UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

LOW-FLOW CHARACTERISTICS OF EAU CLAIRE RIVER BASIN NEAR ANTIGO, WISCONSIN

Open-File Report 75-336

Prepared in cooperation with the

Wisconsin Department of Natural Resources

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CONTENTS

ILLUSTRATIONS

TABLES

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ABSTRACT

This report presents low-flow characteristics at six sites on streams in the Eau Claire River basin near Antigo, Wis., where applications for irrigation permits were made. The low-flow characteristics presented are the annual minimum 7-day mean flows at the 2-year recurrence interval and 10-year recurrence interval.

A seepage run made October 10, 1974, showed a substantial gain in discharge from site 2 (3.75 ft^3/s [cubic feet per second] or 0.11 m^3/s [cubic metres per second]) to site 6 (30.6 ft^3/s or 0.87 m^3/s) on the East Branch Eau Claire River and from site 12 (3.98 ft^3/s or 0.11 m^3/s) to site 16 (18.1 ft^3/s or 0.51 m^3/s) on the West Branch Eau Claire River; a fairly constant discharge between sites 6 (30.6 ft^3/s or 0.87 m^3/s) and 11 (32.3 ft^3/s or 0.91 m^3/s) on the East Branch and sites 16 (18.1 ft^3/s or 0.51 m^3/s) and 20 (18.8 ft^3/s or 0.53 m^3/s) on the West Branch; and a substantial gain in discharge from site 23 (57.3 ft^3/s or 1.62 m^3/s) to site 24 (63.4 ft^3/s or 1.80 m^3/s) on the Eau Claire River.

A gaging station was established at the downstream potential irrigation site to collect continuous stage and discharge data on streamflow to assist the Wisconsin Department of Natural Resources in the regulation of irrigation withdrawals.

INTRODUCTION

This report presents low-flow characteristics at six sites on streams in the Eau Claire River basin near Antigo, Wis., where applications for irrigation permits were made. The study was done in cooperation with the Wisconsin Department of Natural Resources. The low-flow information will be used by the Wisconsin Department of Natural Resources to determine the availability of water for irrigation withdrawals from the stream and to maintain sufficient streamflow to support fishlife in streams in the basin.

The study area is located in the western part of an outwash plain, known as the "Antigo flats", which has a history of water withdrawals for crop irrigation (Harder and Drescher, 1954). Presently, there are five irrigators who are authorized to pump a maximum of 8.4 ft^3/s (0.24 m^3/s) from the Eau Claire River upstream from County Trunk Y (pl. 1). There are also several irrigators pumping ground-water supplies in and adjacent to the study area. The relationship between ground water and surface water in the Antigo flats area is similar to other outwash plains, where pumping during the growing season may lower stream stage and reduce streamflow (Weeks and others, 1955).

For use of readers who may prefer to use metric units rather than English units, the conversion factors for the terms used in this report are listed below:

Multiply English unit	By	To obtain metric unit
miles (mi)	1.609	kilometres (km)
square miles (mi^2)	2.590	square kilometres (km^2)
cubic feet per second (ft^3/s)	2.832×10^{-2}	cubic metres per second (m^3/s)
cubic feet per second per square mile $[(ft^3/s)/mi^2]$	1.093×10^{-2}	cubic metres per second per square kilometre $[(m^3/s)/km^2]$

DATA AVAILABLE

Four discharge measurements were made at each of the six potential irrigation-withdrawal sites during 1974. On October 10, 1974, discharge measurements at base-flow conditions were obtained at these 6 sites and at 20 additional sites in the study area to determine gains and losses in stream reaches within the basin (pl. 1). These discharge measurements are listed in table 1. Also included is a column listing unit runoff, the discharge per square mile, for the October 10, 1974, seepage run.

Gaging-station records are available on Eau Claire River near Antigo (1949-55), site 8, and on Eau Claire River at Kelly (since 1939).

Figure 1 is a hydrograph for the Eau Claire River at Kelly gaging

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Figure 1 (caption next page) near here.

