HYDROLOGY OF PINE CREEK, WISCONSIN

By

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OPEN-FILE REPORT

U.S. GEOLOGICAL SURVEY

Madison, Wisconsin

Prepared in Cooperation with

The Wisconsin Department of Natural Resources

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The purpose of this study was to determine the hydrologic characteristics of Pine Creek, Price County, Wisconsin, in order to evaluate a proposed reservoir on Pine Creek. The streamflow characteristics estimated are the mean flows, low flows, and flood peaks. The study was done by the U.S. Geological Survey in cooperation with the Wisconsin Department of Natural Resources.

To collect streamflow information for this study, a continuous-record gaging station was installed on Pine Creek near Oxbo, at County Trunk Highway EE, Sawyer County (figure 1), in October 1970. Before October the site was a partial-record station, where low-flow discharge measurements had been made periodically since August 1967. The drainage area at the gaging station is 37.8 square miles while the drainage area at the proposed reservoir site is 36.1 square miles. Streamflow characteristics at the proposed reservoir site are expected to be similar to those determined for the gaging station because the drainage areas are approximately the same.

Mean Flows

The monthly mean streamflow ranged from 19 cfs (cubic feet per second) in September to 178 cfs in April; the average discharge for the year was 45 cfs. The monthly mean streamflow and the recorded and estimated daily discharges at the Pine Creek gaging station for water year 1971 are shown in table 1. A maximum instantaneous discharge of 590 cfs was recorded on April 12, while the maximum daily was 565 cfs on April 13. The minimum recorded discharge was 17 cfs on August 17, but a lower daily discharge of 16 cfs was estimated for September 19-22.

Mean flows on Pine Creek for a period longer than 1 year were estimated from a relationship between the monthly mean discharges recorded at the Pine Creek and the South Fork Flambeau River near Phillips gaging stations. Monthly mean discharges for the 10-year period 1962-1971 are shown in table 2.

Low Flow

The low-flow characteristics determined in this study are the annual minimum 7-day mean flow that occurs on the average of once in 2 years ($Q_{7,2}$), and the annual minimum 7-day mean flow that occurs on the average of once in 10 years ($Q_{7,10}$). The values determined for Pine Creek are 14 cfs for the $Q_{7,2}$ and 10 cfs for the $Q_{7,10}$. These low-flow values are based on a relationship between measured and recorded discharge at the Pine Creek gaging station and recorded discharges at the South Fork Flambeau River gaging station near Phillips.

A seepage run was made on October 12, 1971, during a period of low flow, to identify reaches of inflow or outflow on Pine Creek near the damsite. The seepage run did not identify any reach in the area of the damsite to have an exceptionally large gain or loss. It appears that the reach between sites 2 and 3 is a losing reach, but this might be due to poor measuring conditions at those sites.

There was no large gain in streamflow between sites 5, 6 and 7. This fact might be an indication that large seepage losses will not occur from the proposed reservoirs. To determine the seepage losses from the reservoir, test holes should be drilled in the valley floor and in the ridge east of the damsite. The drill holes would provide information about the elevation of the water table and the hydraulic conductivity of the glacial deposits at those sites. This information along with the streamflow measurements could be used to determine if a serious seepage problem from the reservoir did exist.

Measurement sites are shown on figure 1 with the discharge and water temperature measured at each site shown in table 3.

Flood Peaks

Estimated flood peaks of Pine Creek should aid in selecting or evaluating the inflow design flood for the proposed dam.

100-year flood.--The estimated 100-year flood peak at the damsite is 2,500 cfs under natural conditions (this excludes the effect of the reservoir on the flood peak). The 100-year flood peak was estimated by plotting computed floods for the 2-, 5-, 10-, and 50-year recurrence intervals (Conger, 1971) on an extreme log plot. The defined relationship then was extended to the 100-year recurrence interval. This method was used because data are insufficient to define an equation for the 100-year flood peak on streams with drainage areas less than 50 square miles.

100-year flood peaks for gaging stations in northern Wisconsin.--The 100-year flood peaks at gaging stations in the general area of Pine Creek have been estimated by extending the computed frequency curves at the stations. These peaks with their corresponding drainage areas are plotted on figure 2. An envelope curve was drawn based on the plotted points. The estimated 100-year flood for Pine Creek (2,500 cfs) plots below the envelope curve and agrees with plotted points from nearby gaging stations.

