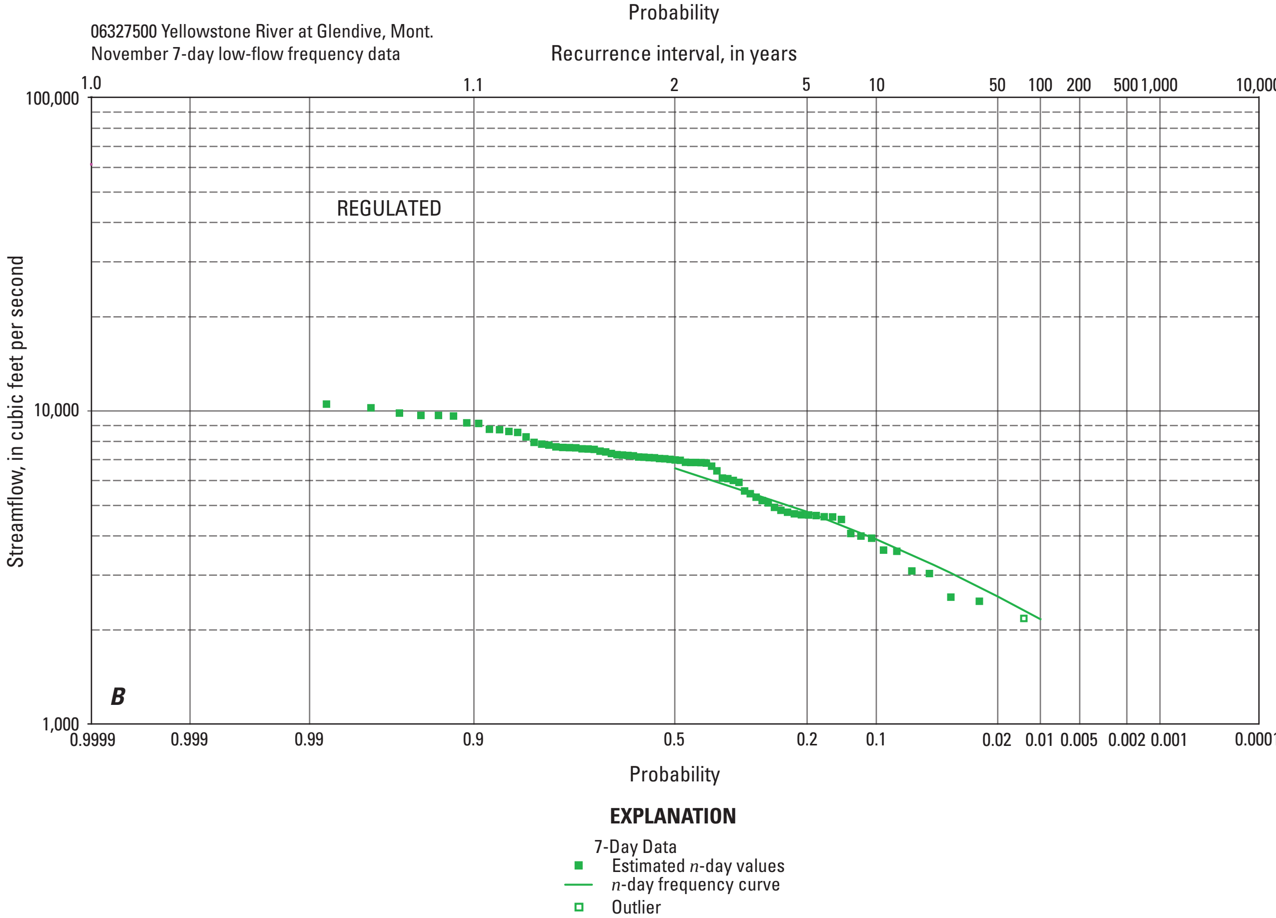


Figure 2-3-19. November 7-day low-flow frequency data for streamflow-gaging station 06327500 (Yellowstone River at Glendive, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

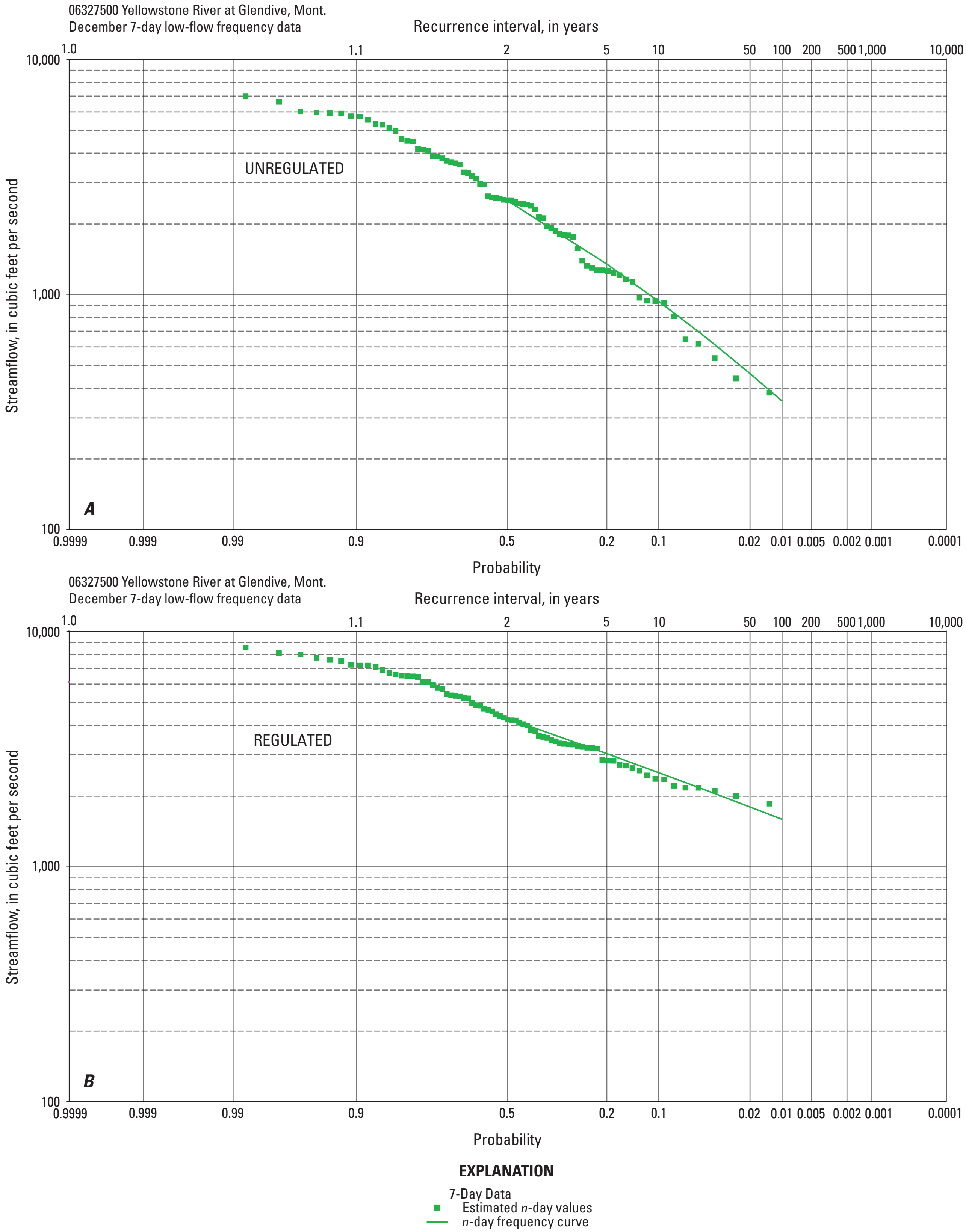
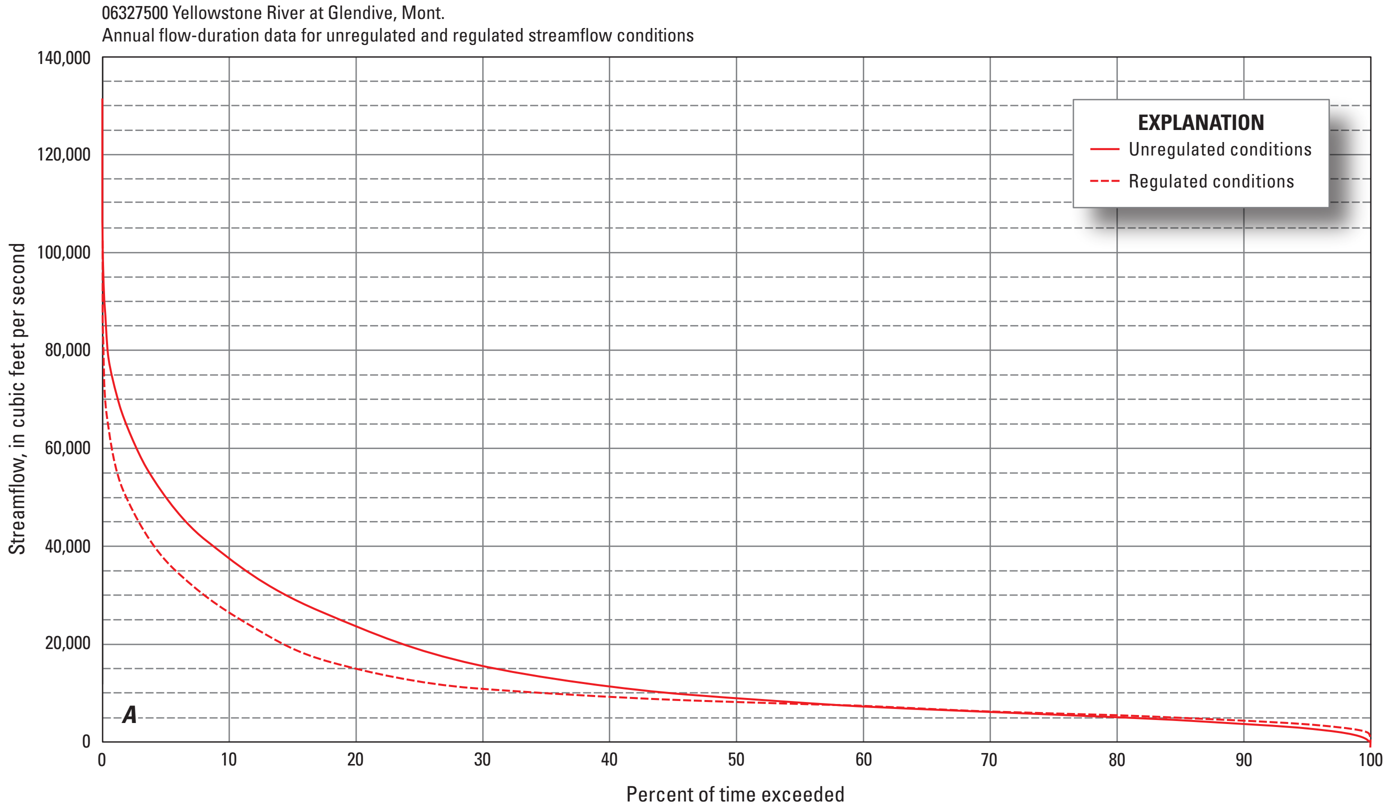


Figure 2-3-20. December 7-day low-flow frequency data for streamflow-gaging station 06327500 (Yellowstone River at Glendive, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.



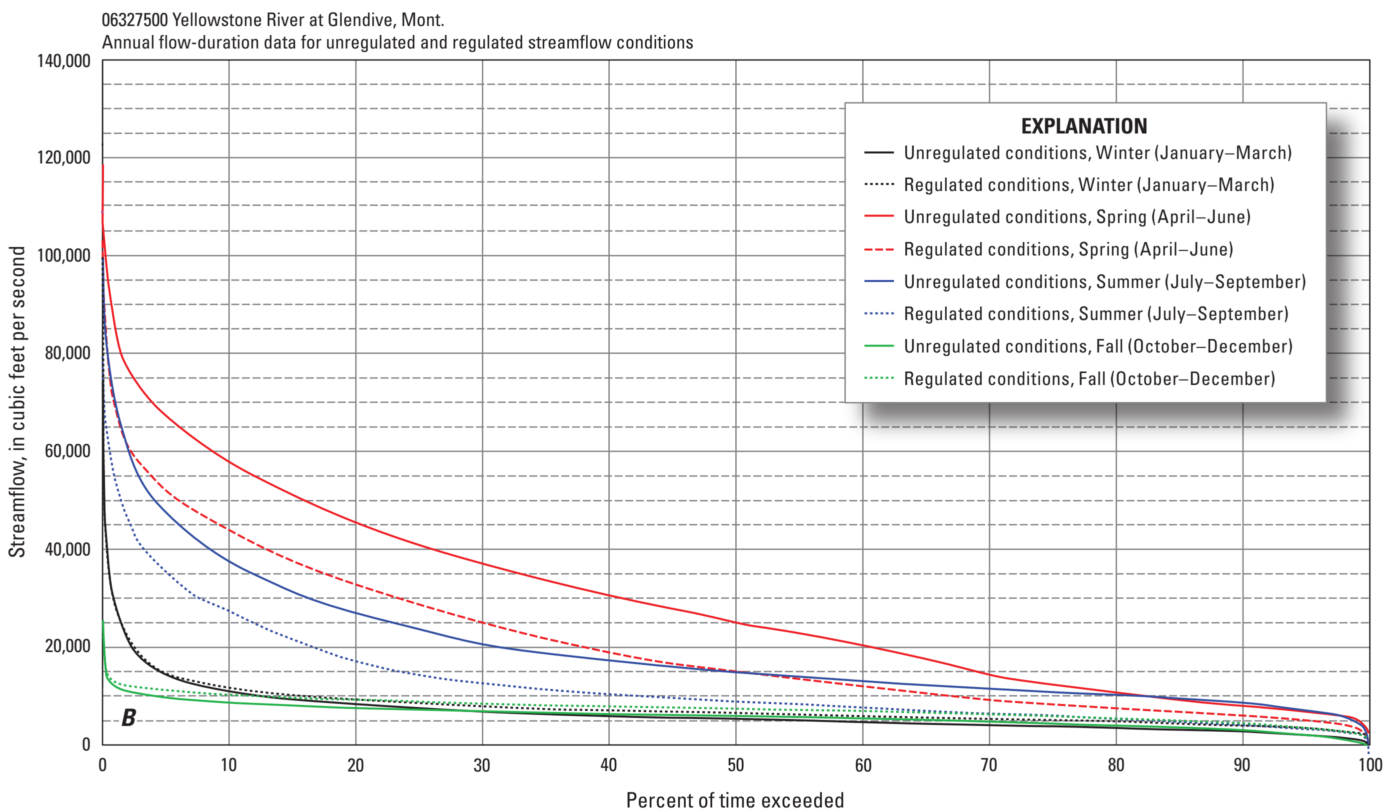


Figure 2-3-21. *A,* Annual and *B,* seasonal flow-duration data for streamflow-gaging station 06327500 (Yellowstone River at Glendive, Mont.) for unregulated and regulated streamflow conditions, 1928–2002.

Appendix 2–4. Statistics for Streamflow-Gaging Station 06329500 (Yellowstone River at Sidney, Mont.)

Table 2-4-1. Annual *n*-day high-flow frequency data for streamflow-gaging station 06329500 (Yellowstone River at Sidney, Mont.) for unregulated and regulated streamflow conditions, 1928–2002.

[Abbreviations: ft^3/s, cubic feet per second. Symbol: %, percent]

n, period of consecutive days	Streamflow, in ft^3/s, for indicated recurrence interval, in years, and exceedance probability, in percent						
Unregulated							
	2 50%	5 20%	10 10%	20 5%	25 4%	50 2%	100 1%
1	67,700	86,200	97,400	108,000	111,000	120,000	129,000
3	65,000	82,200	92,500	102,000	105,000	113,000	121,000
7	60,500	76,600	86,200	94,800	97,400	105,000	113,000
15	55,700	70,000	78,500	86,000	88,300	95,000	102,000
30	50,300	62,900	70,400	77,000	79,000	85,000	90,700
60	42,200	52,000	57,800	62,900	64,500	69,100	73,500
90	35,900	43,400	47,800	51,600	52,700	56,100	59,200
120	30,900	37,000	40,500	43,600	44,500	47,200	49,700
183	24,200	28,800	31,400	33,700	34,400	36,400	38,300
Regulated							
n, period of consecutive days	Streamflow, in ft^3/s, for indicated recurrence interval, in years, and exceedance probability, in percent						
	2 50%	5 20%	10 10%	20 5%	25 4%	50 2%	100 1%
1	52,600	71,500	83,500	91,700	98,300	109,000	119,000
3	50,000	67,000	77,400	86,900	89,800	98,400	107,000
7	45,500	60,300	69,200	77,000	79,400	86,500	93,100
15	40,700	54,100	62,200	69,300	71,500	77,900	84,000
30	35,900	48,500	55,700	61,900	63,700	68,900	73,700
60	28,700	39,100	45,200	50,500	51,100	56,800	61,200
90	23,600	31,800	36,500	40,700	42,000	45,700	49,000
120	20,400	26,900	30,600	33,900	34,800	37,600	40,200
183	16,500	21,300	24,000	26,700	27,500	29,700	31,900

Table 2-4-2. Annual, seasonal, and monthly *n*-day low-flow frequency data for streamflow-gaging station 06329500 (Yellowstone River at Sidney, Mont.) for unregulated and regulated steamflow conditions, 1928–2002.

[Abbreviations: ft^3/s, cubic feet per second. Symbol: %, percent]

Unregulated							
***n*, period of consecutive days (month, for monthly frequency data)**	**Streamflow, in ft^3/s, for indicated recurrence interval, in years, and exceedance probability, in percent**						
	2 50%	**5 20%**	**10 10%**	**20 5%**	**25 4%**	**50 2%**	**100 1%**
Annual							
7	1,750	773	435	249	208	121	71
30	3,450	2,580	2,200	1,910	1,830	1,620	1,450
Winter (January–March)							
7	2,620	1,620	1,210	940	864	682	545
30	4,110	3,040	2,560	2,210	2,120	1,860	1,650
Spring (April–June)							
7	8,850	6,650	5,660	4,920	4,720	4,170	3,720
30	10,500	7,940	6,810	5,970	5,750	5,130	4,630
Summer (July–September)							
7	8,570	5,910	4,190	2,890	2,550	1,720	1,150
30	9,200	7,180	6,170	5,400	5,180	4,590	4,100
Fall (October–December)							
7	2,320	970	527	291	241	135	76
30	4,280	3,170	2,670	2,290	2,190	1,910	1,680
Monthly							
7 (January)	2,910	1,750	1,280	959	878	672	524
7 (February)	3,950	2,710	2,190	1,820	1,720	1,460	1,260
7 (March)	5,560	4,020	3,400	2,970	2,850	2,540	2,300
7 (April)	8,850	6,650	5,660	4,920	4,720	4,170	3,720
7 (May)	20,000	15,900	14,000	12,500	12,000	10,900	9,00
7 (June)	35,800	28,000	24,600	22,100	21,400	19,600	18,000
7 (July)	22,500	17,600	15,400	13,700	13,300	12,000	11,000
7 (August)	12,500	10,400	9,460	8,720	8,510	7,950	7,460
7 (September)	8,580	5,900	4,180	2,880	2,550	1,720	1,150
7 (October)	5,790	4,260	3,590	3,110	2,980	2,630	2,340
7 (November)	5,550	2,940	1,500	707	547	240	101
7 (December)	2,440	1,210	784	530	471	329	234

Table 2-4-2. Annual, seasonal, and monthly *n*-day low-flow frequency data for streamflow-gaging station 06329500 (Yellowstone River at Sidney, Mont.) for unregulated and regulated steamflow conditions, 1928–2002.—Continued

[Abbreviations: ft³/s, cubic feet per second. Symbol: %, percent]

n, period of consecutive days (month, for monthly frequency data)	Regulated						
	Streamflow, in ft³/s, for indicated recurrence interval, in years, and exceedance probability, in percent						
	2 50%	5 20%	10 10%	20 5%	25 4%	50 2%	100 1%
Annual							
7	3,120	2,190	1,780	1,480	1,400	1,200	1,030
30	4,600	3,200	2,530	2,030	1,900	1,540	1,260
Winter (January–March)							
7	4,060	3,130	2,720	2,420	2,340	2,120	1,940
30	5,440	4,390	3,920	3,560	3,470	3,200	2,980
Spring (April–June)							
7	7,000	4,850	3,780	2,980	2,760	2,200	1,760
30	8,070	5,820	4,810	4,070	3,870	3,330	2,890
Summer (July–September)							
7	4,420	2,690	2,000	1,530	1,410	1,110	878
30	5,280	3,230	2,400	1,840	1,700	1,340	1,060
Fall (October–December)							
7	3,900	2,770	2,310	1,990	1,900	1,680	1,500
30	5,640	4,400	3,820	3,380	3,260	2,920	2,640
Monthly							
7 (January)	4,420	3,330	2,850	2,490	2,390	2,130	1,910
7 (February)	5,250	4,030	3,490	3,090	2,980	2,680	2,430
7 (March)	6,480	4,950	4,330	3,890	3,770	3,460	3,210
7 (April)	6,730	4,950	4,180	3,620	3,460	3,050	2,720
7 (May)	8,500	5,800	4,700	4,000	3,800	3,300	2,900
7 (June)	23,400	15,900	12,800	10,600	10,000	8,400	7,200
7 (July)	10,900	5,730	3,900	2,760	2,490	1,820	1,350
7 (August)	4,850	2,940	2,210	1,730	1,600	1,290	1,050
7 (September)	5,190	3,390	2,660	2,150	2,020	1,670	1,400
7 (October)	7,180	5,450	4,650	4,050	3,880	3,430	3,060
7 (November)	6,550	4,590	3,650	2,950	2,760	2,260	1,860
7 (December)	4,220	2,960	2,430	2,060	1,960	1,700	1,490

Table 2-4-3. Annual and seasonal flow-duration data for streamflow-gaging station 06329500 (Yellowstone River near Sidney, Mont.) for unregulated and regulated streamflow conditions, 1928–2002.

[Abbreviations: ft³/s, cubic feet per second. Symbol: %, percent]

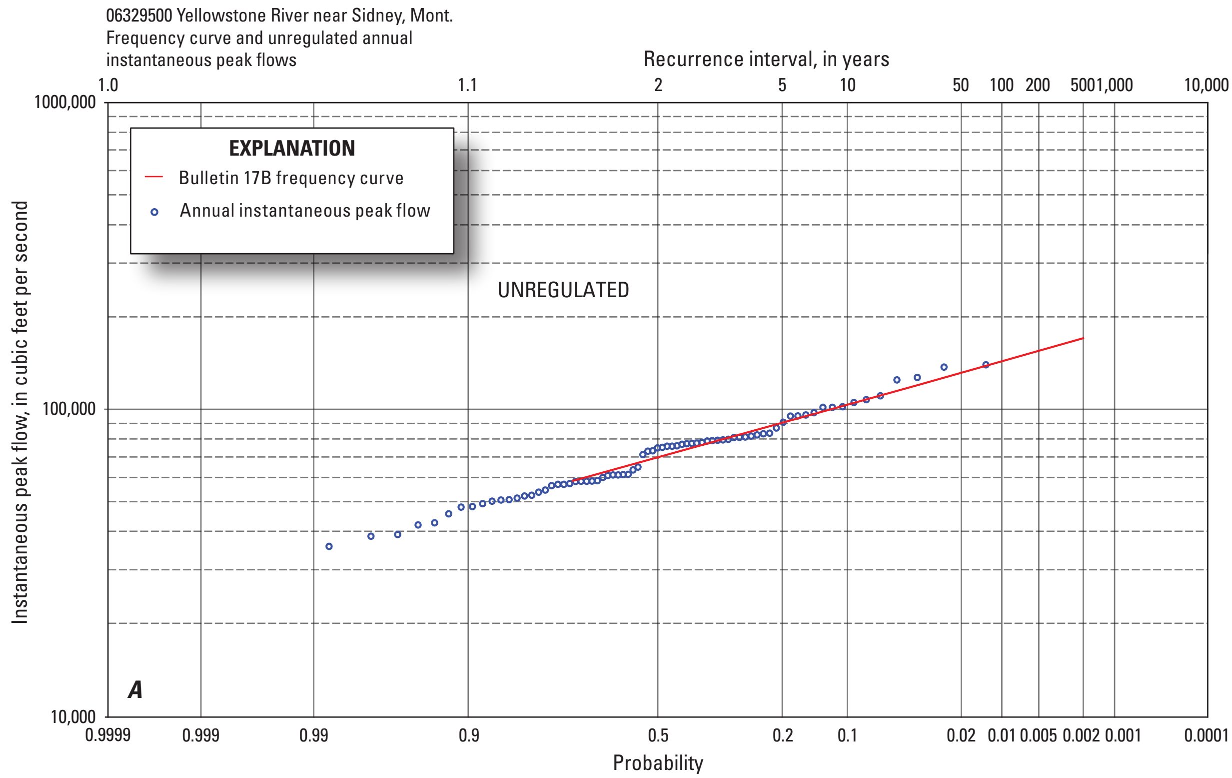
Streamflow condition	Streamflow, in ft³/s, which was equaled or exceeded for indicated percent of time																		
	1%	2%	5%	10%	15%	20%	25%	30%	40%	50%	60%	70%	75%	80%	85%	90%	95%	98%	99%
Annual																			
Unregulated	72,800	64,700	49,700	37,200	29,200	23,300	19,000	15,600	11,300	8,810	7,300	6,090	5,610	5,040	4,420	3,740	2,830	1,810	1,240
Regulated	56,800	49,500	36,900	25,800	18,700	14,500	12,200	10,700	9,030	7,990	7,070	6,210	5,780	5,350	4,880	4,270	3,440	2,520	2,060
Winter (January–March)																			
Unregulated	36,200	24,500	16,500	11,600	9,700	8,600	7,850	7,260	6,280	5,640	4,970	4,360	4,010	3,670	3,300	2,800	2,150	1,470	1,170
Regulated	35,300	25,000	17,000	12,400	10,500	9,500	8,800	8,250	7,500	6,810	6,130	5,560	5,250	4,970	4,560	4,120	3,510	2,830	2,560
Spring (April–June)																			
Unregulated	83,800	76,900	67,400	57,600	50,100	44,600	40,100	36,200	29,800	24,600	20,000	15,200	12,900	11,000	9,430	8,280	7,250	6,030	5,400
Regulated	66,600	60,500	52,000	43,500	36,800	31,600	27,500	23,800	18,000	14,300	11,500	9,110	8,230	7,500	6,640	5,860	5,220	4,530	3,620
Summer (July–September)																			
Unregulated	71,400	61,400	47,800	37,900	31,500	27,000	23,500	20,700	17,000	14,600	12,600	11,000	10,300	9,500	8,590	7,780	6,340	5,240	3,960
Regulated	55,500	46,200	35,300	26,900	21,100	16,600	13,700	12,000	9,700	8,230	6,860	5,680	5,150	4,600	4,010	3,460	2,550	1,940	1,550
Fall (October–December)																			
Unregulated	12,200	11,300	9,950	8,810	8,090	7,590	7,200	6,870	6,280	5,800	5,270	4,590	4,230	3,870	3,490	2,950	1,920	950	492
Regulated	13,700	12,500	11,300	10,400	9,740	9,230	8,840	8,510	7,890	7,300	6,730	6,050	5,660	5,300	4,850	4,320	3,490	2,610	2,200

Table 2-4-4. Monthly and annual streamflow characteristics for streamflow-gaging station 06329500 (Yellowstone River near Sidney, Mont.) for unregulated and regulated streamflow conditions, 1928–2002.

[Abbreviations: ft^3/s, cubic feet per second]

Unregulated						
	Streamflow, in ft^3/s, or year, for indicated streamflow characteristic					
Period	Maximum monthly mean and maximum annual mean streamflow	Year of maximum monthly mean and maximum annual mean streamflow	Minimum monthly mean and minimum annual mean streamflow	Year of minimum monthly mean and minimum annual mean streamflow	Mean monthly and mean annual streamflow	Standard deviation of mean monthly and mean annual streamflow
January	8,090	1983	1,540	1940	4,640	1,430
February	17,300	1971	2,320	1936	6,100	2,780
March	25,800	1972	2,810	2002	10,220	4,760
April	27,500	1952	3,750	1961	11,210	4,020
May	46,600	1928	14,440	1953	27,700	6,580
June	82,600	1997	21,700	1934	48,100	13,300
July	63,600	1975	13,910	1934	32,800	11,740
August	24,400	1997	8,210	1988	15,030	3,560
September	15,600	1997	3,810	1934	9,350	2,480
October	13,400	1971	3,230	2001	7,040	2,340
November	9,000	1968	2,780	1931	5,820	1,650
December	8,050	1975	2,170	1960	4,660	1,350
Annual	23,200	1997	9,410	1934	15,200	3,060

Regulated						
	Streamflow, in ft^3/s, or year, for indicated streamflow characteristic					
Period	Maximum monthly mean and maximum annual mean streamflow	Year of maximum monthly mean and maximum annual mean streamflow	Minimum monthly mean and minimum annual mean streamflow	Year of minimum monthly mean and minimum annual mean streamflow	Mean monthly and mean annual streamflow	Standard deviation of mean monthly and mean annual streamflow
January	9,460	1968	2,980	1937	6,030	1,430
February	17,800	1971	3,540	1936	7,220	2,680
March	25,700	1972	3,240	2002	11,010	4,730
April	22,100	1952	2,700	1961	9,050	3,570
May	35,600	1928	4,600	1961	16,200	5,850
June	65,800	1997	11,200	1934	34,500	12,300
July	49,100	1967	3,460	1934	20,800	11,460
August	18,500	1997	1,170	1988	7,680	3,850
September	16,300	1941	2,460	1960	6,990	2,900
October	15,700	1971	4,020	1960	8,300	2,400
November	11,700	1972	4,020	1977	7,560	1,850
December	9,670	1975	3,380	1960	6,220	1,410
Annual	19,900	1997	5,480	1934	11,700	3,280



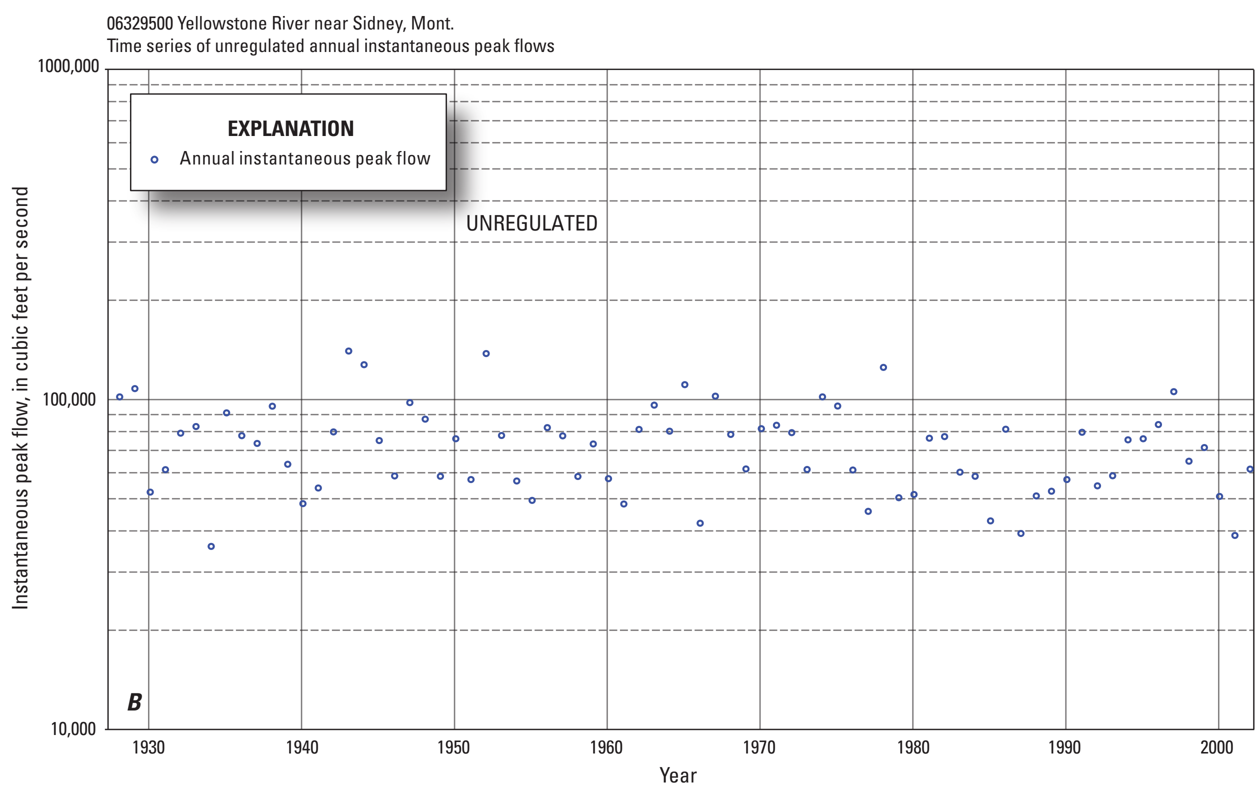
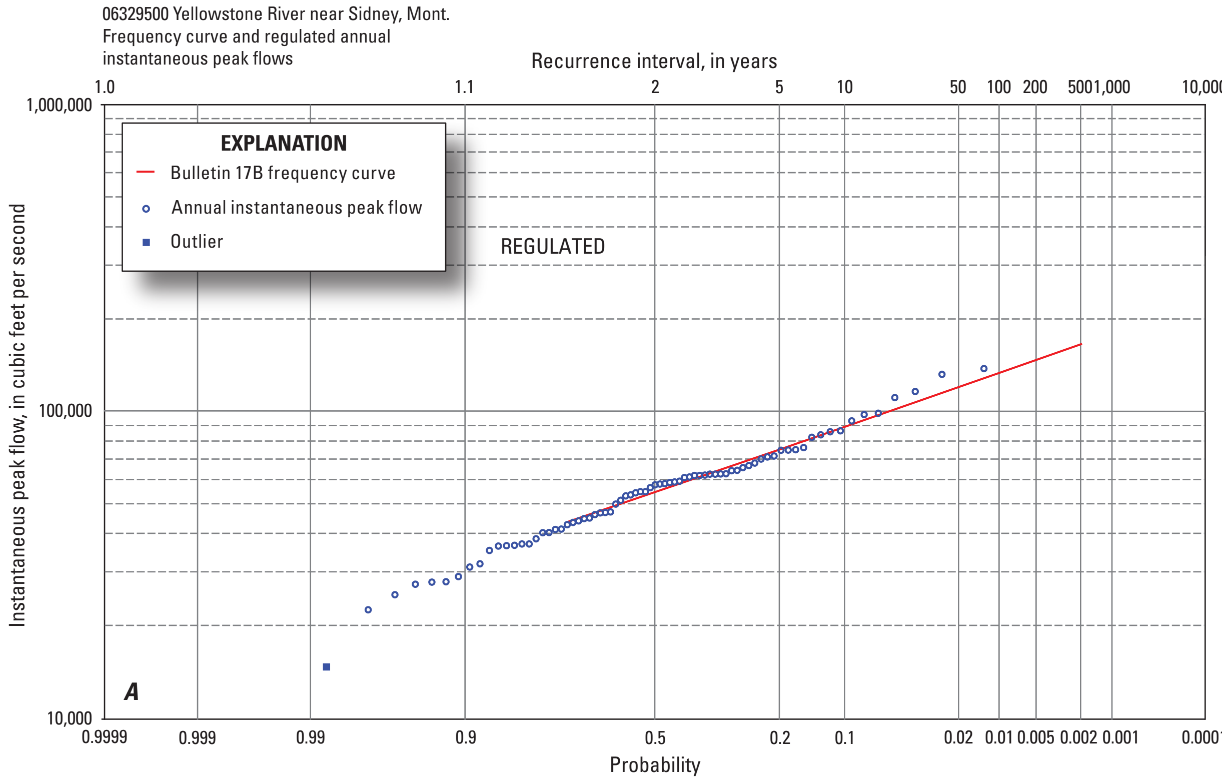


Figure 2-4-1. Annual instantaneous peak-flow data for streamflow-gaging station 06329500 (Yellowstone River at Sidney, Mont.) for unregulated streamflow conditions, 1928–2002. *A*, Frequency curve and unregulated annual instantaneous peak flows. *B*, Time series of regulated annual instantaneous peak flows. [Bulletin 17B: U.S. Interagency Advisory Council on Water Data, 1982]



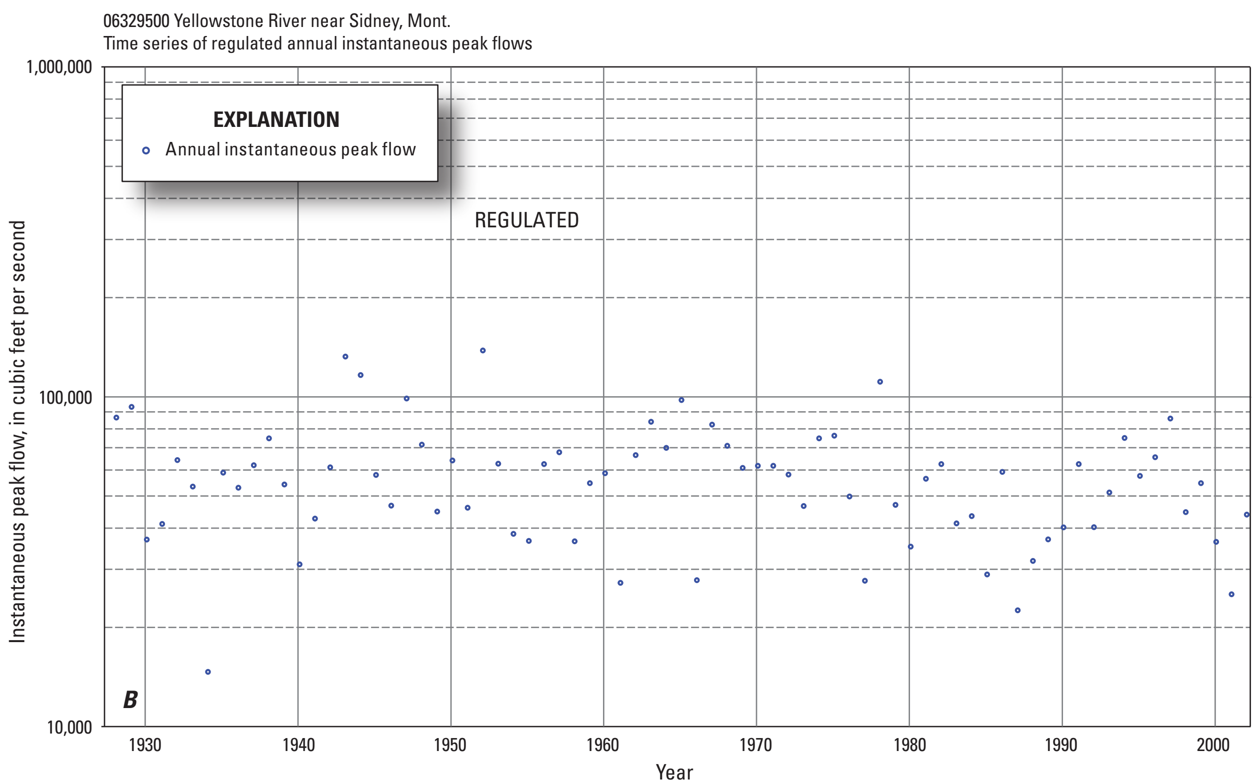


Figure 2-4-2. Annual instantaneous peak-flow data for streamflow-gaging station 06329500 (Yellowstone River at Sidney, Mont.) for unregulated streamflow conditions, 1928–2002. *A*, Frequency curve and unregulated annual instantaneous peak flows. *B*, Time series of regulated annual instantaneous peak flows. [Bulletin 17B: U.S. Interagency Advisory Council on Water Data, 1982]

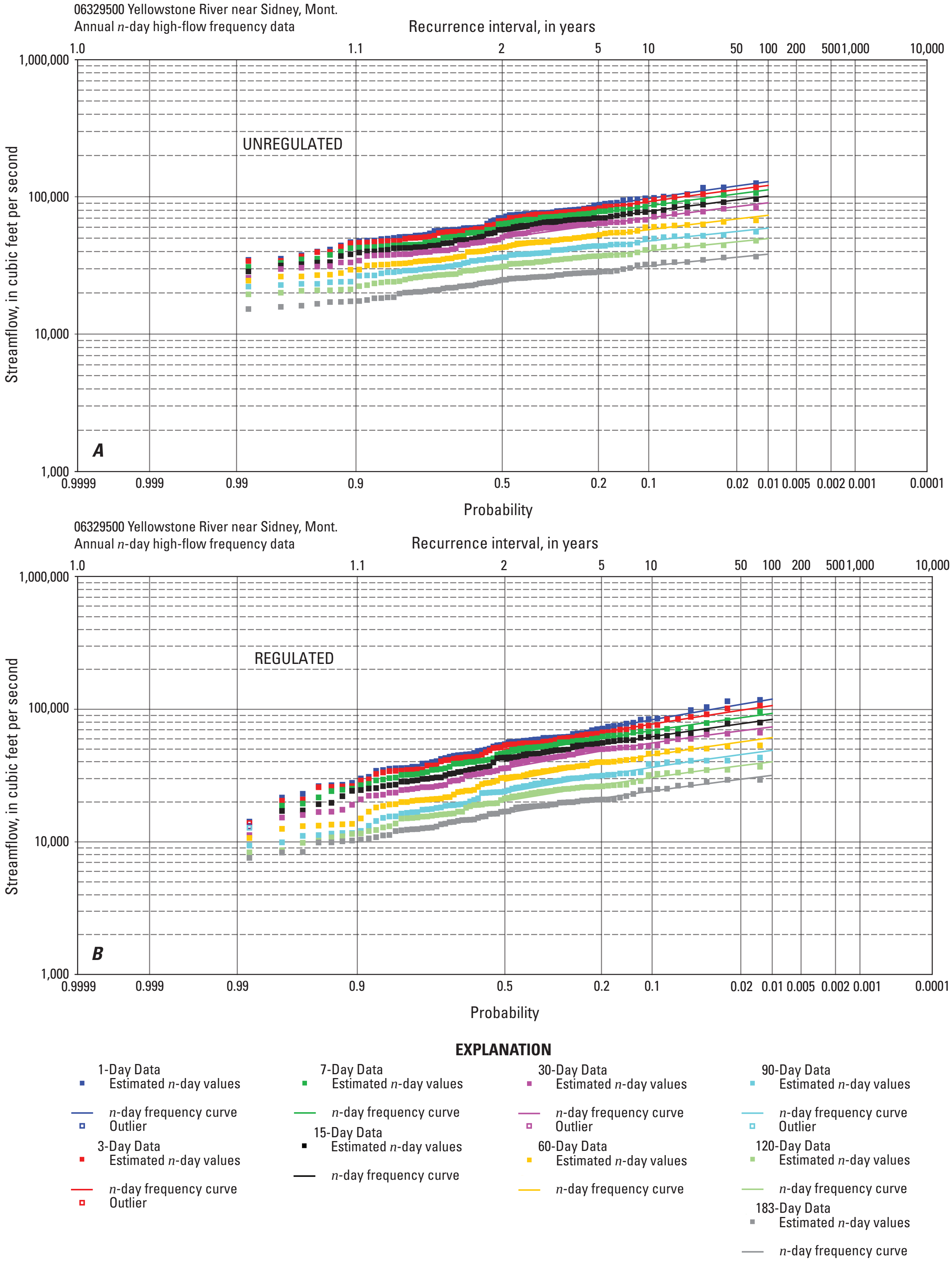


Figure 2-4-3. Annual *n*-day high-flow frequency data for streamflow-gaging station 06329500 (Yellowstone River at Sidney, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

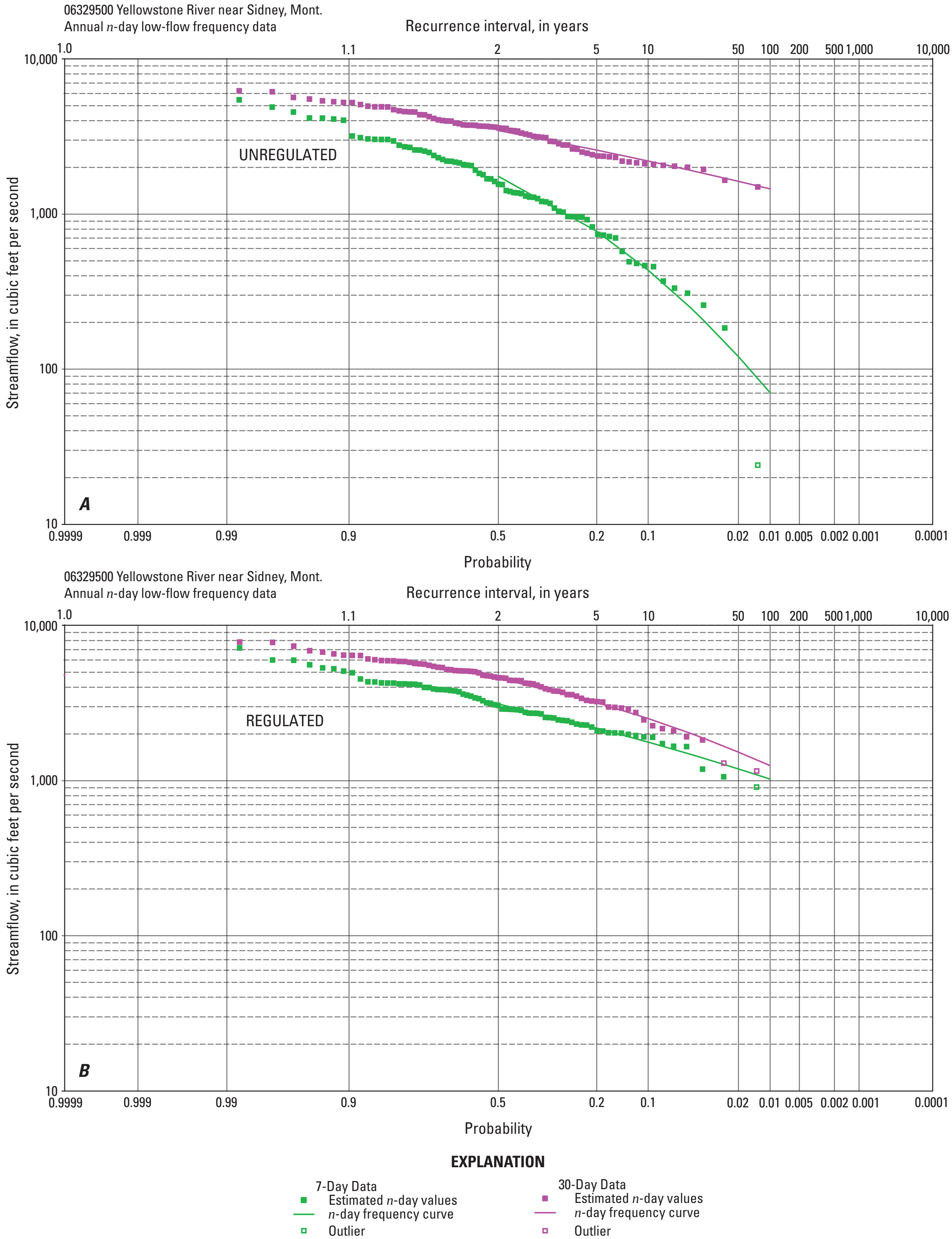


Figure 2-4-4. Annual *n*-day low-flow frequency data for streamflow-gaging station 06329500 (Yellowstone River at Sidney, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.

