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The Division of Highway performed a sediment transport study at eight tributaries to Lake Tahoe, California, during the spring snowmelt runoff of 1971. The objective of the investigation was to determine the quantity of sediment transport from all sources within selected watersheds and then to relate the quantity of sediment from highway cut-and-fill slopes within those watersheds. Stream gage records were maintained and suspended sediment samples collected at various intervals. Instantaneous suspended sediment transport rates were determined using a U.S. Geological Survey computer program.

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HYDROLOGY & SEDIMENT TRANSPORT

(SPRING 1971)

LAKE TAHOE BASIN

71-17

EPORT

December, 1971

STATE OF CALIFORNIA

BUSINESS AND TRANSPORTATION AGENCY

DEPARTMENT OF PUBLIC WORKS

DIVISION OF HIGHWAYS

MATERIALS AND RESEARCH DEPARTMENT

RESEARCH REPORT

NO. M & R 657078-2

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December, 1971

Interim Report
No. M & R 657078-2

Mr. W. L. Warren
District Engineer
Division of Highways
Marysville, California

Dear Sir:

Submitted herewith is a report titled:

HYDROLOGY AND SEDIMENT TRANSPORT

(Spring 1971)

Lake Tahoe, California

Study made by .....Environmental Improvement Section
Under general direction of.....John Skog
Work supervised by .....Earl Shirley
Report prepared by .....Richard Howell
Field assistance .....District 03

Very truly yours,

JOHN L. BEATON
Materials and Research Engineer

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REFERENCE: Howell, R. B.; Shirley, E. C.,; Skog, J. B., Hydrology and Sediment Transport in the Lake Tahoe Basin (Spring 1971), State of California, Department of Public Works, Division of Highways, Materials and Research Department, Report 657078-2, October 1971.

ABSTRACT: The Division of Highways performed a sediment transport study at eight tributaries to Lake Tahoe, California, during the spring snowmelt runoff of 1971. The objective of the investigation was to determine the quantity of sediment transport from all sources within selected watersheds and then to relate the quantity of sediment from highway cut-and-fill slopes within those watersheds. Stream gage records were maintained and suspended sediment samples collected at various intervals. Instantaneous suspended sediment transport rates were determined using a U. S. Geological Survey computer program.

The results show the following quantities of sediment transported from all sources and the corresponding amount from highway sources along with the estimated runoff for the period March 23 to July 1, 1971.

Watershed	Sediment Transport (tons) All Sources	Sediment Transport (tons) (Annual) Highways	Stream Runoff (acre-feet)
43 Trout Creek	503.2	0	16,734
44A Upper Truckee River	1,463.8	216	59,278
44B Upper Truckee River	690.8	216	50,946
44D Upper Truckee River	344.2	173	34,820
53 Lonely Gulch	19.6	0.3	1,161*
56 General Creek	69.7	1.5	16,154
62 Blackwood Creek	375.3	0	23,884
63 Ward Creek	240.2	10.5	20,238
2 Burton Creek	36.2	0.8	5,038
10B Snow Creek	15.3	9	1,957

*Runoff for period May to July

The tons of sediment transported were determined by analyzing suspended sediment samples taken from the streams using a DH-48 depth-integrating sampler. The concentrations were determined in the laboratory using the filter method. The U. S. Geological

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Survey Computer program was used for computing instantaneous sediment rates and mean monthly flows were determined from the hydrologic data collected. The runoff data were then used with suspended sediment rate curves to determine monthly sediment quantities. Bedload transport was not determined in this study.

The annual sediment quantities from highway sources were taken from the Materials and Research Report No. 657078-1 titled "Slope Erosion Transects," Lake Tahoe Basin, July 1971. The results as reported in this report are in cubic yards of sediment. A conversion factor of 1.50 was used to derive "tons" of sediment discharge from highway sources.

Actual measurements of suspended sediment or bed material transport in roadway drainage facilities were not recorded. Thus, the annual sediment discharge from highway sources are merely estimates derived from field measurements of slope erosion.

KEY WORDS: Hydrology, hydraulic, measurement, runoff, sediment, stream gage, suspended sediment, streamflow, water discharge.

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ACKNOWLEDGMENT

The assistance of District 03 in gathering field data and performing laboratory analysis is greatly appreciated. In particular, the District 03 Maintenance Department is to be commended for their help in reading the stage gages and collecting water samples. The assistance of the U.S. Geological Survey has been outstanding. The Carson City office of the U.S.G.S. accelerated gathering streamflow data from their four gaged tributaries in the Basin for our study. The Sedimentation Laboratory of the U.S.G.S. in Sacramento performed laboratory analysis on bed material samples, provided technical guidance on field sampling and loaned the Division sampling equipment. The Menlo Park office of the U.S.G.S. provided technical guidance and allowed the use of their computer program for determining suspended sediment discharge rates. Technical assistance was also provided by the U.S. Soil Conservation Service office in Berkeley on slope erosion. Assistance from other federal, state, and local agencies not mentioned above is sincerely appreciated.