Probable maximum flood.--The probable maximum flood (PMF) is defined by Chow (1964, p. 25-26) as the most severe flood considered reasonably possible in a region. It is commonly used as the design flood for a dam when failure of the dam could lead to great damage or loss of life. Procedures for computations as described by the U.S. Bureau of Reclamation (1960, p. 23) were used to compute the PMF for Pine Creek at the damsite.

Based on data in U.S. Weather Bureau Technical Paper 40 (1961, p. 107), the probable maximum precipitation of 23 inches in 6 hours would cause the PMF in the Pine Creek area. Rainfall was arranged in critical increments to produce the largest peak and was distributed into hourly values not to exceed those indicated by the regional depth-duration curves (U.S. Bureau of Reclamation, 1960, p. 32, fig. 4). An infiltration rate of 0.63 inch per hour, obtained from soil properties listed by the U.S. Soil Conservation Service (1969), was subtracted from the hourly increments.

The PMF at the damsite of the proposed reservoir had a peak of 30,000 cfs and a 48-hour volume of 31,800 acre-feet (figure 3). This flood is an inflow flood to the reservoir and includes the effect the reservoir has on the flood peaks. These values were computed by the unit-hydrograph method of analysis. The unit hydrograph (figure 4) was developed from a dimensionless graph, which was determined from a recorded flood at the gaging station on Pine Creek near Oxbo.

Filling of Reservoir

About 7 months is the estimated time necessary to fill the proposed 12,070 acre-foot capacity reservoir. This filling time does not include seepage losses under the dam or through abutments. The filling time was estimated from the average monthly discharge for the 1962-1971 period and assumed the reservoir is empty at the start of October. A required minimum release from the reservoir of 25 percent of the natural low flow (3.5 cfs) was used in the computation, with an average annual evaporation loss of 27 inches (3,200 acre-feet).

References

Chow, V. T., 1964, Handbook of applied hydrology: New York, McGraw-Hill Book Co., Inc., sec. 25-IV, p. 25-32.

Conger, D. H., 1971, Estimating magnitude and frequency of floods in Wisconsin: U.S. Geological Survey open-file report, 200 p.