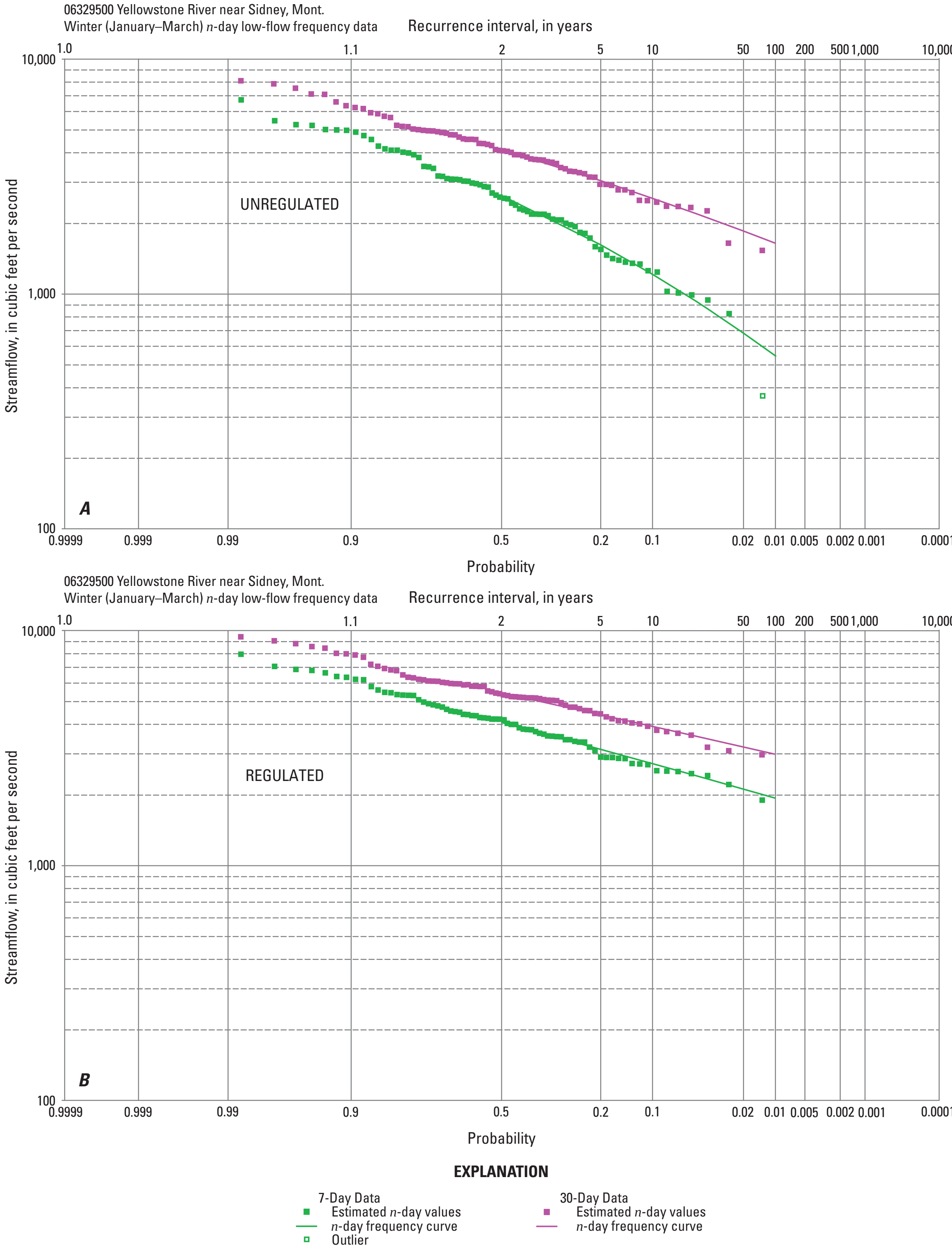


Figure 2-4-5. Winter (January–March) *n*-day low-flow frequency data for streamflow-gaging station 06329500 (Yellowstone River at Sidney, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

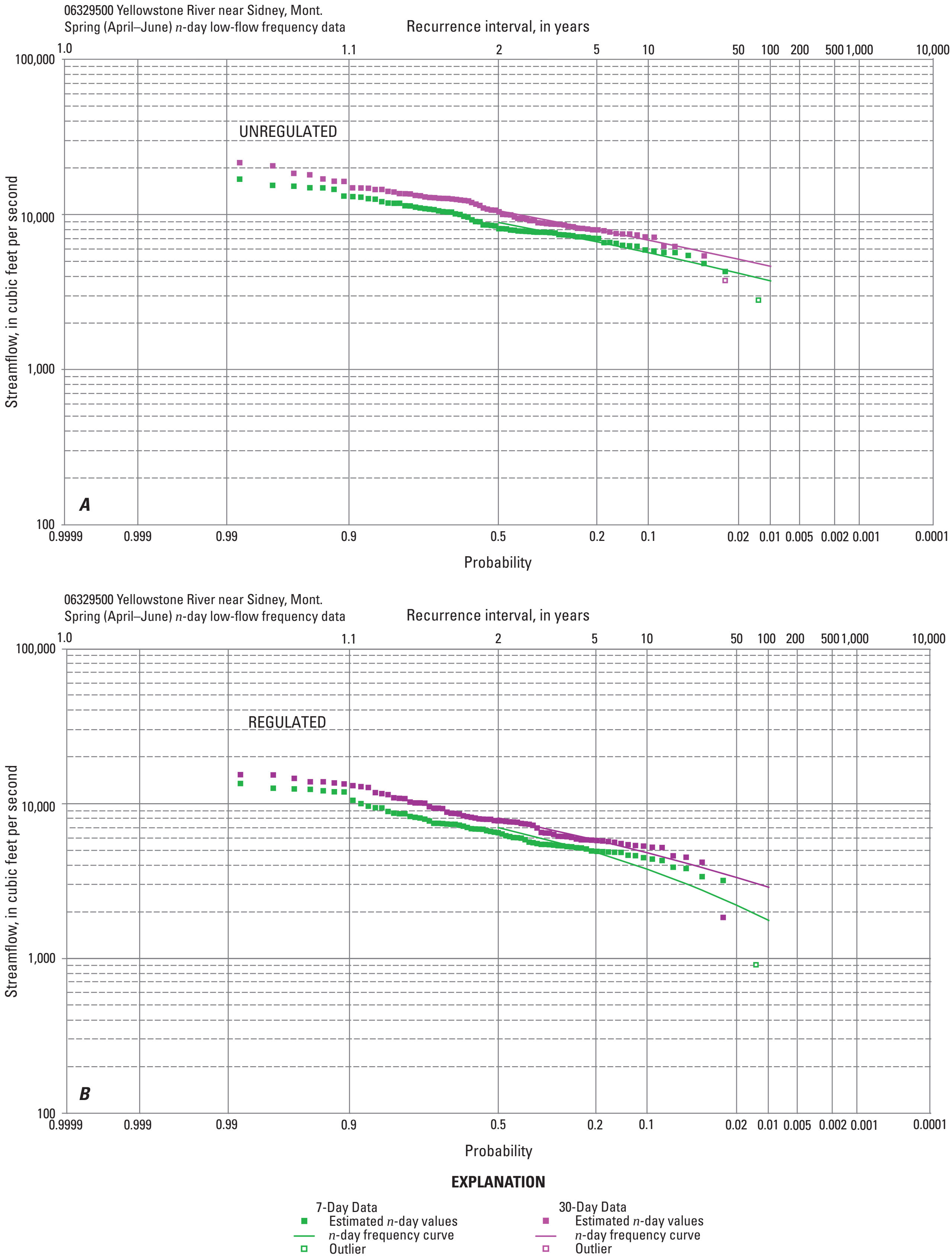


Figure 2-4-6. Spring (April–June) *n*-day low-flow frequency data for streamflow-gaging station 06329500 (Yellowstone River at Sidney, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.

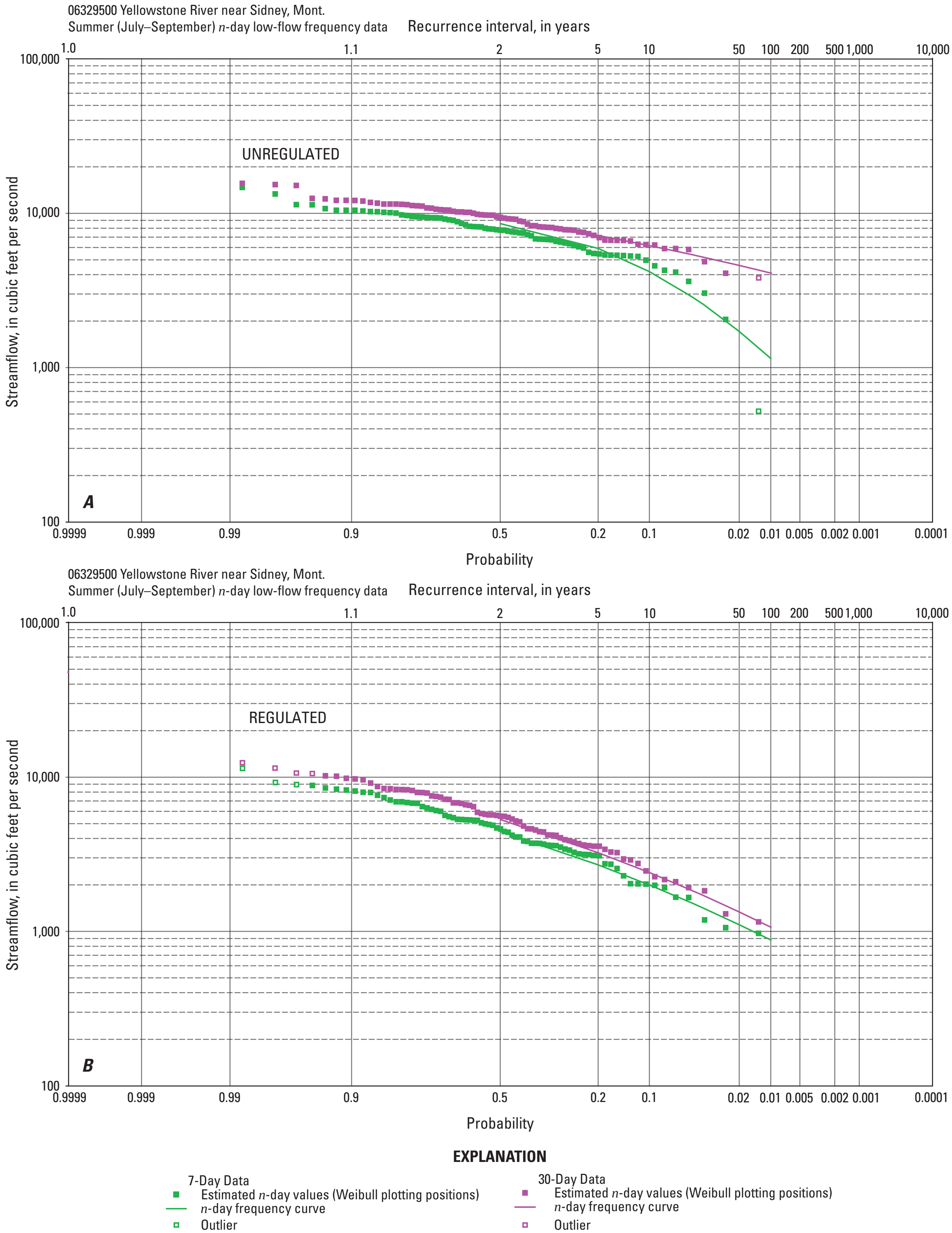


Figure 2-4-7. Summer (July–September) *n*-day low-flow frequency data for streamflow-gaging station 06329500 (Yellowstone River at Sidney, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

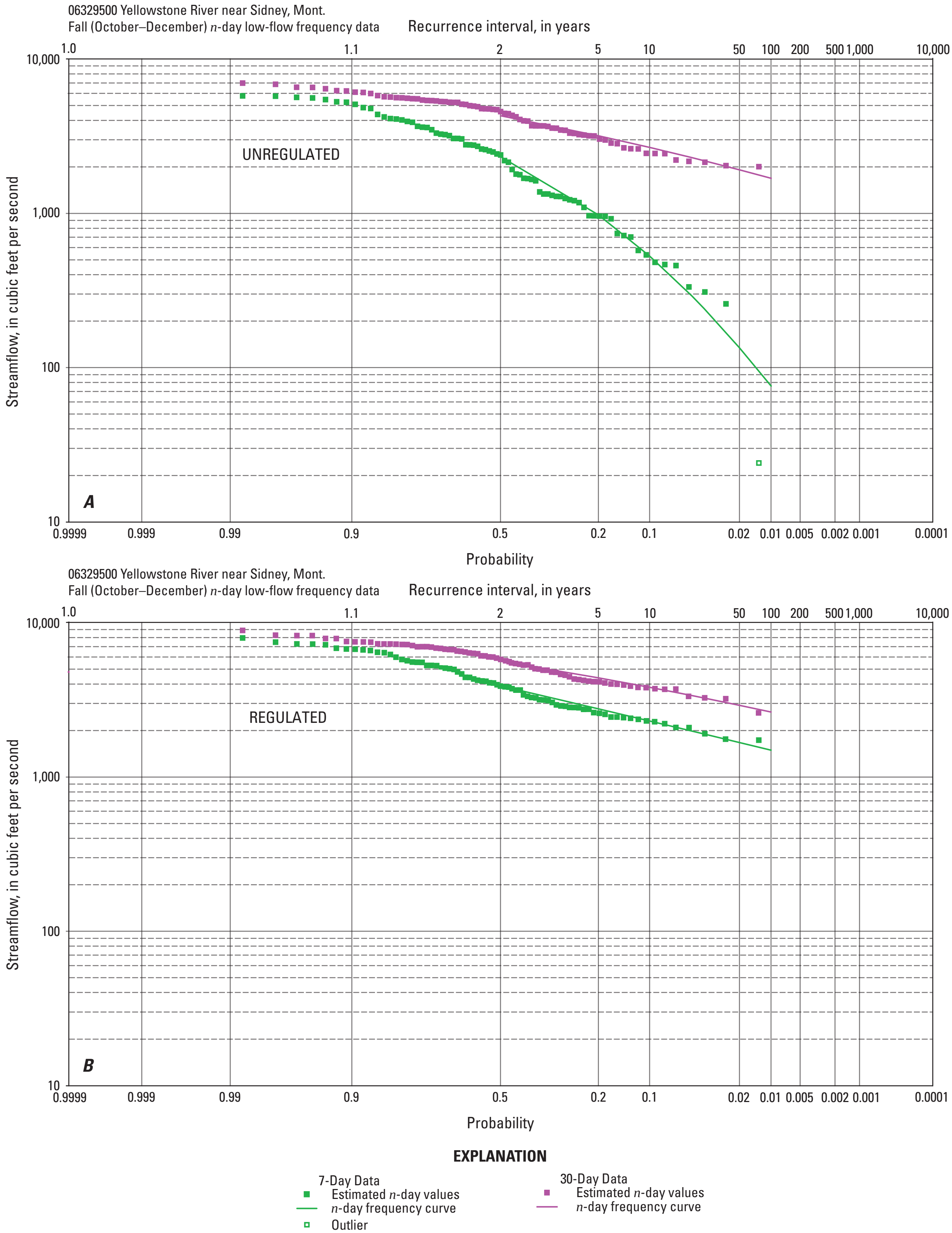


Figure 2-4-8. Fall (October–December) *n*-day low-flow frequency data for streamflow-gaging station 06329500 (Yellowstone River at Sidney, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.

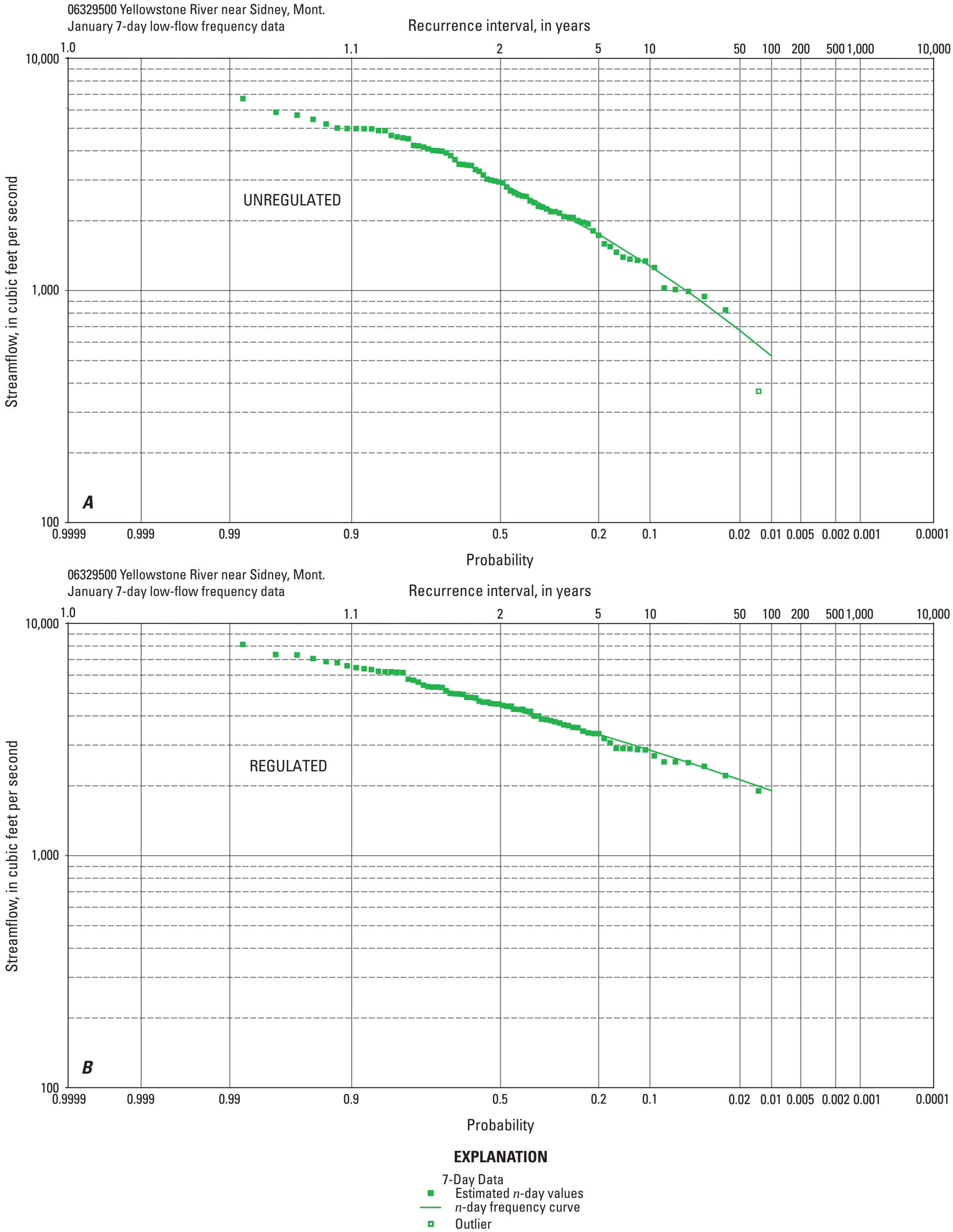


Figure 2-4-9. January 7-day low-flow frequency data for streamflow-gaging station 06329500 (Yellowstone River at Sidney, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

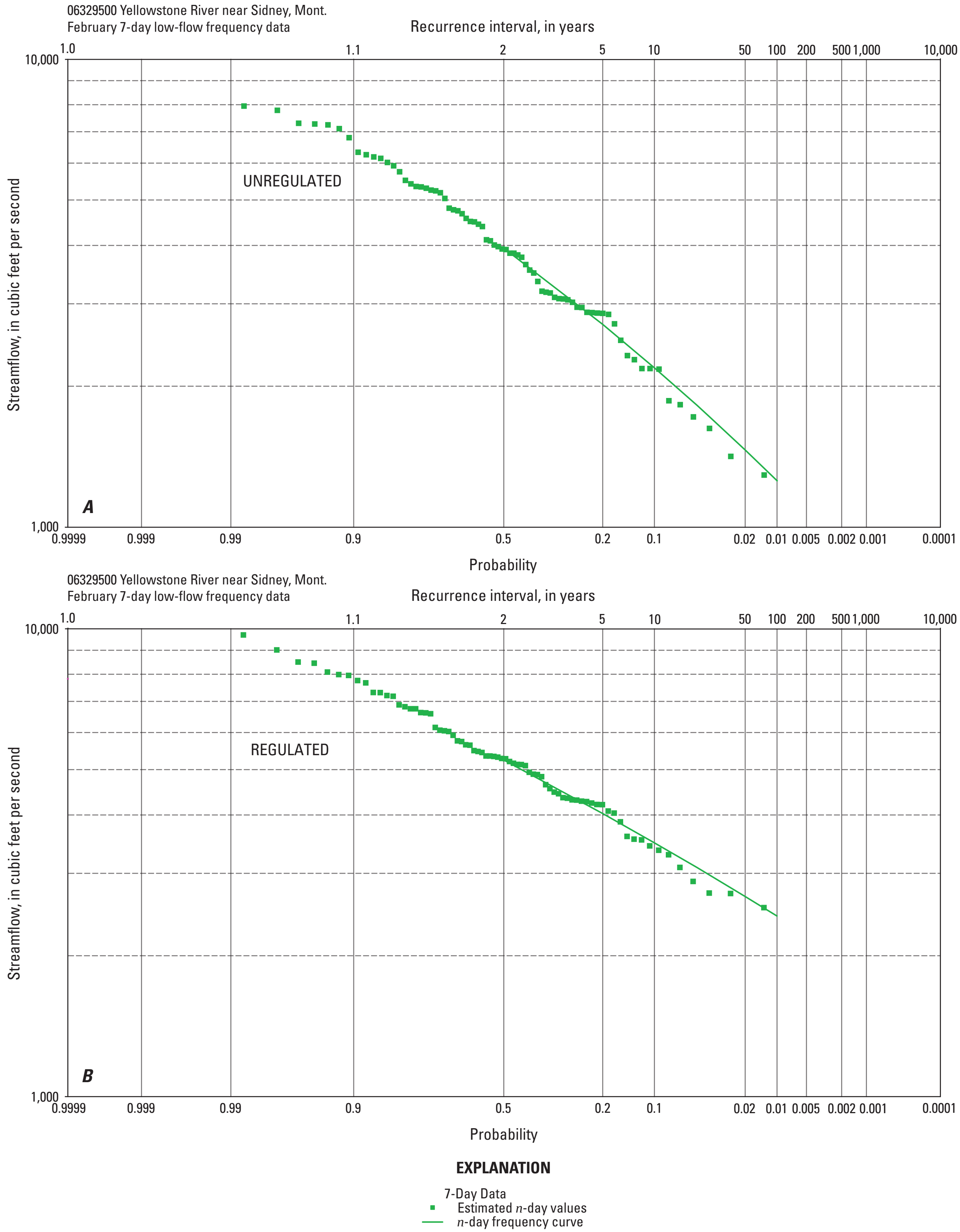
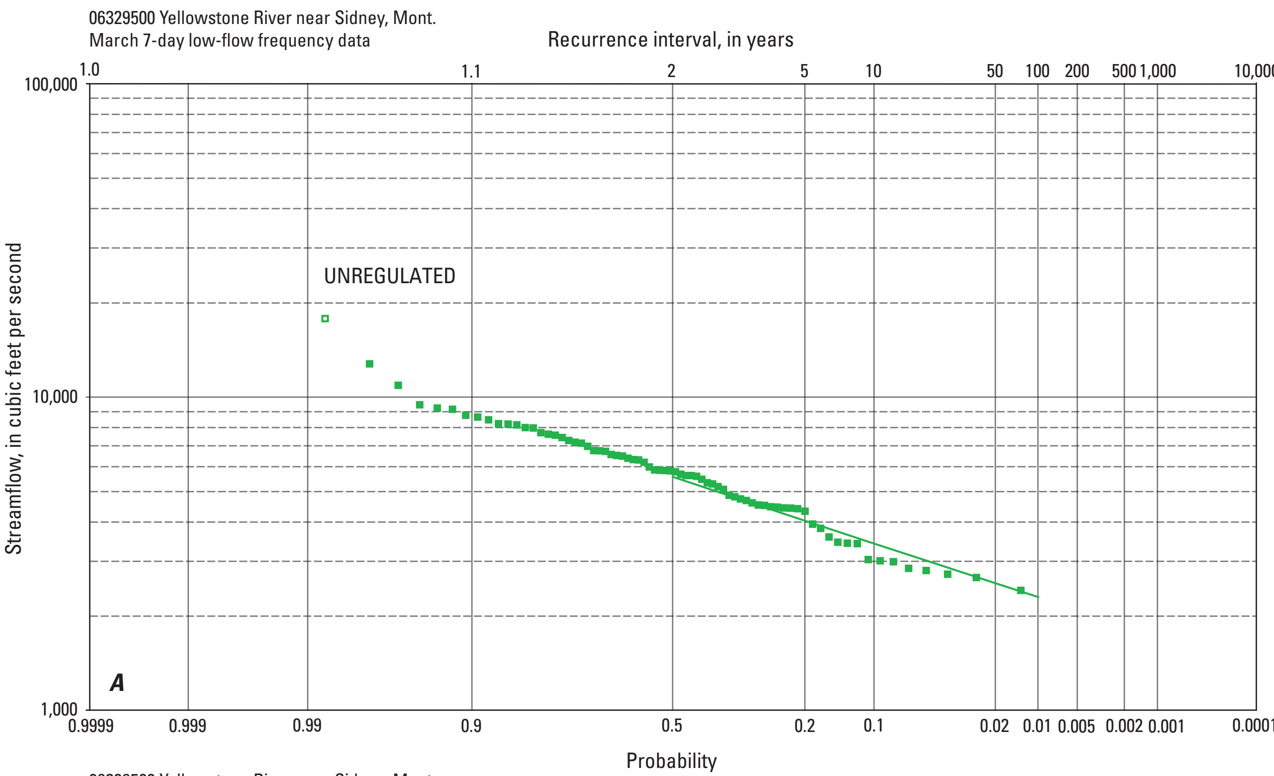
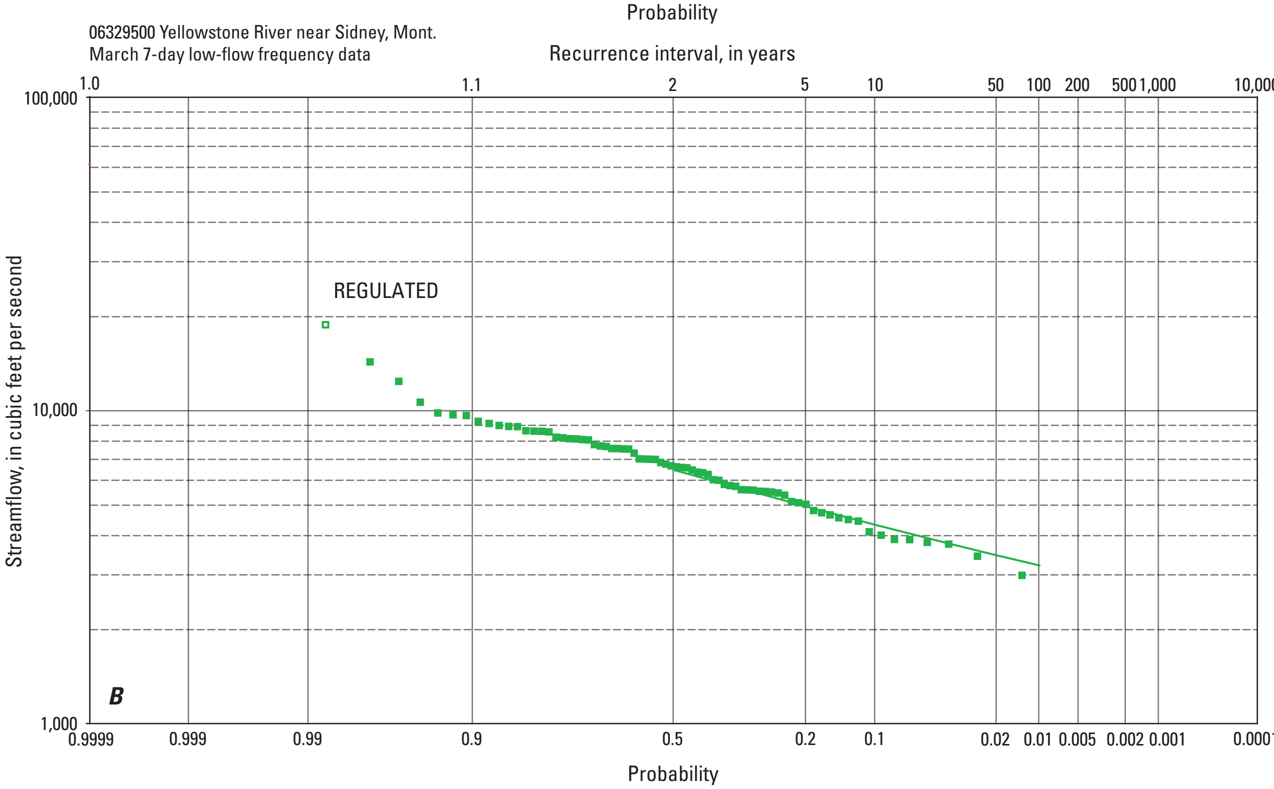


Figure 2-4-10. February 7-day low-flow frequency data for streamflow-gaging station 06329500 (Yellowstone River at Sidney, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.





EXPLANATION

7-Day Data
Estimated *n*-day values
n-day frequency curve
Outlier

Figure 2-4-11. March 7-day low-flow frequency data for streamflow-gaging station 06329500 (Yellowstone River at Sidney, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

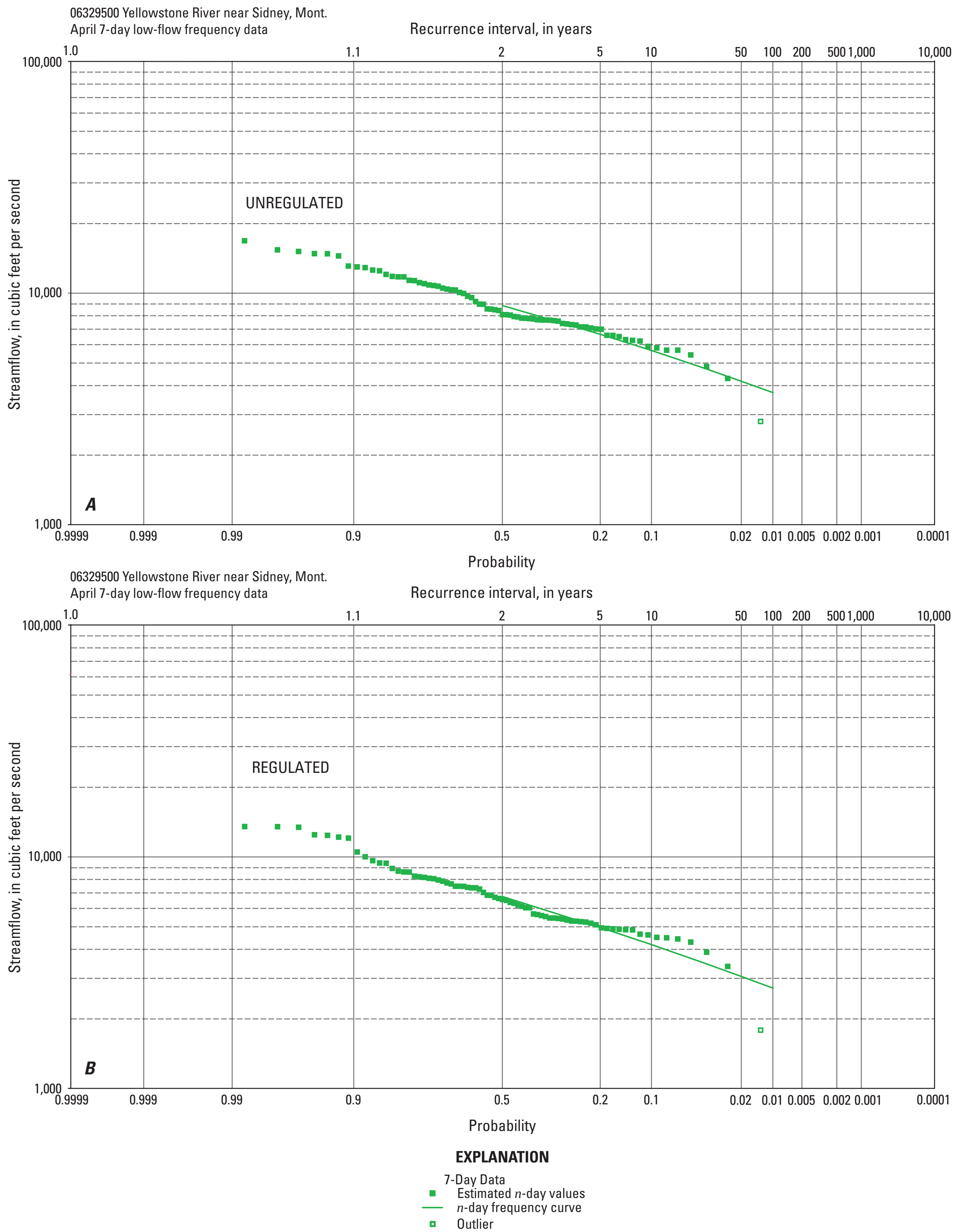
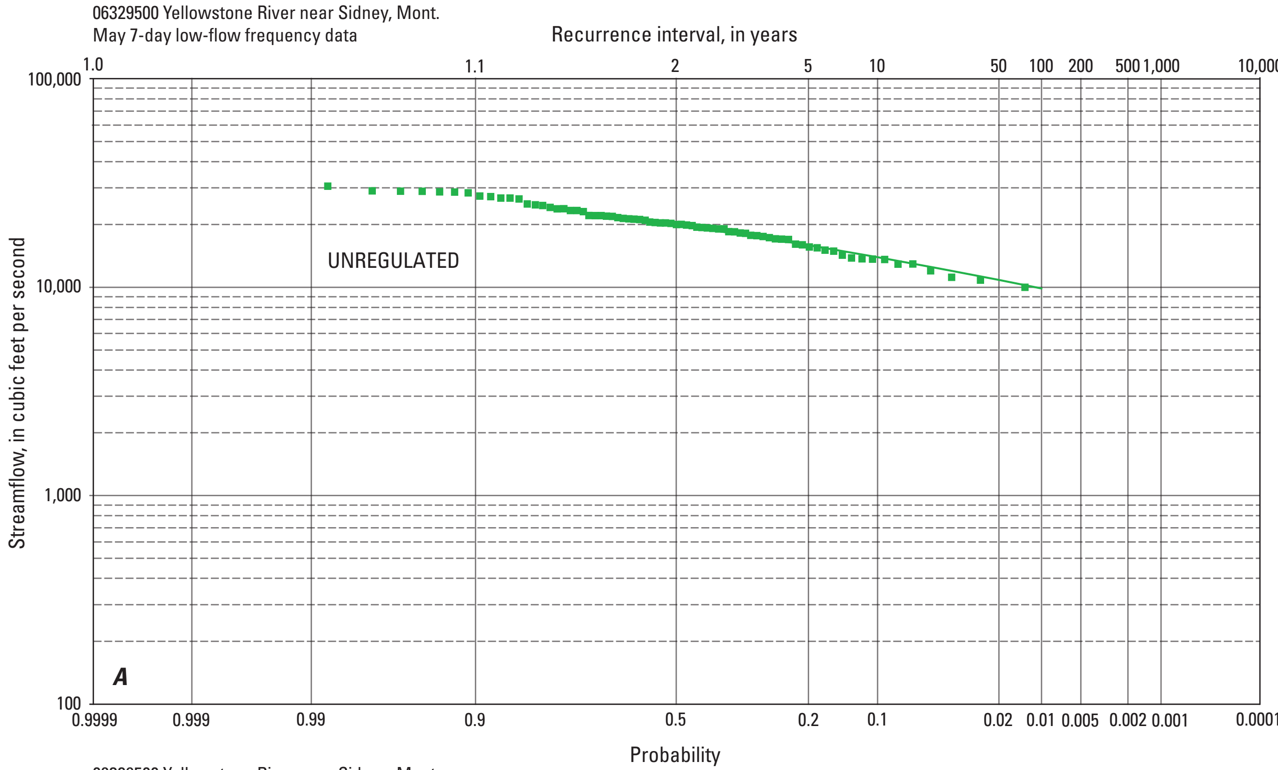


Figure 2-4-12. April 7-day low-flow frequency data for streamflow-gaging station 06329500 (Yellowstone River at Sidney, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.