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station, located 27.7 mi (44.6 km) downstream from site 26, with a drainage area of 326 mi^2 (844 km^2), and a bar graph of precipitation recorded at the National Weather Service station at Antigo (U.S. Dept. of Commerce, Environmental Data Service, 1974). The hydrograph and precipitation graph indicate that discharge measurements made September 17, 1974, may have been affected by precipitation. However, the overland runoff in a sand-and-gravel outwash plain is generally minor, and the increase in discharge may be related to increased groundwater discharge. Therefore, measurements made September 17, 1974, probably indicate high base-flow conditions for the basin. The other measurements were made during low to medium base-flow conditions.

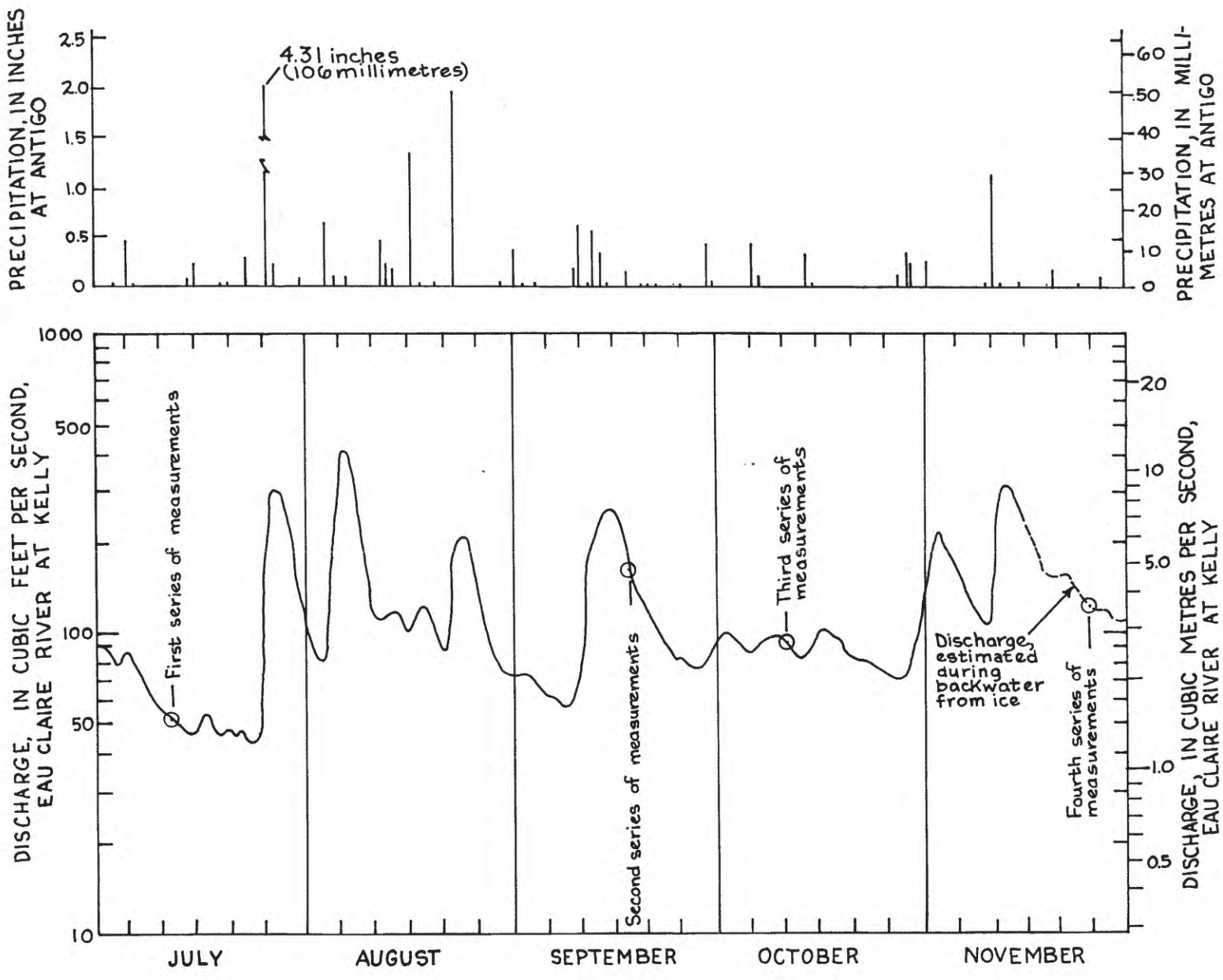

Figure 1.-- Discharge and precipitation recorded during 1974.