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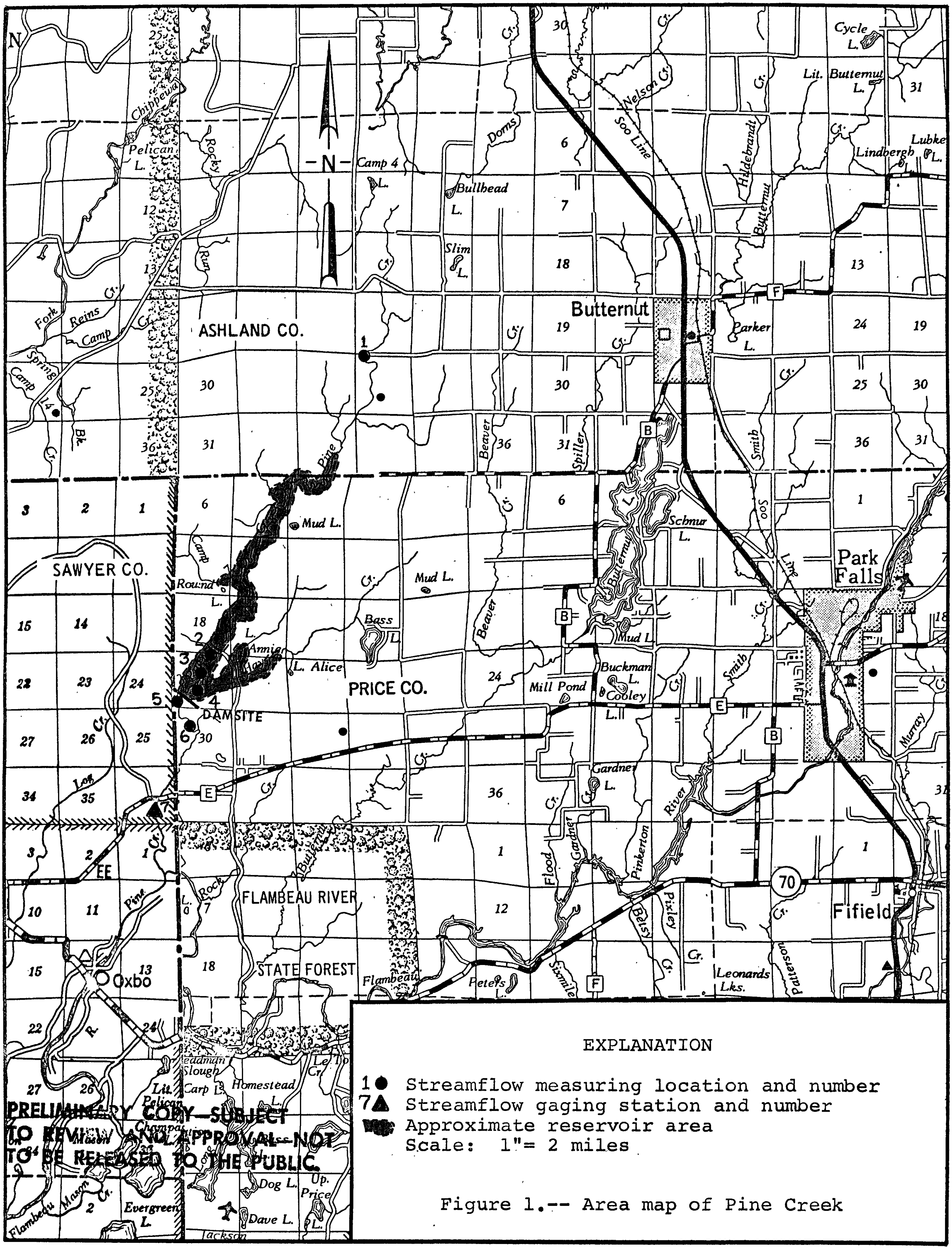
U.S. Soil Conservation Service, 1969, Wisconsin soils, their properties and uses: U.S. Dept. Agri., interm report, 216 p.

U.S. Weather Bureau, 1961, Rainfall frequency atlas of the United States: U.S. Weather Bur. Tech. Rept. 40, 115 p.


N
ASHLAND CO.
SAWYER CO.
PRICE CO.
Butternut
Park Falls
Fifield
Oxbo
DAMSITE
FLAMBEAU RIVER
STATE FOREST
Pine Cr.
Butternut L.
Mud L.
Round L.
Annie L.
L. Alice
Bass L.
Schmur L.
Buckman L.
Cooley L.
Mill Pond
Gardner L.
Parker L.
Pelican L.
Bullhead L.
Slim L.
Camp 4 L.
Cycle L.
Lit. Butternut L.
Lindbergh L.
Lubke L.
Peters L.
Leonards Lks.
Soo Line
Nelson Cr.
Doms Cr.
Rocky Run
Chippewa
Reins Cr.
Camp Cr.
Spring Camp Bk.
Fork
Beaver Cr.
Spiller Cr.
Smith Cr.
Hildebrandt Cr.
Butternut Cr.
Murray Cr.
Flood Cr.
Gardner Cr.
Pinkerton Cr.
Betsy Cr.
Pixley Cr.
Patterson Cr.
Sixmile Cr.
Rock Cr.
Log Cr.
Flambeau R.
River
Mason Cr.
Deadman Slough
Carp L.
Homestead L.
Lit. Pelican L.
Dog L.
Dave L.
Evergreen L.
Up. Price L.
Le Tom Cr.
Jackson
1
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4
5
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B
E
EE
F
70

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EXPLANATION

1● Streamflow measuring location and number

7▲ Streamflow gaging station and number

▨ Approximate reservoir area

Scale: 1" = 2 miles

Figure 1.-- Area map of Pine Creek

K+E LOGARITHMIC 46 7522
3 X 5 CYCLES MADE IN U.S.A.
KEUFFEL & ESSER CO.