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TABLE OF CONTENTS

	Page
ABSTRACT	i
ACKNOWLEDGMENT	iii
INTRODUCTION	1
DATA SUMMARY	3
INVESTIGATION	6
Hydrology	6
Stream Gage and Sampling Locations	10-12
Stage - Discharge Curves	14-18
Stream Characteristics	19
24-Hour Flow Measurement	29
Runoff Hydrographs	29
Suspended Sediment	46
Sampling Techniques	46
Sediment Concentrations	47
Sediment Discharge	47
Sediment Rating Curves	88
Sediment Discharge Quantities	99
Sediment Size Analysis	100
Bed Load	107
Bed Material Samples	107
Size Analysis	107
BIBLIOGRAPHY	109
APPENDIX	110
Location Map	111

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ILLUSTRATIONS

		Page
Fig. 1 - 8	Gage Reading vs. Discharge	14-18
Fig. 9 - 15	Gage Height, Area, Depth	20-26
Fig. 16, 17	Channel Configuration	27-28
Fig. 18 - 21	Diurnal Discharge Measurement	30-33
Graph 1 - 9	Runoff Hydrograph	35-45
Table 1 - 10	Tributary Data	48-77
Table 11 - 20	Instantaneous Sediment Rates	78-87
Fig. 22 - 31	Suspended Material Rating Curve	89-98
Plate 1 - 10	Grain Size Distribution	102-106

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OBJECTIVE

The purpose of this study was to determine the quantity of sediment transported by selected tributaries and to identify the estimated amount of sediment emanating from highway sources.

INTRODUCTION

In February 1971, the Materials and Research Department developed a program to monitor certain streams tributary to Lake Tahoe for sediment transport information. The goal for this program was to collect basic data for the period of March-July 1971 from which estimates could be made of sediment transport from the selected watersheds. This information, when combined with the slope erosion transect data [1], would provide:

1. The quantity of sediment from highway sources compared to total watershed sources.

2. Establish base-line data for comparison in future years.

3. Valuable sediment transport information for other studies in the Tahoe Basin.

To determine the quantity of sediment transported from watersheds, it is necessary to obtain hydrologic data for each of the sampling locations. The hydrologic data consist mainly of streamflow determinations for the period of observation, stream gradients, channel configurations, and water temperatures.

To develop streamflow records, stage gages were established at the following locations:

44A	Upper Truckee River (near mouth)
44B	Upper Truckee River (near airport)
44C	Echo Drain (near confluence with Upper Truckee River)
44D	Upper Truckee River (Portal Drive)
43	Trout Creek (near Highway 50)
53	Lonely Gulch (downstream of Highway 89)
56	General Creek (upstream of Highway 89)
63	Ward Creek (upstream of Highway 89)
2	Burton Creek (downstream of Highway 28)
10B	Snow Creek (upstream of Highway 28)

[1] "Slope Erosion Transects," Materials and Research Report 657078-1, July 1971.

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Blackwood Creek was also monitored for suspended sediment transport. The U. S. Geological Survey maintains a permanent stream gage on Blackwood Creek which was used to determine flows.

U. S. Geological Survey stream gages are also located on Trout Creek, the Upper Truckee River, and Taylor Creek. The Trout Creek records were monitored to correlate the streamflow readings obtained at Station 43. Records from the U. S. Geological Survey gage on the Upper Truckee River were used for stream flow information for Station 44D.

Station 44C was not used to develop suspended sediment data. During June, the stage gage was dislodged from its location by debris.

The stage gage at Ward Creek was also dislodged on June 26. The gage was referenced to an elevation point on the Ward Creek Bridge and was re-established for further stage height readings.

Division of Highways District 03 Maintenance personnel were responsible for taking stage height recordings on the tributaries. The gages were generally read between the hours of 4-6 p.m. each day except for weekends. This time of the day represented the mean daily flow in most cases. The period of observation for this study was March 23, 1971, to July 1, 1971.

Water samples were also taken for turbidity analysis at several locations. Maintenance personnel generally were responsible for procuring the samples. The water samples were analyzed on the District 03 Hach 1860 Turbidimeter located at South Lake Tahoe. During May, the Headquarters Materials and Research Department obtained a Hach 2100 A Turbidimeter which was used by District personnel to analyze water samples at the Marysville District Laboratory.

Turbidity is an expression of the optical property of the water which results in the light being absorbed or scattered rather than transmitted through. Suspended matter such as clay, silt, finely divided organic and inorganic matter, plankton and other microscopic organisms are the source of turbidity. The Hach Turbidimeter utilizes a "light scattering" or nephelometric principle of operation. A light beam strikes the particles in sample and are scattered at right angles where a photomultiplier tube converts the light energy to an electrical signal. The

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instrument displays the turbidity in Jackson Turbidity Units (JTU) and is calibrated against Formazin. Since turbidity is a measure of optical properties of water, there is no correlation with suspended sediment concentration. The turbidity readings are reported in Tables 1 to 10.

Suspended sediment samples were taken at various times during the study to obtain instantaneous suspended sediment load rates. The U.S. Geological instantaneous suspended sediment computer program was utilized to determine these rates. Suspended sediment rating curves were developed for each watershed which were used with mean daily flows to determine total tons of suspended sediment discharge from each tributary.

DATA SUMMARY

It appears that initial snowmelt runoff transported significant quantities of sediment. During the months of April and May, sediment concentrations were not unusually high. However, in June, snowmelt runoff reached a maximum as ambient air temperatures sustained high daily readings. Correspondingly, suspended sediment concentrations also reached maximum rates for the period of May through June.