Table 1.--Streamflow measurements in the Eau Claire River basin

Stream name	Site number	Drainage area (mi^2)	Date	Discharge (ft^3/s)	Discharge (ft^3/s)/mi^2
E. Br. Eau Claire River	1	15.0	Oct. 10, 1974	4.08	0.27
Do	2	38.7	Oct. 10, 1974	3.75	0.10
Do	3	58.5	Oct. 10, 1974	16.3	0.28
Do	4	60.6	Oct. 10, 1974	18.6	0.31
Do	5	63.0	July 11, 1974	19.6	
			Sept. 17, 1974	28.6	
			Oct. 10, 1974	22.0	0.35
			Nov. 25, 1974	19.1	
Do	6	66.4	Oct. 10, 1974	30.6	0.46
Do	7	77.7	July 11, 1974	27.5	
			Sept. 17, 1974	37.2	
			Oct. 10, 1974	29.9	0.38
			Nov. 25, 1974	26.2	
Do	8	79.4	July 9, 1974	27.4	
			July 11, 1974	26.3	
			Sept. 17, 1974	42.8	
			Oct. 10, 1974	33.1	0.42
			Nov. 25, 1974	31.3	
			Feb. 10, 1975	26.5	
Do	9	80.2	Oct. 10, 1974	32.0	0.40
Do	10	85.4	July 11, 1974	29.3	
			Sept. 17, 1974	47.3	
			Oct. 10, 1974	33.5	0.39
Do	11	86.4	Oct. 10, 1974	32.3	0.37

Table 1.--Streamflow measurements in the Eau Claire River basin--continued

Stream name	Site number	Drainage area (mi^2)	Date	Discharge (ft^3/s)	Discharge (ft^3/s)/mi^2
W. Br. Eau Claire River	12	17.4	Oct. 10, 1974	3.98	0.23
Sucker Creek	13	7.11	Oct. 10, 1974	1.23	0.17
W. Br. Eau Claire River	14	35.0	Oct. 10, 1974	9.04	0.25
Do	15	51.1	Oct. 10, 1974	15.3	0.30
Do	16	52.2	Oct. 10, 1974	18.1	0.35
Do	17	54.4	Oct. 10, 1974	17.6	0.32
Do	18	55.7	Oct. 10, 1974	18.8	0.33
Do	19	53.0	Oct. 10, 1974	17.4	0.30
Do	20	59.2	Oct. 10, 1974	18.8	0.32
Black Brook	21	11.3	Sept. 17, 1974	0	
			Oct. 10, 1974	1.22	0.11
W. Br. Eau Claire River	22	89.9	July 11, 1974	10.8	
			Sept. 17, 1974	58.6	
			Oct. 10, 1974	24.9	0.28
			Nov. 25, 1974	42.6	
Eau Claire River	23	177	July 11, 1974	37.4	
			Sept. 17, 1974	102	
			Oct. 10, 1974	57.3	0.32
			Nov. 25, 1974	74.9	
Do	24	183	July 9, 1974	44.0	
			July 11, 1974	42.8	
			Sept. 17, 1974	101	
			Oct. 10, 1974	63.4	0.35
			Nov. 25, 1974	85.3	
			Feb. 10, 1975	52.4	

Table 1.--Streamflow measurements in the Eau Claire River basin--continued

Stream name	Site number	Drainage area (mi^2)	Date	Discharge (ft^3/s)	Discharge (ft^3/s)/mi^2
Eau Claire River tributary	25	14.4	Oct. 10, 1974	1.70	0.12
Eau Claire River	26	213	Oct. 10, 1974	67.5	0.32

The discharge at the Eau Claire River at Kelly gaging station, during the seepage run of October 10, 1974, was at the 64 percent duration. This is typical of medium base-flow conditions for the basin.