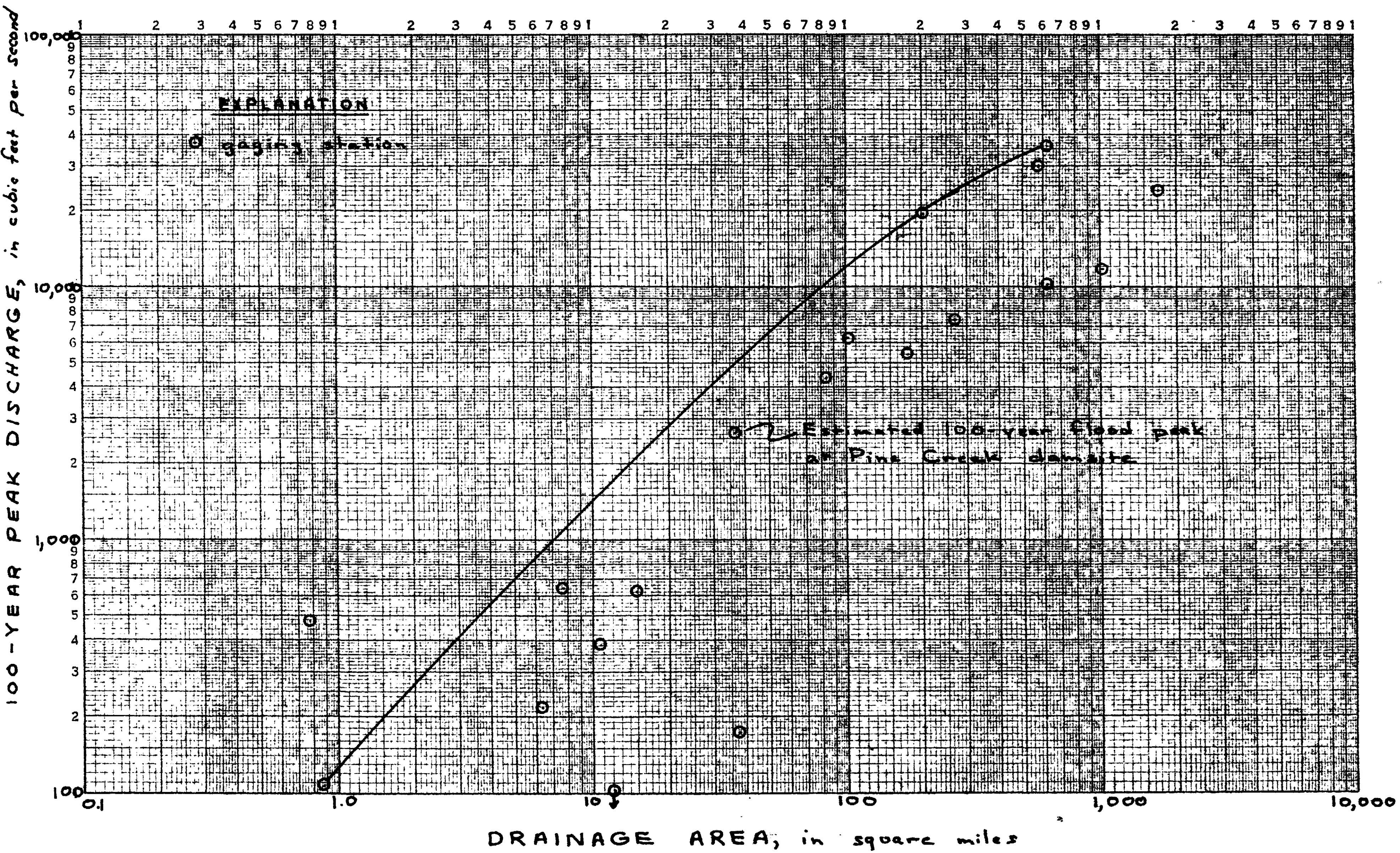

Figure 2 - Envelope curve of 100-year flood peaks for gaging stations in northern Wisconsin.