The mean daily flows and the runoff yield as measured are presented below.

Stream		Mean Daily Flow (cfs)			
		Mar.	Apr.	May	June
43	Trout Creek	49	57	79	126
44A	Upper Truckee River	156	161	326	443
44B	Upper Truckee River	144	153	305	339
44D	Upper Truckee River	59	84	225	311
53	Lonely Gulch			7	12
56	General Creek	18	31	123	106
62	Blackwood Creek	38	53	152	179
63	Ward Creek	44	53	119	148
2	Burton Creek	8	11	59	10
10B	Snow Creek	5	10	17	4

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	Stream	Runoff Yield (ac-ft) Mar.	Apr.	May	June	Total
43	Trout Creek	882	3,410	4,880	7,562	16,734
44A	Upper Truckee River	2,808	9,688	20,212	26,570	59,278
44B	Upper Truckee River	2,586	9,142	18,896	20,322	50,946
44D	Upper Truckee River	1,058	5,010	13,810	14,942	34,820
53	Lonely Gulch			441	720	1,161
56	General Creek	322	1,858	7,610	6,364	16,154
62	Blackwood Creek	684	3,180	9,340	10,680	23,884
63	Ward Creek	792	3,178	7,392	8,876	20,238
2	Burton Creek	142	668	3,632	596	5,038
10B	Snow Creek	91	590	1,038	238	1,957

Results of the investigation show the following estimated tonnage of suspended sediment discharge from all sources for the period March 23 - July 1, 1971:

	Watershed	Suspended Sediment tons	Runoff Yield acre-feet
43	Trout Creek	503	16,734
44A	Upper Truckee River	1,464	59,278
44B	Upper Truckee River	691	50,946
44D	Upper Truckee River	344	34,820
53	Lonely Gulch	20	1,161*
56	General Creek	70	16,154
62	Blackwood Creek	375	23,884
63	Ward Creek	240	20,238
2	Burton Creek	36	5,038
10B	Snow Creek	15	1,957

*Runoff for period of May 1 to July 1

Based on USGS streamflow records for the Upper Truckee River near Meyers, the runoff for each month from October 1970 to August 1971 is as follows:

Month and Year	Total runoff acre-feet	Pct of Total
October 1970	408	1
November 1970	1,170	2
December 1970	978	2
January 1971	1,320	3
February 1971	1,240	3
March 1971	2,150	4
April 1971	5,010	10
May 1971	13,810	27
June 1971	18,730	37
July 1971	4,480	9
August 1971	1,240	2
	50,536	100

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The period of March 23 to July 1 represents 75% of the annual runoff. A similar analysis of Blackwood Creek shows 74% for this time period. Assuming a direct linear relationship between water yield and sediment transport, the sediment attributable to highway slopes for the March 23 to July 1st period is 75% of the total 12-month sediment determined from field surveys.

Estimates of sediment entering streams from highway sources and available for transport indicate the relative percentage of sediment from highways are:

Watershed	3-month total for Watershed	Tons of Sediment: 12-month total for Highways	Tons of Sediment: 3-month total for Highways	Highway slopes as % of total watershed
43 Trout Creek	503	0	0	0
44A Upper Truckee	1,464	216	162	11
44B Upper Truckee	691	216	162	23
44D Upper Truckee	344	173	130	38
53 Lonely Gulch	20	1	1	5
56 General Creek	70	2	1	1
62 Blackwood Creek	375	0	0	0
63 Ward Creek	240	11	8	3
2 Burton Creek	36	1	1	3
10B Snow Creek	15	9	7	47

The suspended sediment transport from highway slopes for Trout Creek (43), Lonely Gulch (53), General Creek (56), Blackwood Creek (62), and Burton Creek (2) is not significant. Most erosion of highway slopes in these watersheds is of a minor nature.

The sediment from highway slopes is indicated as a high percentage of total sediment for Snow Creek. Actually, Snow Creek, Watershed Number 10B, includes sediment discharge from eroding slopes on Highway 267. The total watershed tons of sediment discharge shown is low because of inadequate suspended sediment discharge measurements. During the period from May 20, 1971, to July 1, 1971, a total of eight suspended sediment measurements were taken for a period of 42 days. During this period, the peak runoff from snowmelt also occurred. If more measurements had been taken, the total sediment discharge from all sources would have yielded a higher amount as indicated by high sediment discharge with increased flows, thus decreasing the relative percentage from highway sources. On the basis of slope transect data, it is believed that erosion from highway slopes in this watershed is of a minor nature.

The relatively high percentage of sediment discharge from Highway sources for 44B and 44D can be attributed to the severe erosion occurring on Old Meyers Grade and on numerous slopes near Luther Pass (Highway 89) parallel to Grass Lake Creek, a tributary to the Upper Truckee River.

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Actual measurements of suspended sediment or bed material transport in roadway drainage facilities were not recorded. Thus, annual sediment discharge from highway sources are merely estimates derived from field measurements of slope erosion. Bed material transport from all watershed sources were not determined.