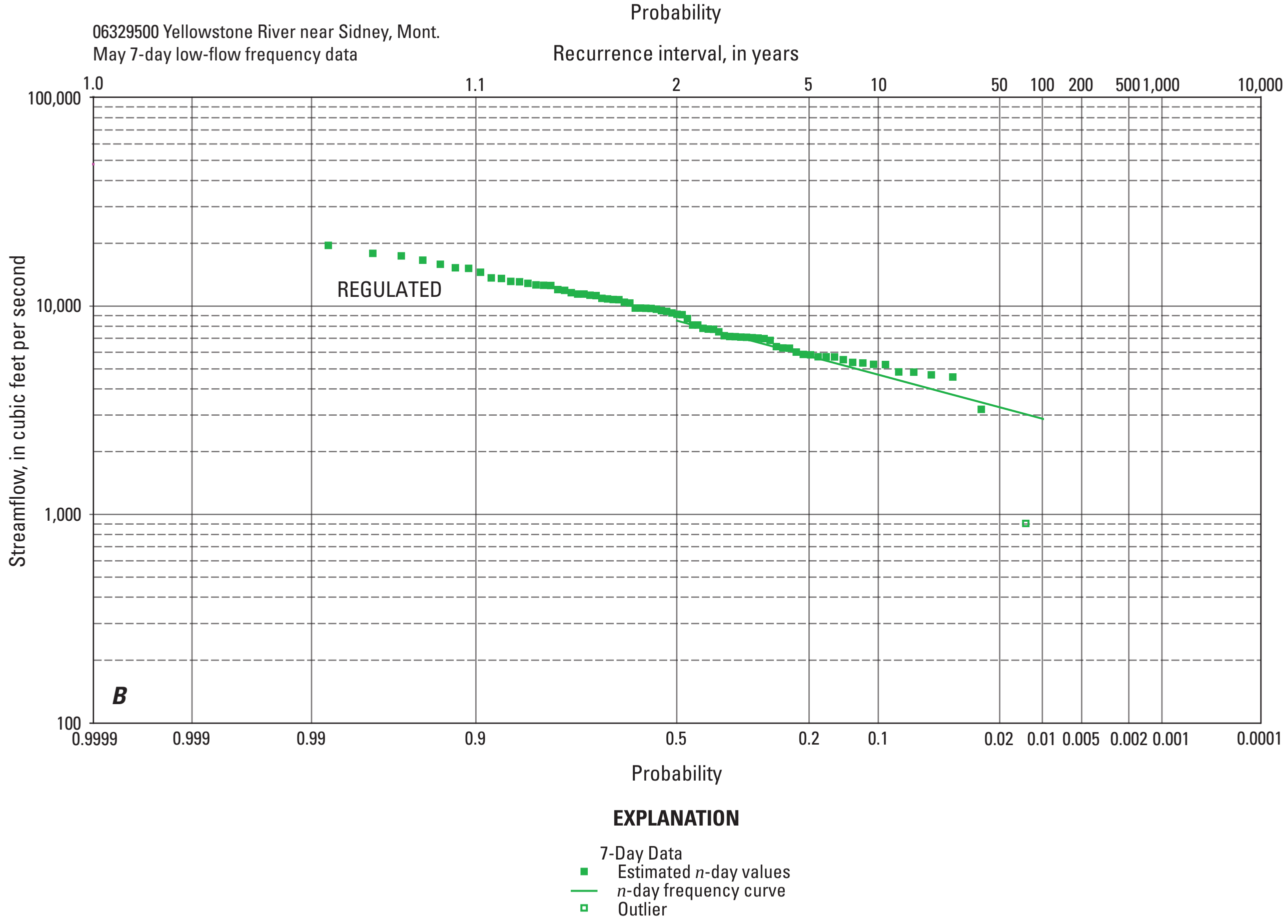
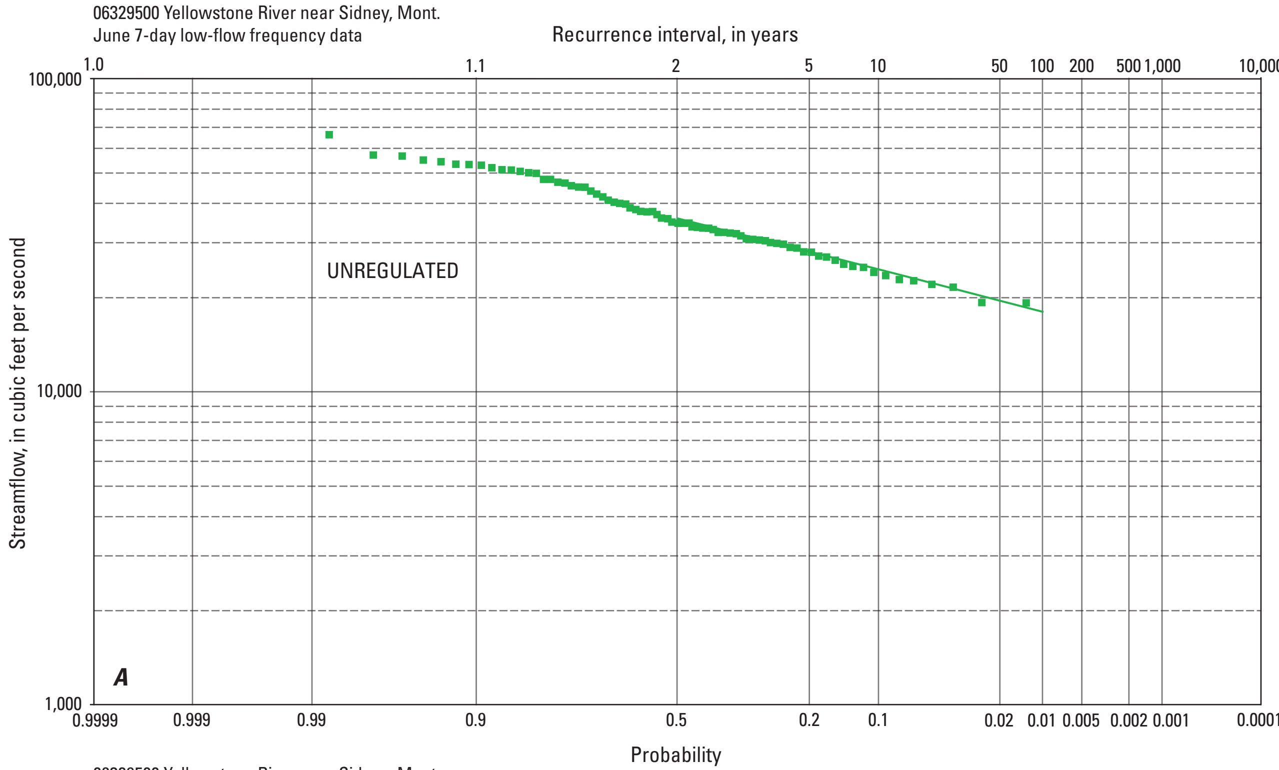


Figure 2-4-13. May 7-day low-flow frequency data for streamflow-gaging station 06329500 (Yellowstone River at Sidney, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.



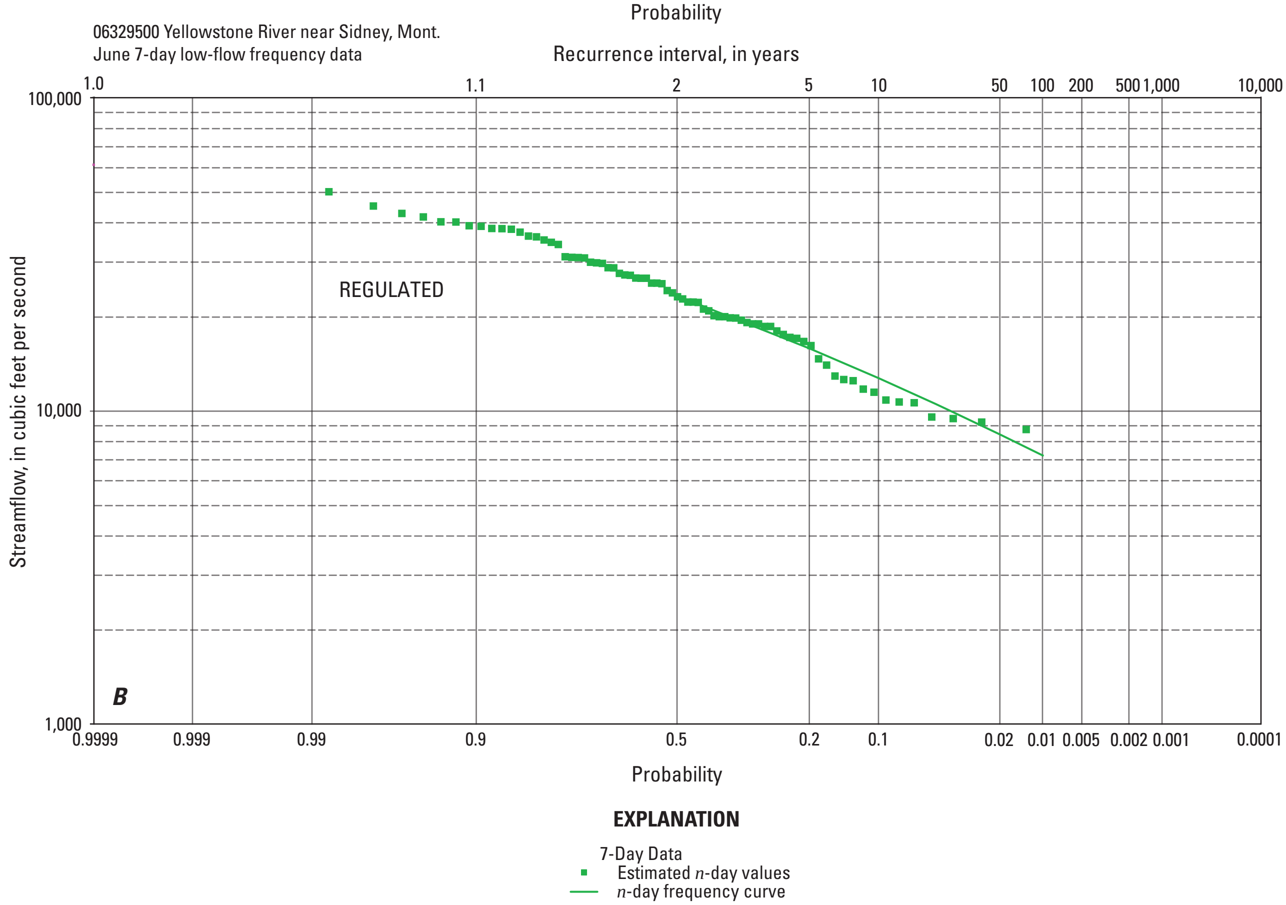
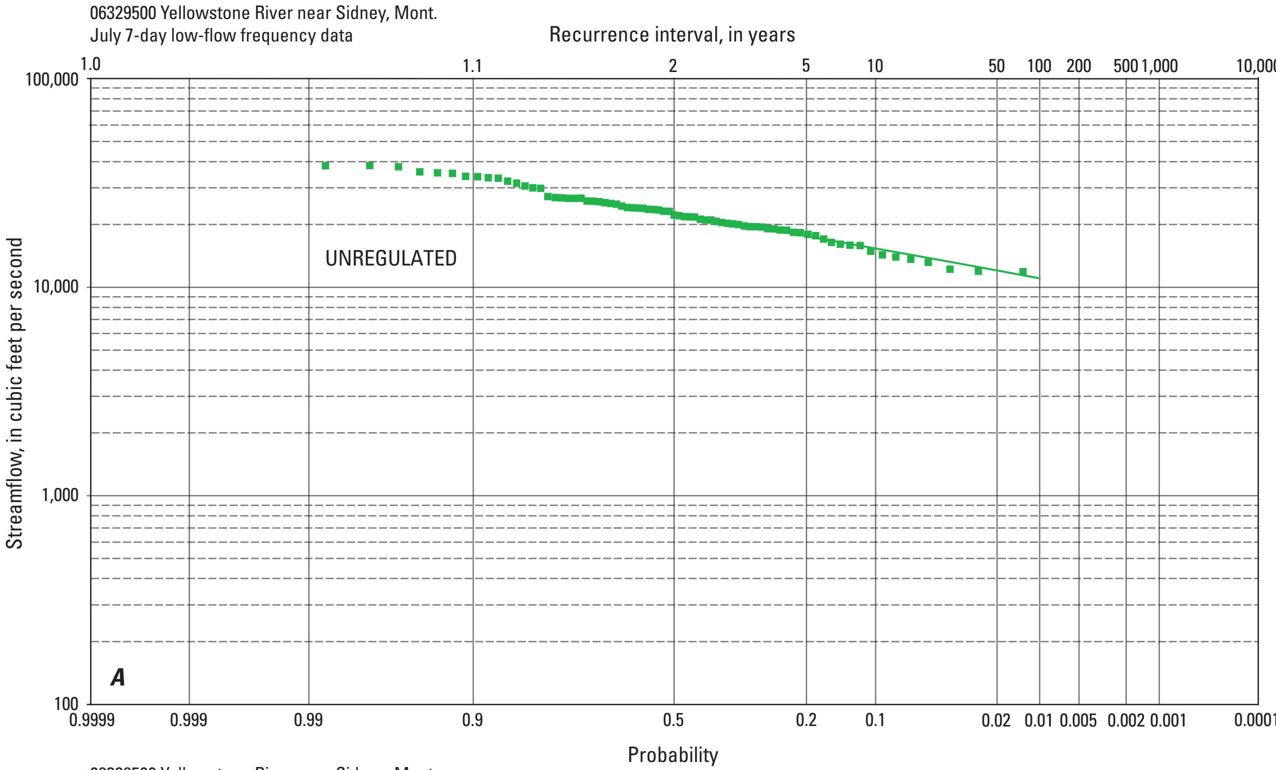
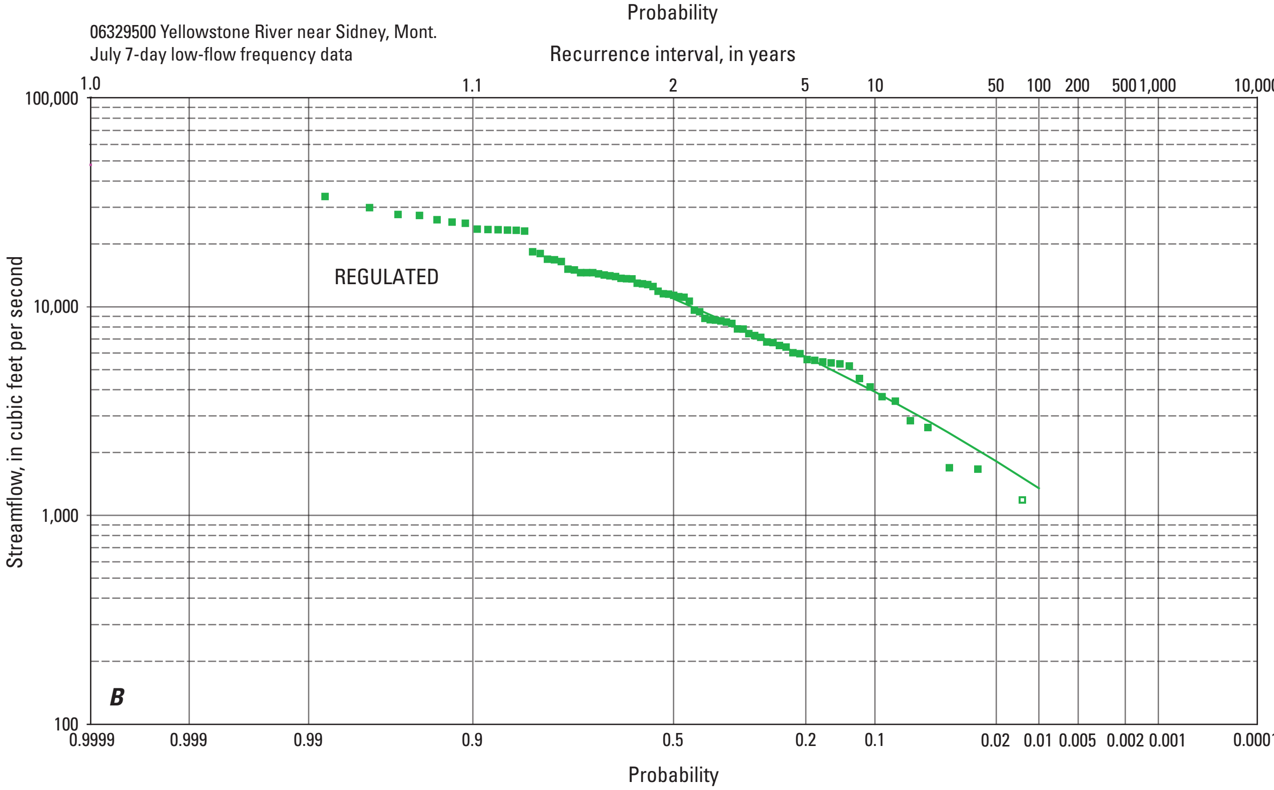


Figure 2-4-14. June 7-day low-flow frequency data for streamflow-gaging station 06329500 (Yellowstone River at Sidney, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.





EXPLANATION

7-Day Data
- Estimated *n*-day values
- *n*-day frequency curve
- Outlier

Figure 2-4-15. July 7-day low-flow frequency data for streamflow-gaging station 06329500 (Yellowstone River at Sidney, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

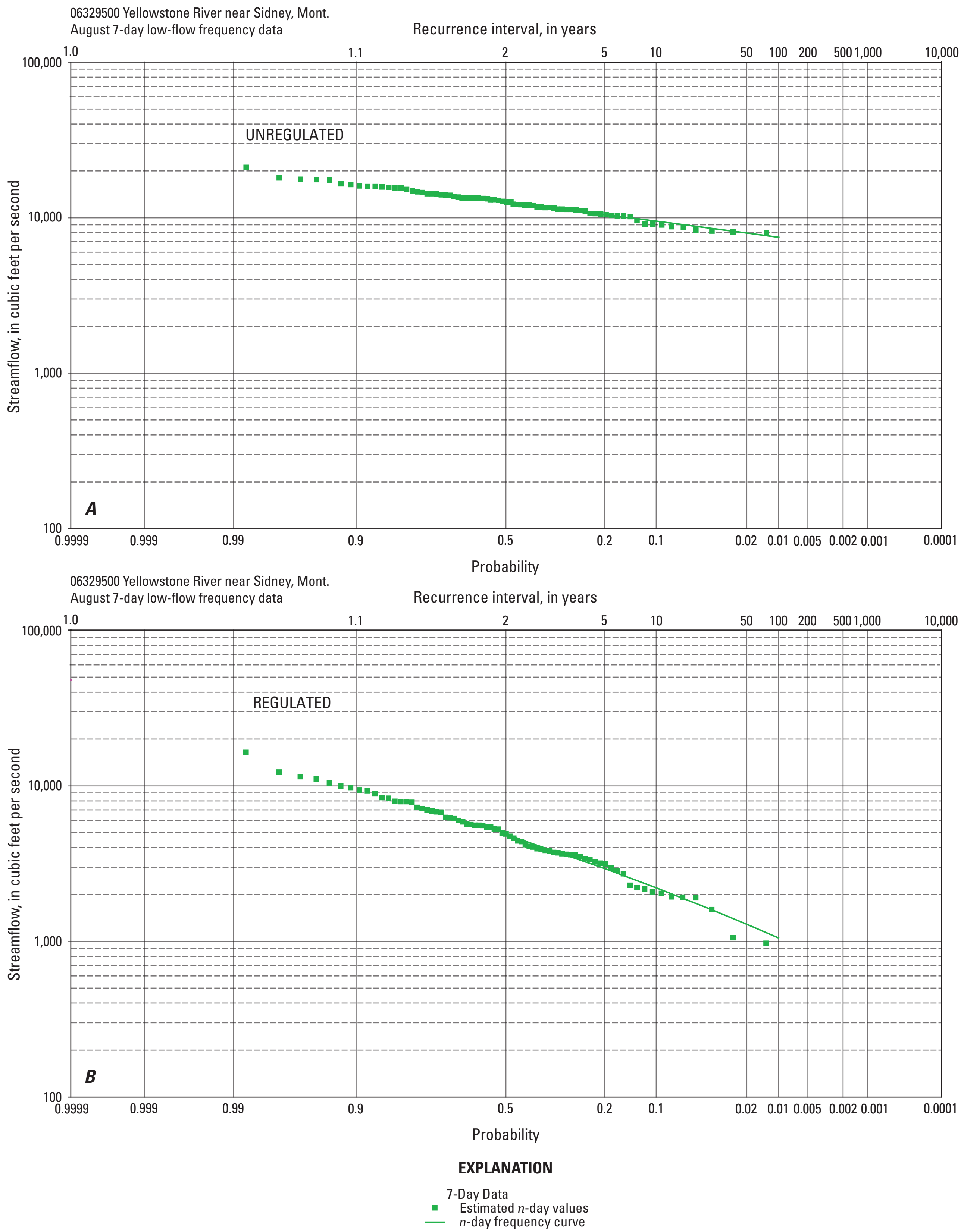


Figure 2-4-16. August 7-day low-flow frequency data for streamflow-gaging station 06329500 (Yellowstone River at Sidney, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.

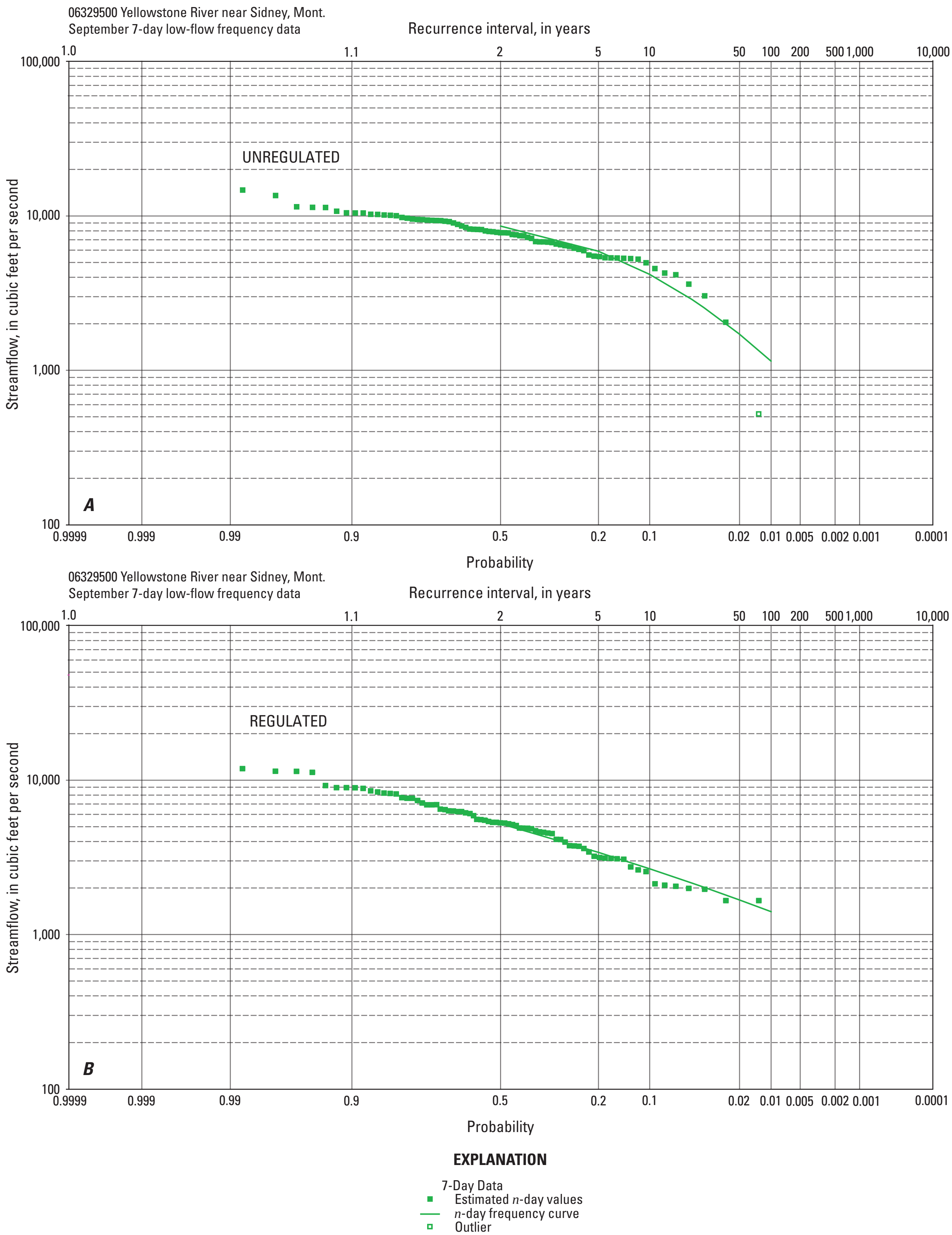


Figure 2-4-17. September 7-day low-flow frequency data for streamflow-gaging station 06329500 (Yellowstone River at Sidney, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

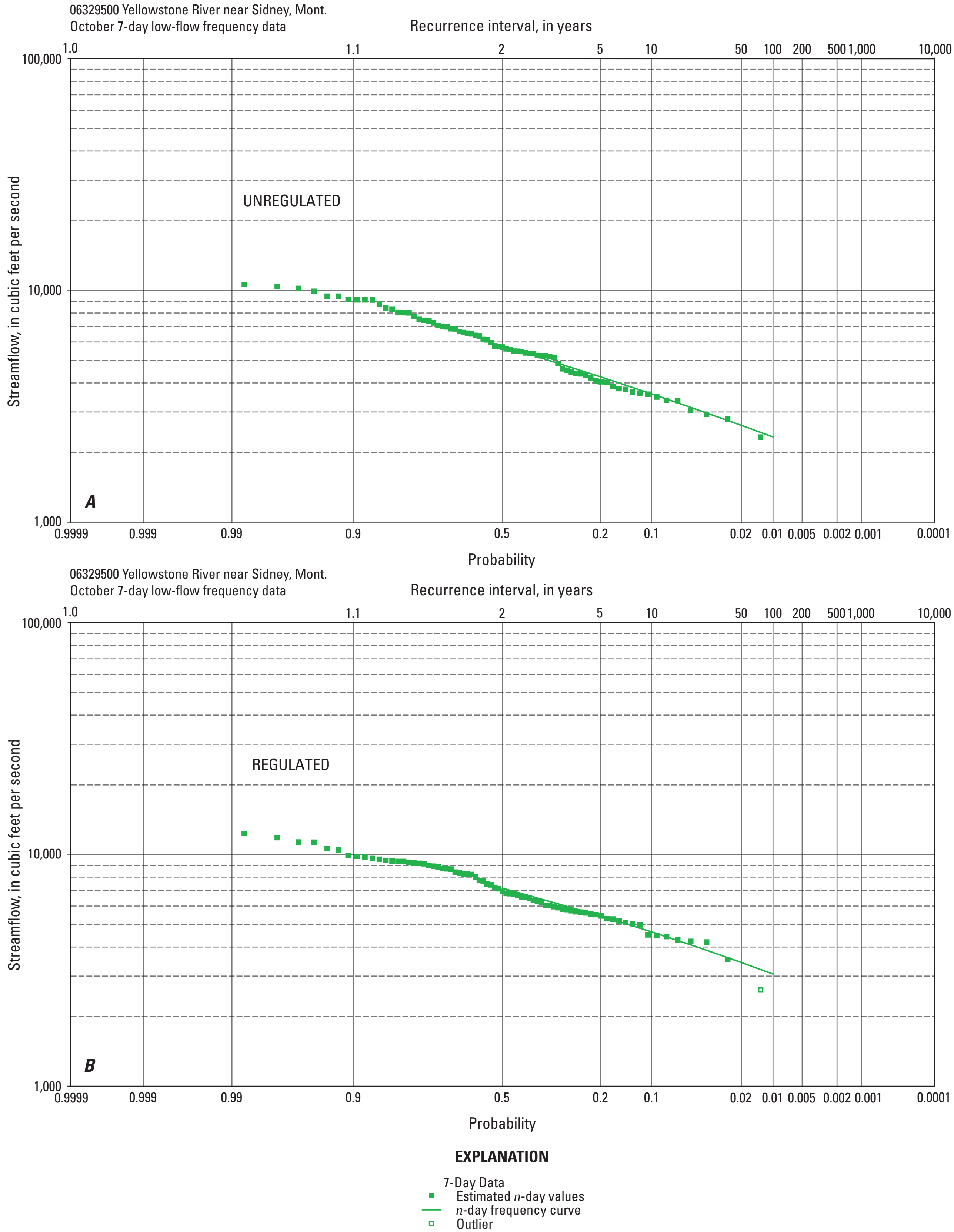


Figure 2-4-18. October 7-day low-flow frequency data for streamflow-gaging station 06329500 (Yellowstone River at Sidney, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.

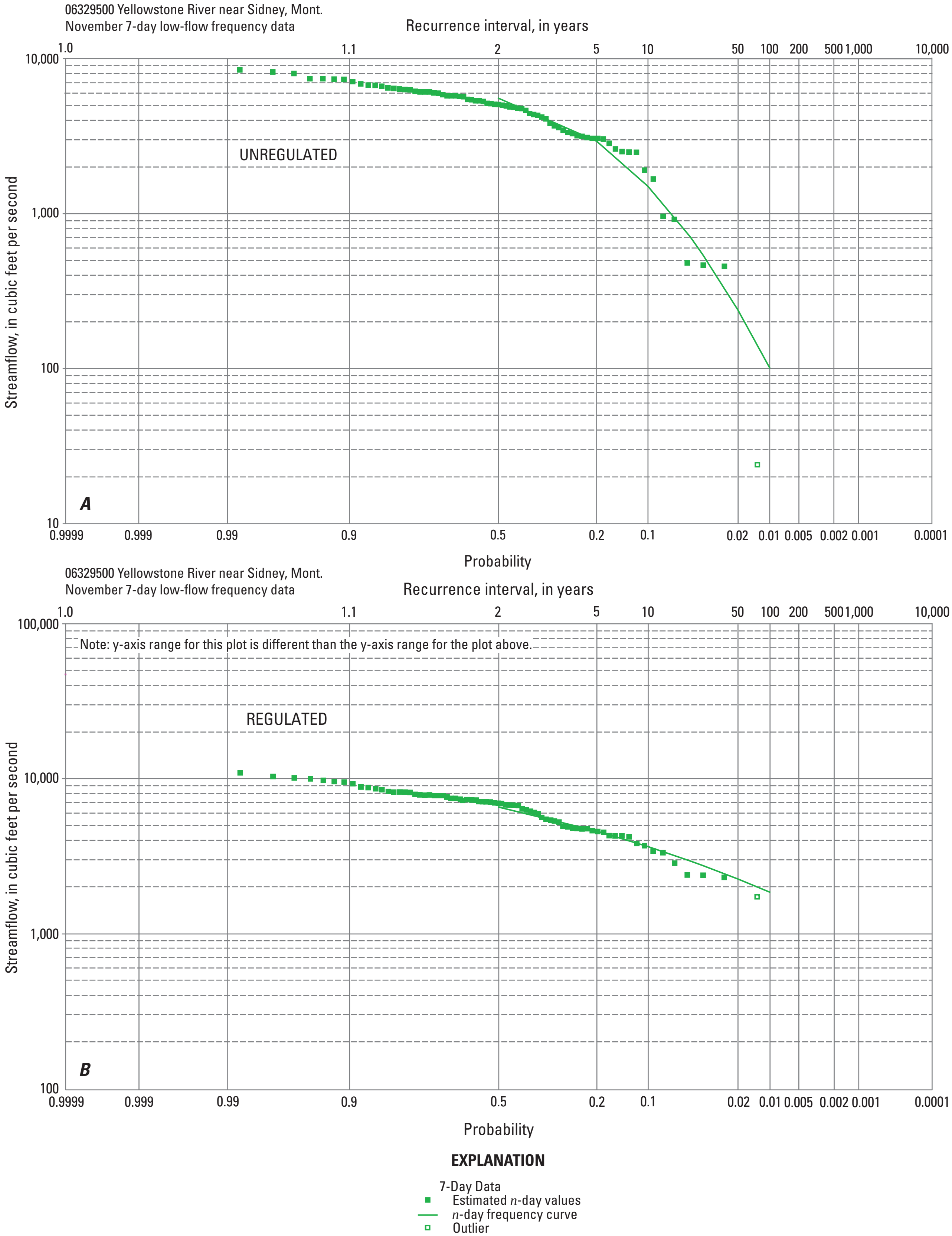


Figure 2-4-19. November 7-day low-flow frequency data for streamflow-gaging station 06329500 (Yellowstone River at Sidney, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

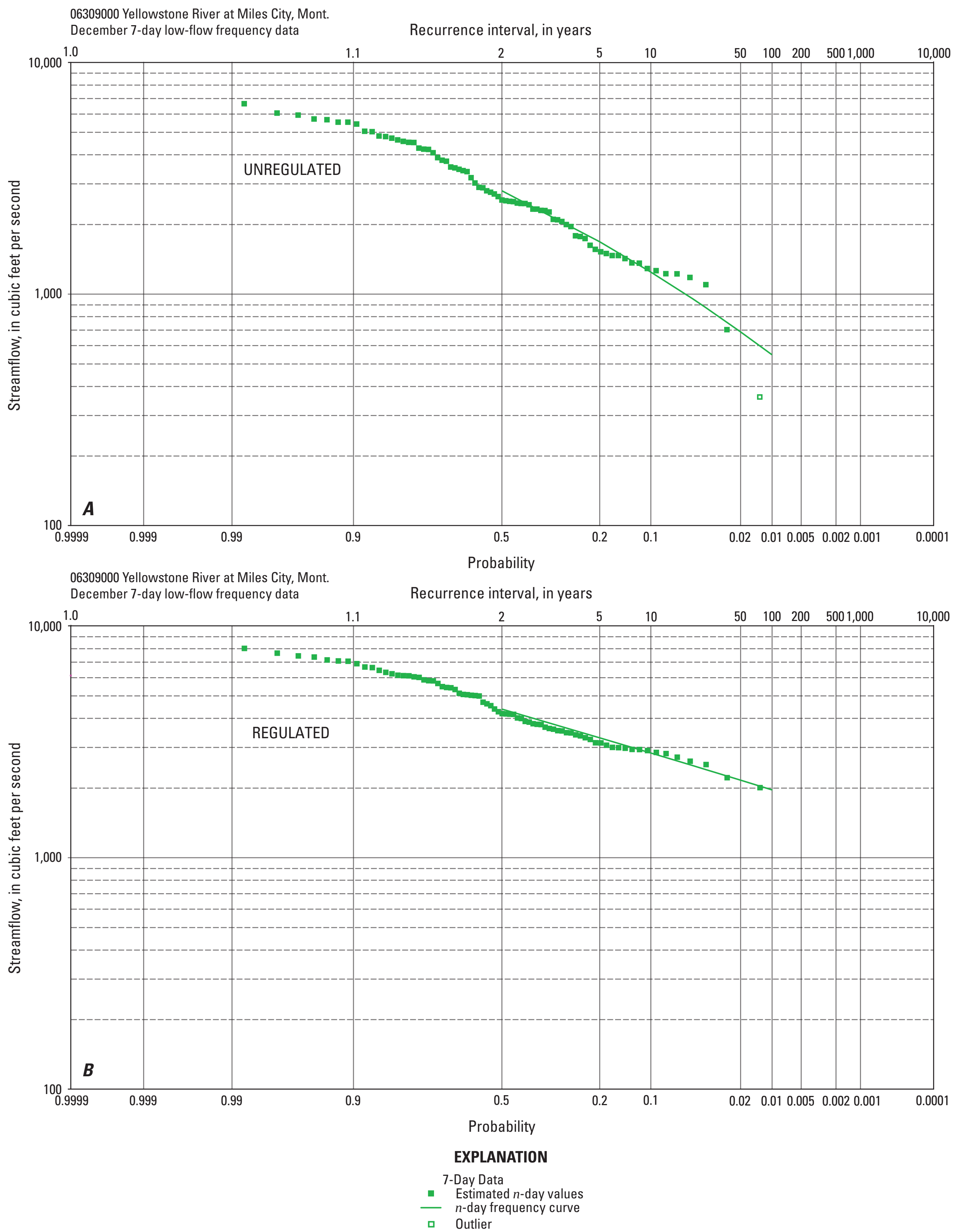
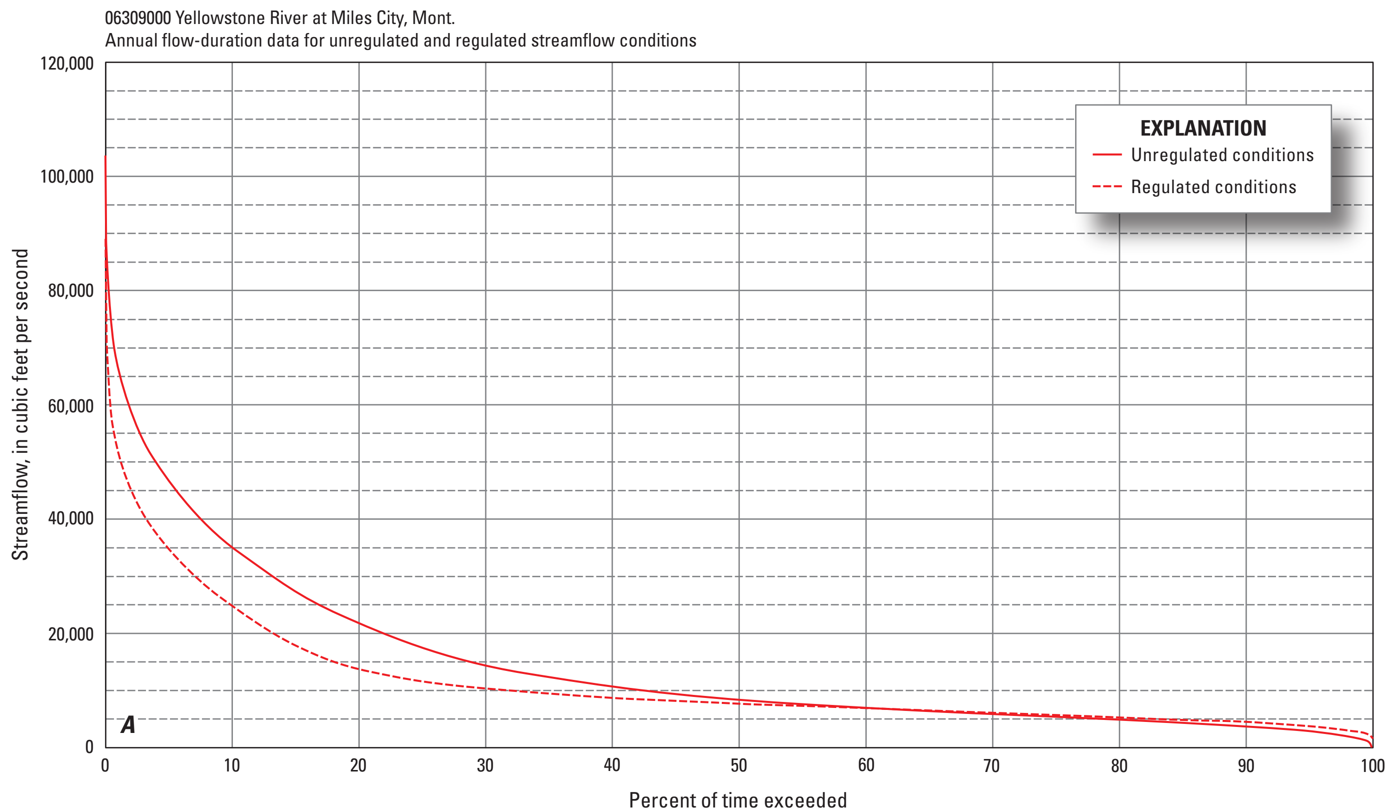


Figure 2-4-20. December 7-day low-flow frequency data for streamflow-gaging station 06329500 (Yellowstone River at Sidney, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.



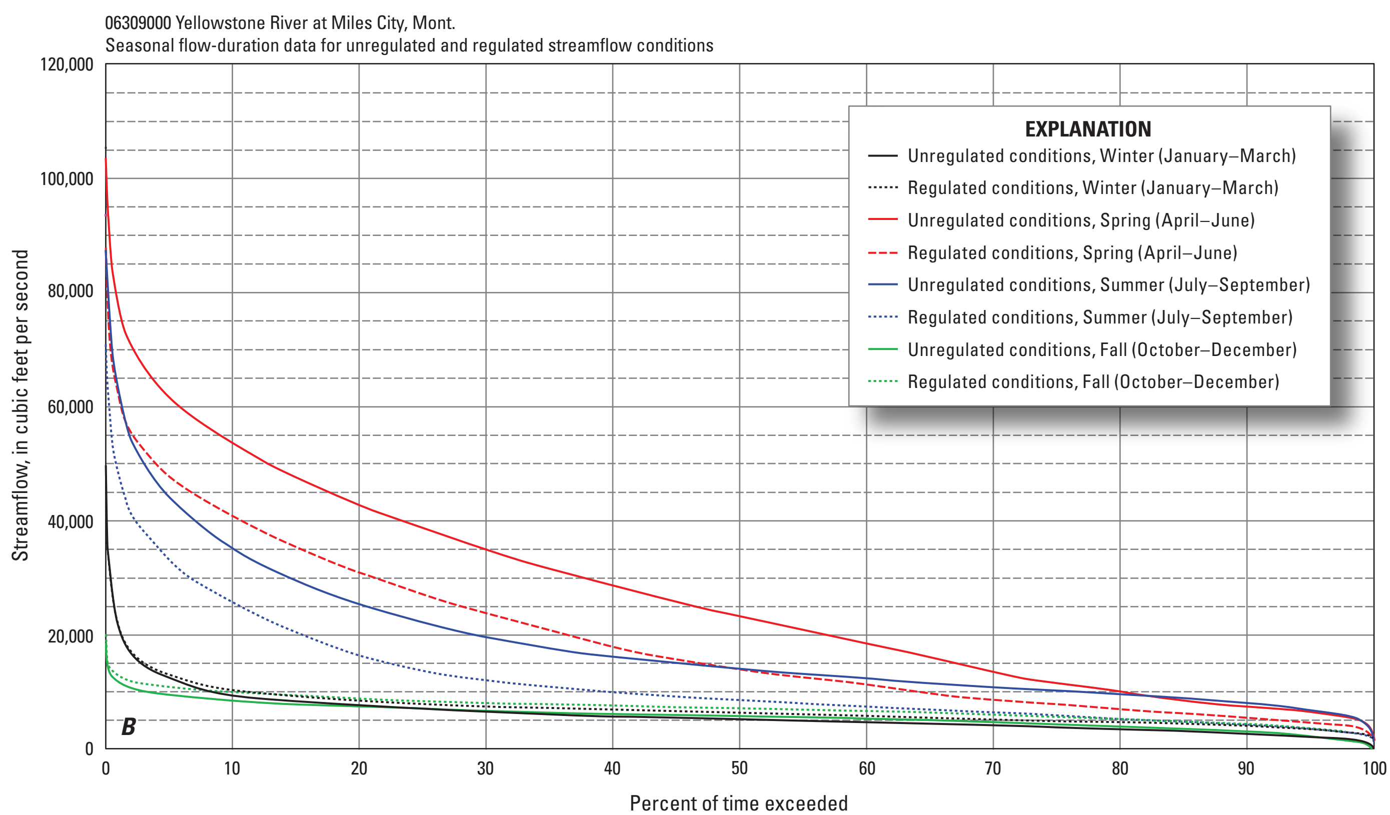


Figure 2-4-21. *A*, Annual and *B*, seasonal flow-duration data for streamflow-gaging station 06329500 (Yellowstone River at Sidney, Mont.) for unregulated and regulated streamflow conditions, 1928–2002.

Appendix 2–5. Statistics for Streamflow-Gaging Station 06308500 (Tongue River at Miles City, Mont.)

Table 2-5-1. Annual *n*-day high-flow frequency data for streamflow-gaging station 06308500 (Tongue River at Miles City, Mont.) for unregulated and regulated streamflow conditions, 1928–2002.