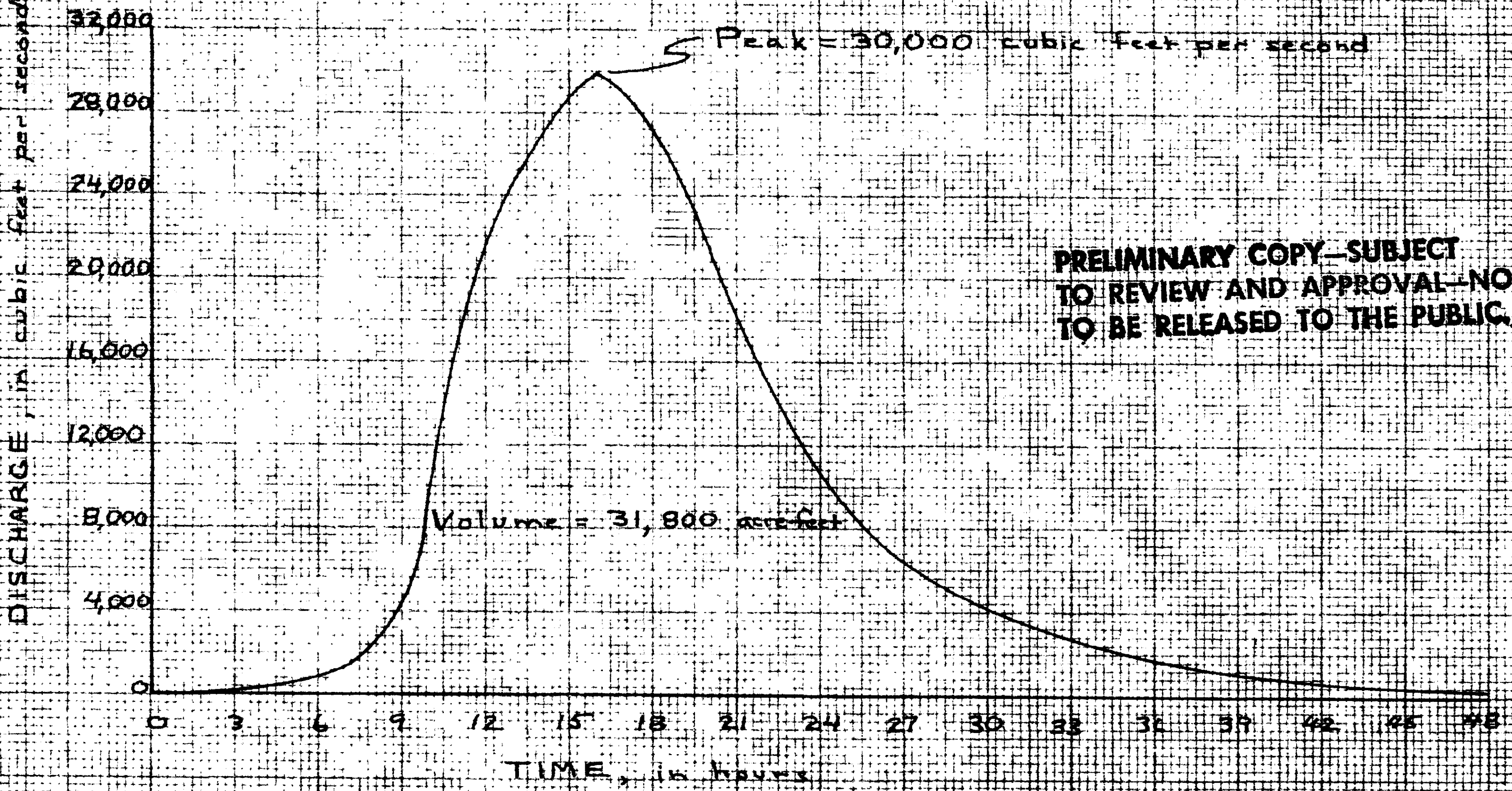

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Figure 3— Probable maximum flood for Pine Creek at damsite.

9-213-E
(March 1949)
Cross-Section

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File ....