INVESTIGATION

Hydrology

During the month of February 1971, several watersheds were investigated to select monitoring sites. Most of the sites were under a canopy of snow which posed difficulties in determining good sampling locations.

A description of the sites that were selected for sediment monitoring follows:

Lonely Gulch #53

General

Lonely Gulch passes under Highway 89 in Sec. 32, R17E, T14N, MDB&M. Subdivisions exist in the area known as Rubicon Bay. Lonely Gulch is located about 1/3 the way up the West Shore from the south end of the Lake. The area is heavily forested.

Hydrological

Rainfall - Average annual rainfall varies from 28 inches at the Lake to about 30-32 inches in the upper watershed.

Runoff - Average annual runoff is estimated to be 1,260 ac-ft/yr.

Stream - The stream meanders and has a steep gradient. There are several large boulders in the channel.

Road

There are road cuts in the area and the road profile is dipping slightly.

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General Creek #56

General

General Creek is located nearly half way up the west side of Lake Tahoe from the south. Highway 89 crosses General Creek in Sec. 20, R17E, T14N, MDB&M. The creek passes under Highway 89 through two large culverts.

Hydrological

Rainfall - Average annual rainfall ranges from 25 inches near the road crossing to 35 inches in the upper watershed.

Runoff - Average annual runoff is estimated to be 13,400 ac-ft./yr.

Stream - The upstream reach is parallel with Highway 89. There are some cobbles and pebbles in the streambed.

Road

There are road cuts in the area.

Blackwood Creek #62

General

Blackwood Creek is located in the middle of the west shore of Lake Tahoe. Highway 89 crosses the creek in Sec. 36, R17E, T15N, MDB&M. The crossing is located between Tahoe Pines and Idlewild. There are several buildings in the area.

Hydrological

Rainfall - Average annual rainfall at the road crossing is about 32 inches and in the upper watershed about 40-45 inches.

Runoff - Average annual runoff is 19,600 ac-ft./yr. The USGS has a stream gage station located upstream near the Highway 89 bridge.

Stream - The streambed slope is uniform; however, the upstream slope appears to be steeper with more curves than downstream. Streambed material looks to be sandy with small gravel. The channel width widens downstream of the bridge to about 50 feet.

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Upstream the channel is about 30-40 feet wide. There are some cobbles from 4-5 inches up to 10 inches in diameter in the streambed. Vegetation is growing along the channel banks. An estimate of the downstream roughness coefficient is 0.035 and upstream 0.040.

Road

Appears to be small road cuts in area. The road profile is mainly level.

Ward Creek

General

Ward Creek watershed is adjacent to the Truckee River watershed located in the northwestern portion of the Basin. Highway 89 crosses Ward Creek in Sec. 24, R17E, T15N, MDB&M which is just south of Sunnyside. A major subdivision plan has been accepted by the Tahoe Regional Planning Agency for Ward Creek upstream from Highway 89.

Hydrological

Rainfall - The average annual rainfall varies from 30 inches at the road crossing to 40 inches in the upper watershed.

Runoff - Average annual runoff is estimated to be 18,900 ac-ft./yr.

Stream - The upstream and downstream channel slopes are uniform and moderately sloping. The channel width is approximately 25 feet.

Road

The road profile is fairly flat with no appreciable cuts in the area. The Highway 89 bridge was widened recently.

Burton Creek

General

Burton Creek is located north of Tahoe City in the northwestern portion of Lake Tahoe. The Coast Guard Station is about 1,000

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feet west of the creek. Highway 28 crosses Burton Creek in Sec. 5, R17E, T15N, MDB&M.

Hydrological

Rainfall - Average annual rainfall varies from 22 inches at the road crossing to about 24 inches in the upper watershed.

Runoff - The average annual runoff is estimated to be 5,020 ac-ft./yr.

Stream - The channel width is about 6 feet upstream and downstream with an irregular channel slope. Vegetation is growing along the channel banks. Pebbles and cobbles on the order of one inch to three inches are in the streambed.

Road

Several road cuts in the area.

Snow Creek

General

Snow Creek is located in the northern portion of Lake Tahoe Basin. Highway 28 crosses Snow Creek Sec. 22, R17E, T16N, MDB&M. The area adjacent to Snow Creek on the northwest side of the creek is presently used for a snow stockpiling operation.

Hydrological

Rainfall - Average annual rainfall is about 22 inches at the road crossing to about 24 inches in the upper watershed.

Runoff - Average annual runoff is estimated to be 2,600 ac-ft./yr.

Stream - Stream width is narrow and uniformly sloping. Both streambanks are lined with vegetation.

Road

No road cuts near the Highway 28 crossing. The upper watershed drainage includes runoff from Highway 267.

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Stream Gages

Stream gages consisted of metal measuring tape fastened to wooden 2" x 2" stakes which were attached to metal guide-post driven into the stream bottom. To determine daily stream flows, the water height on the gage tape was read. The discharges for various gage heights had been prepared from discharge measurements.

The stream gages were established at the following locations:

Trout Creek - located about 10 feet downstream of highway bridge No. 25-13 near the east bank.

Upper Truckee River -

(a) Approximately 100 feet downstream of bridge No. 25-10 near east bank. This location is about 1 mile from the Lake.