[Abbreviations: ft³/s, cubic feet per second. Symbol: %, percent]

n, period of consecutive days	Streamflow, in ft³/s, for indicated recurrence interval, in years, and exceedance probability, in percent						
	2 50%	5 20%	10 10%	20 5%	25 4%	50 2%	100 1%
Unregulated							
1	3,480	5,520	7,030	8,580	9,090	10,700	12,500
3	3,150	4,870	6,080	7,270	7,660	8,880	10,100
7	2,750	4,120	5,060	5,990	6,280	7,210	8,150
15	2,370	3,440	4,170	4,870	5,100	5,800	6,510
30	2,020	2,910	3,530	4,150	4,360	5,000	5,660
60	1,640	2,300	2,750	3,210	3,360	3,830	4,310
90	1,410	1,910	2,250	2,590	2,700	3,050	3,410
120	1,250	1,660	1,930	2,190	2,280	2,550	2,820
183	990	1,290	1,480	1,670	1,730	1,910	2,090
Regulated							
n, period of consecutive days	Streamflow, in ft³/s, for indicated recurrence interval, in years, and exceedance probability, in percent						
	2 50%	5 20%	10 10%	20 5%	25 4%	50 2%	100 1%
1	3,070	5,380	6,930	8,390	8,840	10,200	11,500
3	2,760	4,730	5,910	6,930	7,220	8,060	8,790
7	2,350	3,940	4,850	5,590	5,800	6,380	6,870
15	1,950	3,200	3,920	4,500	4,660	5,110	5,480
30	1,560	2,580	3,180	3,680	3,820	4,230	4,570
60	1,150	1,890	2,340	2,730	2,840	3,160	3,440
90	940	1,510	1,850	2,130	2,210	2,440	2,640
120	830	1,300	1,560	1,790	1,850	2,030	2,190
183	660	990	1,180	1,330	1,380	1,500	1,600

Table 2-5-2. Annual, seasonal, and monthly *n*-day low-flow frequency data for streamflow-gaging station 06308500 (Tongue River at Miles City, Mont.) for unregulated and regulated steamflow conditions, 1928–2002.

[Abbreviations: ft³/s, cubic feet per second. Symbol: %, percent]

	Unregulated						
***n*, period of consecutive days (month, for monthly frequency data)**	**Streamflow, in ft³/s, for indicated recurrence interval, in years, and exceedance probability, in percent**						
	2 50%	**5 20%**	**10 10%**	**20 5%**	**25 4%**	**50 2%**	**100 1%**
			Annual				
7	48	10	2	1	0	0	0
30	96	16	3	1	1	0	0
			Winter (January–March)				
7	87	47	32	23	20	14	10
30	128	85	68	56	53	44	38
			Spring (April–June)				
7	279	142	93	63	55	39	27
30	474	247	157	102	89	59	39
			Summer (July–September)				
7	281	184	136	98	87	56	29
30	342	232	177	134	121	87	56
			Fall (October–December)				
7	49	11	3	1	0	0	0
30	81	22	6	2	1	0	0
			Monthly				
7 (January)	96	50	33	22	19	13	9
7 (February)	113	67	48	36	33	25	19
7 (March)	171	98	73	57	53	43	39
7 (April)	281	142	93	63	55	39	27
7 (May)	481	282	207	158	146	115	92
7 (June)	1109	749	610	515	491	426	375
7 (July)	838	673	600	547	532	493	460
7 (August)	544	438	389	351	341	312	287
7 (September)	276	179	134	99	90	63	41
7 (October)	85	14	3	1	1	1	1
7 (November)	109	25	6	1	1	1	1
7 (December)	79	35	21	13	11	7	4

Table 2-5-2. Annual, seasonal, and monthly *n*-day low-flow frequency data for streamflow-gaging station 06308500 (Tongue River at Miles City, Mont.) for unregulated and regulated steamflow conditions, 1928–2002.—Continued

[Abbreviations: ft^3/s, cubic feet per second. Symbol: %, percent]

Regulated							
n, period of consecutive days (month, for monthly frequency data)	Streamflow, in ft^3/s, for indicated recurrence interval, in years, and exceedance probability, in percent						
	2 50%	5 20%	10 10%	20 5%	25 4%	50 2%	100 1%
Annual							
7	62	20	8	3	2	1	0
30	85	42	25	14	12	7	4
Winter (January–March)							
7	107	73	59	49	46	39	33
30	147	101	83	71	68	59	53
Spring (April–June)							
7	226	69	27	10	7	3	1
30	304	126	72	43	37	23	15
Summer (July–September)							
7	102	33	15	7	5	2	1
30	144	64	35	19	16	9	5
Fall (October–December)							
7	100	48	27	15	13	7	4
30	137	84	63	49	45	36	29
Monthly							
7 (January)	120	80	63	52	48	40	34
7 (February)	132	85	67	54	51	43	37
7 (March)	205	120	85	62	57	42	32
7 (April)	269	116	64	36	30	17	10
7 (May)	336	104	39	14	10	4	1
7 (June)	606	200	94	46	37	18	9
7 (July)	197	77	44	27	24	17	13
7 (August)	134	63	37	21	17	8	2
7 (September)	122	45	21	10	8	4	2
7 (October)	143	59	31	17	14	7	4
7 (November)	161	91	65	48	44	34	26
7 (December)	119	75	57	44	41	33	26

Table 2-5-3. Annual and seasonal flow-duration data for streamflow-gaging station 06308500 (Tongue River at Miles City, Mont.) for unregulated and regulated streamflow conditions, 1928–2002.

[Abbreviations: ft³/s, cubic feet per second. Symbol: %, percent]

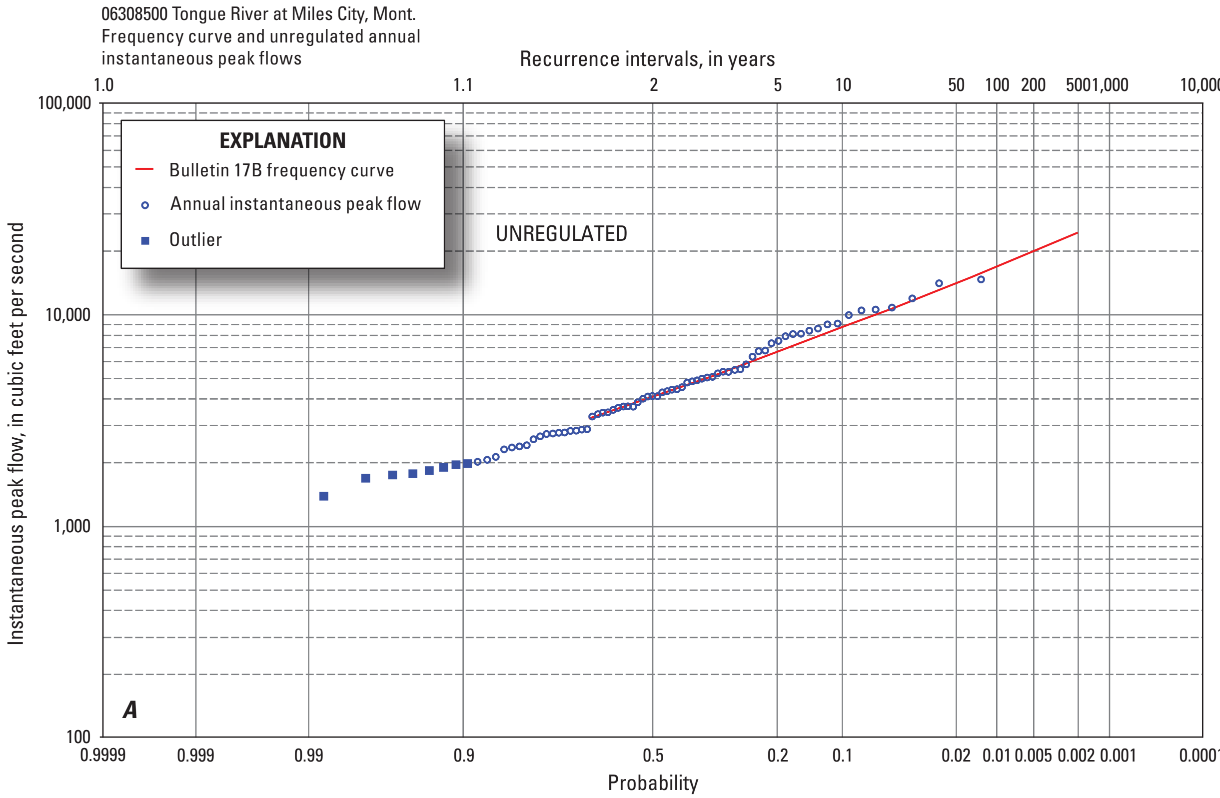
Streamflow condition	Streamflow, in ft³/s, which was equaled or exceeded for indicated percent of time																
	1%	2%	5%	10%	15%	20%	30%	40%	50%	60%	70%	80%	85%	90%	95%	98%	99%
Annual																	
Unregulated	3,880	3,040	2,100	1,450	1,120	922	667	487	339	241	181	135	110	80	41	13	0
Regulated	3,480	2,580	1,620	1,010	699	549	379	288	233	198	161	124	103	78	52	27	16
Winter (January–March)																	
Unregulated	2,790	1,720	930	546	428	342	255	208	180	155	133	111	95	80	61	42	33
Regulated	2,800	1,740	944	559	440	360	270	226	199	173	151	129	114	99	80	61	52
Spring (April–June)																	
Unregulated	4,730	4,250	3,230	2,590	2,140	1,900	1,470	1190	980	817	647	452	352	266	195	107	65
Regulated	4,280	3,840	2,770	2,050	1,650	1,370	978	714	552	425	327	218	183	128	63	30	19
Summer (July–September)																	
Unregulated	2,990	2,380	1,700	1,250	1,050	940	807	685	606	521	441	358	305	258	193	130	109
Regulated	2,430	1,790	1,110	719	538	426	317	254	217	180	146	96	72	50	25	13	6
Fall (October–December)																	
Unregulated	763	642	493	368	309	268	212	178	150	120	88	51	34	18	4	0	0
Regulated	828	681	540	415	360	320	264	225	198	167	135	106	90	70	54	38	29

Table 2-5-4. Monthly and annual streamflow characteristics for streamflow-gaging station 06308500 (Tongue River at Miles City, Mont.) for unregulated and regulated streamflow conditions, 1928–2002.

[Abbreviations: ft^3/s, cubic feet per second]

Period	Maximum monthly mean and maximum annual mean streamflow	Year of maximum monthly mean and maximum annual mean streamflow	Minimum monthly mean and minimum annual mean streamflow	Year of minimum monthly mean and minimum annual mean streamflow	Mean monthly and mean annual streamflow	Standard deviation of mean monthly and mean annual streamflow
Unregulated						
	Streamflow, in ft^3/s, or year, for indicated streamflow characteristic					
January	505	1999	27	1937	161	89
February	1,780	1971	48	1936	239	231
March	1,860	1936	62	2002	526	447
April	1,760	1965	32	1961	489	317
May	3,010	1928	435	1981	1,300	561
June	5,390	1944	558	1998	1,970	954
July	4,080	1937	494	1994	1,190	559
August	1,140	1975	274	2002	618	152
September	717	1968	32	1961	350	140
October	1,000	1945	0	1935	194	177
November	612	1929	1	1963	204	147
December	387	1949	13	1937	146	79
Annual	1,140	1978	255	2,002	612	184

Period	Maximum monthly mean and maximum annual mean streamflow	Year of maximum monthly mean and maximum annual mean streamflow	Minimum monthly mean and minimum annual mean streamflow	Year of minimum monthly mean and minimum annual mean streamflow	Mean monthly and mean annual streamflow	Standard deviation of mean monthly and mean annual streamflow
Regulated						
	Streamflow, in ft^3/s, or year, for indicated streamflow characteristic					
January	528	1999	46	1937	183	89
February	1,790	1971	63	1936	257	230
March	1,870	1936	75	2002	539	447
April	1,700	1965	12	1961	439	304
May	2,980	1978	53	1961	771	596
June	5,330	1944	42	2002	1,430	1,010
July	3,590	1937	19	2002	593	564
August	714	1975	0	1949	230	150
September	610	1968	19	1960	205	133
October	1,040	1945	44	1963	253	173
November	662	1929	62	1988	259	146
December	424	1949	46	1934	179	78
Annual	1,010	1978	70	2002	441	197



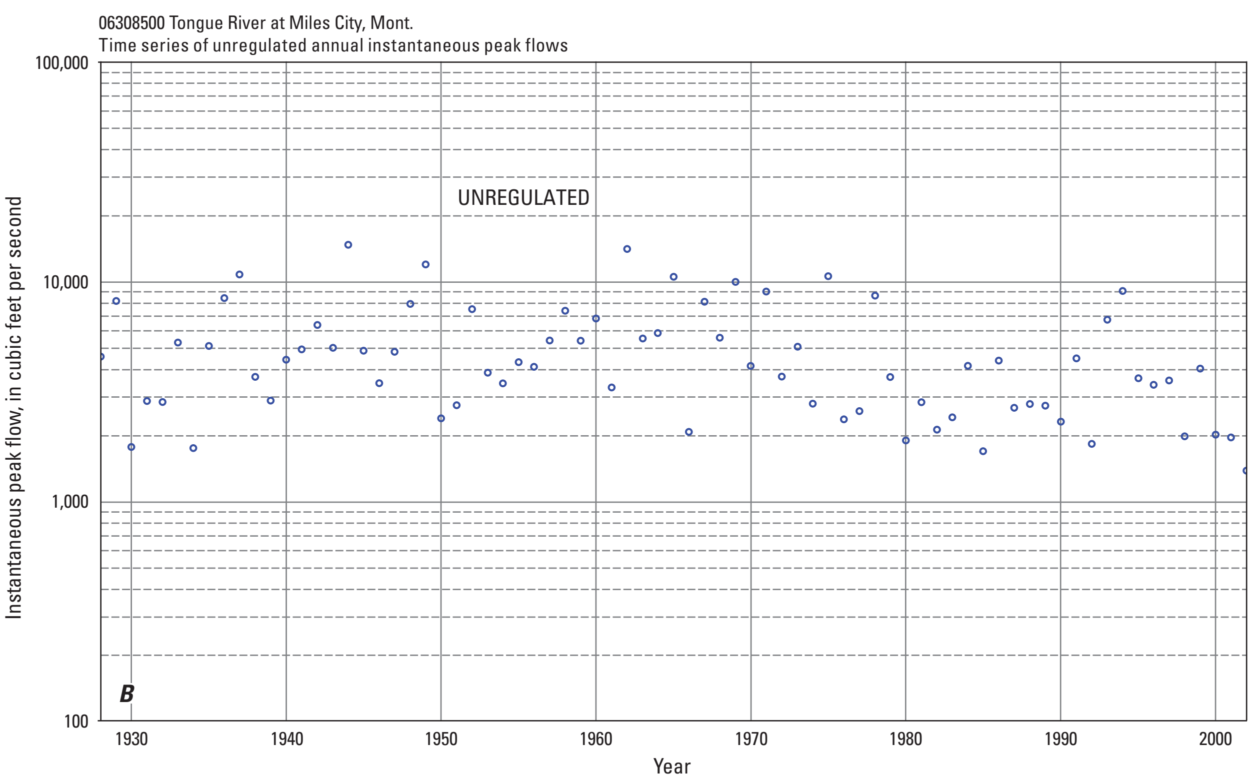
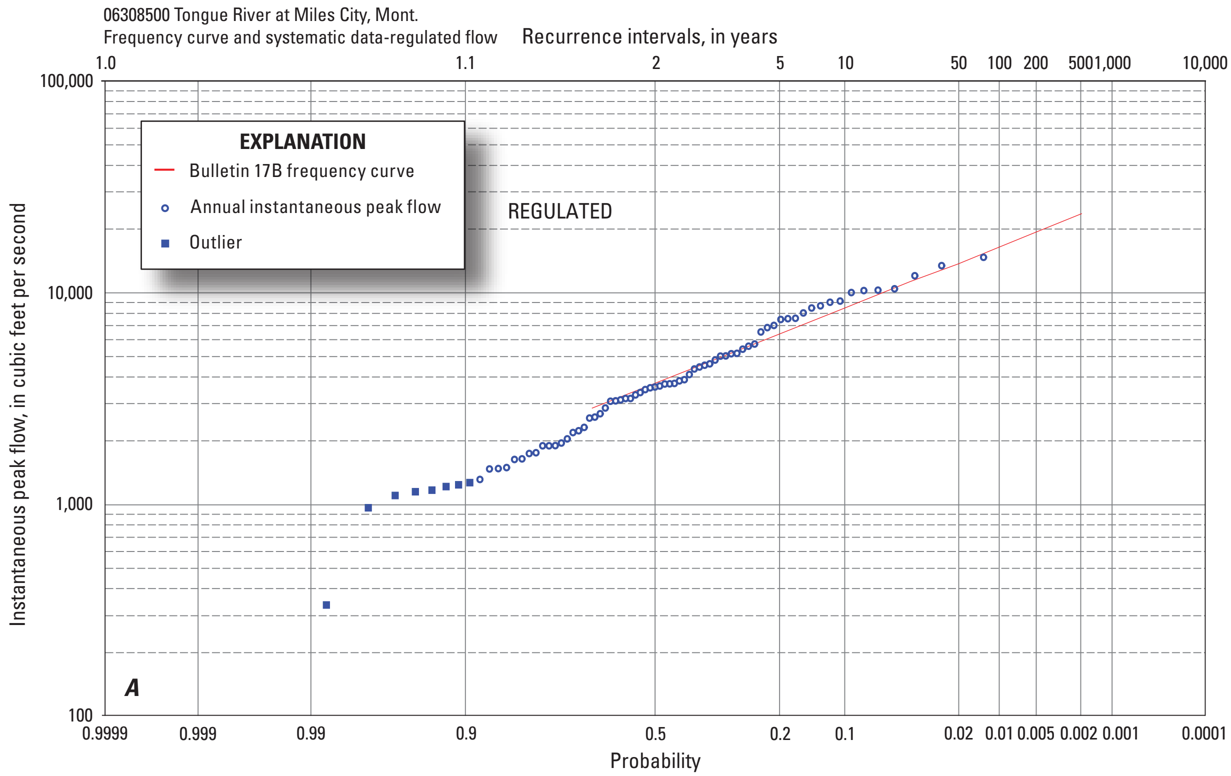


Figure 2-5-1. Annual instantaneous peak-flow data for streamflow-gaging station 06308500 (Tongue River at Miles City, Mont.) for unregulated streamflow conditions, 1928–2002. *A*, Frequency curve and unregulated annual instantaneous peak flows. *B*, Time series of unregulated annual instantaneous peak flows. [Bulletin 17B: U.S. Interagency Advisory Council on Water Data, 1982]



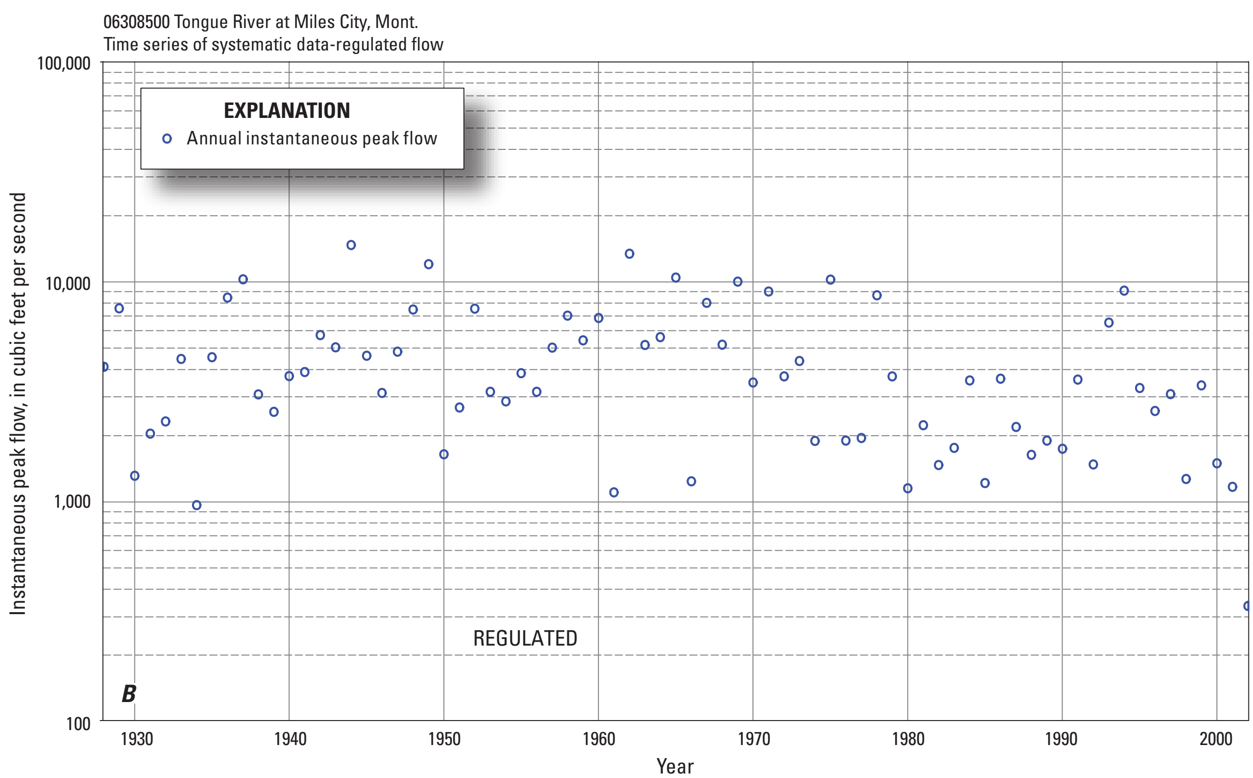


Figure 2-5-2. Annual instantaneous peak-flow data for streamflow-gaging station 06308500 (Tongue River at Miles City, Mont.) for unregulated streamflow conditions, 1928–2002. *A*, Frequency curve and regulated annual instantaneous peak flows. *B*, Time series of regulated annual instantaneous peak flows. [Bulletin 17B: U.S. Interagency Advisory Council on Water Data, 1982]

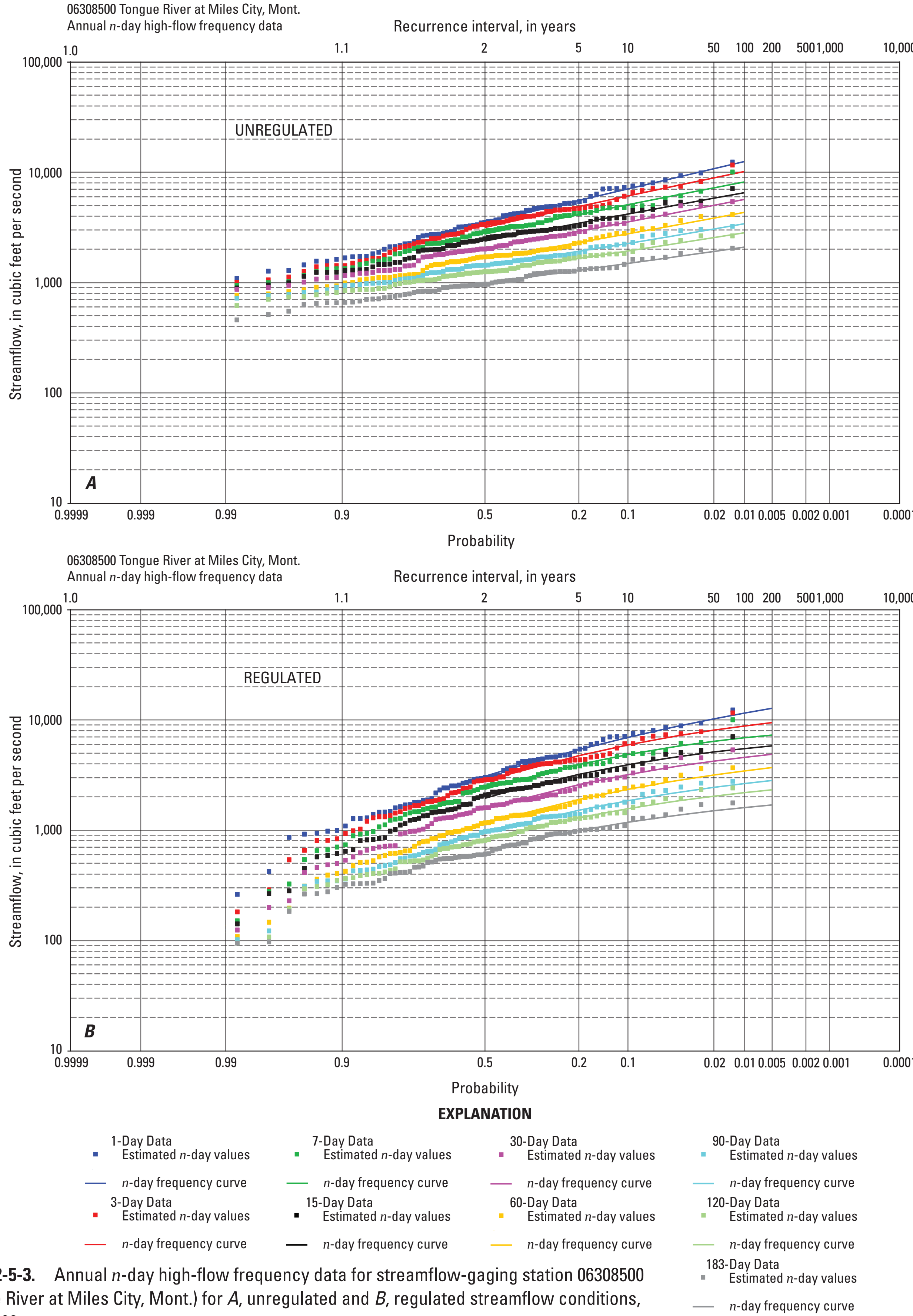


Figure 2-5-3. Annual *n*-day high-flow frequency data for streamflow-gaging station 06308500 (Tongue River at Miles City, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

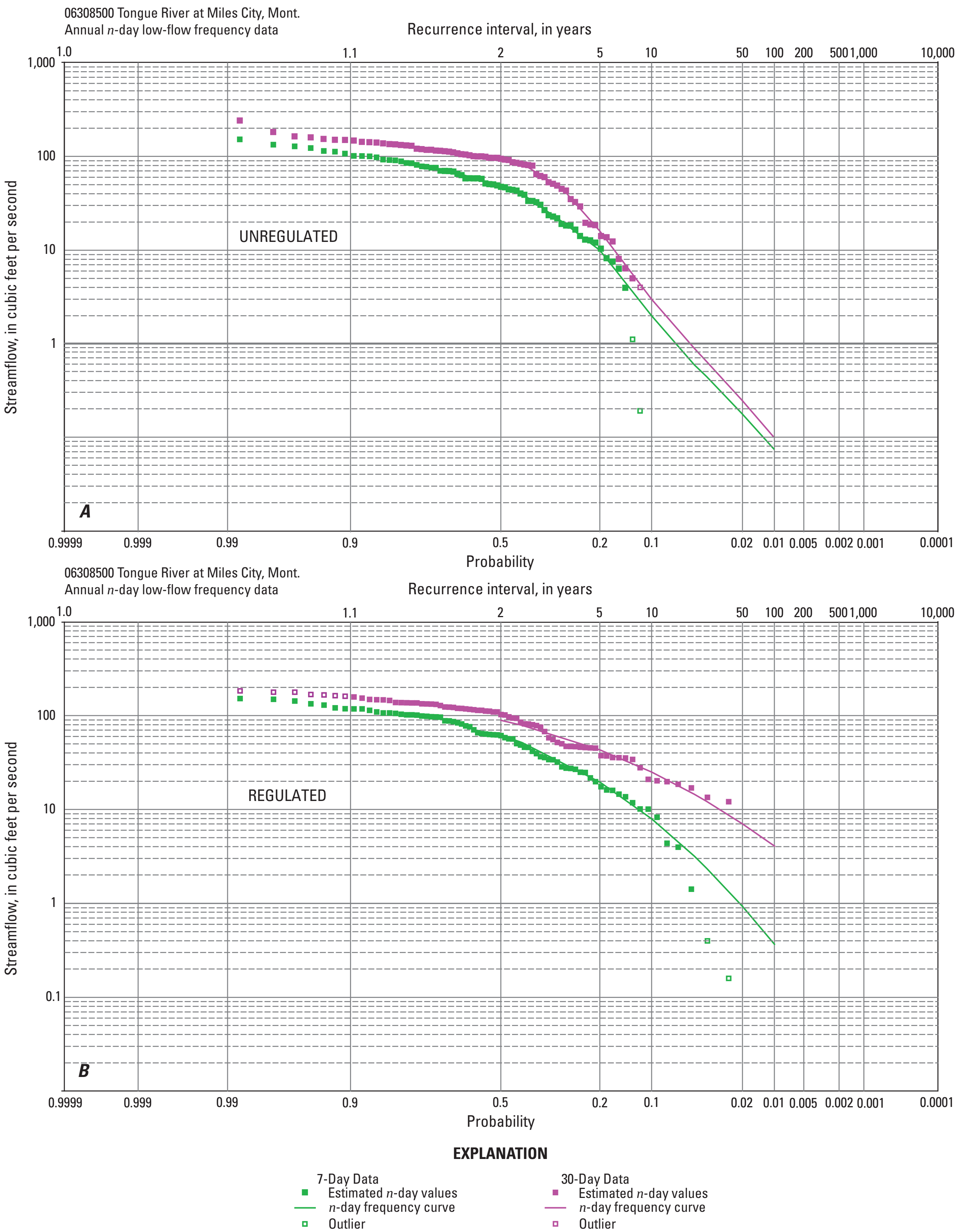


Figure 2-5-4. Annual *n*-day low-flow frequency data for streamflow-gaging station 06308500 (Tongue River at Miles City, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.

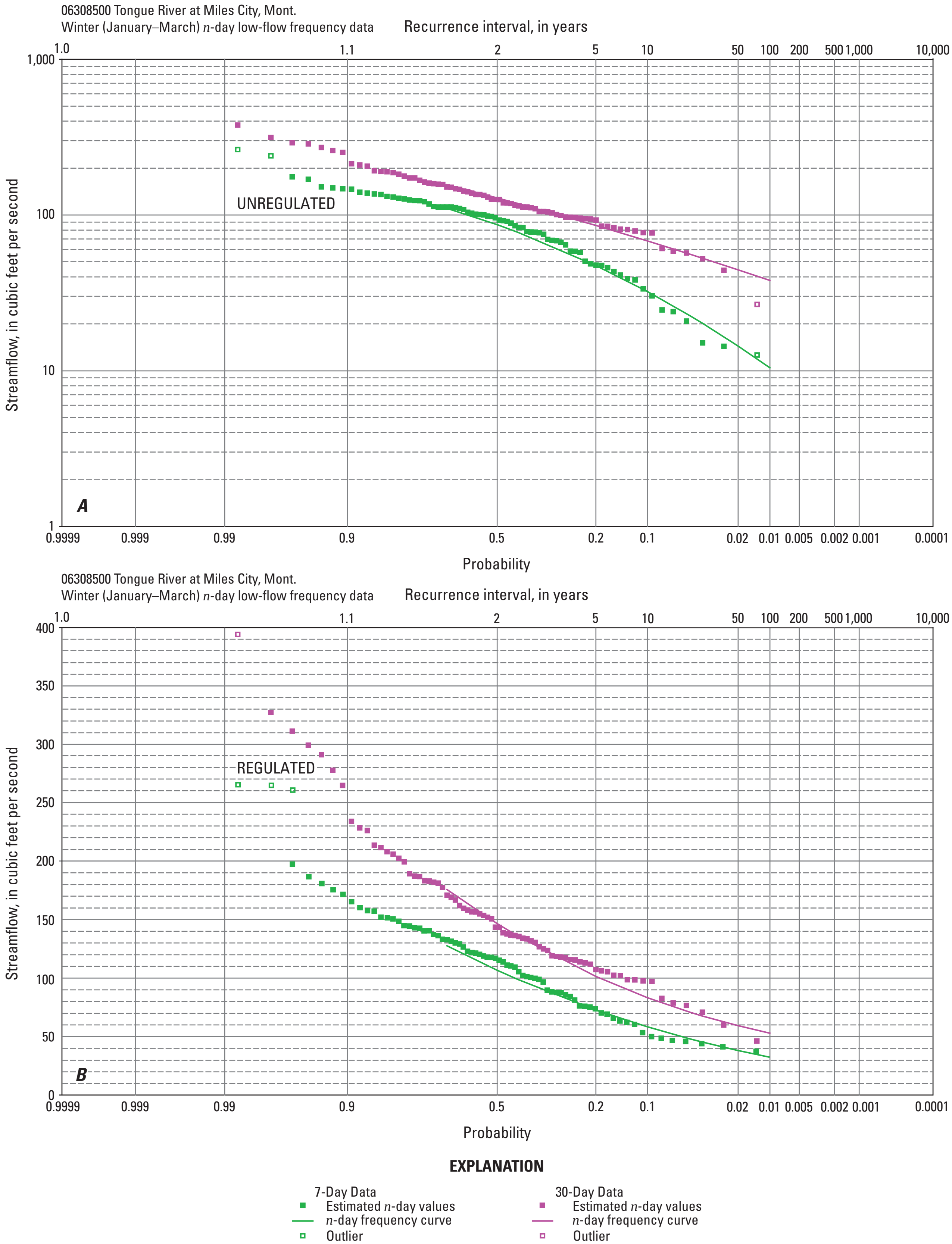
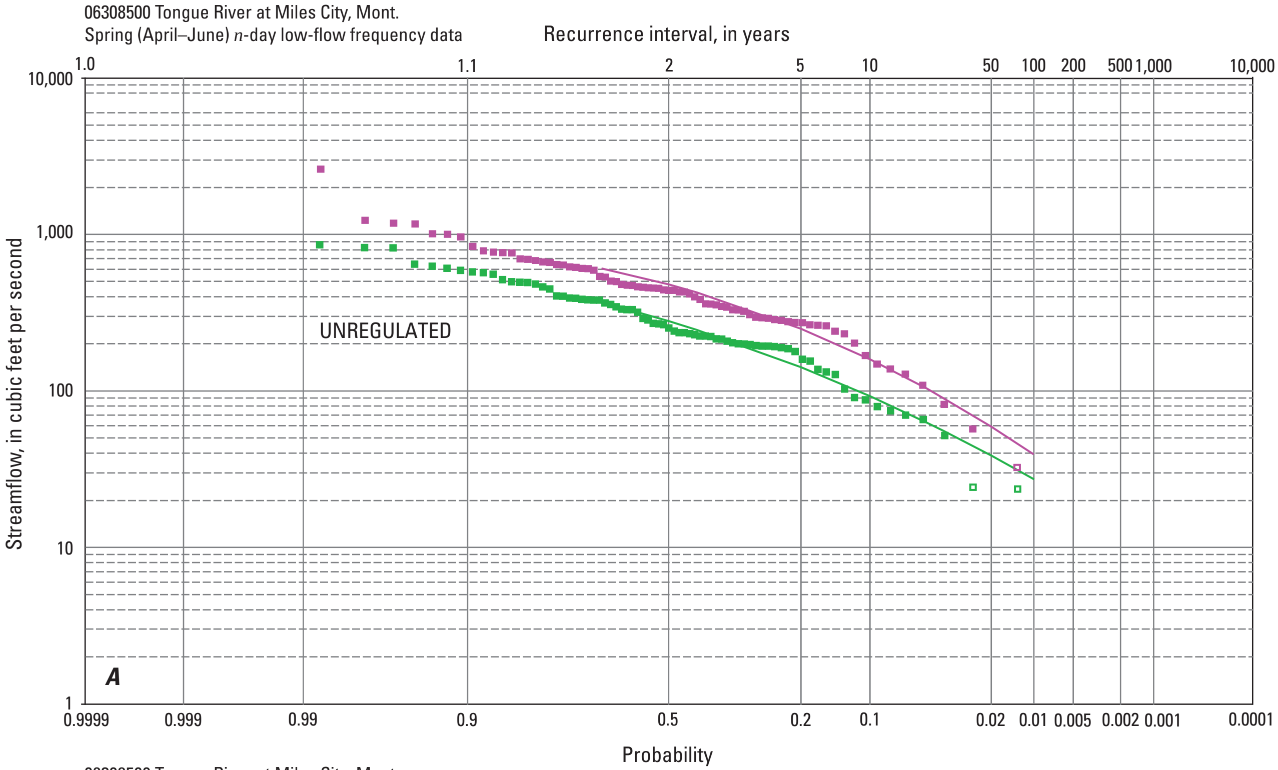
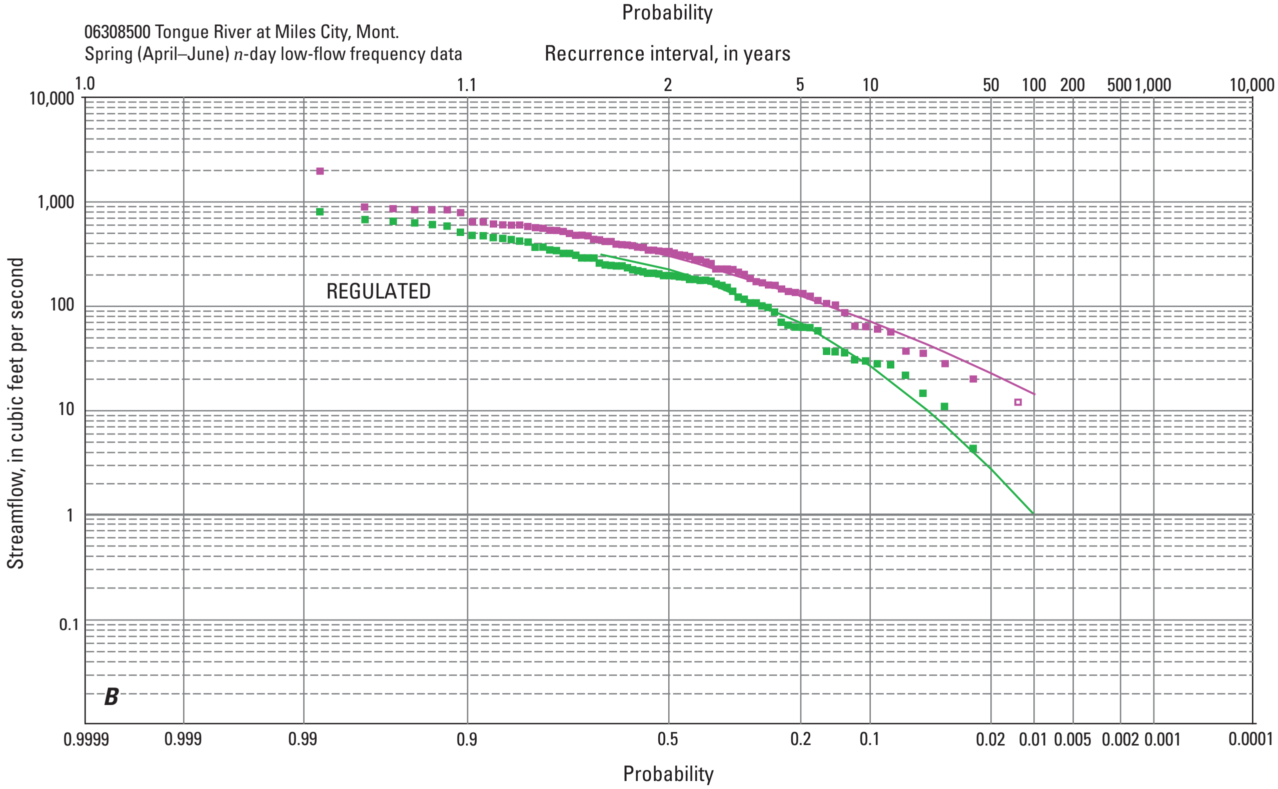


Figure 2-5-5. Winter (January–March) *n*-day low-flow frequency data for streamflow-gaging station 06308500 (Tongue River at Miles City, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.





EXPLANATION

7-Day Data	30-Day Data
Estimated *n*-day values	Estimated *n*-day values
n-day frequency curve	*n*-day frequency curve
Outlier	Outlier

Figure 2-5-6. Spring (April–June) *n*-day low-flow frequency data for streamflow-gaging station 06308500 (Tongue River at Miles City, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.