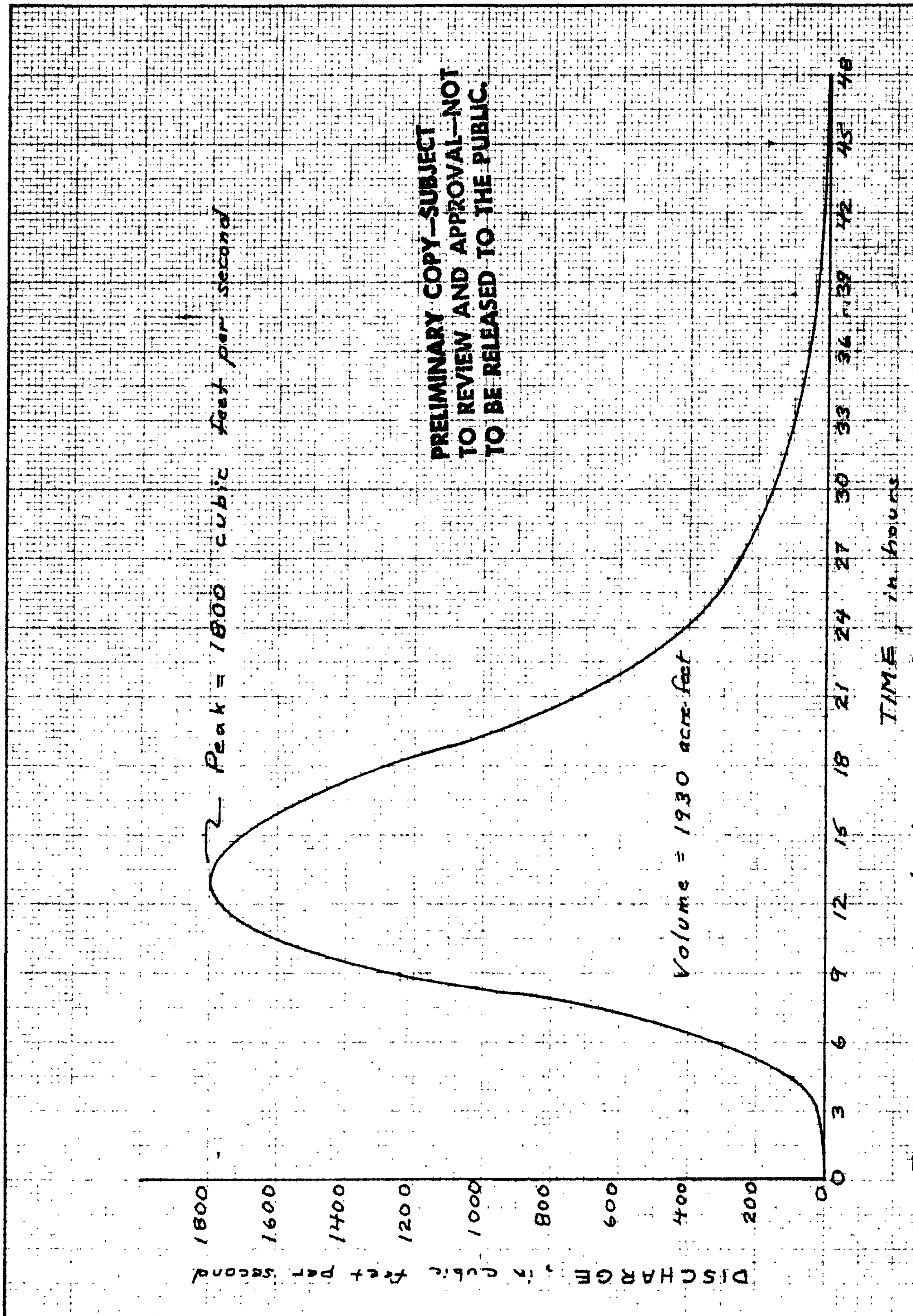

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Figure 4 – Unit hydrograph for Pine Creek at damsite.

Sheet No. ...... of ...... Sheets. Prepared by .... Date ...... Checked by ...... Date ......

9-192-a. (Rev. 7-67)

Daily Gage Height, in Feet, and Discharge, in Second-Feet, of Pine ~~River~~ Creek

At / Near Oxbow **for the Year Ending September 30, 19**71

Drainage Area 37.8 **Square Miles. Water-Stage Recorder** ______ **Ratio** ___ : ___

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Gage Read to ______ Once / Twice **a Day by** ______

Station Number 05358300

TABLE 1

Used rating table dated ______

Gage heights used to half tenths between ___ **and** ___ **feet; hundredths below and tenths above these limits.**

Max Disch. 590 Sec-ft at 2300 on April 12 (G.H. 4.73 (ft). Max G.H. 4.7 ft at 2300 on April 12

Min. Disch. 16 (estimated) Sec.-ft. on ~~August 17~~ Sept 19-22 (G.H. ~~1.55~~ (ft). Min G.H. ______ ft. on ______

e - estimated from discharge at South Fork Flambeau R. Nr Phillips for periods Oct. 1-19, Oct. 25 - Nov.15, Nov.19-23, April 27 - May 6, July 8 - Aug.11 and Aug.28 - Sept.30. Stage discharge relationship affected by ice Dec. 20 to Apr. 6 and by beavers August 30 to Sept. 30.

a - No gage height record.