(b) About 50 feet upstream of bridge No. 25-15 near west bank. This location is between the Tahoe Airport and the golf course.

(c) Approximately 60 feet downstream of Portal Drive near Highway 89. The gage is located near the west bank.

A stage gage was established on General Creek (56) 30 feet upstream of the Highway 89 bridge near the northwest bank.

On Ward Creek (63), a stage gage was set approximately 40 feet upstream of the Highway 89 bridge near the north bank.

About 20 feet downstream of the Highway 28 culvert on Burton Creek (2), a stage gage was attached to a wood pole.

A stage gage was set approximately 15 feet upstream of the Highway 28 bridge on Snow Creek (10B).

Lonely Gulch (53) was not accessible until the middle of May because of the snow mantle. The gage was established downstream of Highway 89.

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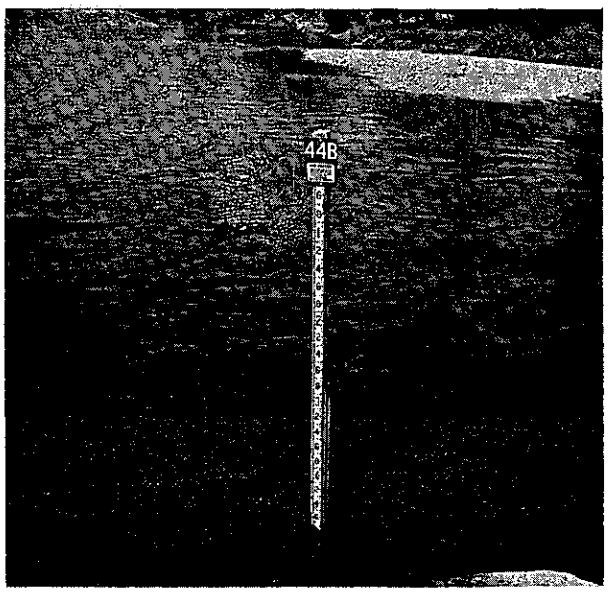
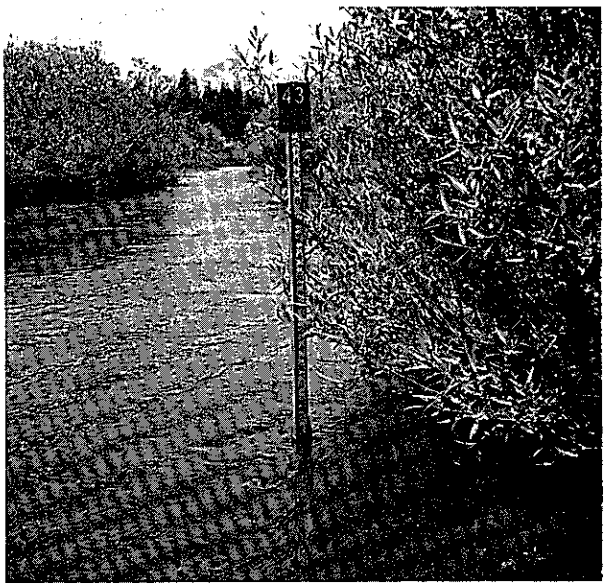


Stage gage on Upper Truckee River (Station 44B) located upstream of Highway 50 Bridge near golf course.



Stage gage on Trout Creek (Station 43) located downstream of Highway 50 Bridge at South Lake Tahoe.

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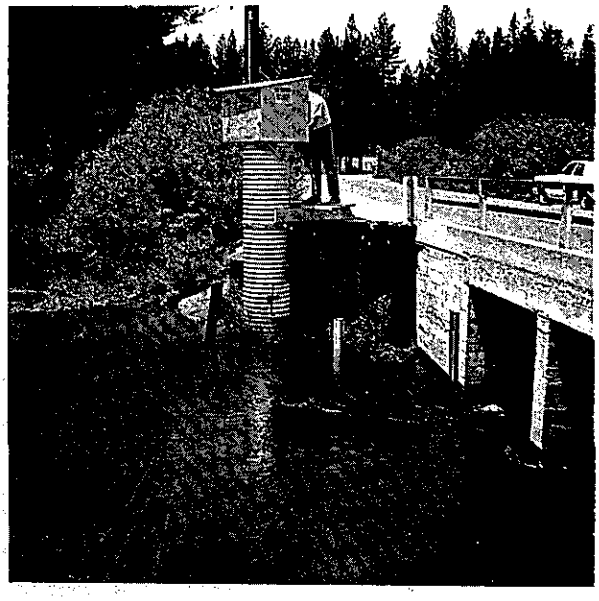
Stage Gage on Lonely Gulch (53) located downstream of Highway 89 near Rubicon Bay.



U. S. Geological Survey permanent stream gage recorded on Trout Creek at Martin Avenue.

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Stream flow records for the USGS permanent gages at Trout Creek, the Upper Truckee River, Taylor, and Blackwood Creeks were provided on a monthly basis from the Carson City office of the U.S. Geological Survey. The stream gage records for Taylor Creek were not utilized in the hydrologic analysis of this study.

A Price-Current meter was used to determine streamflow velocities at selected vertical sections in the channels. Coupled with cross-sectional area information taken at the time of the measurements, stream flow quantities were calculated for various stage heights.