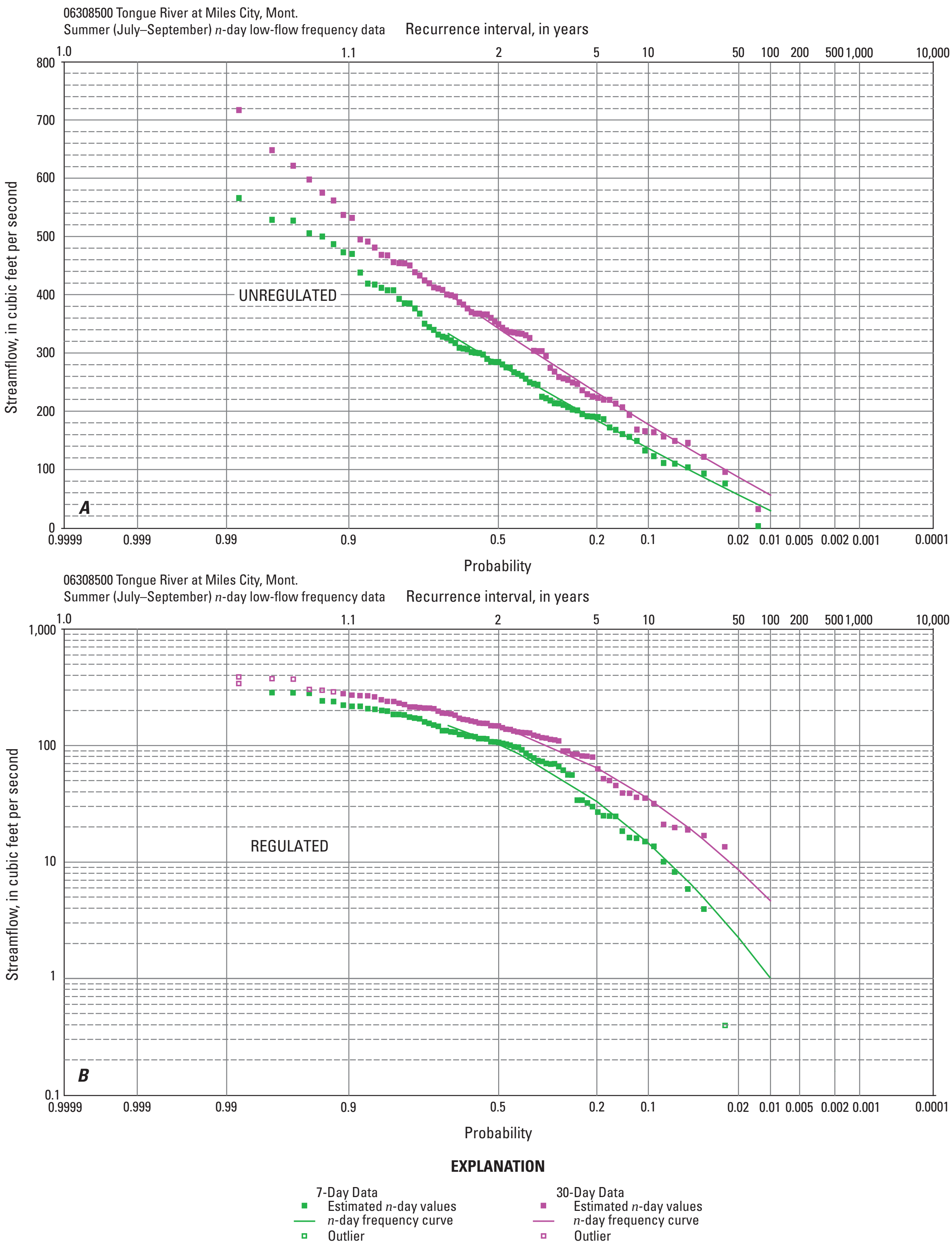


Figure 2-5-7. Summer (July–September) *n*-day low-flow frequency data for streamflow-gaging station 06308500 (Tongue River at Miles City, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

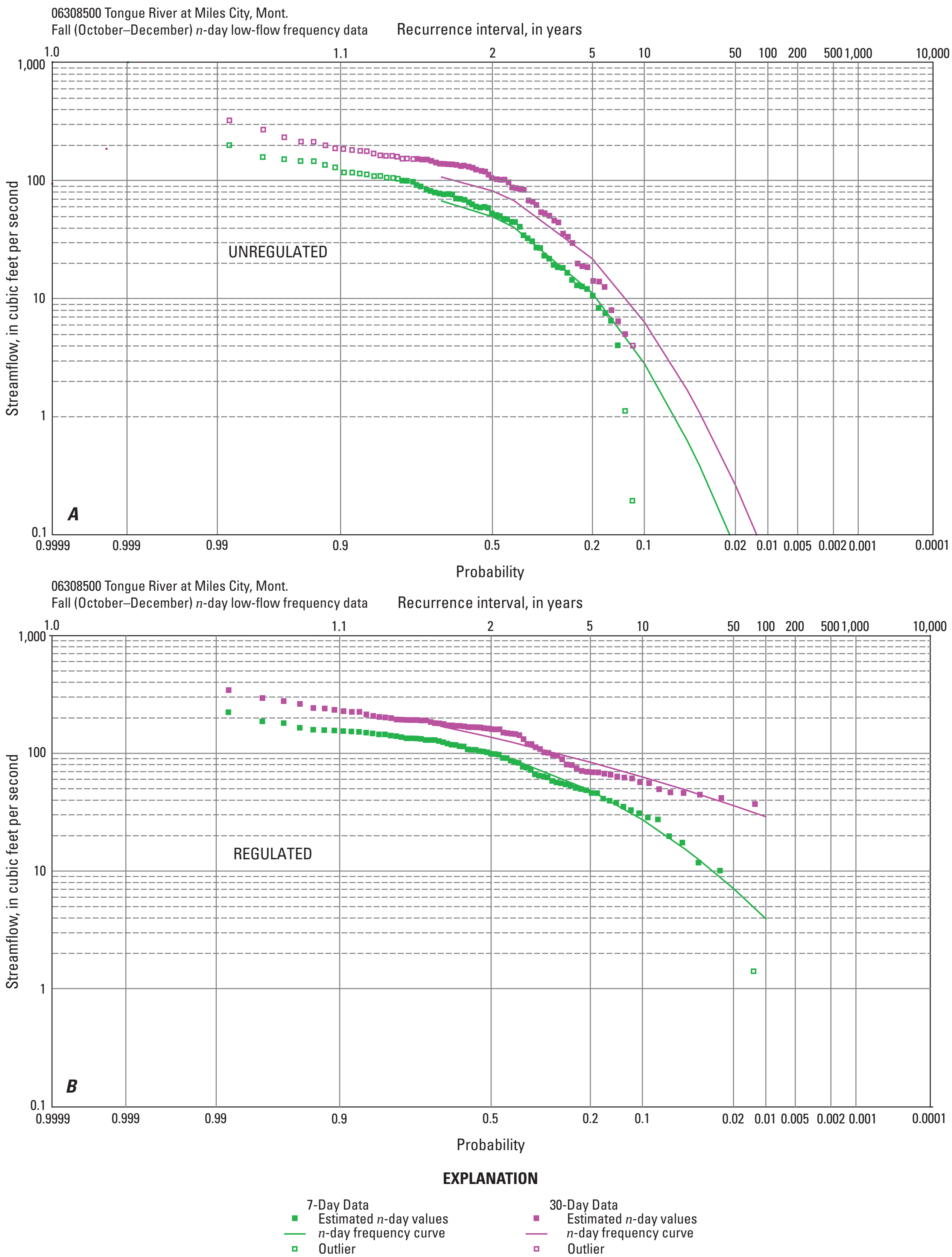


Figure 2-5-8. Fall (October–December) *n*-day low-flow frequency data for streamflow-gaging station 06308500 (Tongue River at Miles City, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.

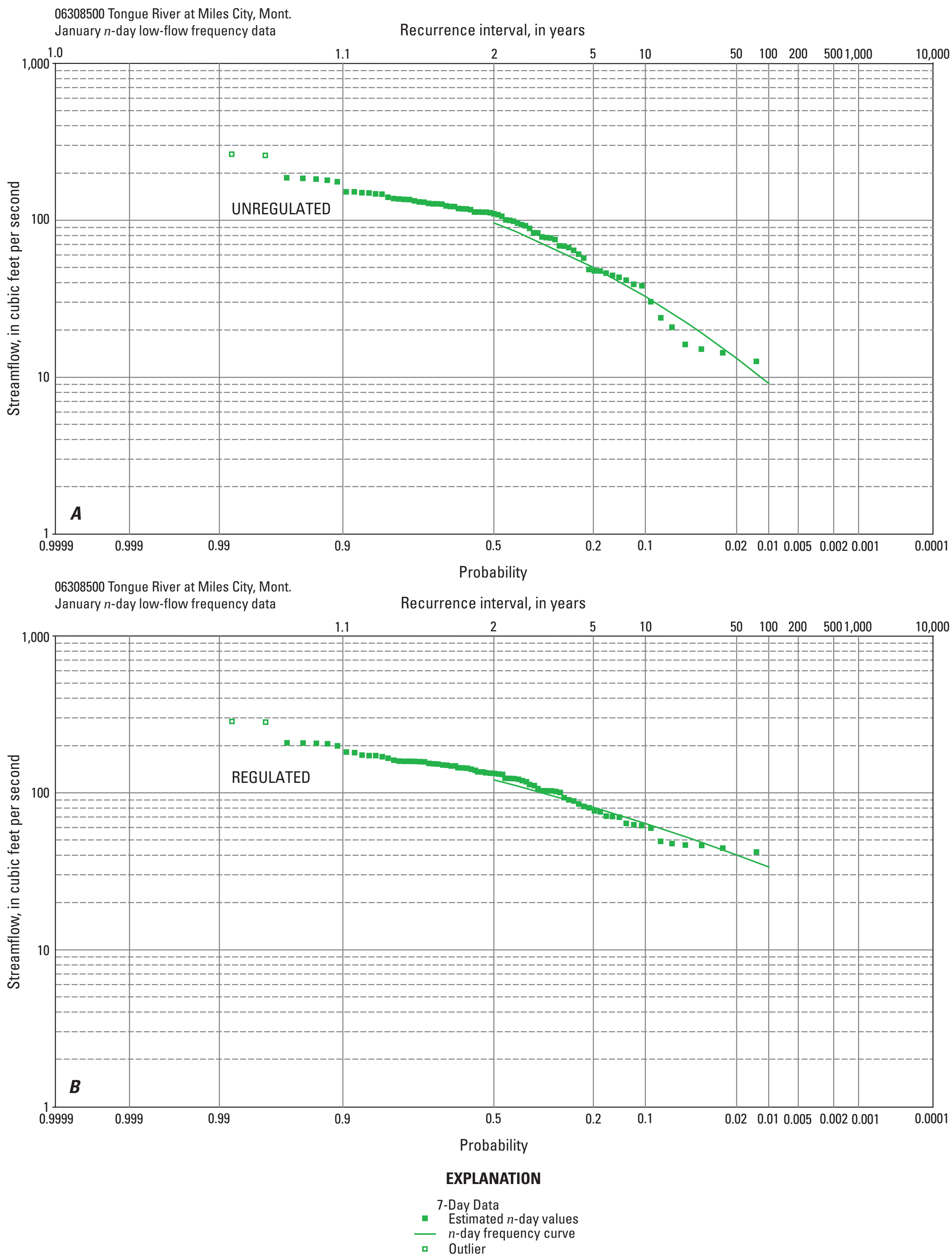
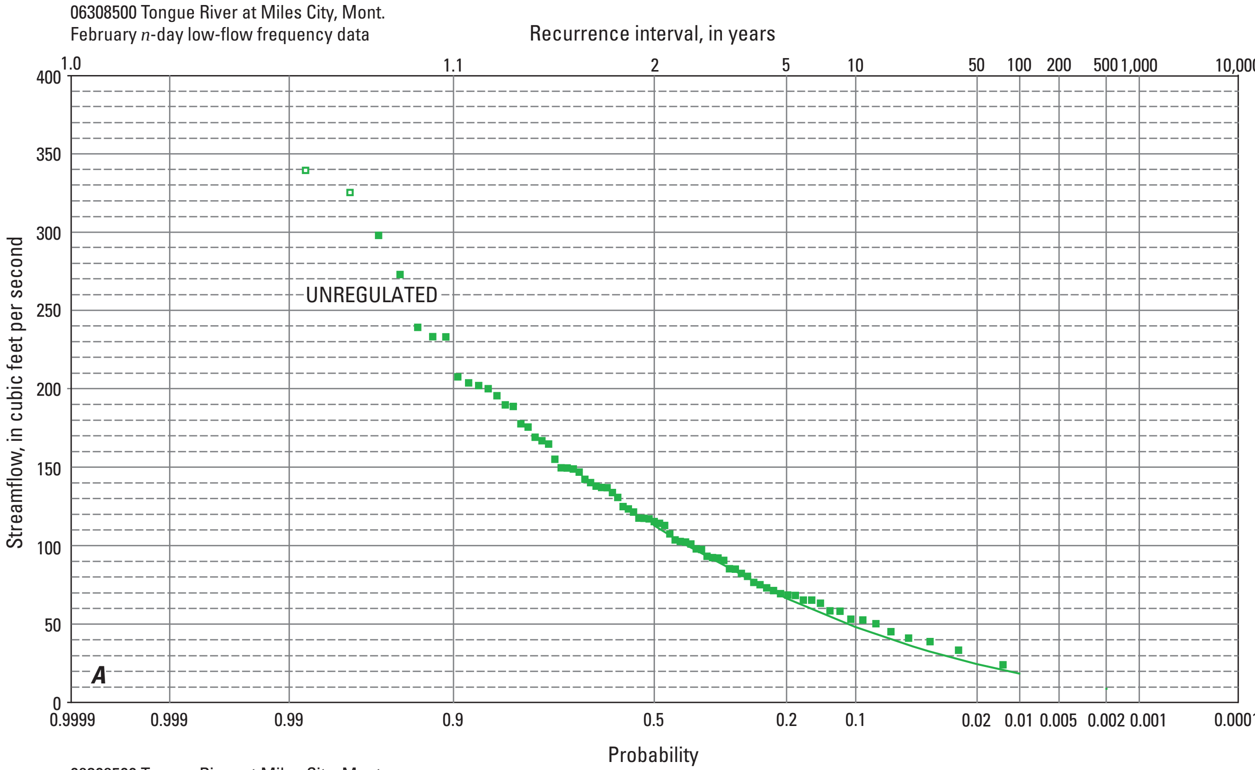
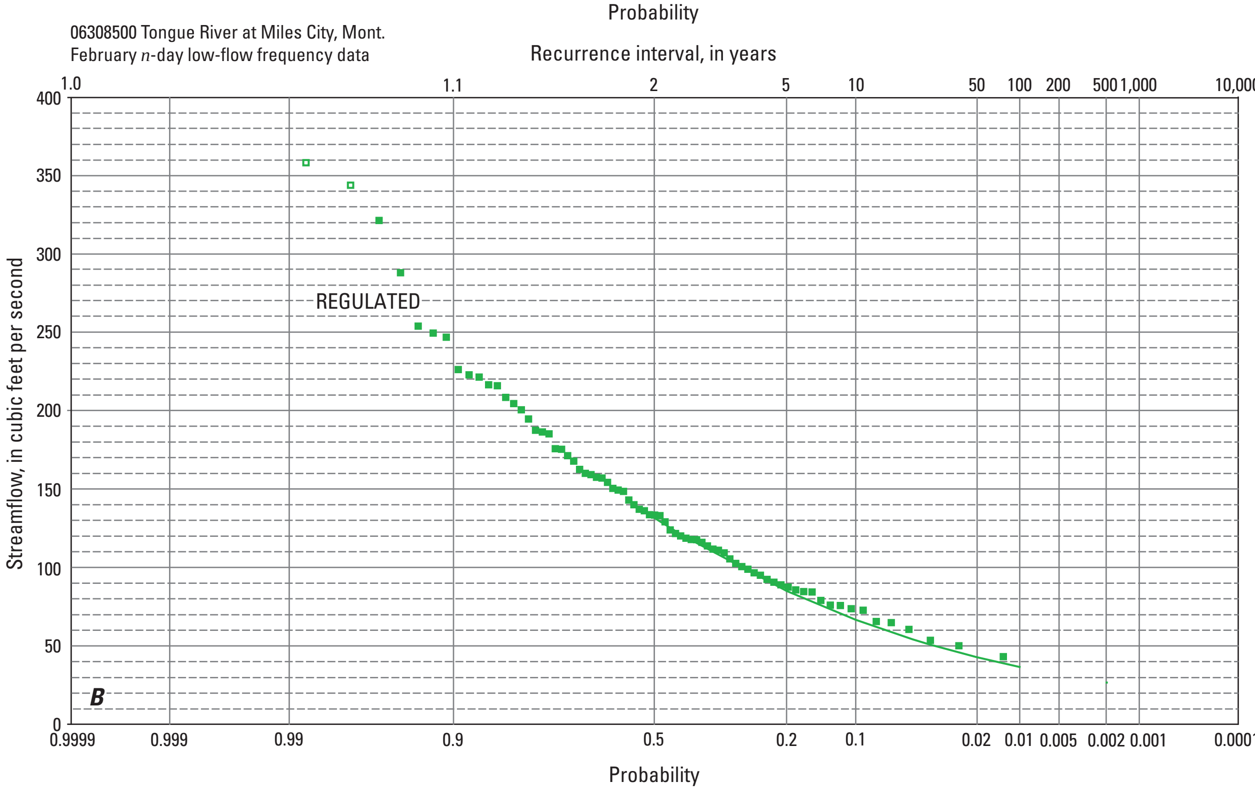


Figure 2-5-9. January *n*-day low-flow frequency data for streamflow-gaging station 06308500 (Tongue River at Miles City, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.





EXPLANATION

7-Day Data
- Estimated *n*-day values
- *n*-day frequency curve
- Outlier

Figure 2-5-10. February *n*-day low-flow frequency data for streamflow-gaging station 06308500 (Tongue River at Miles City, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

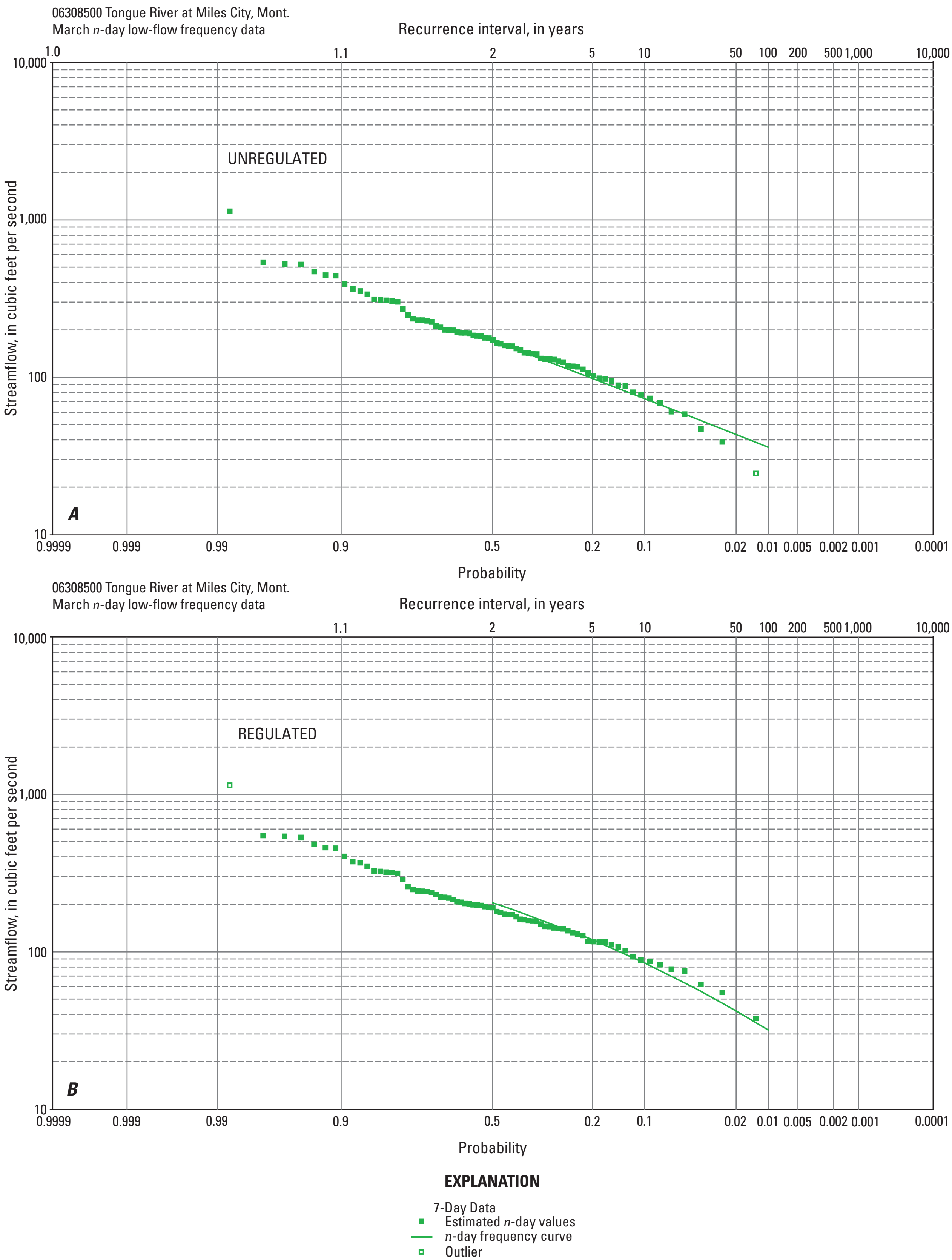


Figure 2-5-11. March *n*-day low-flow frequency data for streamflow-gaging station 06308500 (Tongue River at Miles City, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

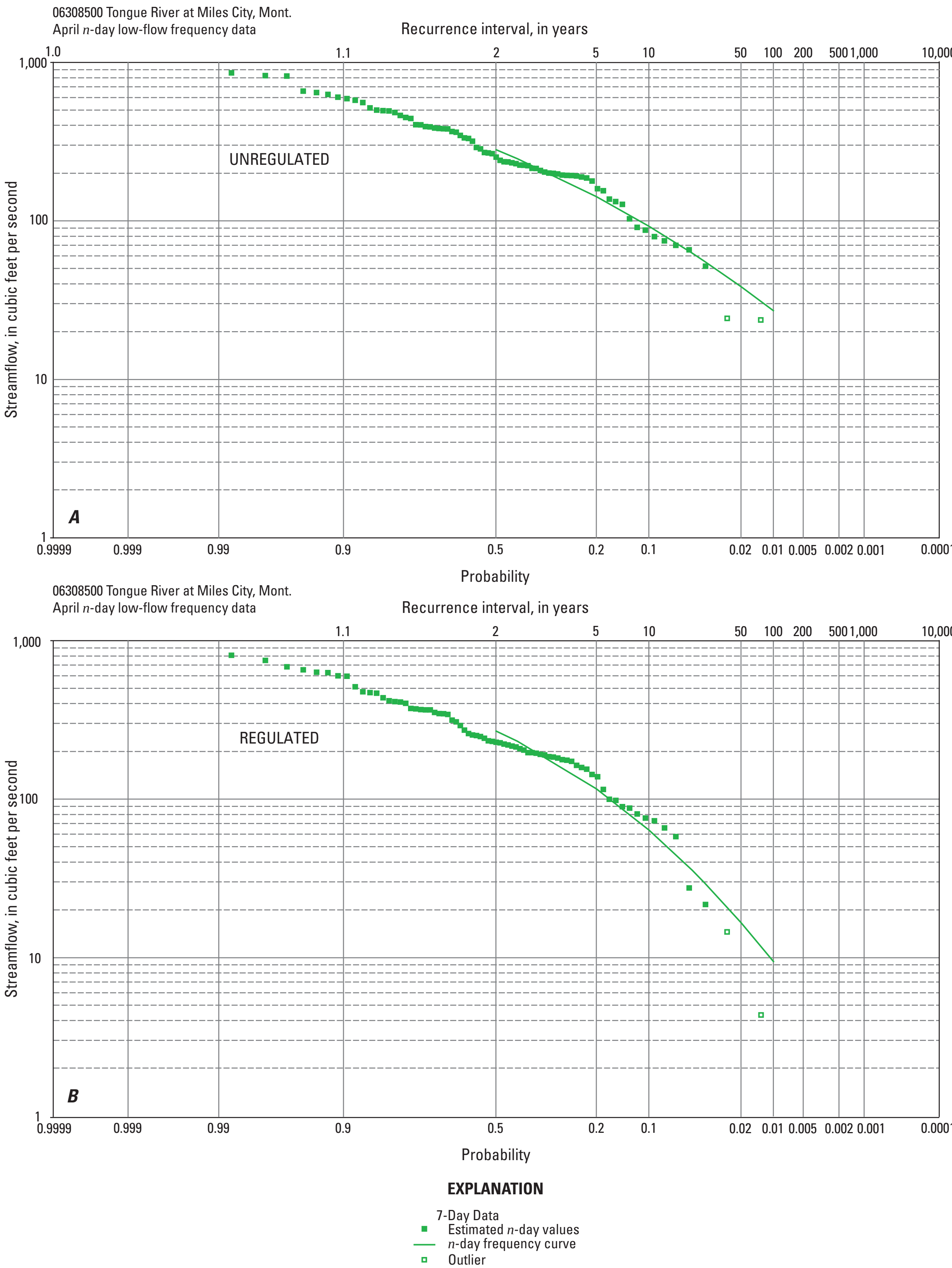


Figure 2-5-12. April *n*-day low-flow frequency data for streamflow-gaging station 06308500 (Tongue River at Miles City, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.

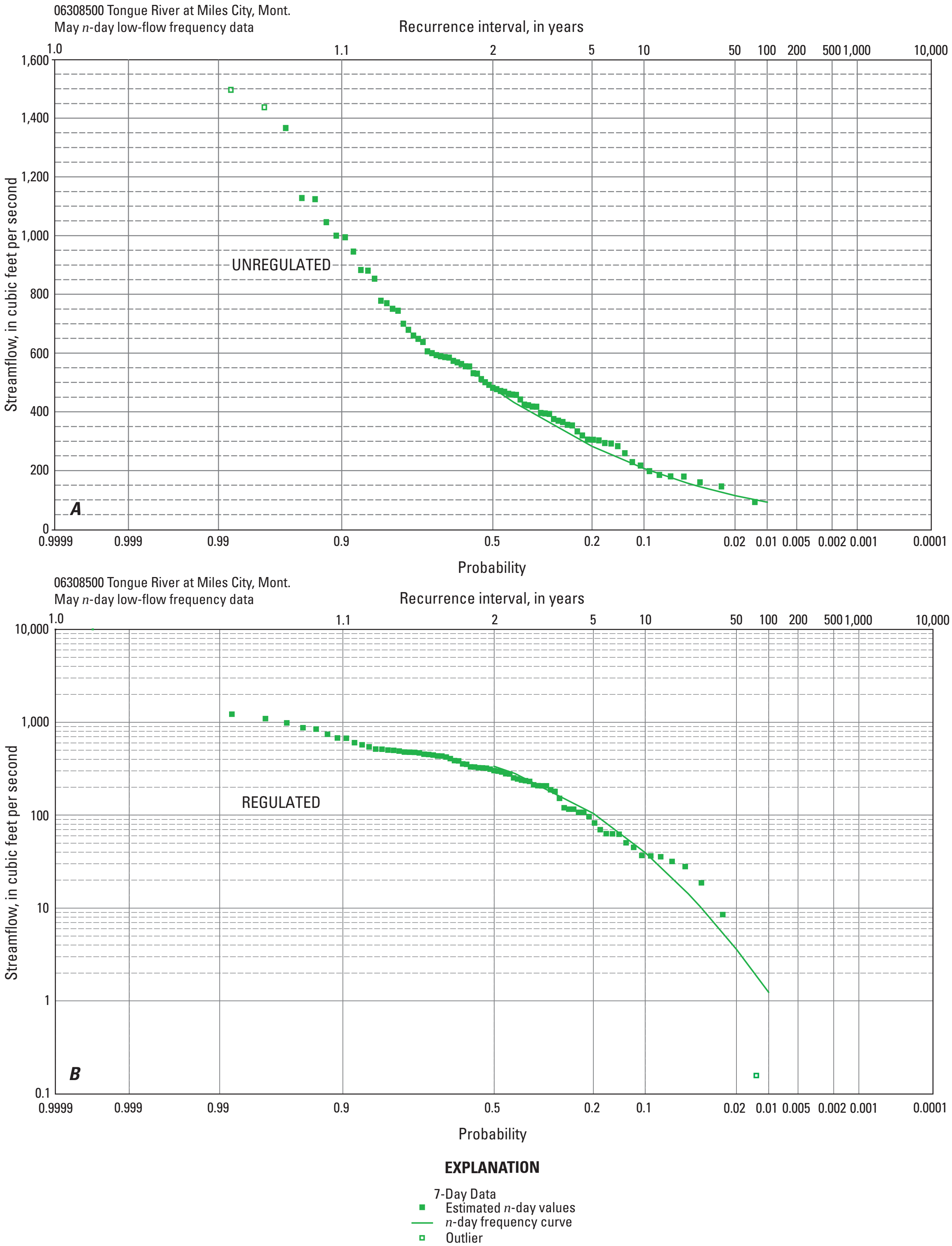


Figure 2-5-13. May *n*-day low-flow frequency data for streamflow-gaging station 06308500 (Tongue River at Miles City, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

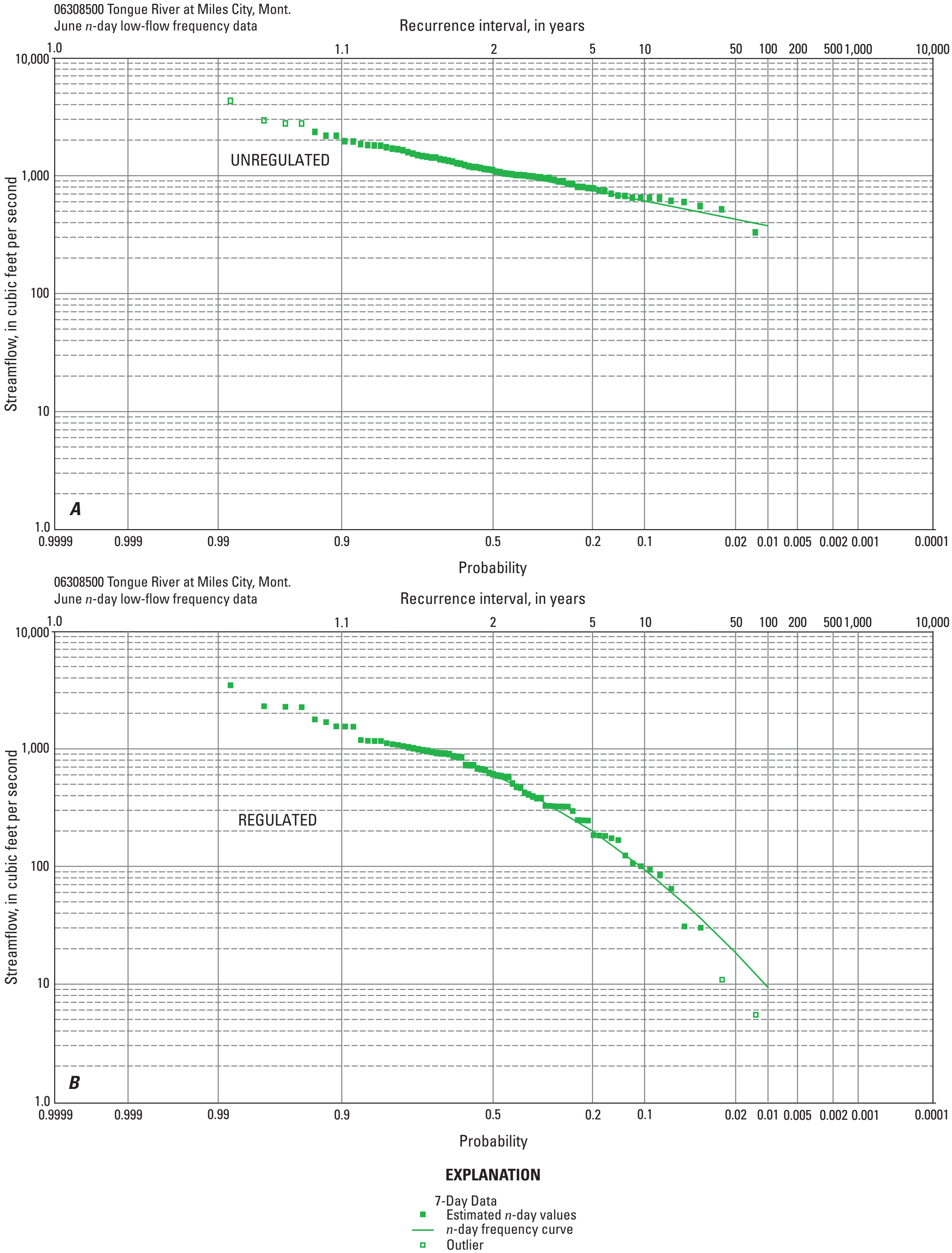


Figure 2-5-14. June *n*-day low-flow frequency data for streamflow-gaging station 06308500 (Tongue River at Miles City, Mont.) for *A,* unregulated and *B,* regulated streamflow conditions, 1928–2002.

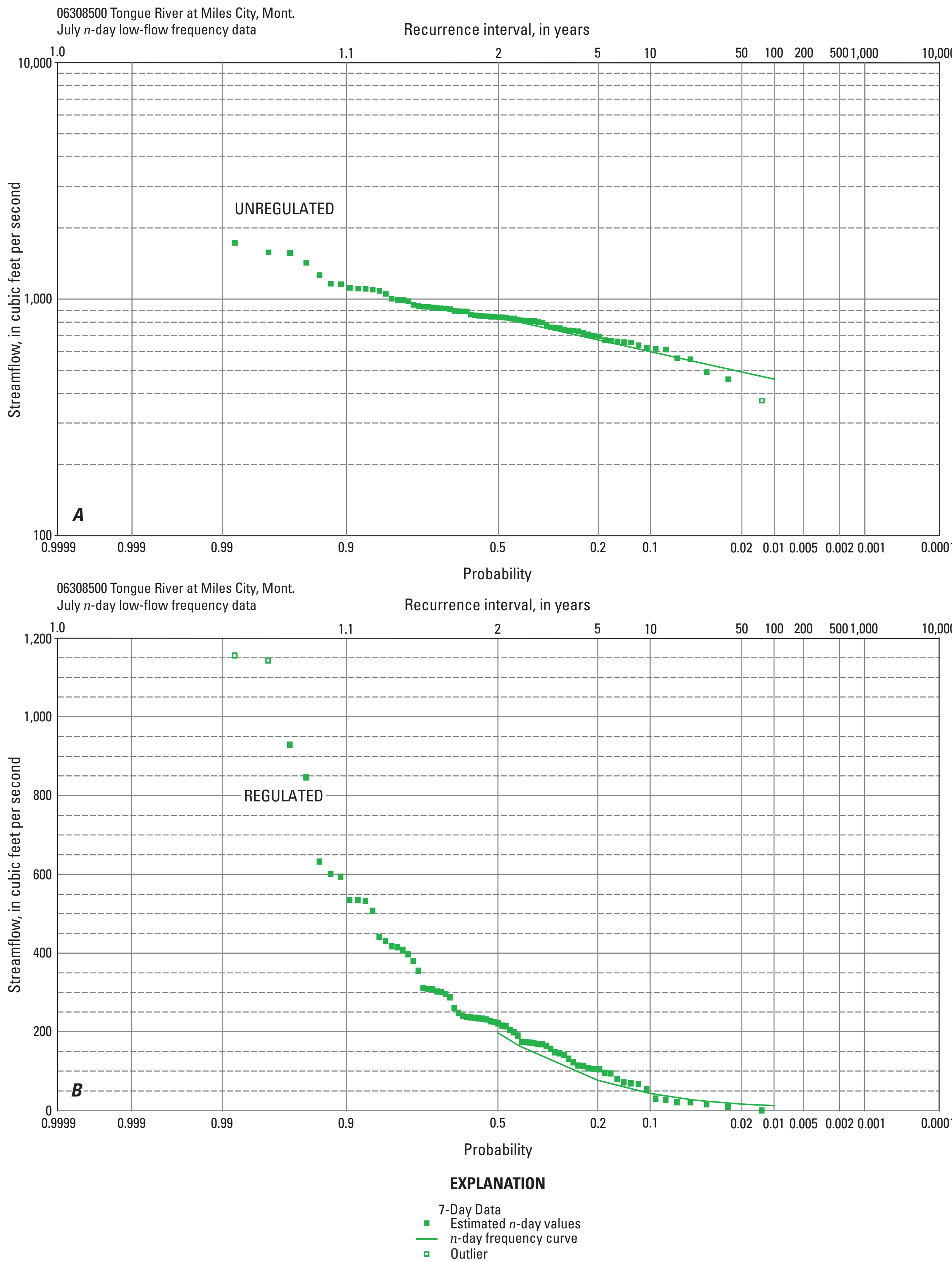


Figure 2-5-15. July *n*-day low-flow frequency data for streamflow-gaging station 06308500 (Tongue River at Miles City, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

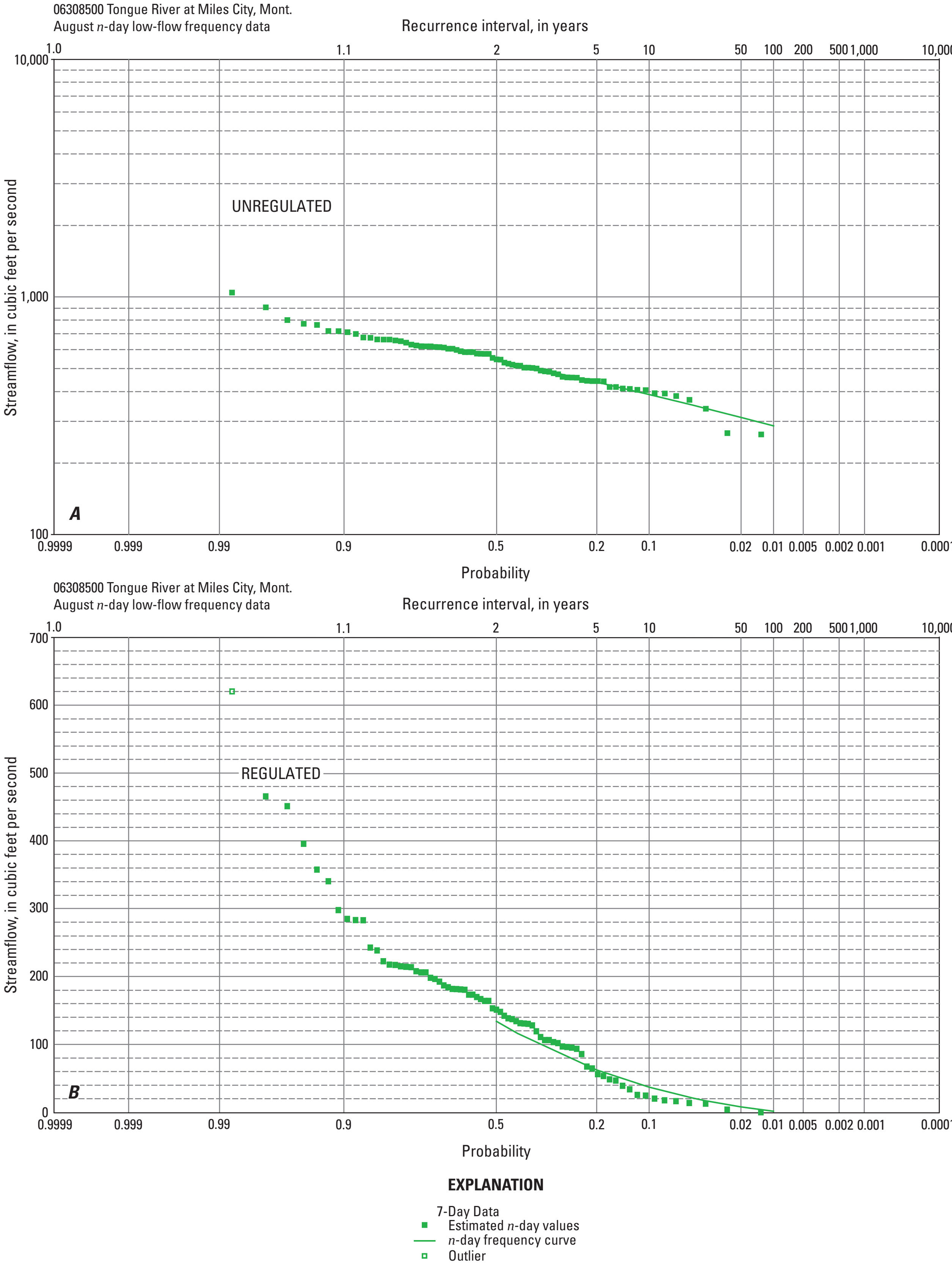
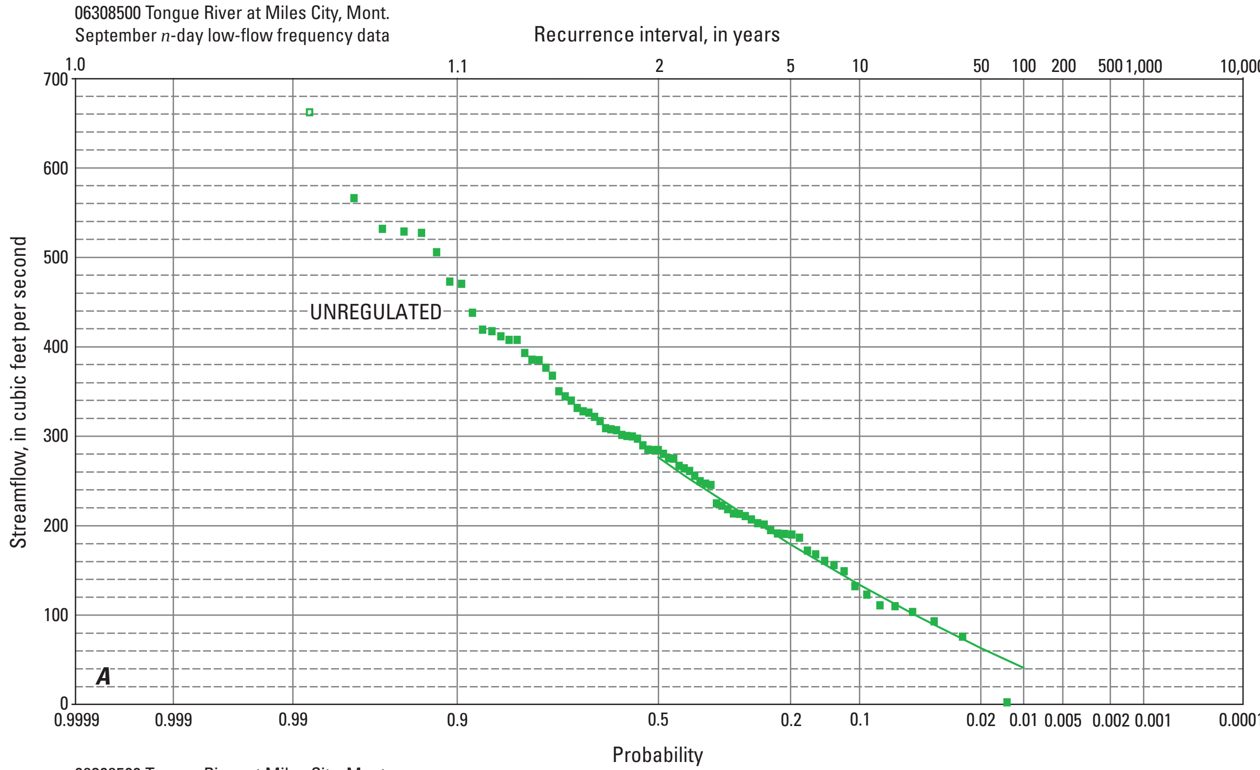


Figure 2-5-16. August *n*-day low-flow frequency data for streamflow-gaging station 06308500 (Tongue River at Miles City, Mont.) for *A*, unregulated and *B,* regulated streamflow conditions, 1928–2002.