Day	October Gage height	October Discharge	November Gage height	November Discharge	December Gage height	December Discharge	January Gage height	January Discharge	February Gage height	February Discharge	March Gage height	March Discharge	April Gage height	April Discharge	May Gage height	May Discharge	June Gage height	June Discharge	July Gage height	July Discharge	August Gage height	August Discharge	September Gage height	September Discharge	Calendar Year / Period Year
1		e21	a	57	1.76	26	a	25	1.92	21		21	2.21	40	a	54	2.11	60	2.32	85	a	21	1.88	18	
2		e20	a	54	2.17	64	a	25	1.92	21	2.09	21	2.27	43	a	56	2.03	53	1.99	69	a	20	1.89	18	
3		e19	a	54	2.08	55	a	25	1.92	21	2.11	22	2.24	47	a	55	1.98	48	1.85	36	a	20	1.93	18	
4		e19	a	54	2.01	48	a	25	1.92	21	2.11	22	2.25	52	a	55	1.92	42	1.75	28	a	19	1.95	17	
5		e18	a	53	2.00	46	a	25	1.92	21	2.11	23	2.26	59	a	53	1.88	39	1.73	27	a	19	2.03	17	
6		e18	a	51	1.95	42	a	25	1.92	21	2.12	24	2.28	66	a	51	1.85	36	1.79	31	a	18	2.11	17	
7		e18	a	48	1.97	44	a	25	1.93	21	2.13	24	2.28	79	2.06	56	1.93	43	1.80	32	a	17	2.10	17	
8		e20	a	44	1.93	40	a	25	1.93	21	2.13	25	2.29	81	2.03	53	1.99	49	a	28	a	17	2.02	17	
9		e26	a	43	1.90	37	2.02	24	1.92	21	2.14	26	2.32	85	1.96	46	1.92	42	a	27	a	17	1.98	17	
10		e26	a	46	1.83	31	2.02	24	1.92	21	2.15	27	2.65	134	1.93	43	1.83	35	a	26	a	17	2.09	17	
11		e26	a	46	1.83	33	2.01	24	1.93	21	2.15	28	2.83	349	1.90	40	1.80	32	a	25	a	17	2.08	17	
12		e25	a	48	1.82	31	2.00	23	1.93	21	2.15	29	4.55	530	1.88	39	1.79	31	a	24	1.57	18	2.02	18	
13		e24	a	47	1.83	31	1.97	23	1.93	21	2.15	30	4.65	565	1.86	37	1.78	31	a	24	1.61	19	2.00	18	
14		e22	a	45	1.83	31	1.94	22	1.93	21	2.16	31	4.42	500	1.88	39	1.78	31	a	24	1.76	29	1.99	19	
15		e21	a	40	1.82	31	1.90	22	1.93	21	2.19	32	4.07	390	1.80	32	1.74	28	a	23	1.69	24	1.97	18	
16	1.74	24	2.08	55	1.83	31	1.86	22	1.94	21	2.20	33	3.79	340	1.75	28	1.70	25	a	22	1.60	18	1.98	18	
17	1.72	23	2.08	55	1.83	31	1.86	21	1.95	21	2.20	34	3.83	349	1.73	27	1.68	24	a	22	1.57	18	1.98	18	
18	1.70	22	2.06	53	1.82	31	a	21	1.95	21	2.21	35	3.80	342	1.85	36	1.68	24	a	23	1.81	33	2.03	17	
19	1.68	20	a	35	1.78	28	a	21	1.96	21	2.22	36	3.50	276	2.18	68	1.70	25	a	26	2.26	77	2.06	16	
20	1.67	20	a	27	1.77	27	1.90	21	1.96	21	2.21	35	3.18	215	2.38	92	1.70	25	a	26	2.04	54	2.10	16	
21	1.67	20	a	27	1.79	26	1.93	21	a	21	2.21	35	2.83	156	2.33	86	1.70	25	a	24	1.78	31	2.12	16	
22	1.66	19	a	27	1.82	26	1.94	21	a	21	2.18	34	2.55	114	2.16	66	1.70	25	a	24	1.70	25	2.16	16	
23	1.67	20	a	26	1.83	26	1.92	21	a	21	2.20	34	2.44	99	2.12	62	1.66	22	a	23	1.68	24	2.34	18	
24	1.80	29	1.77	27	1.83	26	1.92	21	a	21	2.19	34	2.32	85	3.02	208	1.66	22	a	23	1.65	22	2.38	19	
25	a	25	1.89	36	1.83	26	1.92	21	a	21	2.13	34	2.29	81	3.56	335	1.68	24	a	22	1.64	21	2.33	19	
26	a	27	1.86	34	1.83	26	1.92	21	2.08	21	2.13	34	2.17	67	3.36	270	1.68	24	a	20	1.63	20	2.32	19	
27	a	42	1.80	29	1.82	26	1.92	21	2.08	21	2.11	35	a	53	2.95	190	1.66	22	a	19	1.60	18	2.35	20	
28	a	61	1.87	31	a	26	1.92	21	2.08	21	2.11	36	a	53	2.59	124	1.64	21	a	22	1.60	18	2.43	22	
29	a	69	1.82	21	a	26	1.92	21			2.13	38	a	54	2.34	87	1.72	26	a	22	1.63	20	2.50	28	
30	a	69	1.84	32	a	25	1.92	21			2.19	40	a	52	2.24	75	2.54	116	a	22	1.77	18	2.52	45	
31	a	62			a	25	1.92	21			2.18	39			2.18	68			a	22	1.83	18			
Total		875		1245		1022		699		588		951		5354		2531		1050		871		727		570	16,483
Mean		28.2		41.5		33.0		22.5		21.0		30.7		178		81.6		35.1		28.1		23.4		19.0	45.2
Second-feet per square mile																									
Run-off in inches																									
Run-off in acre-feet																									
Maximum																									
Minimum																									