The criteria[1/] used to select the metering section were as follows:

1. Uniform channel for a distance of 5 times the width upstream and twice the width downstream.

2. Location away from bridge piers (exception: 44A Upper Truckee River).

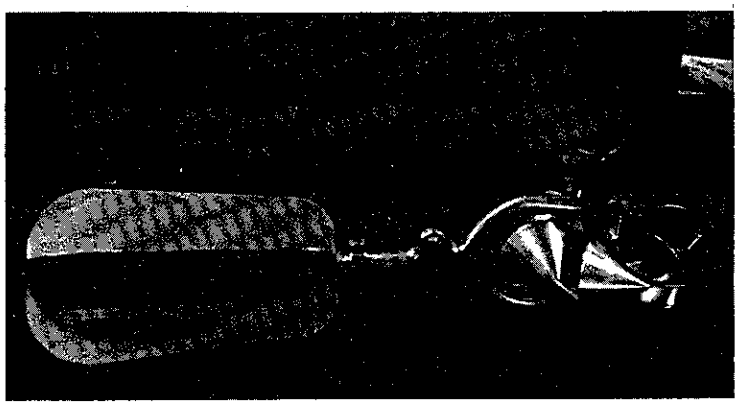
3. Current normal to section.

4. Velocities within 1 fps and 4 fps.

5. Accessibility to section.

A total of five separate streamflow determinations were made for various stage heights. Lonely Gulch was only metered four times. Velocity measurements were determined at the 0.2 and 0.8 stream depth.

Stage-Discharge curves were developed for each of the monitoring stations and are shown in Figures 1 through 8.



Price-Current Stream Velocity Meter.