The East Branch Eau Claire River has higher unit discharge than the West Branch during base-flow conditions. Site 11 on the East Branch had a unit discharge of 0.37 $(ft^3/s)/mi^2$ or 0.004 $(m^3/s)/km^2$ and site 22 on the West Branch had a unit discharge of 0.28 $(ft^3/s)/mi^2$ or 0.003 $(m^3/s)/km^2$. This difference is attributed to the decreased thickness of the sand-and-gravel deposits from east to west, and to the higher permeability of soils in the contributing area to the East Branch (Devaul and Green, 1971).

The upper parts of both branches were significantly gaining reaches. The discharge increased from 3.75 ft^3/s (0.11 m^3/s) at site 2 to 30.6 ft^3/s (0.87 m^3/s) at site 6 on the East Branch and from 3.98 ft^3/s (0.11 m^3/s) at site 12 to 18.1 ft^3/s (0.51 m^3/s) at site 16 on the West Branch. The contributing drainage area for the upper reaches is mainly permeable sand and gravel.

The slight change in discharge between sites 6 and 11 on the East Branch is caused by the reduced volume of water available for base flow from ground-water storage. A potentiometric map (Drescher, 1954, pl. 1) shows a significant narrowing of the basin and a reduction of ground-water contribution to the stream for these reaches. Also, part of the surficial glacial aquifer, the primary source of base flow in this area, consists of relatively impermeable silty and clayey till (Devaul and Green, 1971).

The change in discharge on the West Branch between sites 16 and 20 also is slight. Hydrologic conditions of this reach are similar to those explained above.

The lower reach of the stream, from site number 23 to 24, showed a substantial gain in discharge. This reach received ground-water discharge from permeable sand-and-gravel outwash deposits to the east-northeast.

LOW-FLOW CHARACTERISTICS

The low-flow characteristics determined at the six potential irrigation-withdrawal sites are the annual minimum 7-day mean flows at the 2-year recurrence interval ($Q_{7,2}$) and 10-year recurrence interval ($Q_{7,10}$). The characteristics were based on a graphical regression relating three to five discharge measurements at each site to the concurrent discharges at the gaging station near Antigo (site 8, in the study area). Figure 2 is an example of the graphical regression

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Figure 2 (caption next page) near here.

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for site 24.

The $Q_{7,2}$ and $Q_{7,10}$ at the gaging station near Antigo (site 8) were obtained from a low-flow frequency curve at this site. The annual low-flow record near Antigo was extended on the basis of the record at the Kelly station before defining the low-flow frequency curve. The $Q_{7,2}$ and $Q_{7,10}$ at the station near Antigo (site 8) were transferred through the relations such as figure 2 to estimate the $Q_{7,2}$ and $Q_{7,10}$ at the six potential irrigation sites. Results are given in table 2.