Quarter			
Fourth, Third, Second, First Quarter	Computed	Checked	Date
Fourth, Third, Second, First Quarter	Disch. applied	Disch. checked	Date
Fourth, Third, Second, First Quarter	G.H. copied	G. H. checked	Date

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(Oct. 1951)

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WATER RESOURCES DIVISION

Sheet ______ of ______ Sheets

Table 2.--Estimated

Monthly and annual discharge, in cfs, of Pine Creek ~~River~~ near Oxbo
[Drainage area, ______ square miles]

16—26489-6 U.S. GOVERNMENT PRINTING OFFICE

WATER YEAR	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	ANNUAL
1962	24	34	27	20	18	24	84	108	34	19	18	40	38
63	36	26	24	16	13	22	53	55	38	13	17	14	27
64	15	16	13	12	12	13	60	73	18	14	15	37	25
65	20	27	18	16	16	22	187	204	45	19	14	26	51
66	30	26	39	26	25	97	73	41	35	14	41	23	39
67	39	31	23	20	16	27	251	56	84	29	17	14	51
68	15	17	16	13	16	28	47	114	158	102	24	50	50
69	50	28	31	31	30	30	145	45	43	47	24	15	43
1970	25	25	20	17	15	19	60	64	64	18	12	16	30
71	28	42	33	22	21	31	178	82	35	28	23	19	45
TOTAL	282	272	244	193	182	313	1138	842	554	303	205	254	399
AVG.	28	27	24	19	18	31	114	84	55	30	20	25	40

Table 3.--Discharge and water temperatures of Pine Creek during seepage run of October 12, 1971

Streamflow measuring location number	Stream and location	Discharge (cfs)	Water temperature (°F)
1	Pine Creek above proposed reservoir	2.9	43
2	Pine Creek near Pine Creek Road	15.4	45
3	Pine Creek above Hay Creek	13.7	46
4	Hay Creek at confluence of Pine Creek	1.9	45
5	Pine Creek at damsite	18.4	48
6	Pine Creek below damsite	18.9	45
7	Pine Creek at gaging station	21.4	46