1/ "Hydrology," Wisler and Brater, page 381

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FIG. 1

#44A UPPER TRUCKEE RIVER

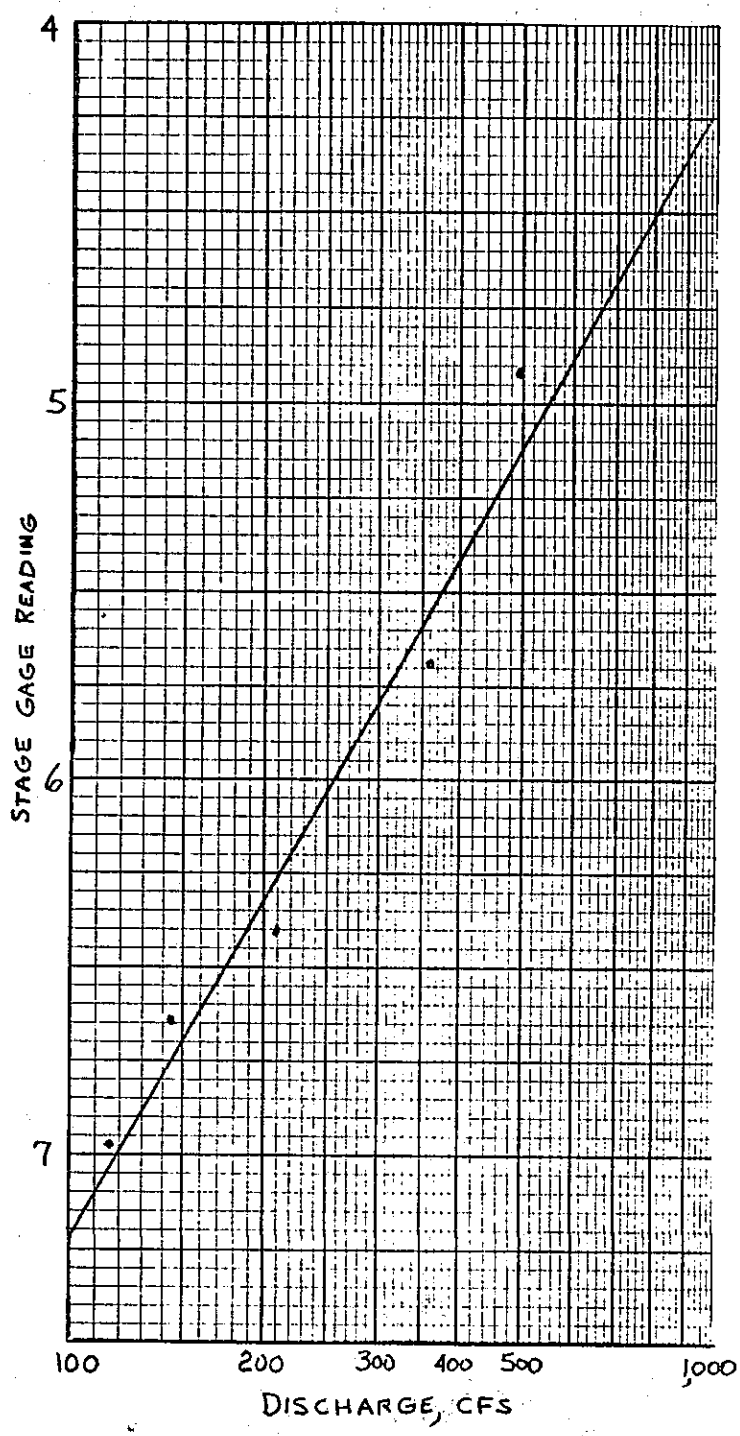
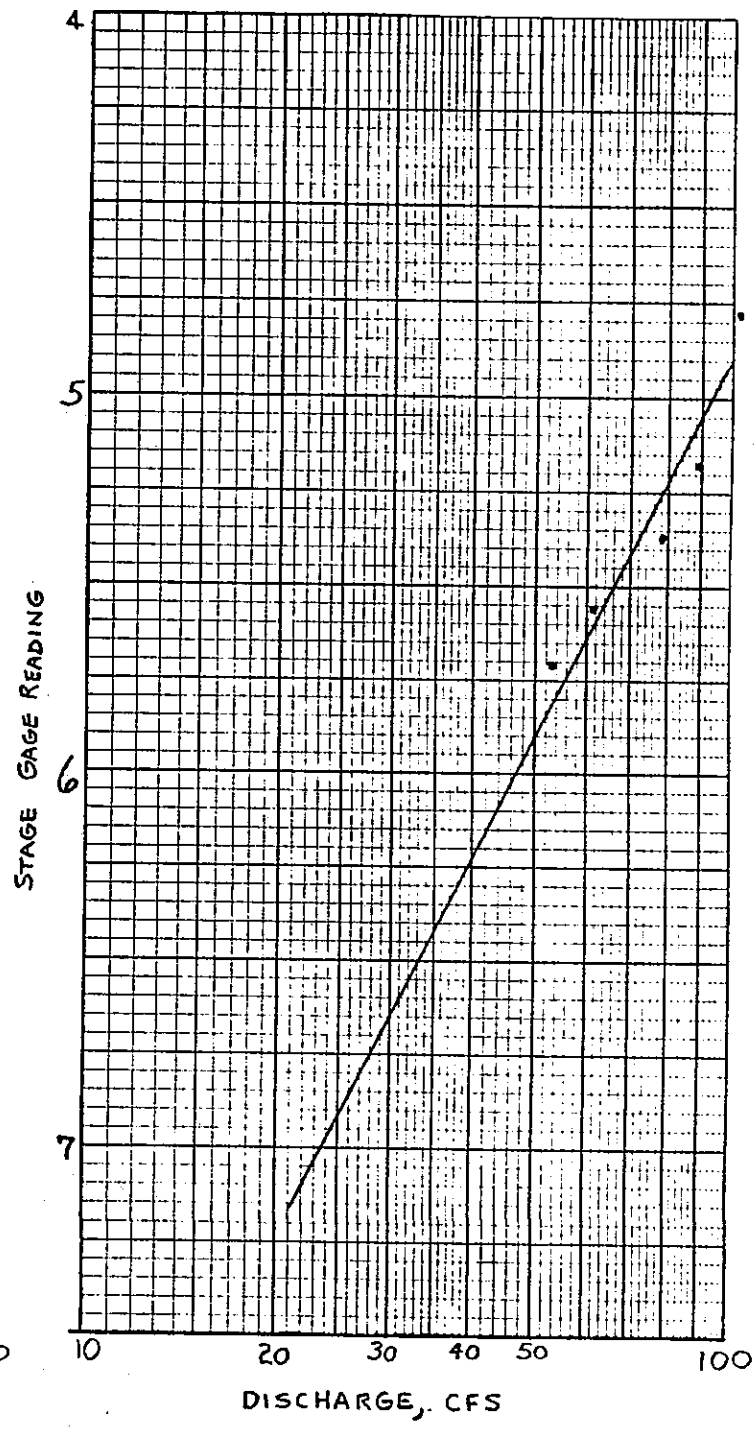