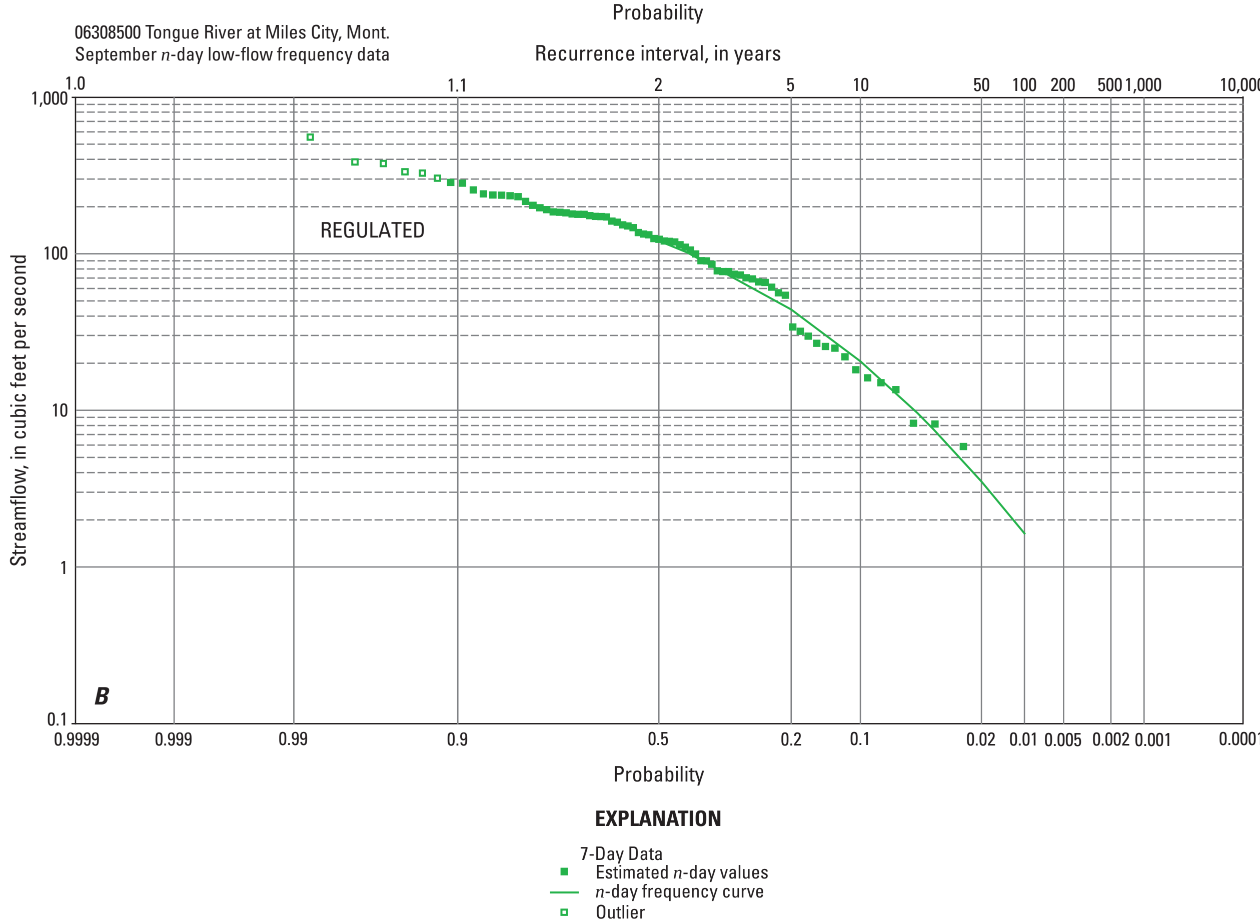


Figure 2-5-17. September *n*-day low-flow frequency data for streamflow-gaging station 06308500 (Tongue River at Miles City, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

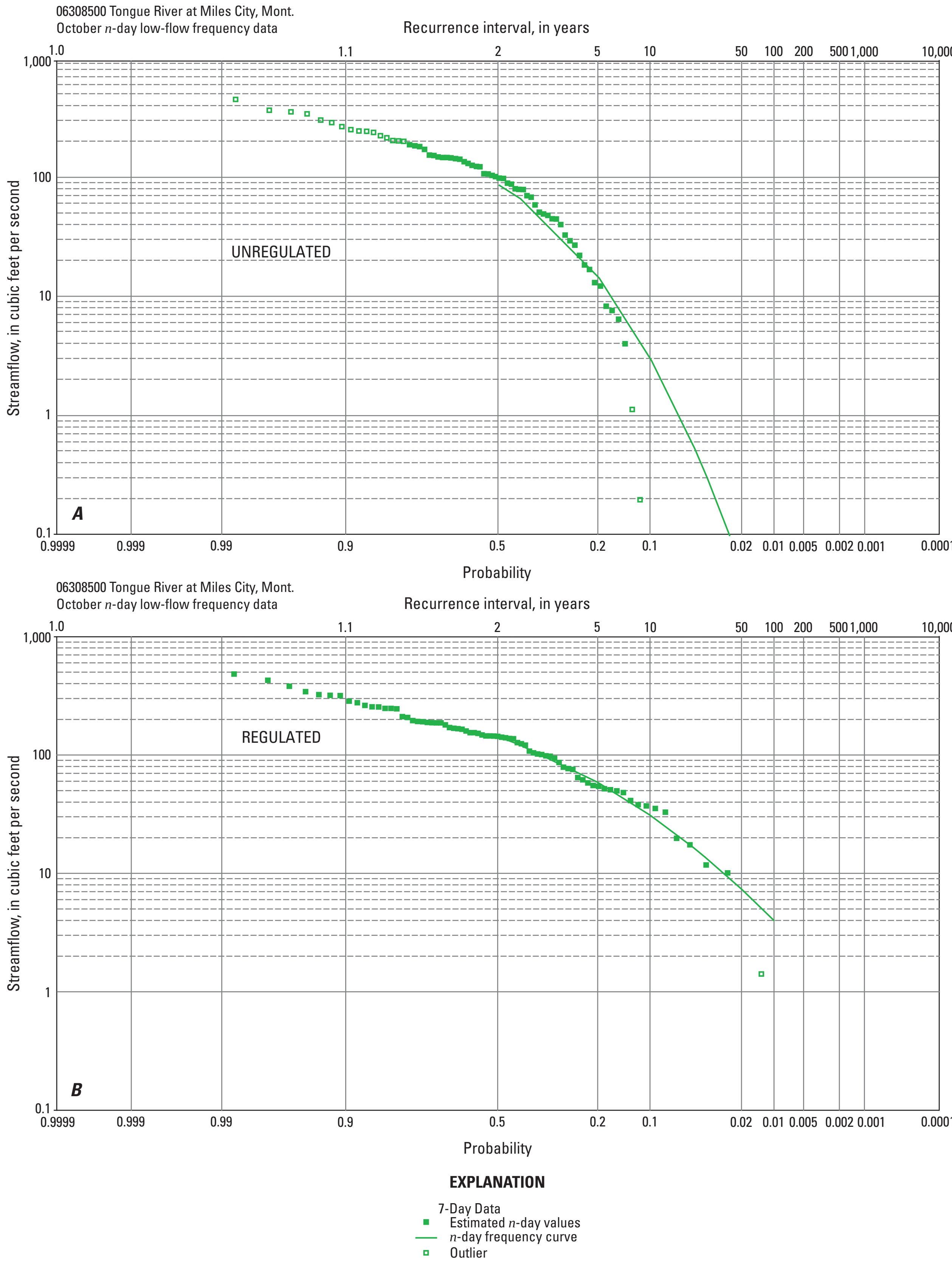
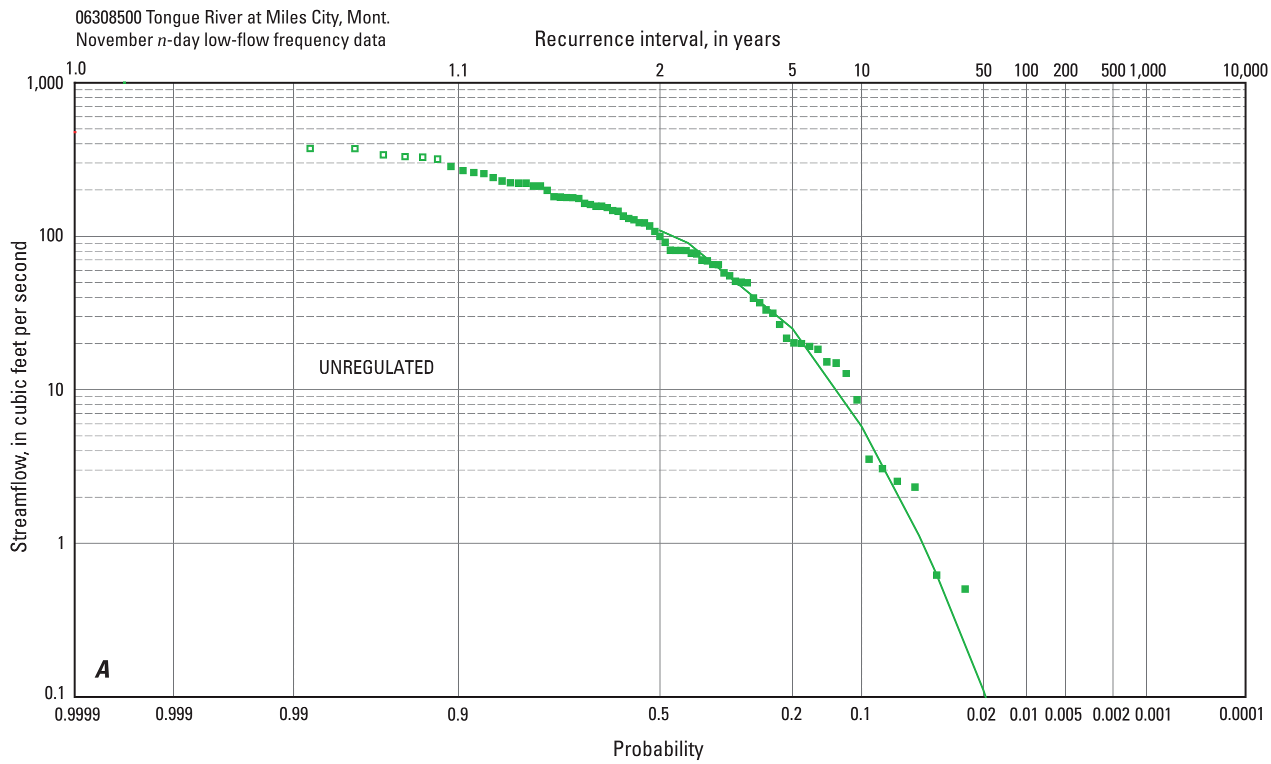
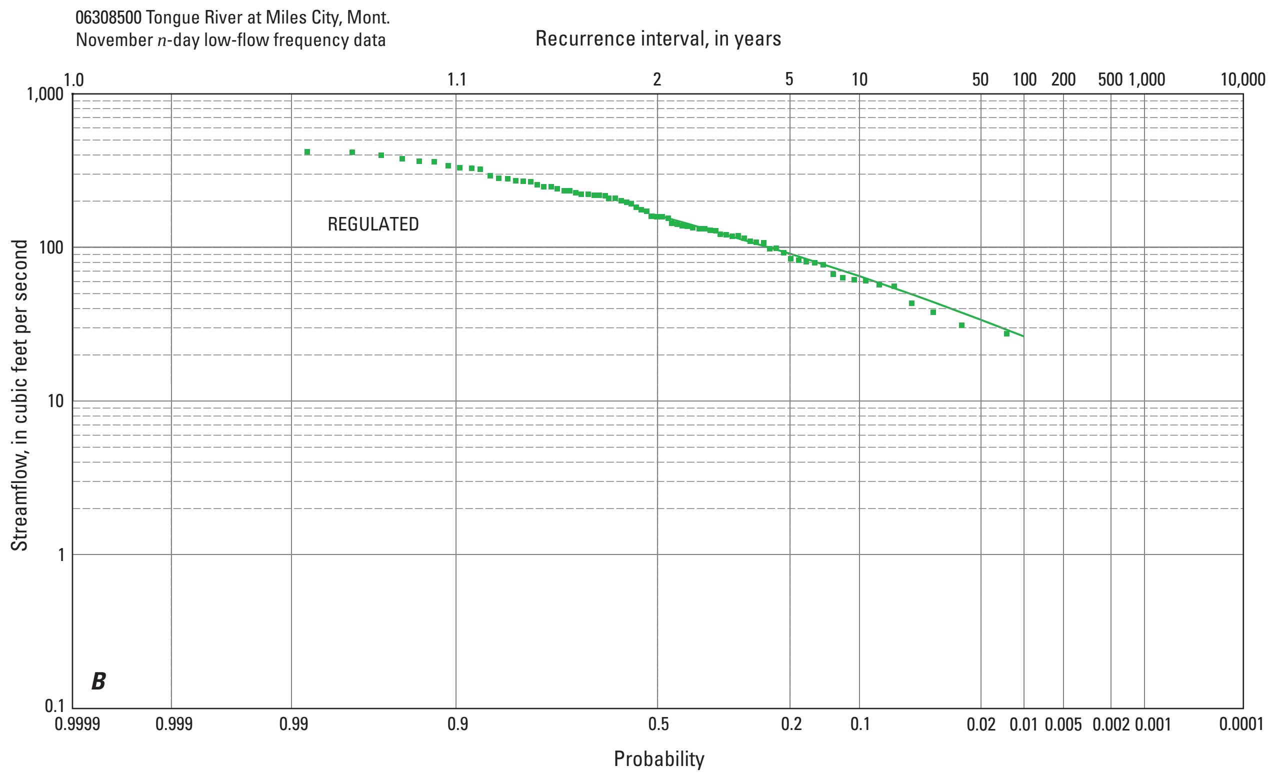


Figure 2-5-18. October *n*-day low-flow frequency data for streamflow-gaging station 06308500 (Tongue River at Miles City, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.





EXPLANATION

7-Day Data
- Estimated *n*-day values
- *n*-day frequency curve
- Outlier

Figure 2-5-19. November *n*-day low-flow frequency data for streamflow-gaging station 06308500 (Tongue River at Miles City, Mont.) for *A*, unregulated and *B*, regulated streamflow conditions, 1928–2002.

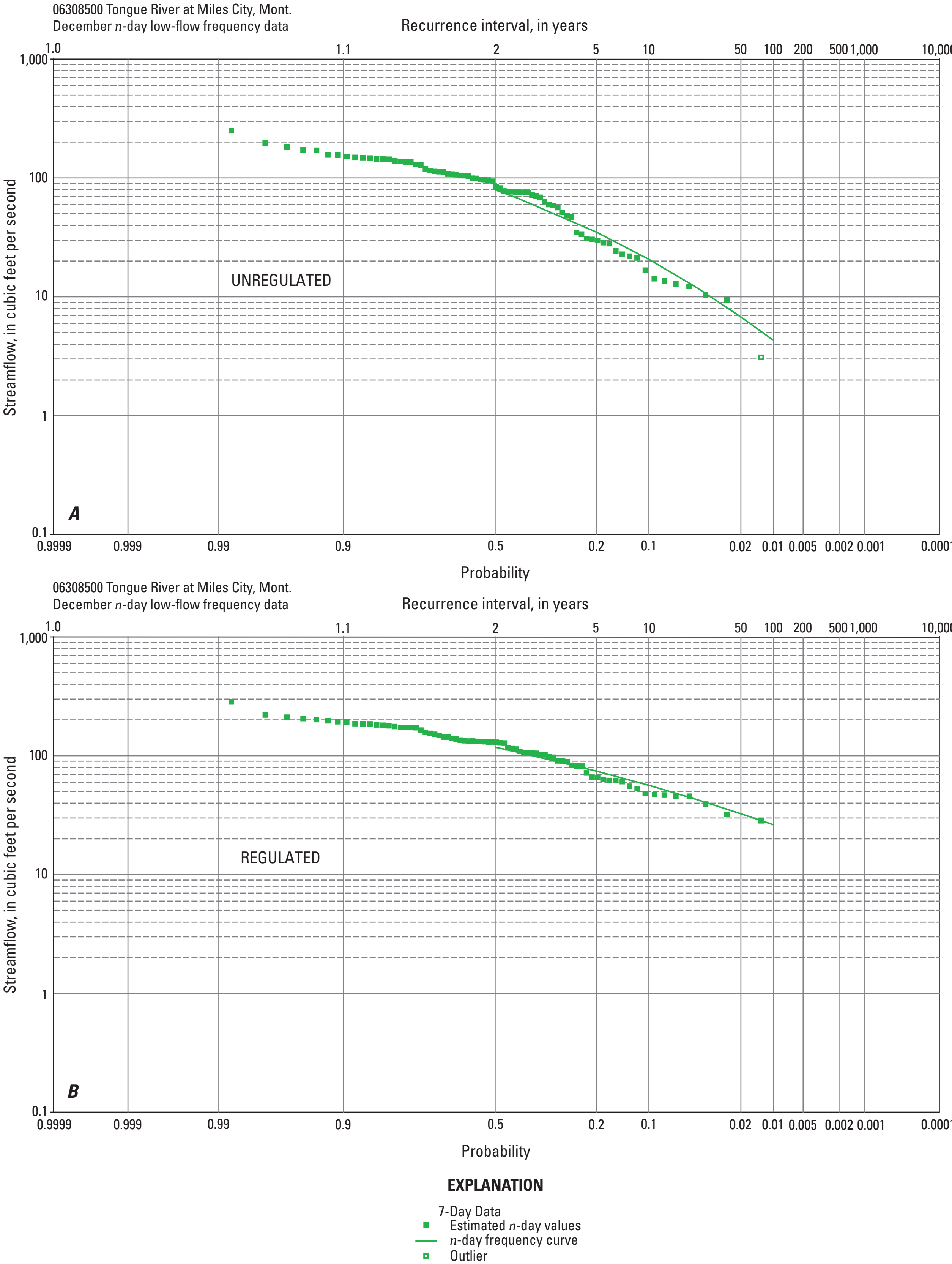
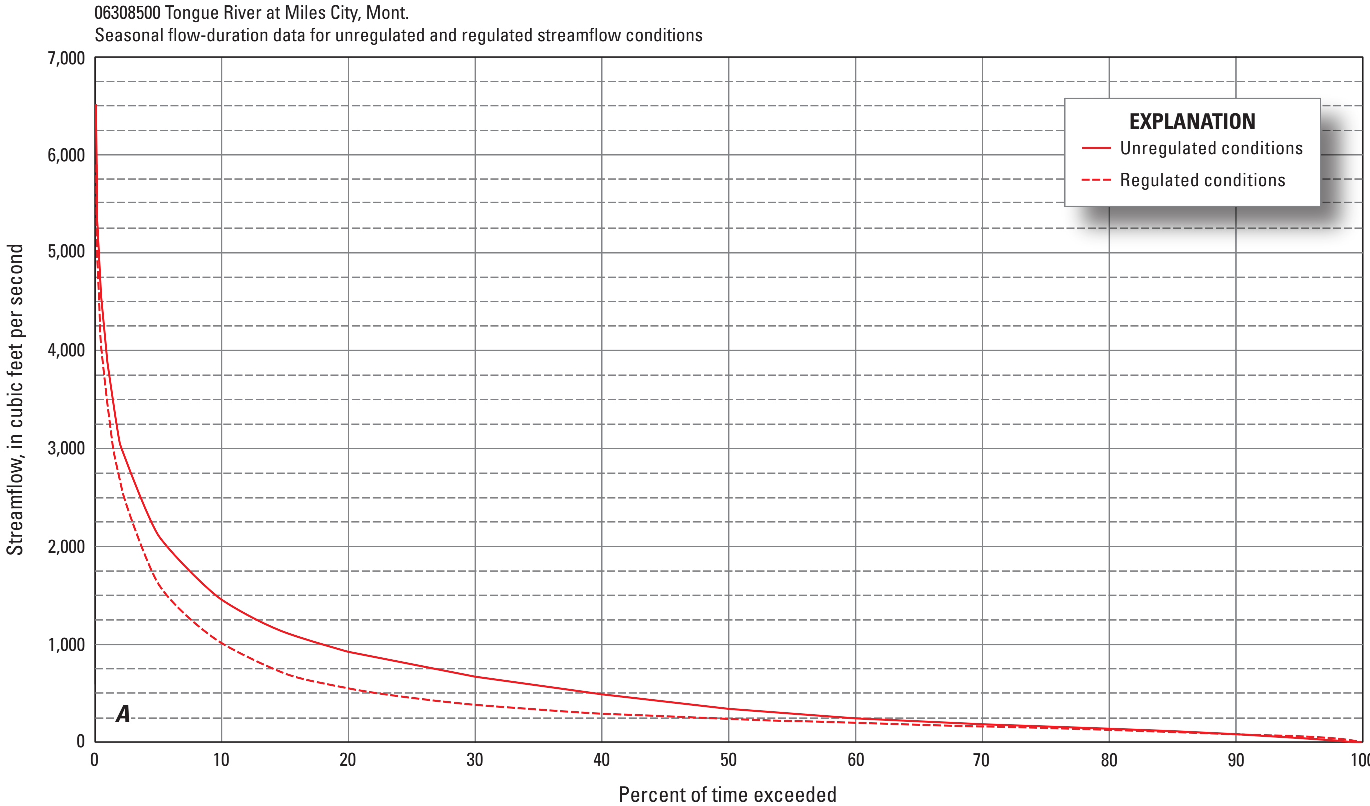


Figure 2-5-20. December n-day low-flow frequency data for streamflow-gaging station 06308500 (Tongue River at Miles City, Mont.) for *A*, unregulated and *B,* regulated streamflow conditions, 1928–2002.



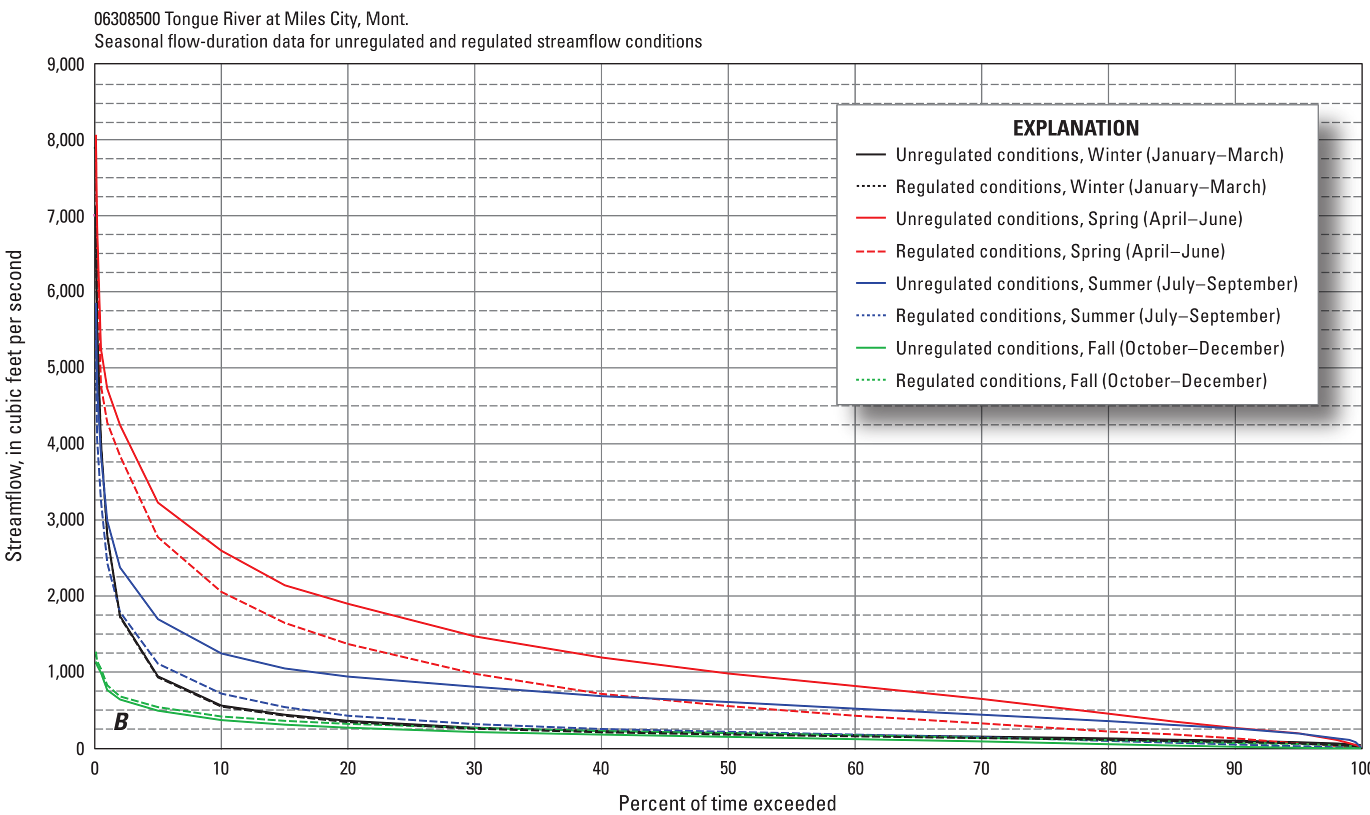


Figure 2-5-21. *A,* Annual and *B*, seasonal flow-duration data for streamflow-gaging station 06308500 (Tongue River at Miles City, Mont.) for unregulated and regulated conditions, 1928–2002.

Appendix 2–6. Statistics for Streamflow-Gaging Station 06326500 (Powder River near Locate, Mont.)

Table 2-6-1. Annual *n*-day high-flow frequency data for streamflow-gaging station 06326500 (Powder River near Locate, Mont.) for unregulated and regulated streamflow conditions, 1928–2002.

[Abbreviations: ft^3/s, cubic feet per second. Symbol: %, percent]

n, period of consecutive days	Streamflow, in ft^3/s, for indicated recurrence interval, in years, and exceedance probability, in percent						
	2 50%	5 20%	10 10%	20 5%	25 4%	50 2%	100 1%
Unregulated							
1	6,100	11,400	15,900	21,100	23,000	29,300	36,600
3	5,110	9,470	13,300	17,700	19,200	24,500	30,700
7	4,030	7,200	9,850	12,800	13,800	17,300	21,200
15	3,200	5,230	6,800	8,450	9,010	10,800	12,800
30	2,570	3,950	4,970	6,020	6,360	7,480	8,660
60	2,030	2,990	3,670	4,350	4,580	5,290	6,040
90	1,750	2,480	2,990	3,490	3,660	4,170	4,710
120	1,550	2,190	2,650	3,110	3,260	3,740	4,230
183	1,250	1,730	2,070	2,390	2,500	2,830	3,180
Regulated							
1	6,090	11,300	15,600	20,400	22,100	27,800	34,100
3	5,010	9,400	13,100	17,100	18,500	23,200	28,300
7	3,840	7,030	9,630	12,500	13,400	16,600	20,200
15	2,930	4,960	6,500	8,110	8,640	10,400	12,200
30	2,280	3,630	4,620	5,640	5,980	7,050	8,190
60	1,600	2,700	3,430	4,120	4,340	4,990	5,610
90	1,330	2,170	2,710	3,200	3,360	3,800	4,230
120	1,180	1,900	2,370	2,810	2,940	3,350	3,730
183	923	1,450	1,790	2,100	2,190	2,470	2,730

Table 2-6-2. Annual, seasonal, and monthly *n*-day low-flow frequency data for streamflow-gaging station 06326500 (Powder River near Locate, Mont.) for unregulated and regulated steamflow conditions, 1928–2002.

[Abbreviations: ft³/s, cubic feet per second. Symbol: %, percent]

Unregulated							
***n*, period of consecutive days (month, for monthly frequency data)**	**Streamflow, in ft³/s, for indicated recurrence interval, in years, and exceedance probability, in percent**						
	2 50%	**5 20%**	**10 10%**	**20 5%**	**25 4%**	**50 2%**	**100 1%**
Annual							
7	13	0	0	0	0	0	0
30	54	4	1	0	0	0	0
Winter (January–March)							
7	64	22	9	4	3	1	0
30	102	40	19	9	7	3	1
Spring (April–June)							
7	472	296	219	166	152	117	91
30	659	435	342	276	258	213	178
Summer (July–September)							
7	248	142	91	58	50	31	20
30	294	174	126	95	87	67	52
Fall (October–December)							
7	14	1	0	0	0	0	0
30	51	10	3	1	1	0	0
Monthly							
7 (January)	73	27	12	5	4	2	1
7 (February)	107	45	23	12	10	5	3
7 (March)	252	130	91	68	62	48	38
7 (April)	475	295	218	165	151	117	91
7 (May)	1,180	784	605	476	442	354	286
7 (June)	1,316	879	714	601	572	496	437
7 (July)	816	665	604	561	550	520	495
7 (August)	493	400	361	333	326	306	290
7 (September)	232	144	101	67	58	31	8
7 (October)	53	4	1	0	0	0	0
7 (November)	53	8	2	1	0	0	0
7 (December)	54	12	3	1	0	0	0

Table 2-6-2. Annual, seasonal, and monthly *n*-day low-flow frequency data for streamflow-gaging station 06326500 (Powder River near Locate, Mont.) for unregulated and regulated steamflow conditions, 1928–2002.—Continued

[Abbreviations: ft^3/s, cubic feet per second. Symbol: %, percent]

n, period of consecutive days (month, for monthly frequency data)	Regulated						
	Streamflow, in ft^3/s, for indicated recurrence interval, in years, and exceedance probability, in percent						
	2 50%	5 20%	10 10%	20 5%	25 4%	50 2%	100 1%
Annual							
7	34	9	3	1	1	0	0
30	60	18	7	2	2	1	0
Winter (January–March)							
7	80	44	31	22	20	15	11
30	113	59	40	28	25	18	13
Spring (April–June)							
7	336	141	73	38	31	16	8
30	540	255	149	88	75	45	27
Summer (July–September)							
7	52	10	3	1	0	0	0
30	95	20	6	2	1	0	0
Fall (October–December)							
7	67	44	37	31	30	27	24
30	102	64	50	41	39	33	28
Monthly							
7 (January)	86	47	34	25	22	17	13
7 (February)	119	59	39	27	25	18	13
7 (March)	264	144	106	82	76	61	51
7 (April)	432	260	187	137	124	92	69
7 (May)	626	252	132	71	58	32	17
7 (June)	751	237	99	41	31	13	5
7 (July)	222	57	20	7	5	2	1
7 (August)	114	30	9	2	1	0	0
7 (September)	62	19	7	3	2	1	0
7 (October)	97	55	48	46	45	45	45
7 (November)	102	69	59	52	51	47	45
7 (December)	81	50	38	30	29	24	20

Table 2-6-3. Annual and seasonal flow-duration data for streamflow-gaging station 06326500 (Powder River near Locate, Mont.) for unregulated and regulated conditions, 1928–2002.

[Abbreviations: ft³/s, cubic feet per second. Symbol: %, percent]

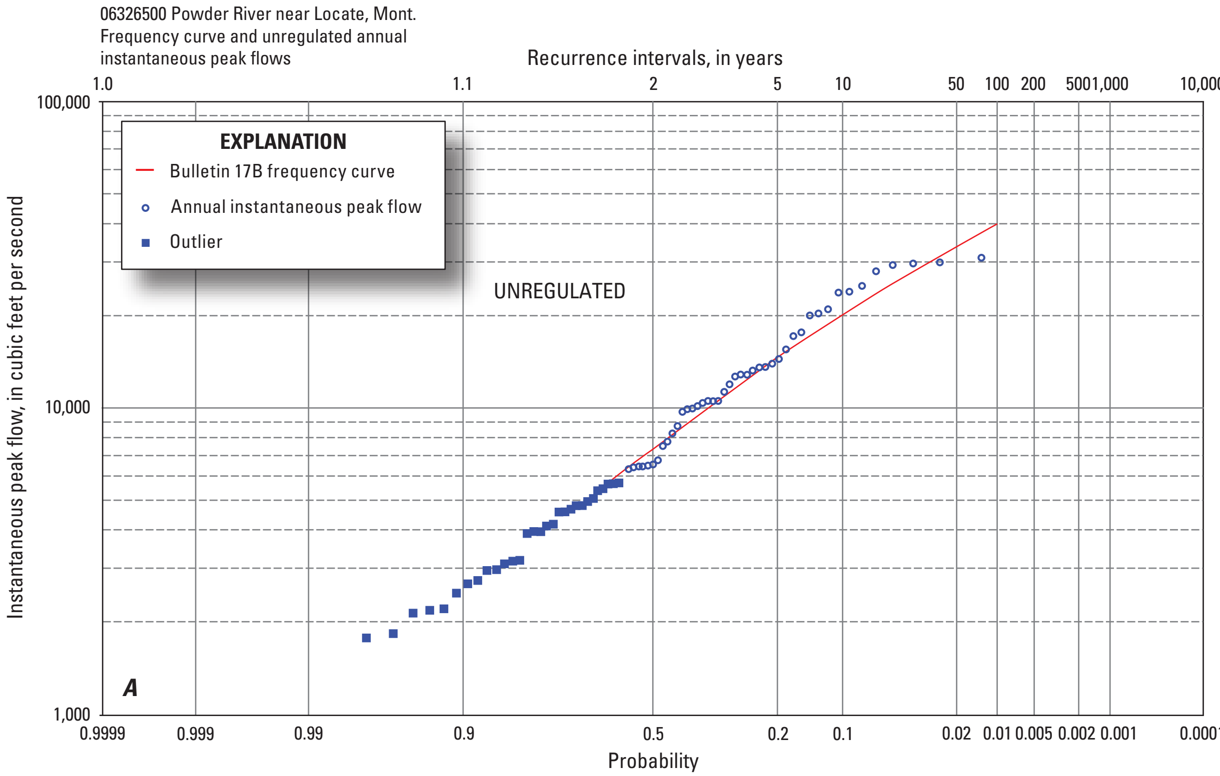
Streamflow condition	Streamflow, in ft³/s, which was equaled or exceeded for indicated percent of time																		
	1.0%	2.0%	5.0%	10%	15%	20%	25%	30%	40%	50%	60%	70%	75%	80%	85%	90%	95%	98%	99%
Annual																			
Unregulated	5,850	4,230	2,610	1,800	1,380	1,120	922	786	565	385	253	163	127	99	71	42	3	0	0
Regulated	5,510	3,880	2,200	1,380	1,000	769	600	482	330	244	174	126	108	89	70	55	31	14	1
Winter (January–March)																			
Unregulated	7,930	4,990	2,050	1,090	780	590	462	367	237	176	132	102	91	75	60	40	10	0	0
Regulated	7,940	5,000	2,060	1,100	799	600	477	380	251	193	150	121	110	96	80	59	30	20	17
Spring (April–June)																			
Unregulated	7,350	5,930	4,250	3,060	2,530	2,220	1,937	1,709	1,400	1,184	994	804	721	640	534	432	341	253	214
Regulated	6,940	5,490	3,840	2,590	2,040	1,700	1,430	1,240	966	766	607	479	425	367	306	246	149	80	49
Summer (July–September)																			
Unregulated	3,370	2,720	1,950	1,460	1,170	1,000	901	822	701	591	507	407	359	297	258	206	152	92	69
Regulated	2,850	2,230	1,430	959	689	503	403	332	246	179	125	81	65	53	38	21	7	0	0
Fall (October–December)																			
Unregulated	867	621	427	315	271	241	211	184	136	101	70	46	31	17	1	0	0	0	0
Regulated	930	681	482	372	322	288	259	234	182	146	115	92	81	72	62	57	44	33	31

Table 2-6-4. Monthly and annual streamflow characteristics for streamflow-gaging station 06326500 (Powder River near Locate, Mont.) for unregulated and regulated streamflow conditions, 1928–2002.

[Abbreviations: ft³/s, cubic feet per second]

Unregulated						
Period	Streamflow, in ft³/s, or year, for indicated streamflow characteristic					
	Maximum monthly mean and maximum annual mean streamflow	Year of maximum monthly mean and maximum annual mean streamflow	Minimum monthly mean and minimum annual mean streamflow	Year of minimum monthly mean and minimum annual mean streamflow	Mean monthly and mean annual streamflow	Standard deviation of mean monthly and mean annual steamflow
January	452	1981	0	1929	117	87
February	3,830	1943	0	1929	399	585
March	4,970	1936	66	1950	1,200	1,120
April	3,130	1965	129	1961	769	477
May	6,580	1928	612	1935	1,790	1,060
June	8,070	1944	674	1994	2,200	1,280
July	4,830	1937	604	1994	1,290	645
August	1,550	1941	259	1960	649	224
September	1,200	1933	49	1961	339	205
October	860	1940	0	1935	186	208
November	729	1998	0	1935	158	139
December	378	1941	0	1960	111	81
Annual	1,757	1944	314	1961	762	279

Regulated						
Period	Streamflow, in ft³/s, or year, for indicated streamflow characteristic					
	Maximum monthly mean and maximum annual mean streamflow	Year of maximum monthly mean and maximum annual mean streamflow	Minimum monthly mean and minimum annual mean streamflow	Year of minimum monthly mean and minimum annual mean streamflow	Mean monthly and mean annual streamflow	Standard deviation of mean monthly and mean annual steamflow
January	477	1981	19	1929	139	87
February	3,850	1943	15	1929	416	584
March	4,990	1936	80	1950	1,210	1,120
April	3,070	1965	109	1961	718	466
May	6,130	1928	123	1992	1,260	1,110
June	8,010	1944	48	2002	1,660	1,360
July	4,340	1937	5	1988	691	669
August	1,230	1941	0	1988	262	233
September	1,061	1933	5	1988	194	214
October	910	1940	50	1939	245	209
November	786	1998	44	1934	214	137
December	407	1941	31	1960	144	80
Annual	1,617	1944	119	1961	590	291



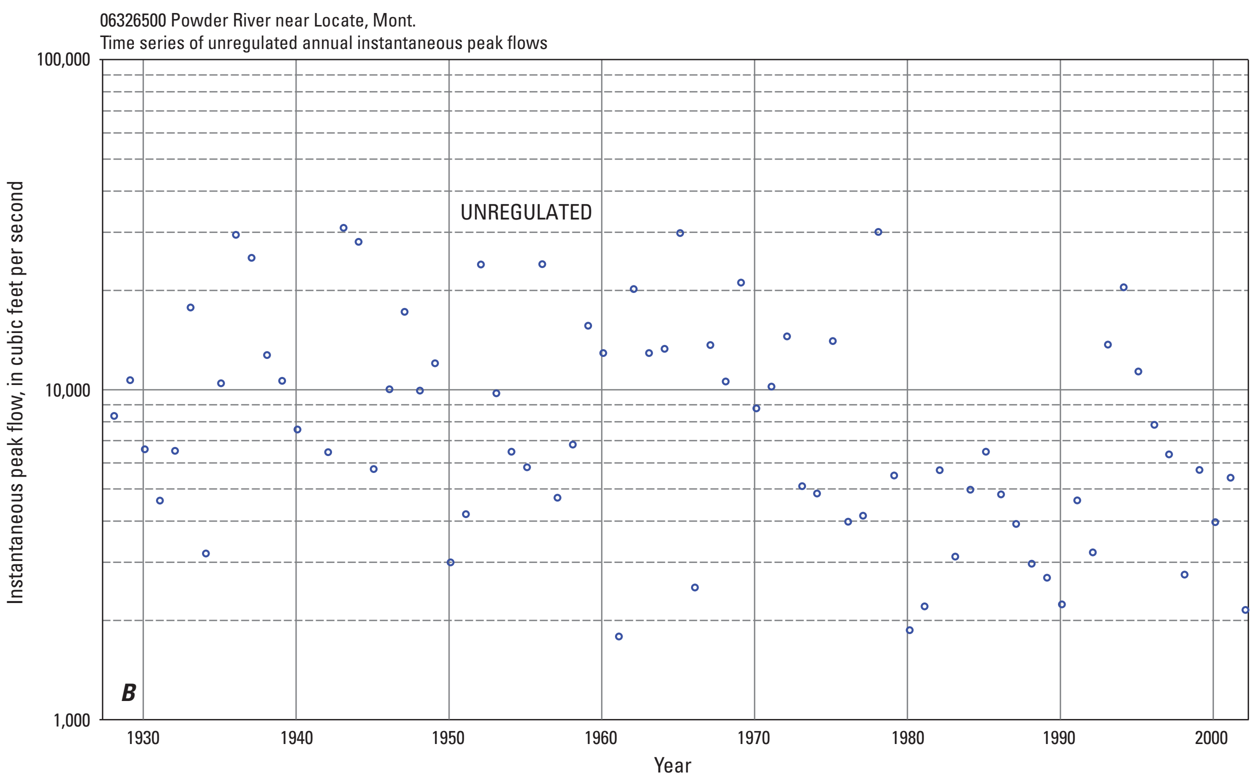
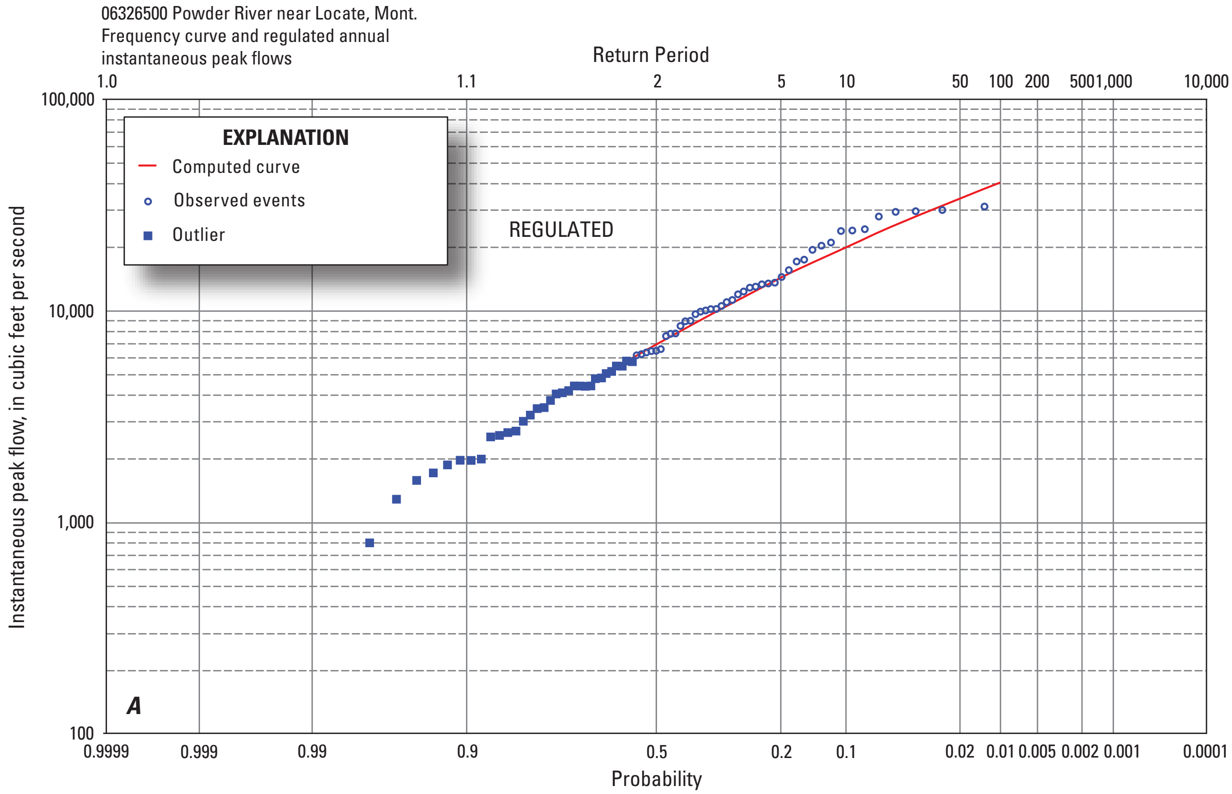


Figure 2-6-1. Annual instantaneous peak-flow data for streamflow-gaging station 06326500 (Powder River near Locate, Mont.) for unregulated conditions, 1928–2002. *A*, Frequency curve and unregulated annual instantaneous peak flows. *B*, Time series of unregulated annual instantaneous peak flows. [Bulletin 17B: U.S. Interagency Advisory Council on Water Data, 1982]