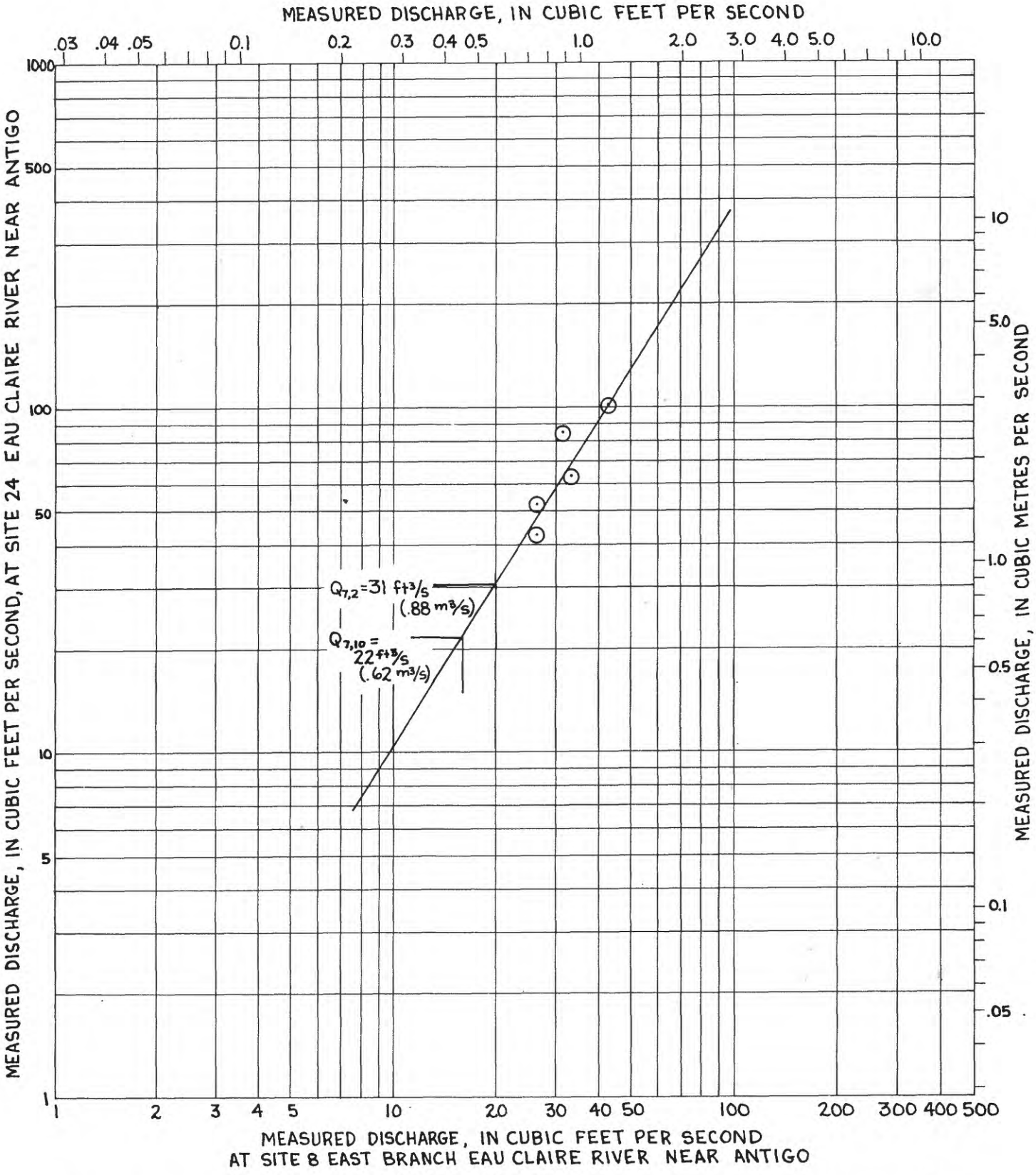

Figure 2.--Relationship used to estimate low-flow characteristics of potential irrigation sites.

Table 2.--Low-flow characteristics in the Eau Claire River basin

Stream name	Site number	Drainage area (mi^2)	Low-flow characteristics $Q_{7,2}$ (ft^3/s)	$Q_{7,10}$ (ft^3/s)
E. Br. Eau Claire River	5	63.0	15	12
Do	7	77.7	19	15
Do	8	79.4	20	16
Do	10	85.4	22	18
W. Br. Eau Claire River	22	89.9	4.0	1.9
Eau Claire River	23	177	27	20
Do	24	183	31	22

DATA COLLECTION FOR STREAM MANAGEMENT

A gaging station was established at site 24 on November 1, 1974, to collect continuous stage and discharge data on streamflow to assist the Wisconsin Department of Natural Resources in the regulation of irrigation withdrawals. Daily management decisions concerning irrigation withdrawals would benefit by the addition of a telemark remote registering system to the gaging station. This would allow immediate determiniation of the stream stage by telephone and conversion to discharge by an established rating curve.

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