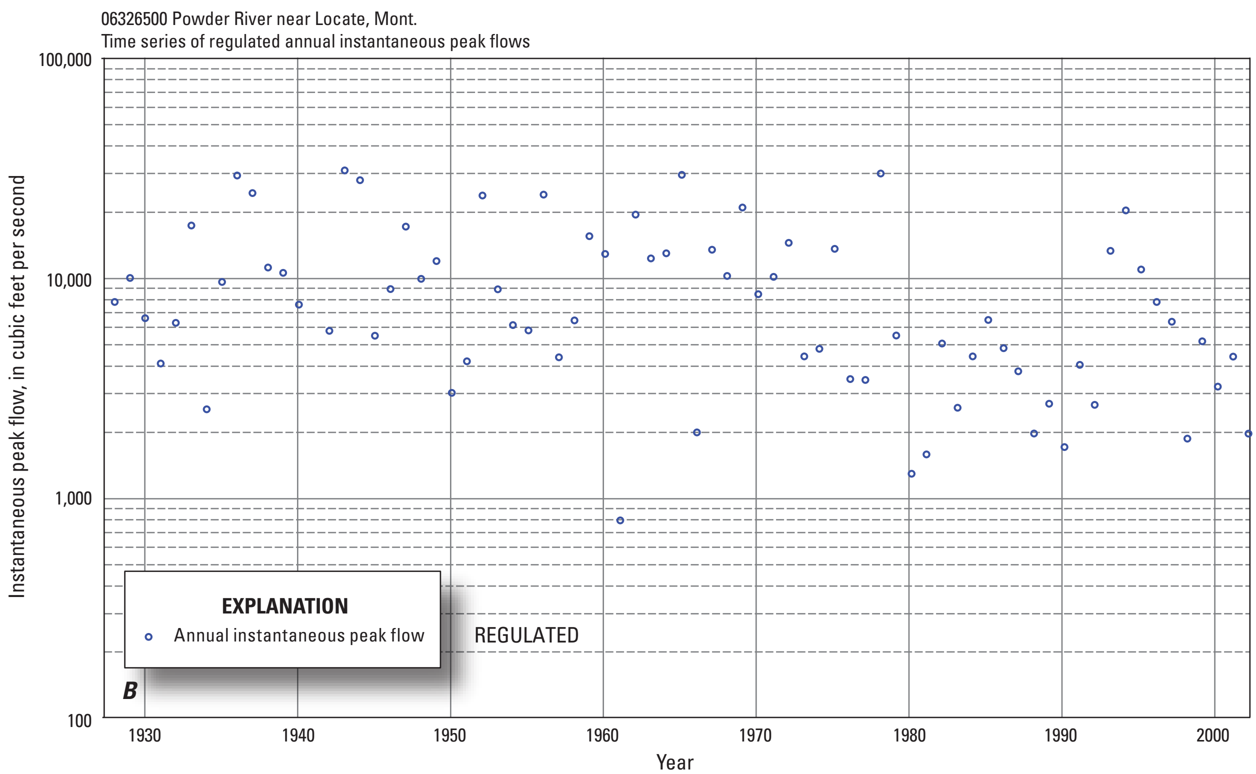


Figure 2-6-2. Annual instantaneous peak-flow data for streamflow-gaging station 06326500 (Powder River near Locate, Mont.) for regulated conditions, 1928–2002. *A*, Frequency curve and regulated annual instantaneous peak flows. *B*, Time series of regulated annual instantaneous peak flows. [Bulletin 17B: U.S. Interagency Advisory Council on Water Data, 1982]

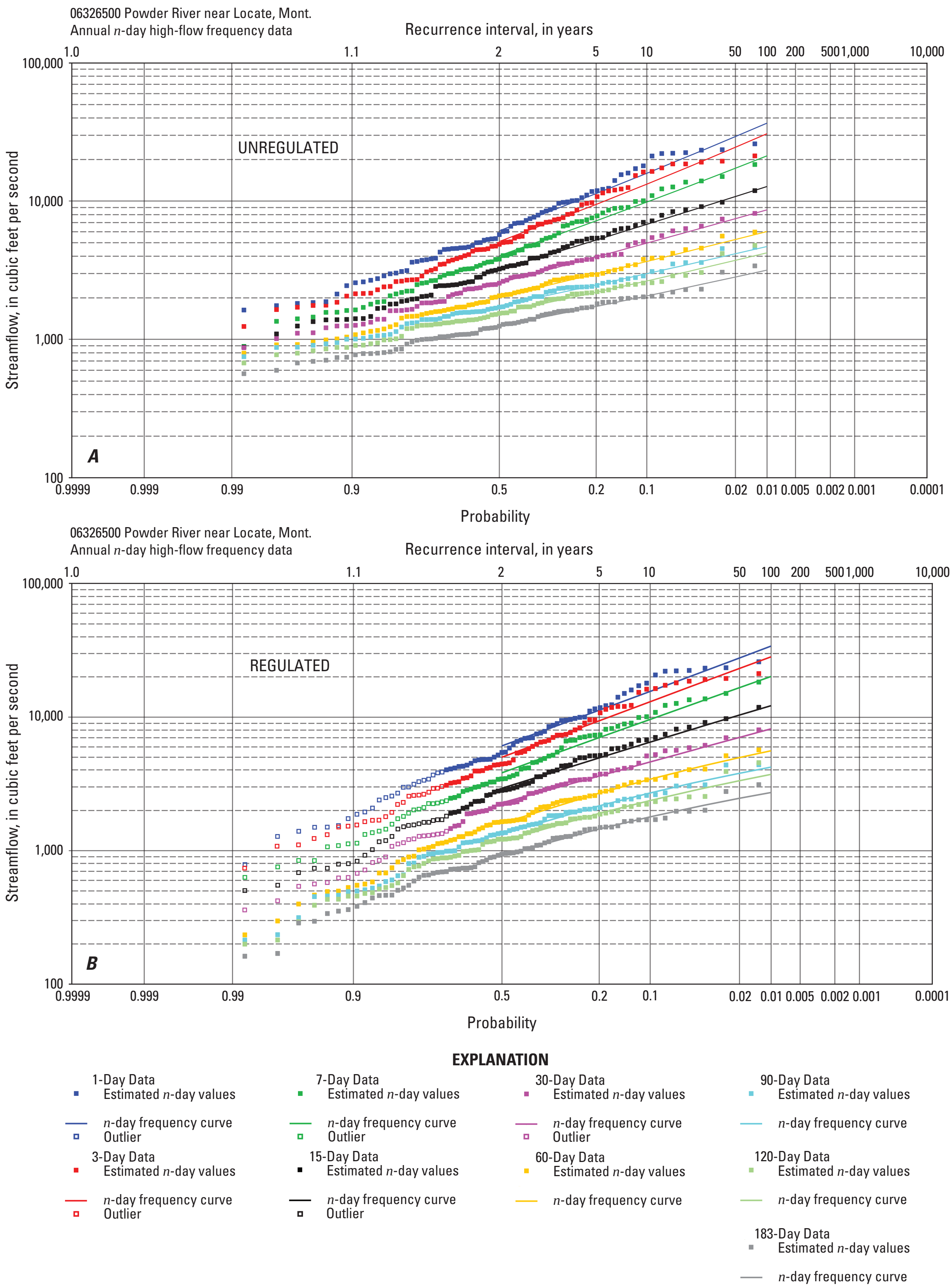


Figure 2-6-3. Annual *n*-day high-flow frequency data for streamflow-gaging station 06326500 (Powder River near Locate, Mont.) for *A*, unregulated and *B*, regulated conditions, 1928–2002.

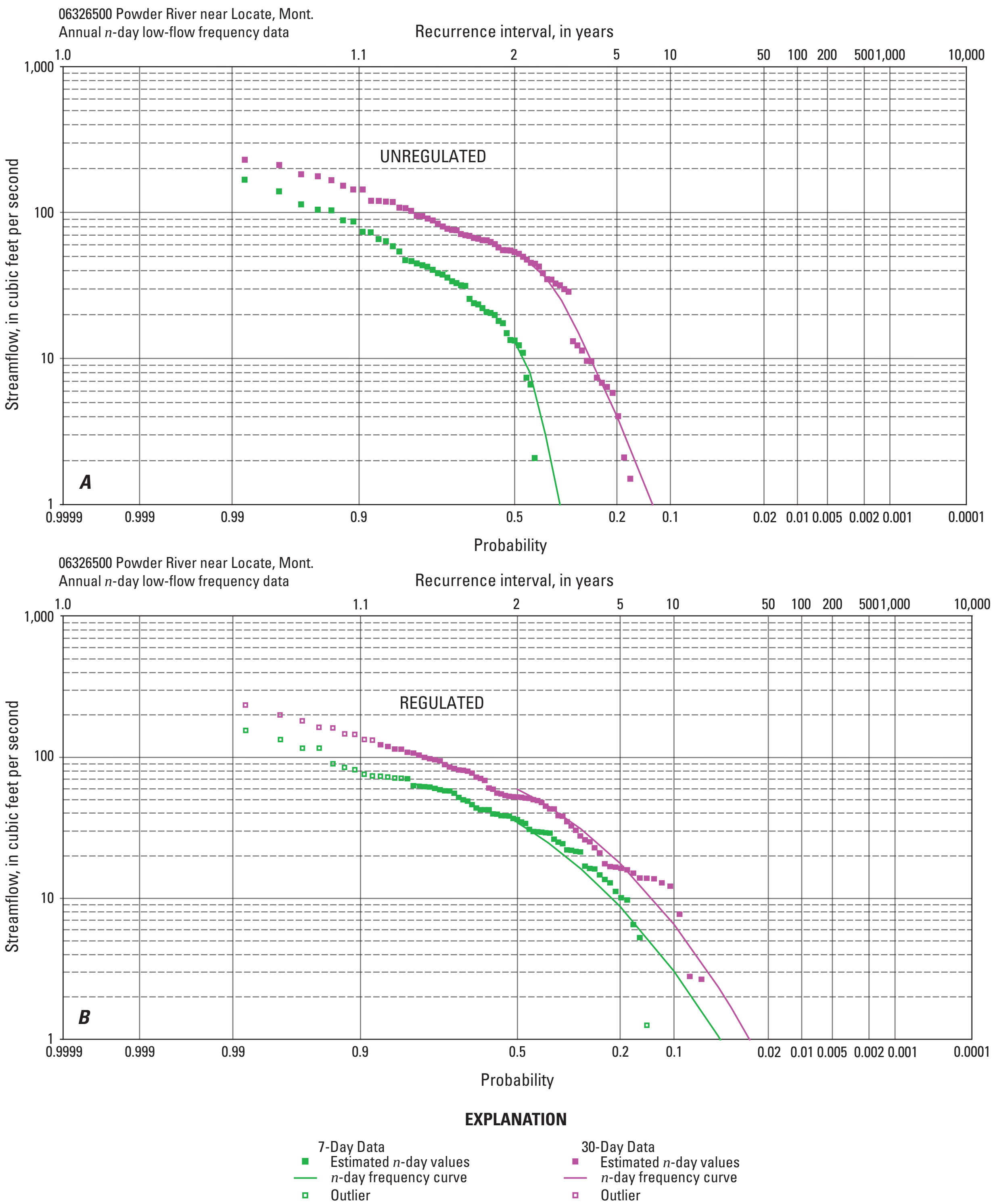


Figure 2-6-4. Annual *n*-day low-flow frequency data for streamflow-gaging station 06326500 (Powder River near Locate, Mont.) for *A*, unregulated and *B*, regulated conditions, 1928–2002.

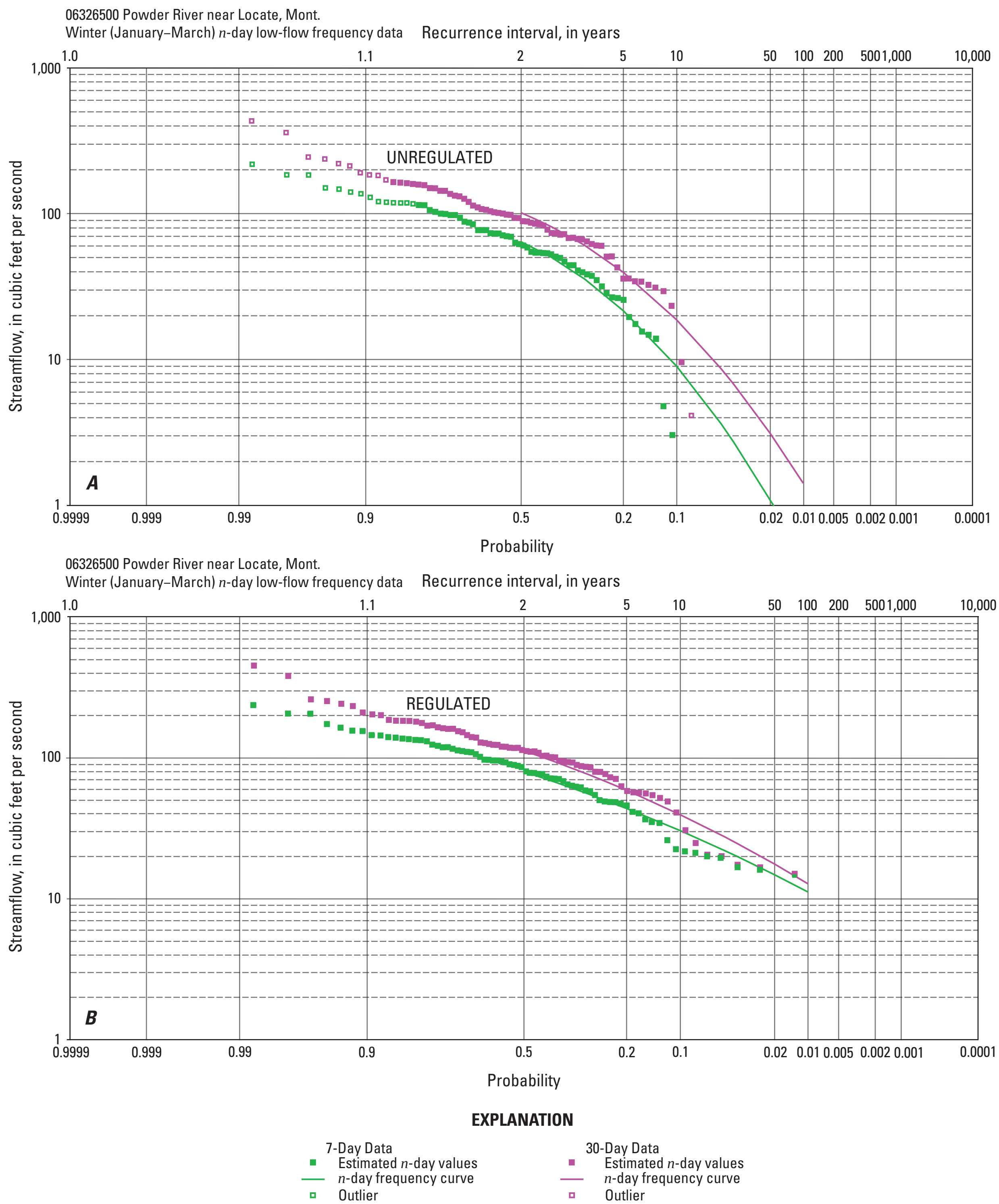
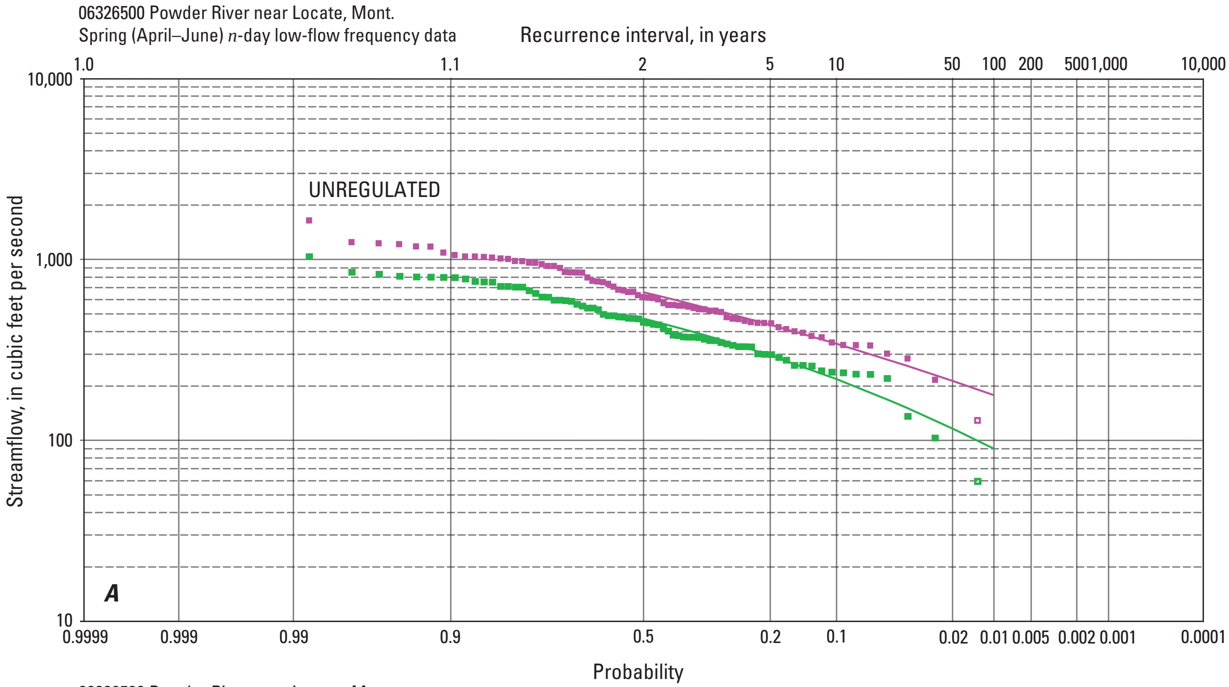


Figure 2-6-5. Winter (January–March) *n*-day low-flow frequency data for streamflow-gaging station 06326500 (Powder River near Locate, Mont.) for *A*, unregulated and *B*, regulated conditions, 1928–2002.



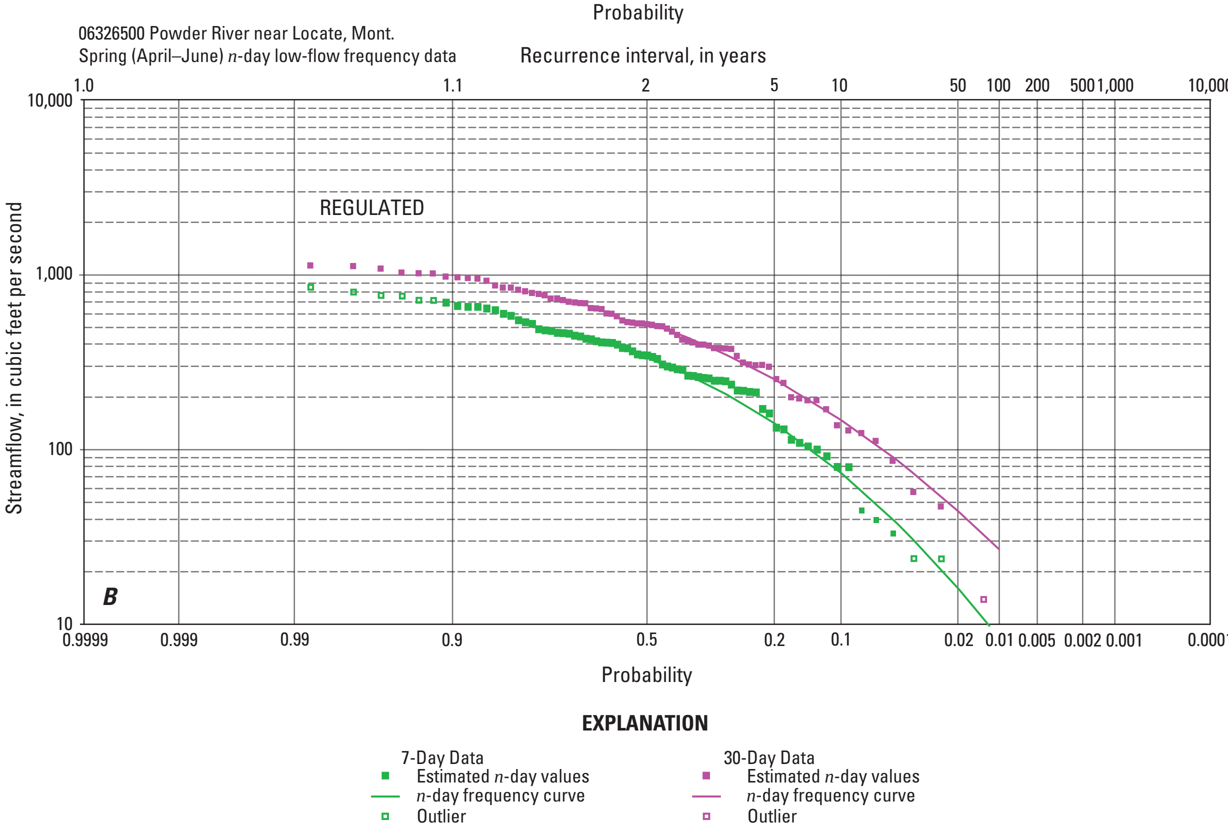


Figure 2-6-6. Spring (April–June) *n*-day low-flow frequency data for streamflow-gaging station 06326500 (Powder River near Locate, Mont.) for *A*, unregulated and *B,* regulated conditions, 1928–2002.

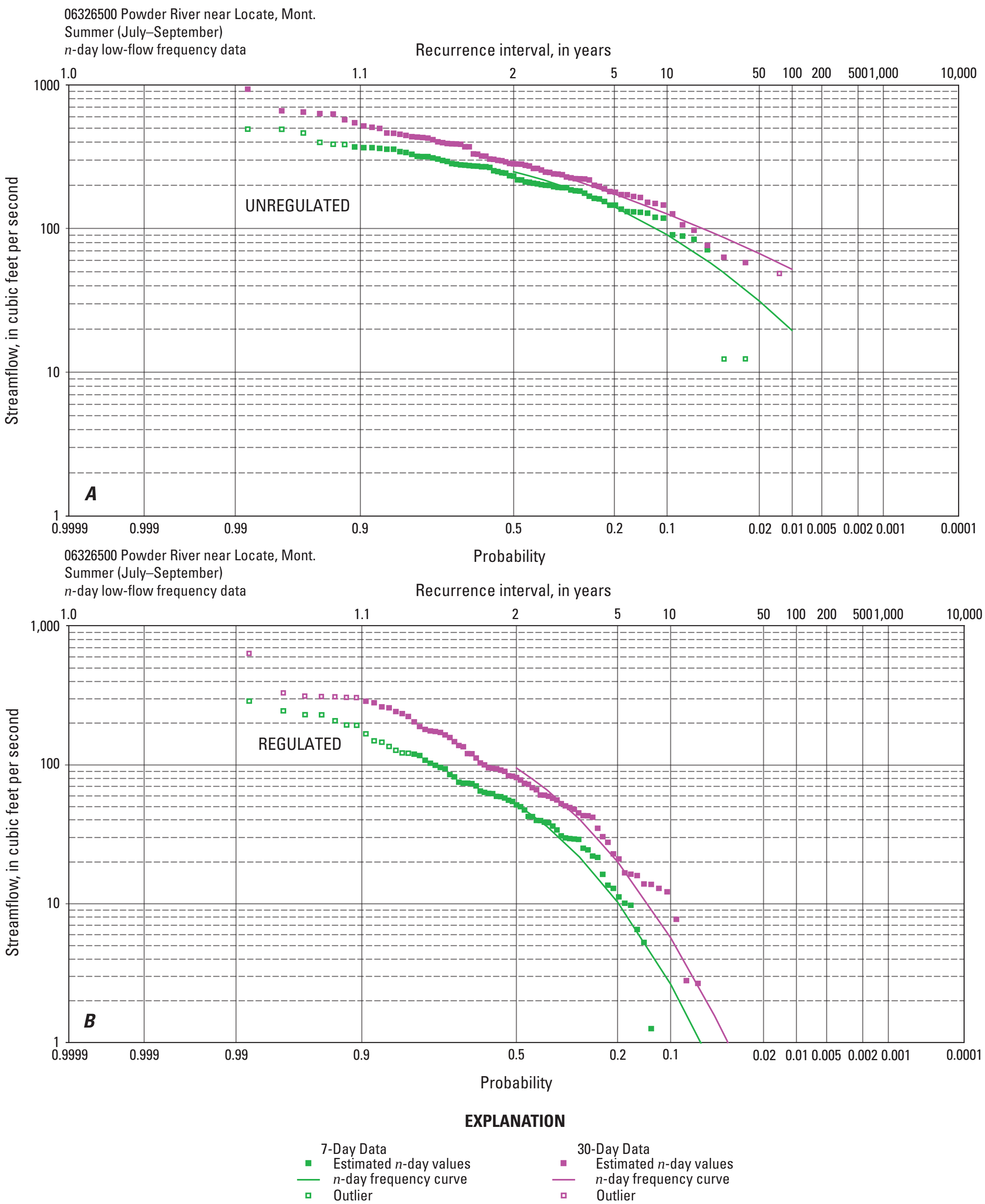


Figure 2-6-7. Summer (July–September) *n*-day low-flow frequency data for streamflow-gaging station 06326500 (Powder River near Locate, Mont.) for *A*, unregulated and *B*, regulated and regulated conditions, 1928–2002.

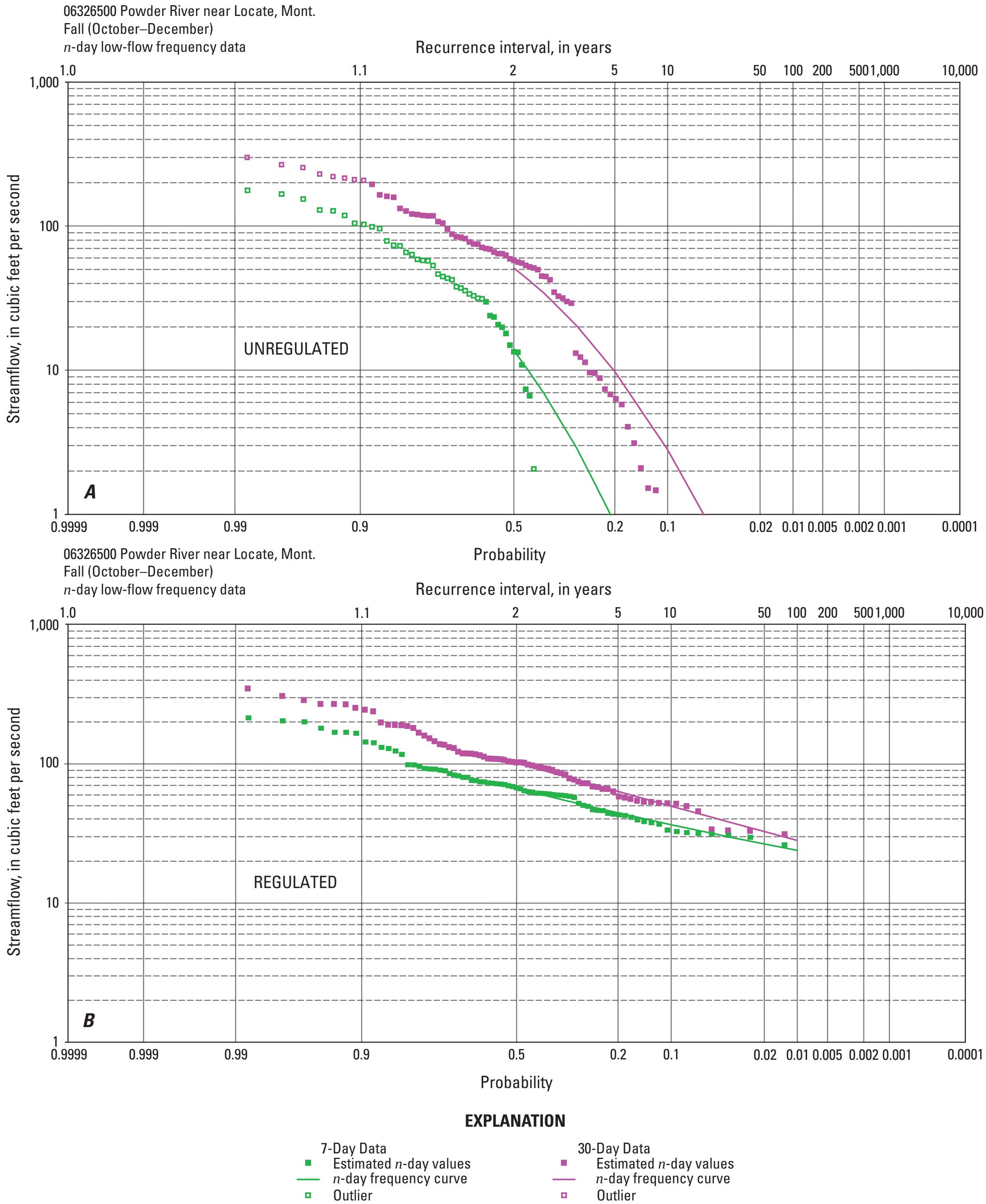


Figure 2-6-8. Fall (October–December) *n*-day low-flow frequency data for streamflow-gaging station 06326500 (Powder River near Locate, Mont.) for *A*, unregulated and *B,* regulated conditions, 1928–2002.

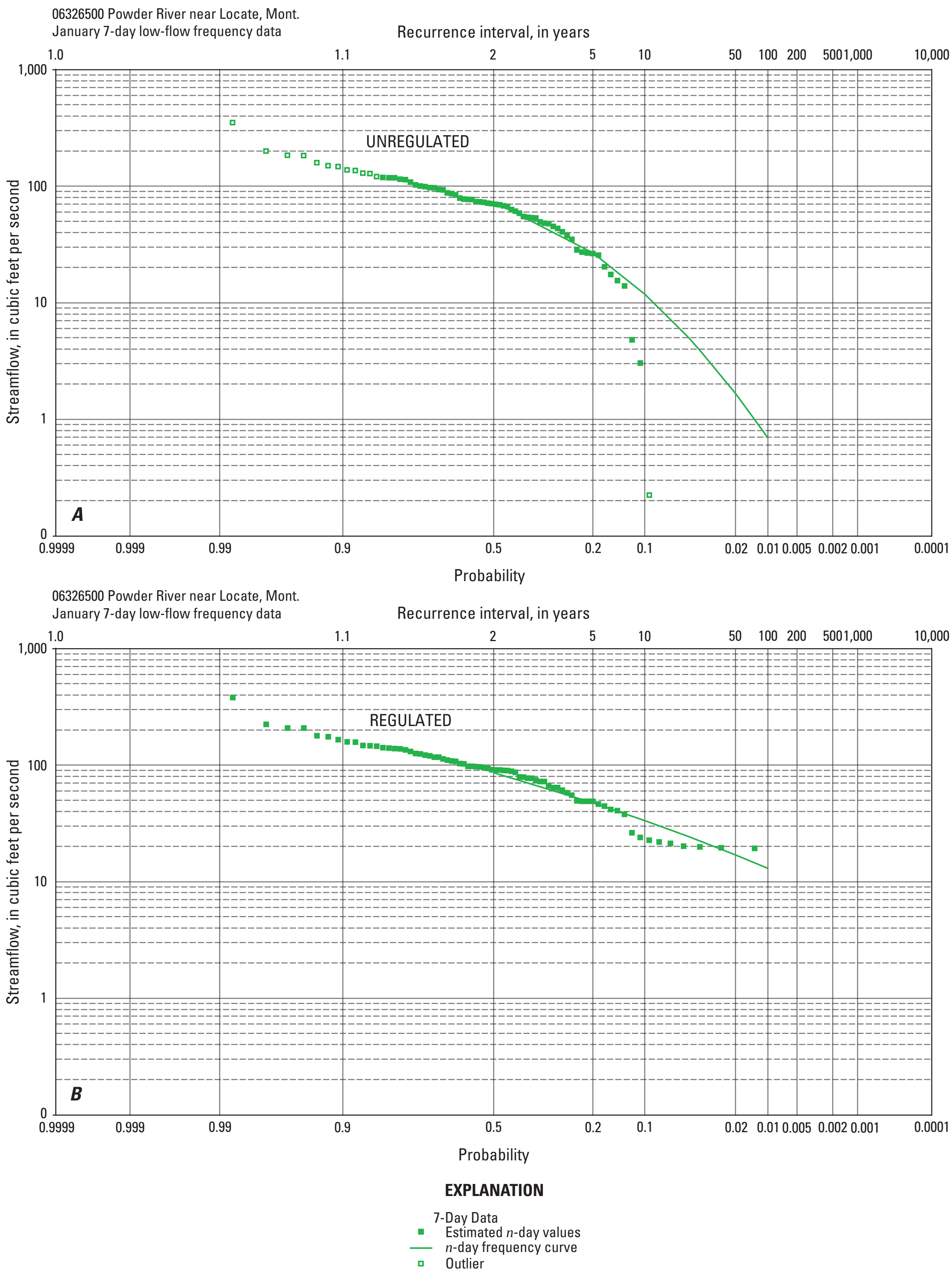


Figure 2-6-9. January 7-day low-flow frequency data for streamflow-gaging station 06326500 (Powder River near Locate, Mont.) for *A*, unregulated and *B*, regulated conditions, 1928–2002.

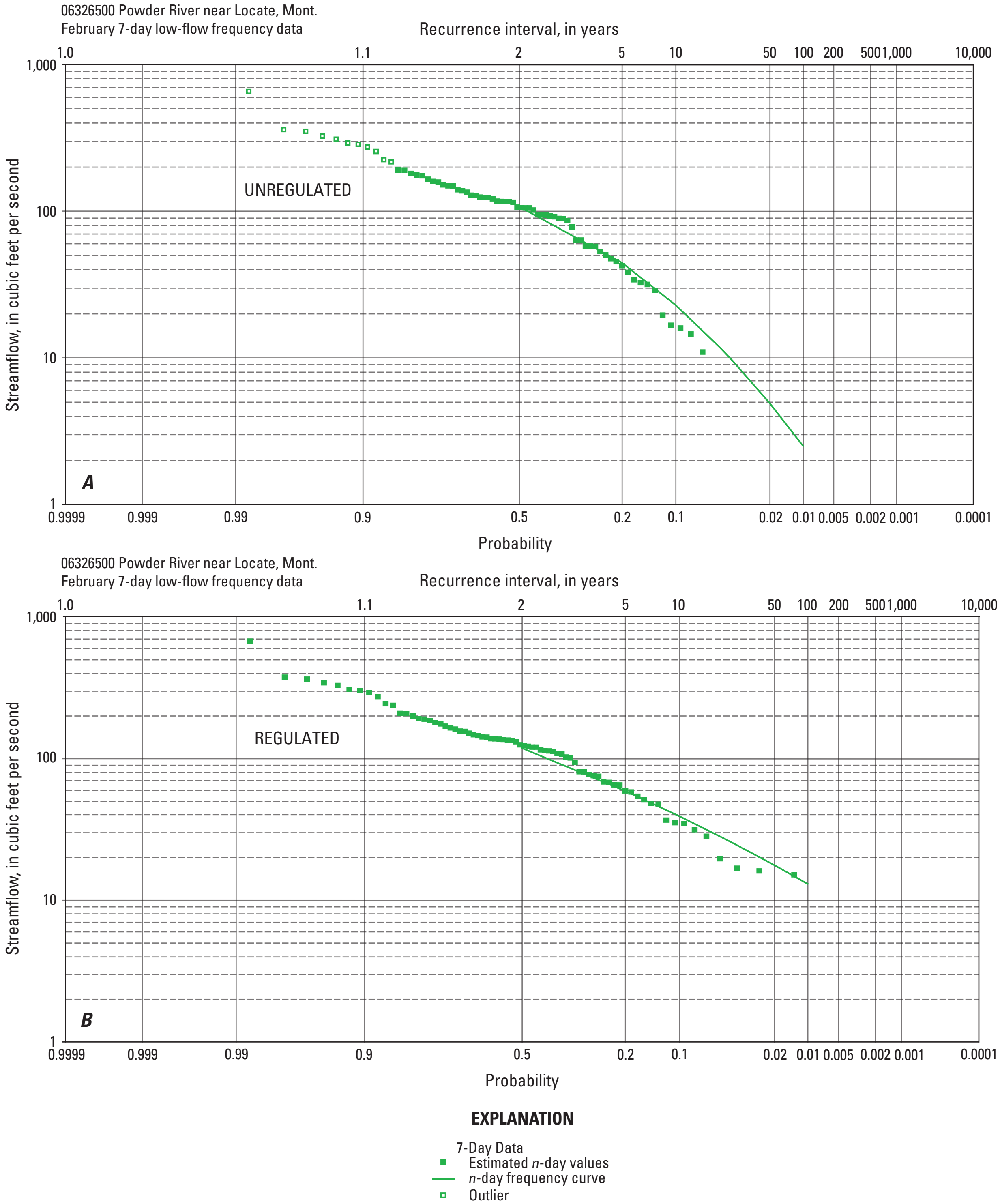


Figure 2-6-10. February 7-day low-flow frequency data for streamflow-gaging station 06326500 (Powder River near Locate, Mont.) for *A*, unregulated and *B,* regulated conditions, 1928–2002.

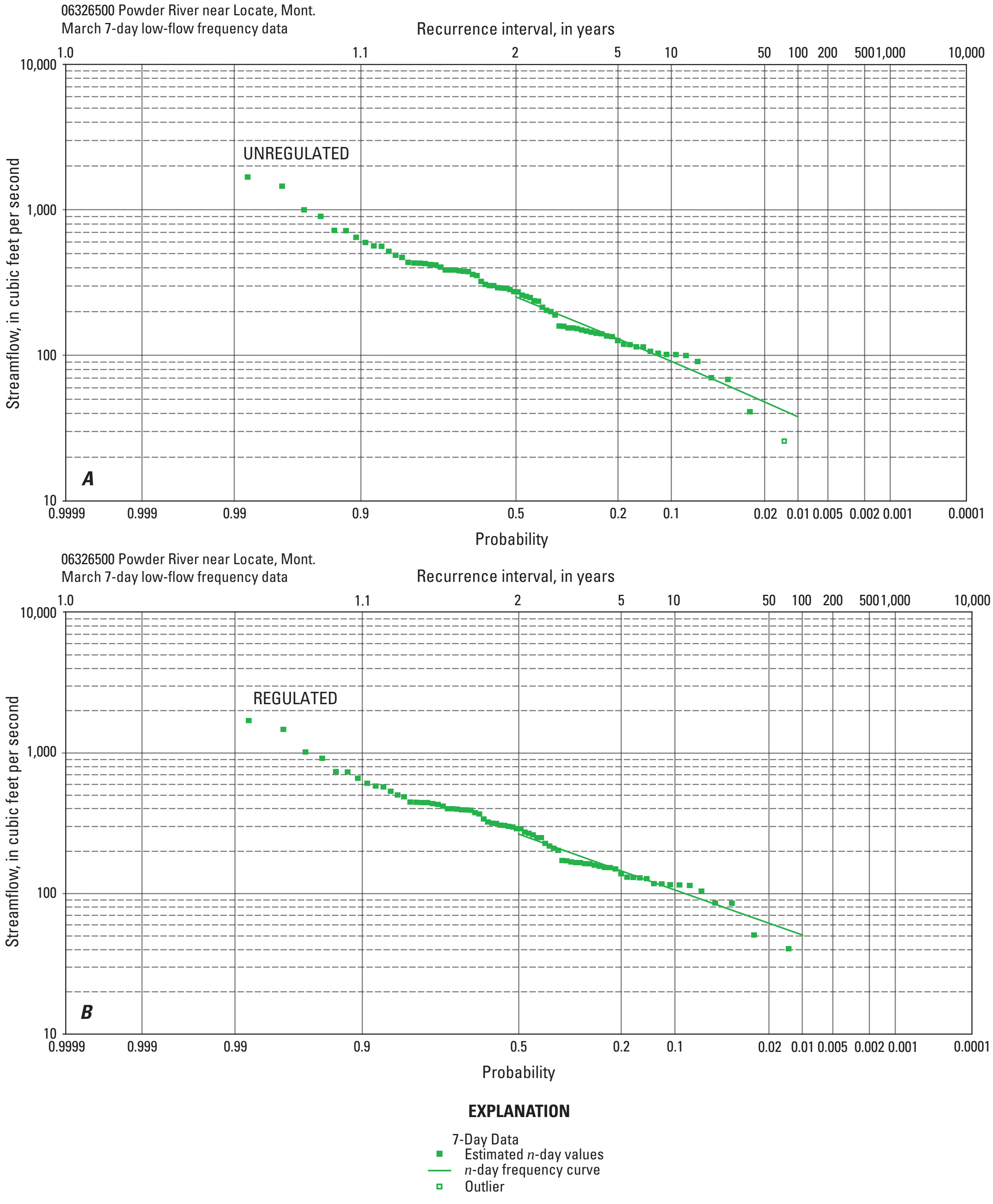


Figure 2-6-11. March 7-day low-flow frequency data for streamflow-gaging station 06326500 (Powder River near Locate, Mont.) for *A*, unregulated and *B*, regulated conditions, 1928–2002.

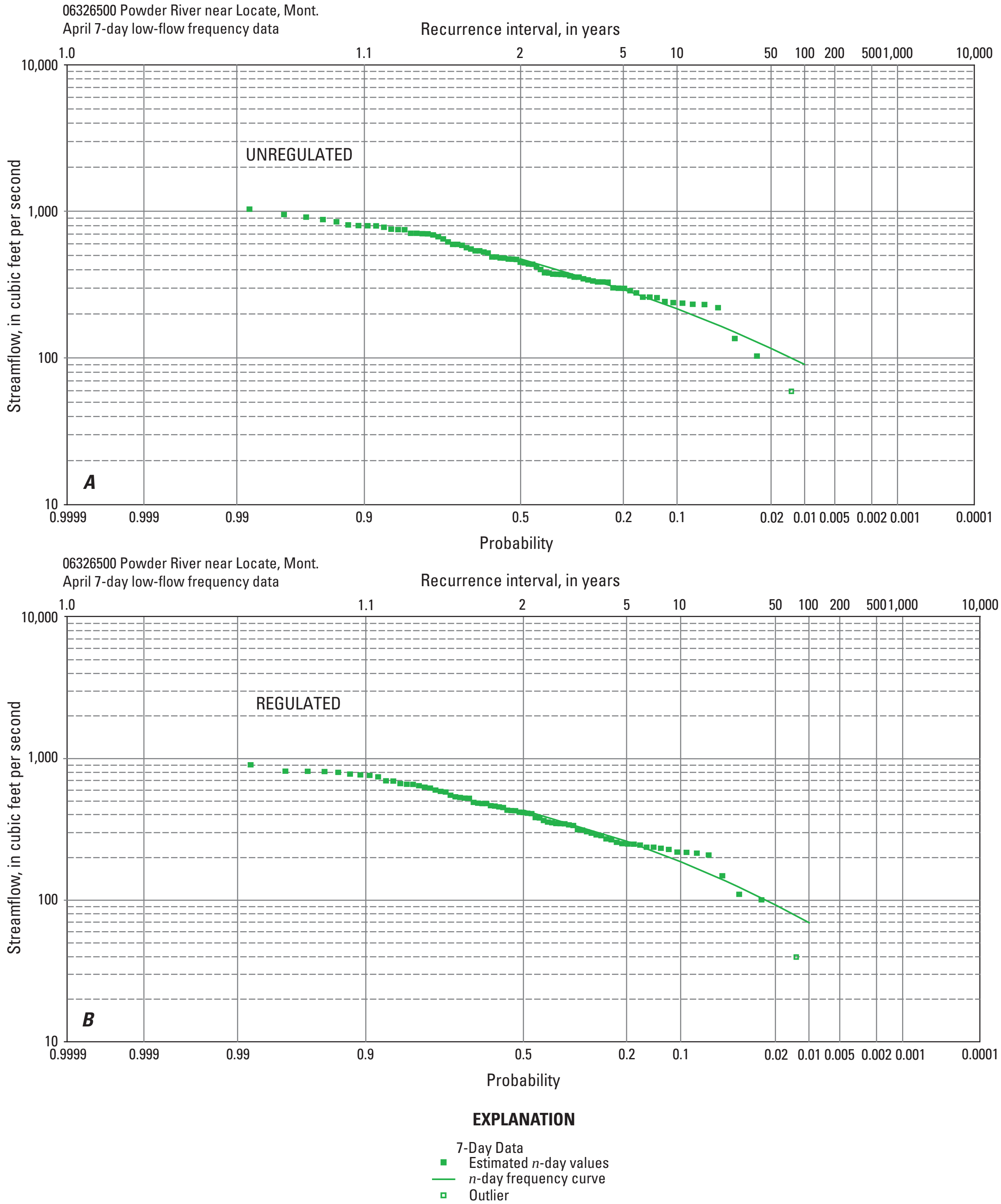


Figure 2-6-12. April 7-day low-flow frequency data for streamflow-gaging station 06326500 (Powder River near Locate, Mont.) for *A*, unregulated and *B,* regulated conditions, 1928–2002.

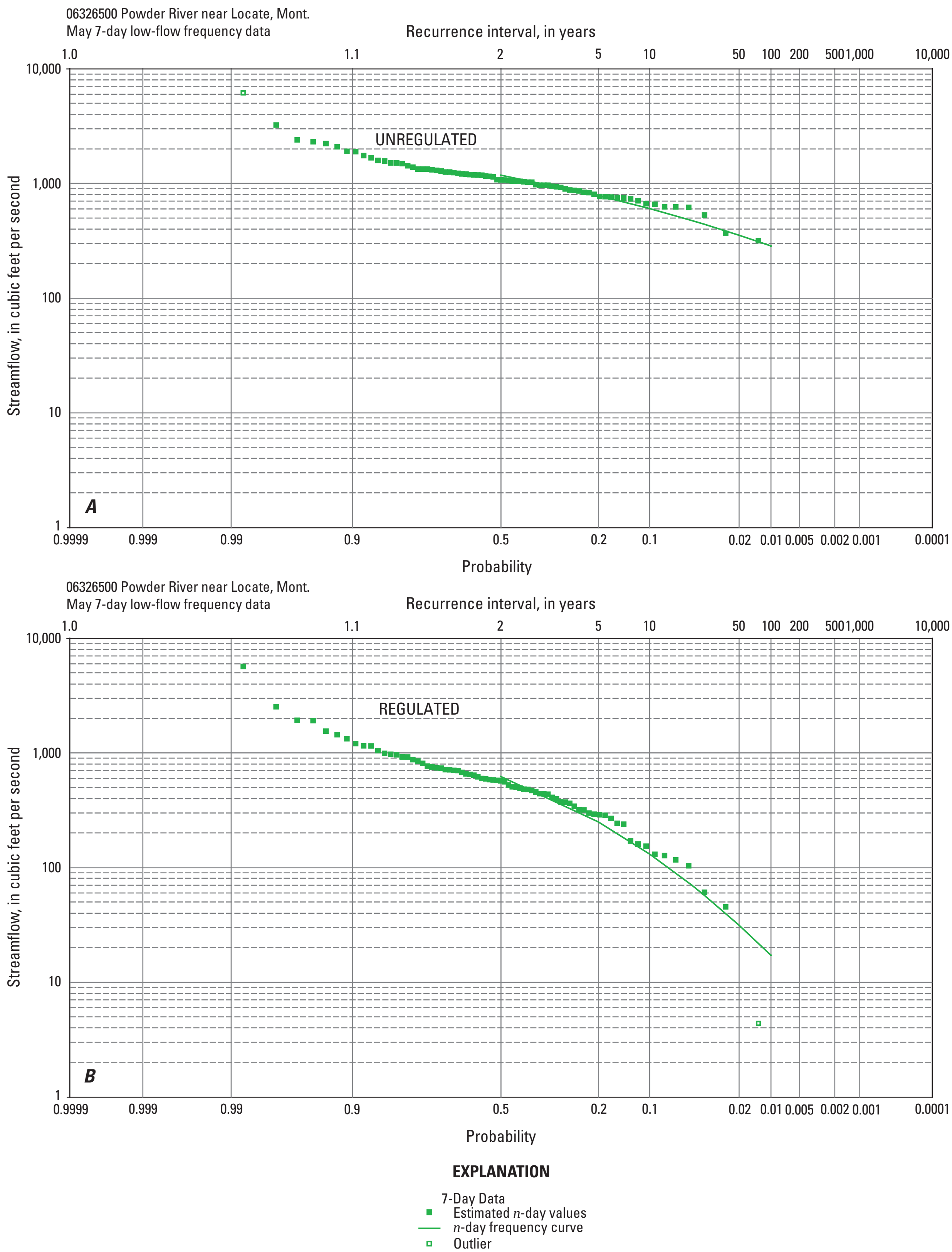


Figure 2-6-13. May 7-day low-flow frequency data for streamflow-gaging station 06326500 (Powder River near Locate, Mont.) for *A*, unregulated and *B*, regulated conditions, 1928–2002.

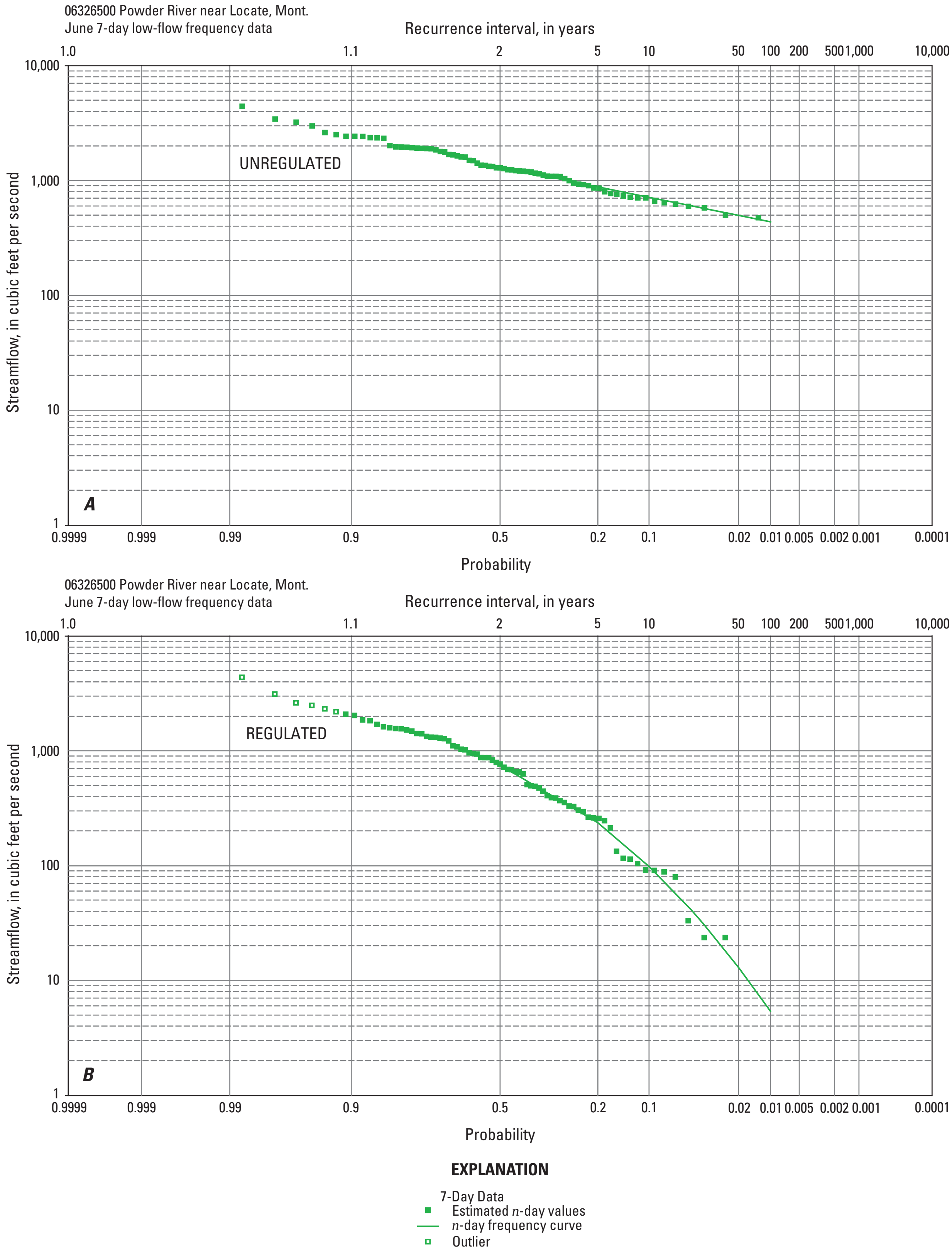


Figure 2-6-14. June 7-day low-flow frequency data for streamflow-gaging station 06326500 (Powder River near Locate, Mont.) for *A*, unregulated and *B,* regulated conditions, 1928–2002.

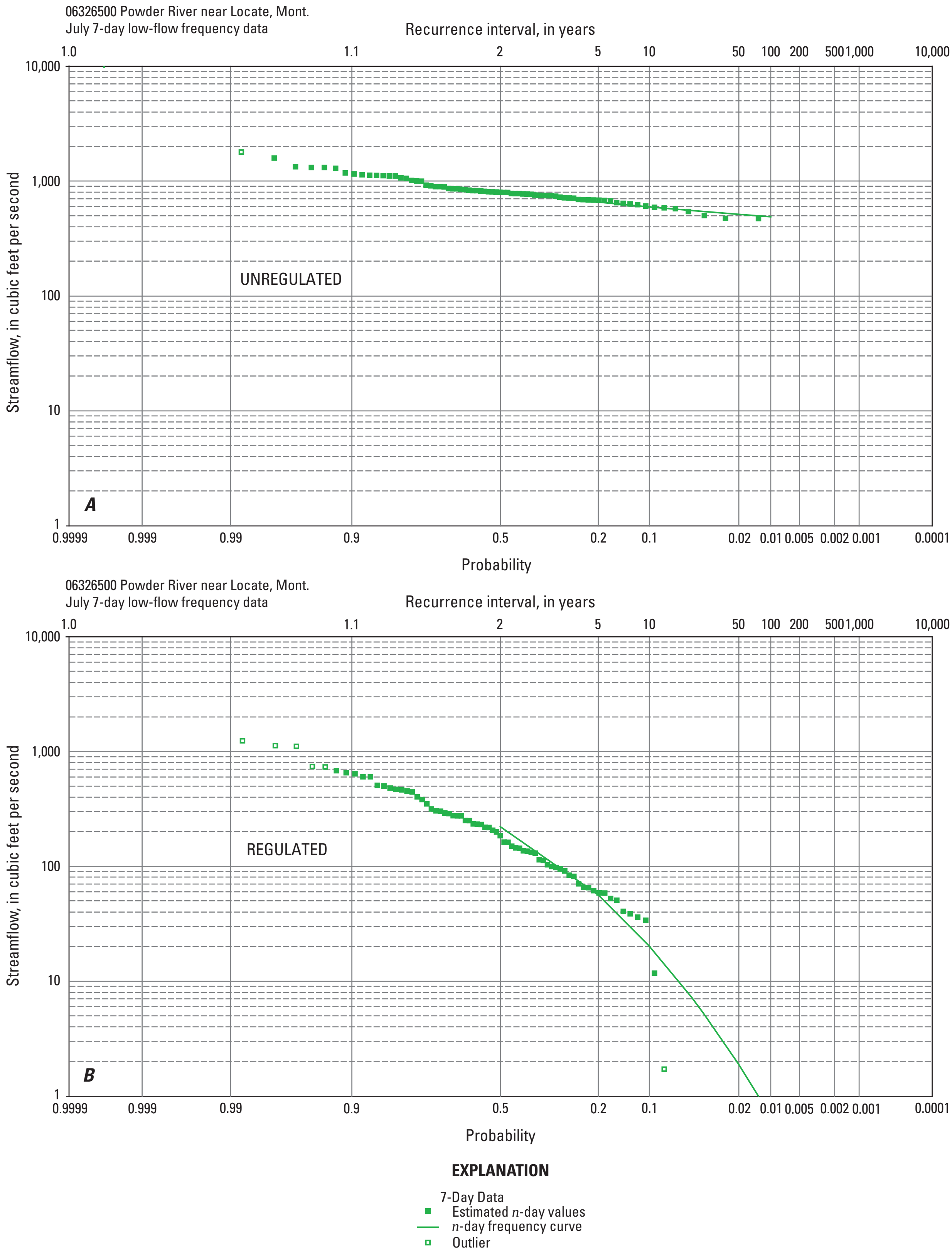


Figure 2-6-15. July 7-day low-flow frequency data for streamflow-gaging station 06326500 (Powder River near Locate, Mont.) for *A*, unregulated and *B,* regulated conditions, 1928–2002.

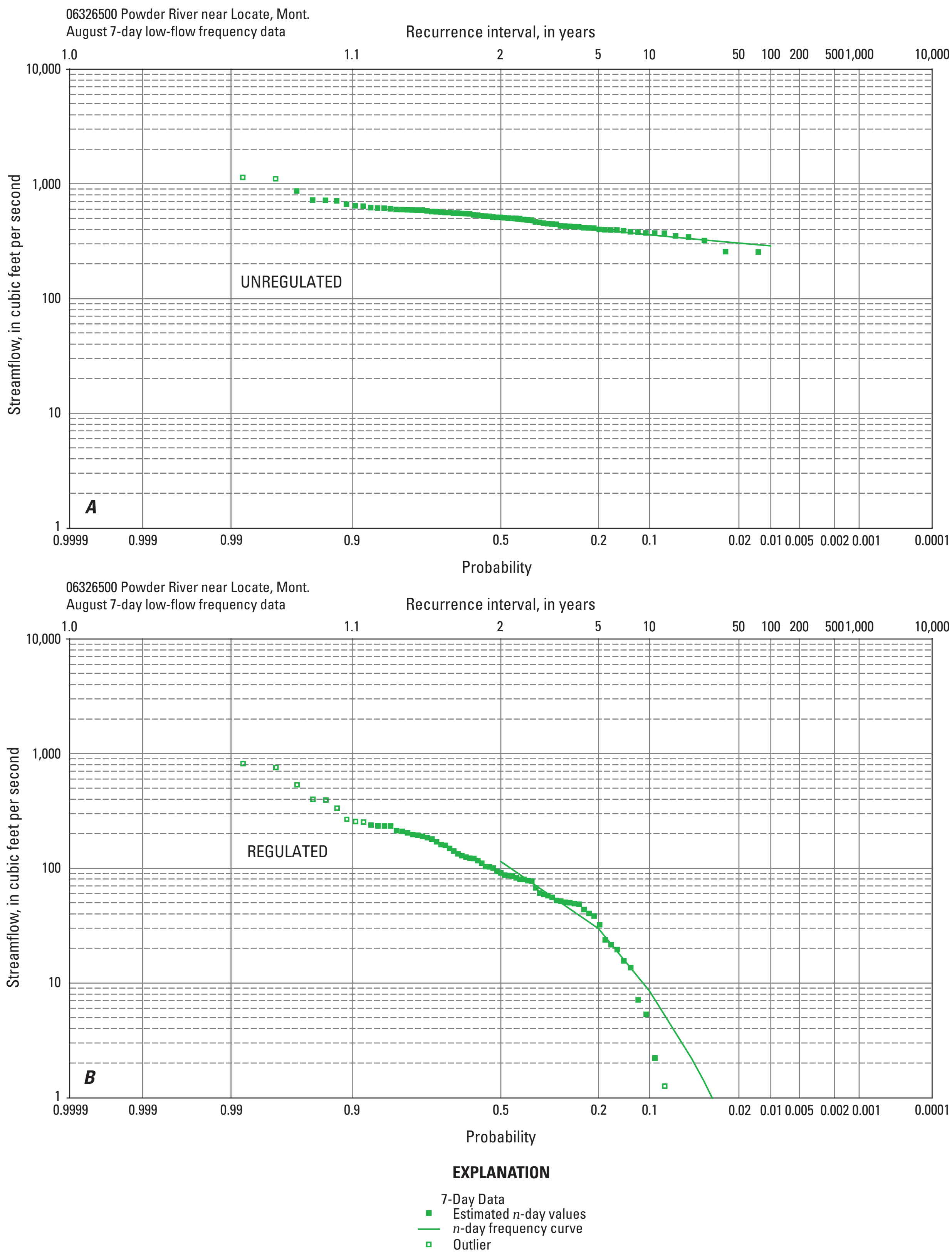


Figure 2-6-16. August 7-day low-flow frequency data for streamflow-gaging station 06326500 (Powder River near Locate, Mont.) for *A*, unregulated and *B*, regulated conditions, 1928–2002.

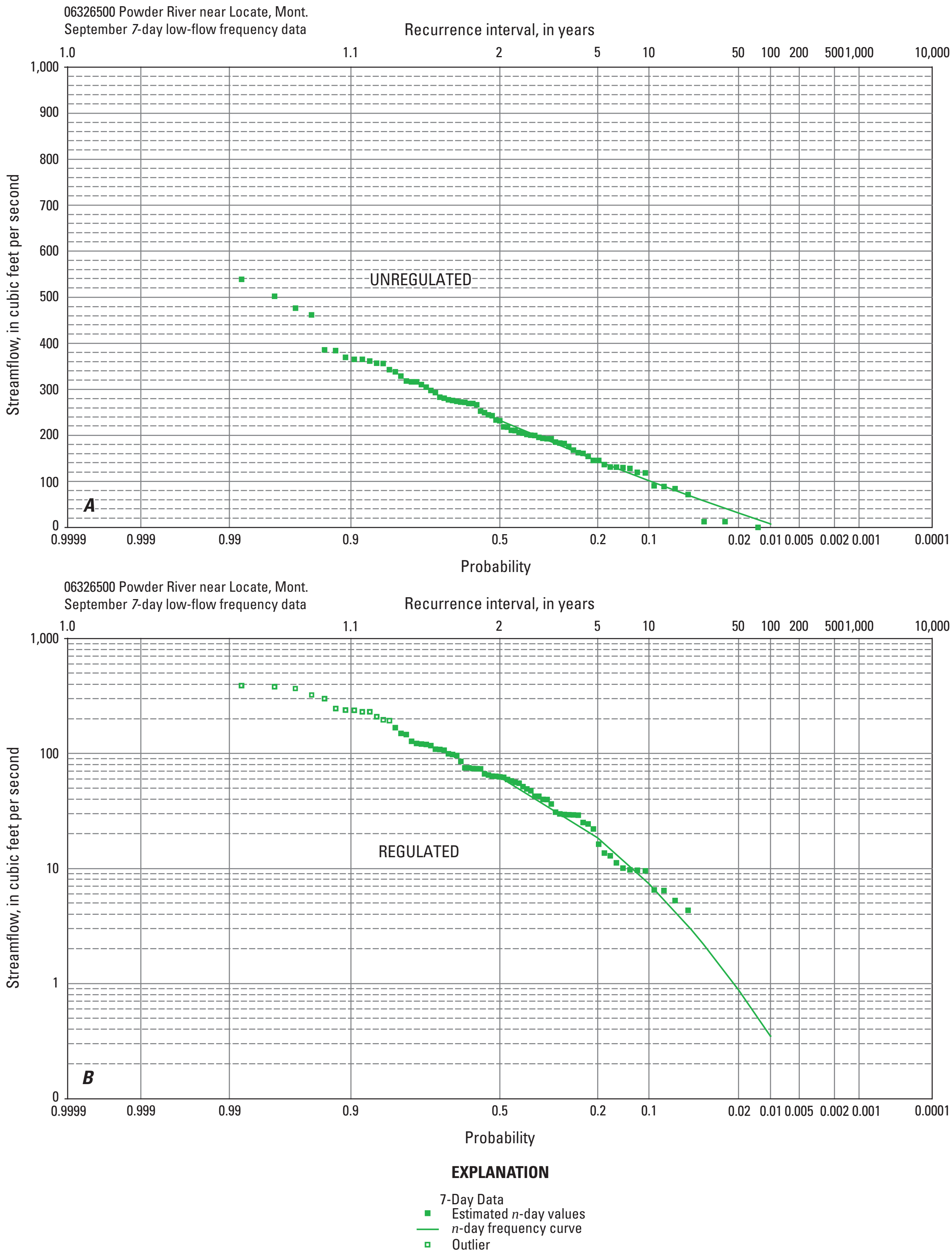


Figure 2-6-17. September 7-day low-flow frequency data for streamflow-gaging station 06326500 (Powder River near Locate, Mont.) for *A*, unregulated and *B,* regulated conditions, 1928–2002.

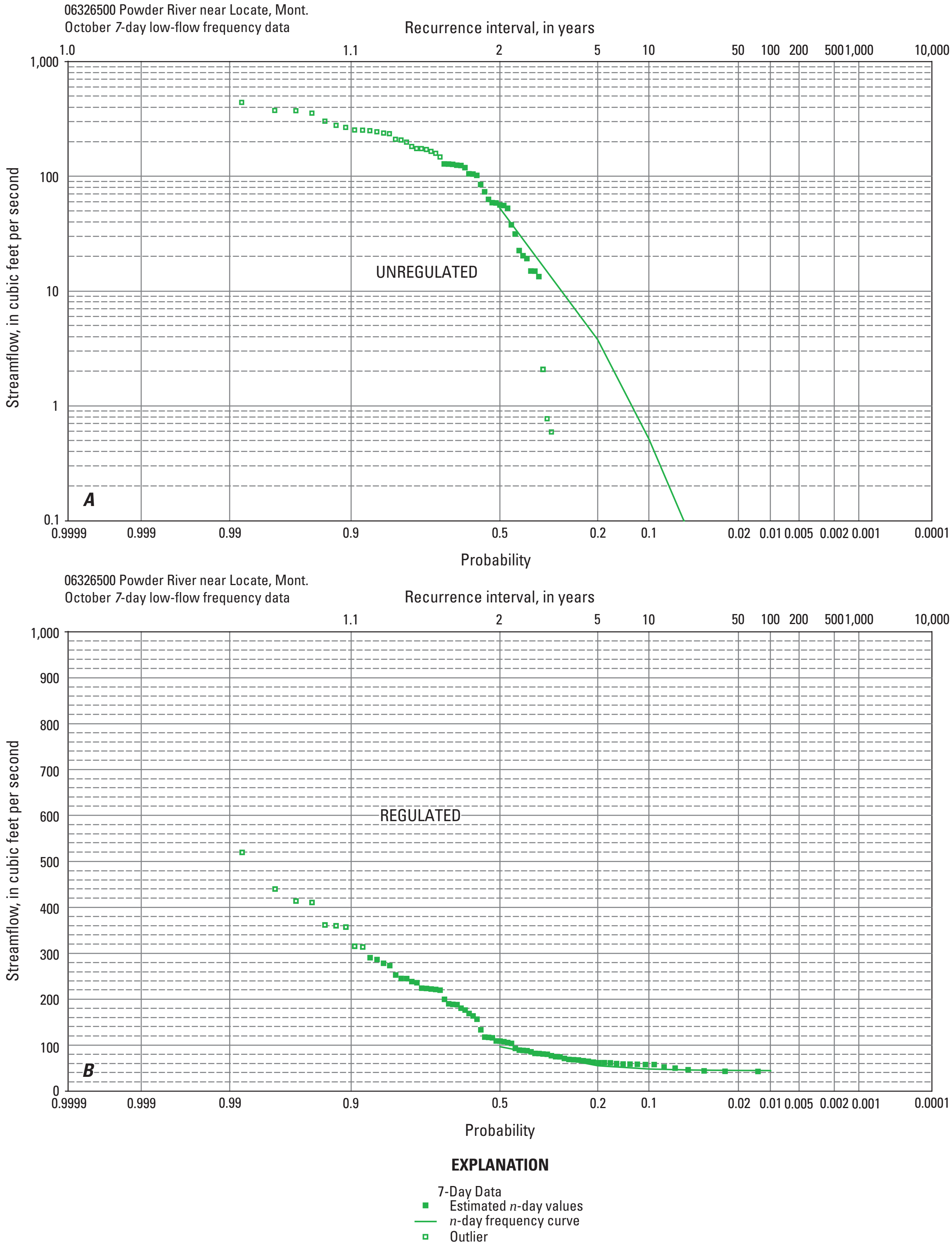


Figure 2-6-18. October 7-day low-flow frequency data for streamflow-gaging station 06326500 (Powder River near Locate, Mont.) for *A*, unregulated and *B,* regulated conditions, 1928–2002.

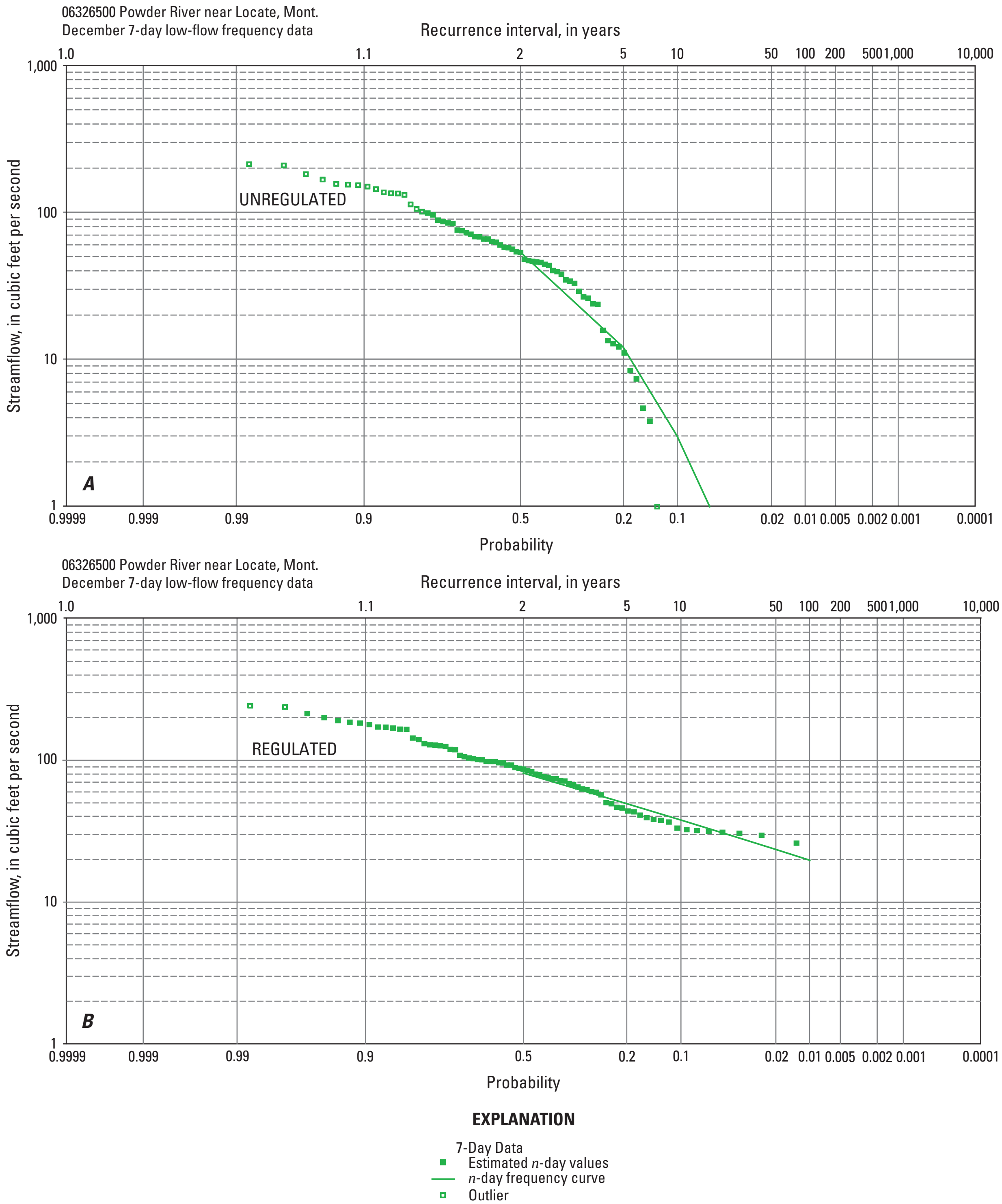


Figure 2-6-19. Novmeber 7-day low-flow frequency data for streamflow-gaging station 06326500 (Powder River near Locate, Mont.) for *A*, unregulated and *B,* regulated conditions, 1928–2002.

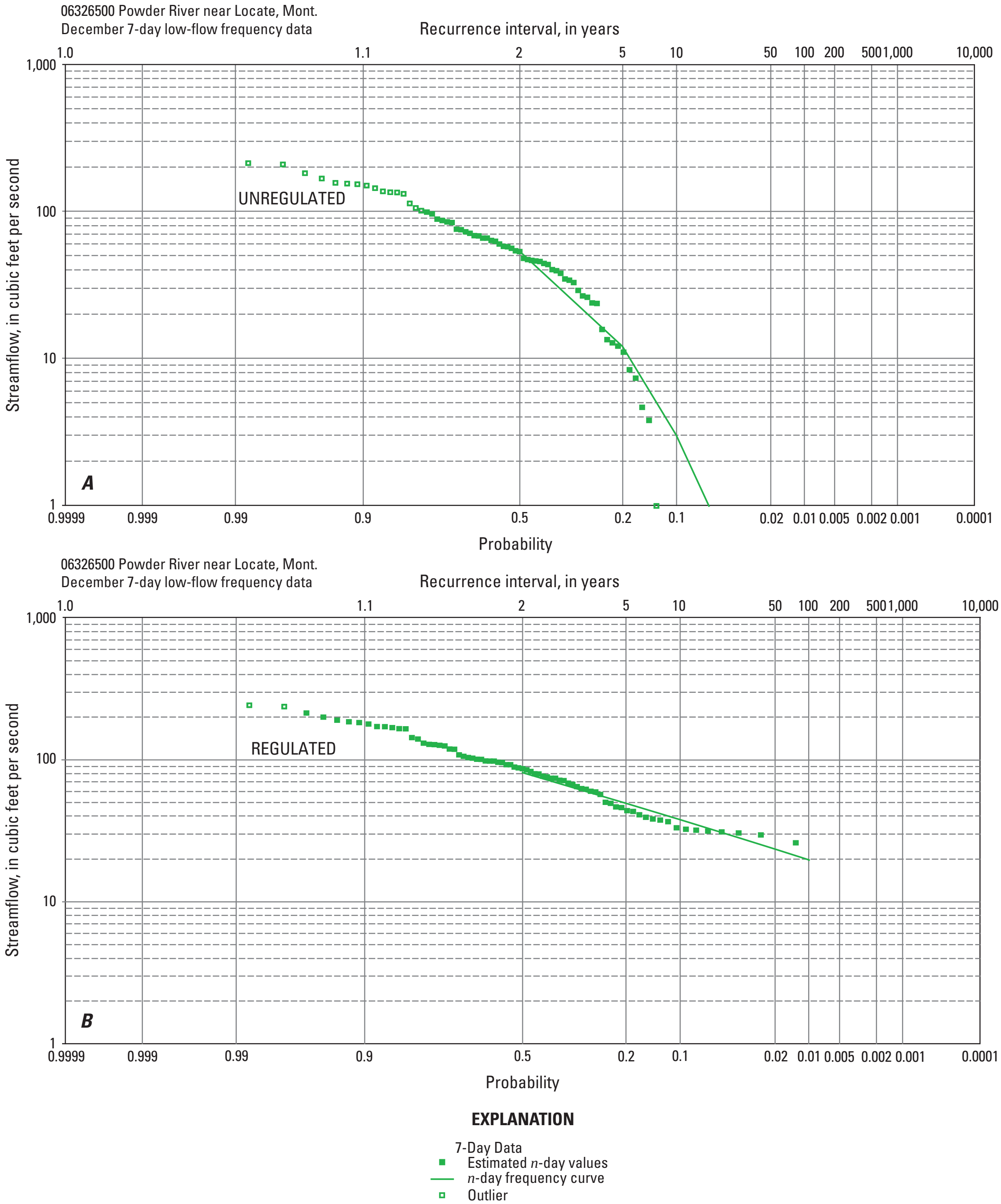
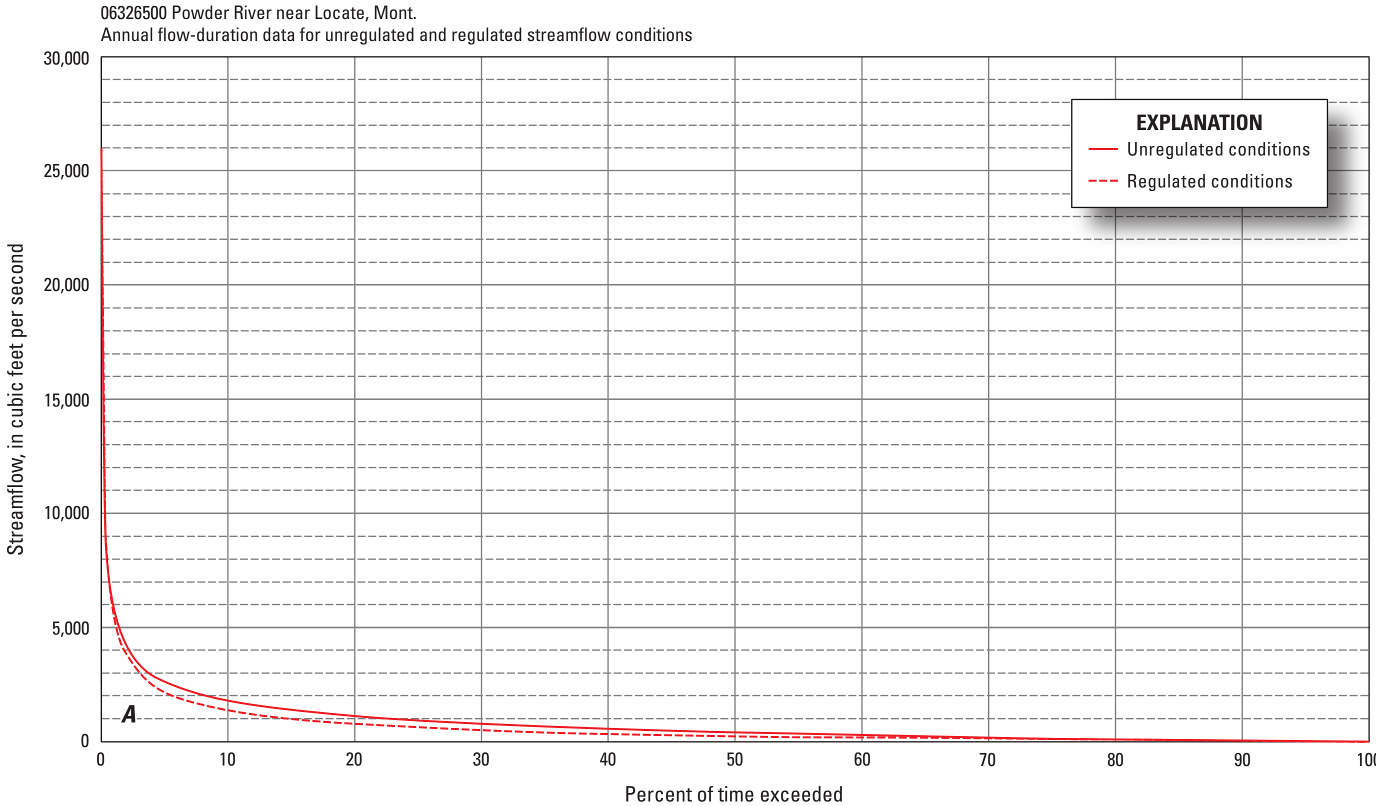


Figure 2-6-20. December 7-day low-flow frequency data for streamflow-gaging station 06326500 (Powder River near Locate, Mont.) for *A*, unregulated and *B,* regulated conditions, 1928–2002.



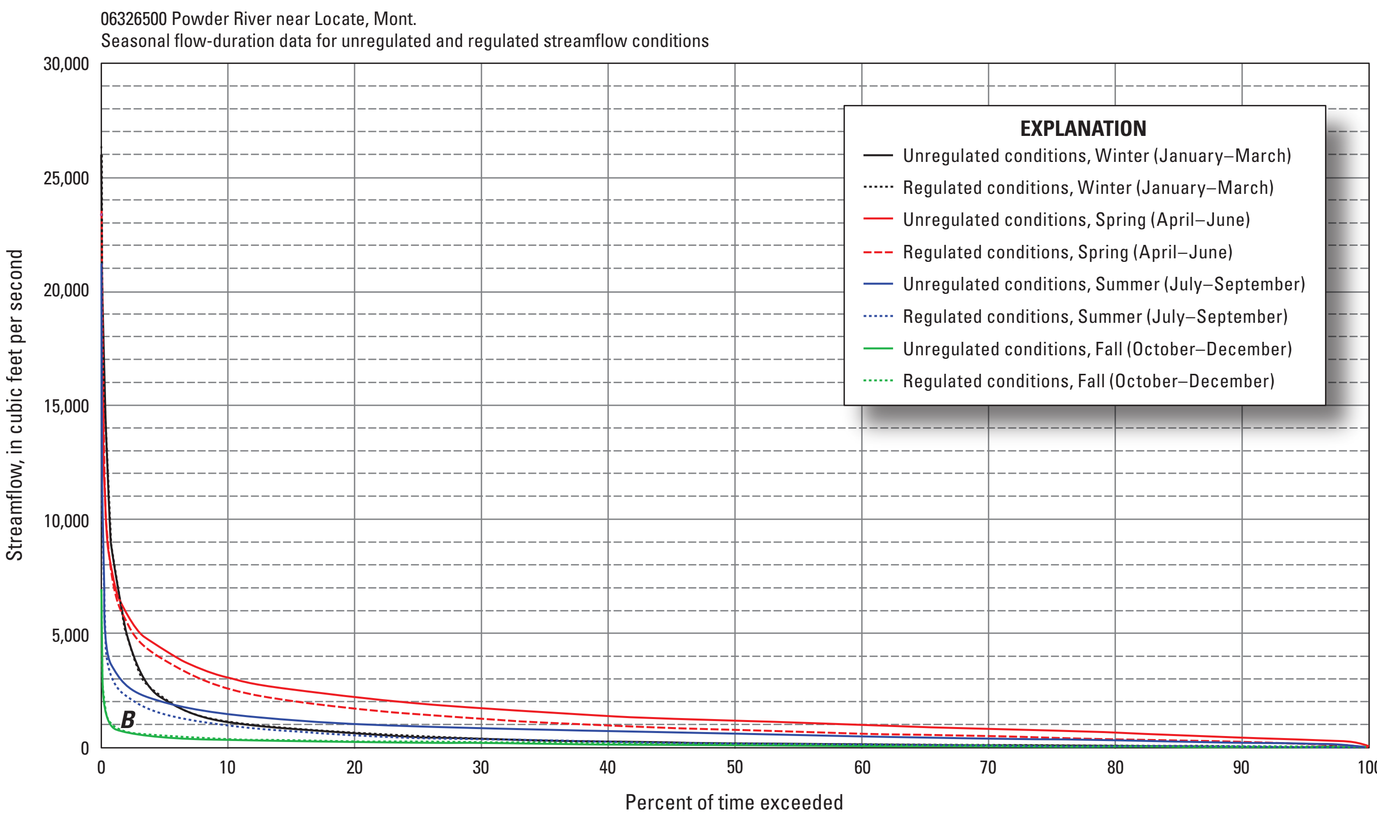


Figure 2-6-21. *A*, Annual and *B*, seasonal flow-duration data for streamflow-gaging station 06326500 (Powder River near Locate, Mont.) for unregulated and regulated conditions, 1928–2002.

Appendix 3. Annual Instantaneous Peak-Flow Data at Selected Locations on the Yellowstone River, Mont., for Unregulated and Regulated Streamflow Conditions, 1928–2002

Appendix 3 contains annual instantaneous peak-flow data at selected streamflow-gaging stations; these data also were interpolated for selected locations on the Yellowstone River, Mont., for unregulated and regulated streamflow conditions. The excel file is named *sir2013-5173_APP_3_peakflow.xlsx.* Locations of the sites are shown on figures 2 and 5 (main report).

Appendix 4. Annual *n*-day High-Flow Frequency Data at Selected Locations on the Yellowstone River, Mont., for Unregulated and Regulated Streamflow Conditions, 1928–2002

Appendix 4 contains annual *n*-day high-flow frequency data at selected streamflow-gaging stations; these data also were interpolated for selected locations on the Yellowstone River, for unregulated and regulated streamflow conditions. The excel file is named *sir2013-5173_APP_4_highflowfreq.xlsx*. Locations of the sites are shown on figures 2 and 5 (main report).

Appendix 5. Annual *n*-day Low-Flow Frequency Data at Selected Locations on the Yellowstone River, Mont., for Unregulated and Regulated Streamflow Conditions, 1928–2002

Appendix 5 contains annual *n*-day low-flow frequency data at selected streamflow-gaging stations; these data also were interpolated for selected locations on the Yellowstone River, Mont., for unregulated and regulated streamflow conditions. The excel file is named *sir2013-5173_APP_5_lowflowfreq.xlsx*. Locations of the sites are shown on figures 2 and 5 (main report).

Appendix 6. Annual and Seasonal Flow-Duration Data at Selected Locations on the Yellowstone River, Mont., for Unregulated and Regulated Streamflow Conditions, 1928–2002

Appendix 6 contains annual and seasonal flow-duration data at selected streamflow-gaging stations; these data also were interpolated for selected locations on the Yellowstone River, Mont., for unregulated and regulated streamflow conditions, 1928–2002. The excel file is named *sir2013-5173_APP_6_Flowduration.xlsx*. Locations of the sites are shown on figures 2 and 5 (main report).

Chase—**Streamflow Statistics for Selected Locations on the Yellowstone, Tongue and Powder Rivers, Montana**—Scientific Investigations Report 2013–5173

ISSN 2328-0328 (online)
http://dx.doi.org/10.3133/sir20135173