FIG. 2

#43 TROUT CREEK



Stage Reading vs. Discharge

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FIG. 3

#44 B UPPER TRUCKEE RIVER

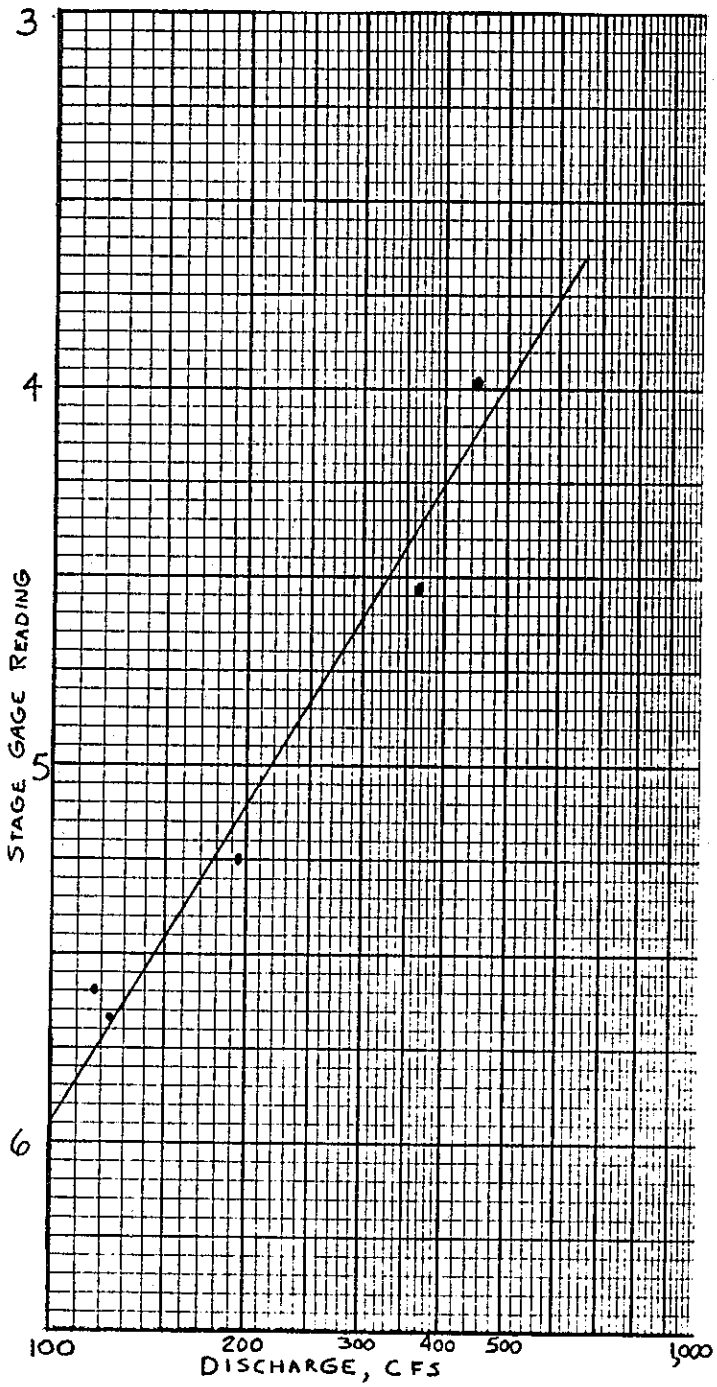
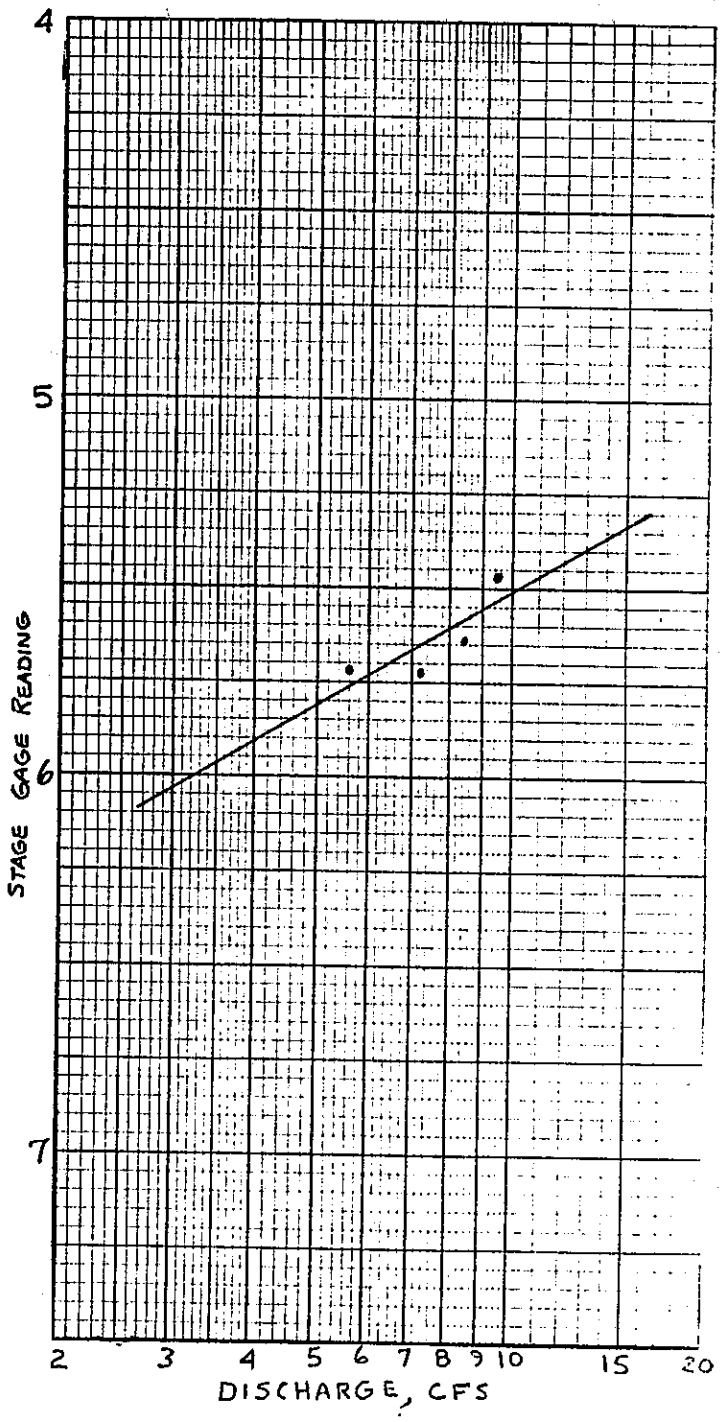


FIG. 4

#53 LONELY GULCH



Stage Reading vs. Discharge

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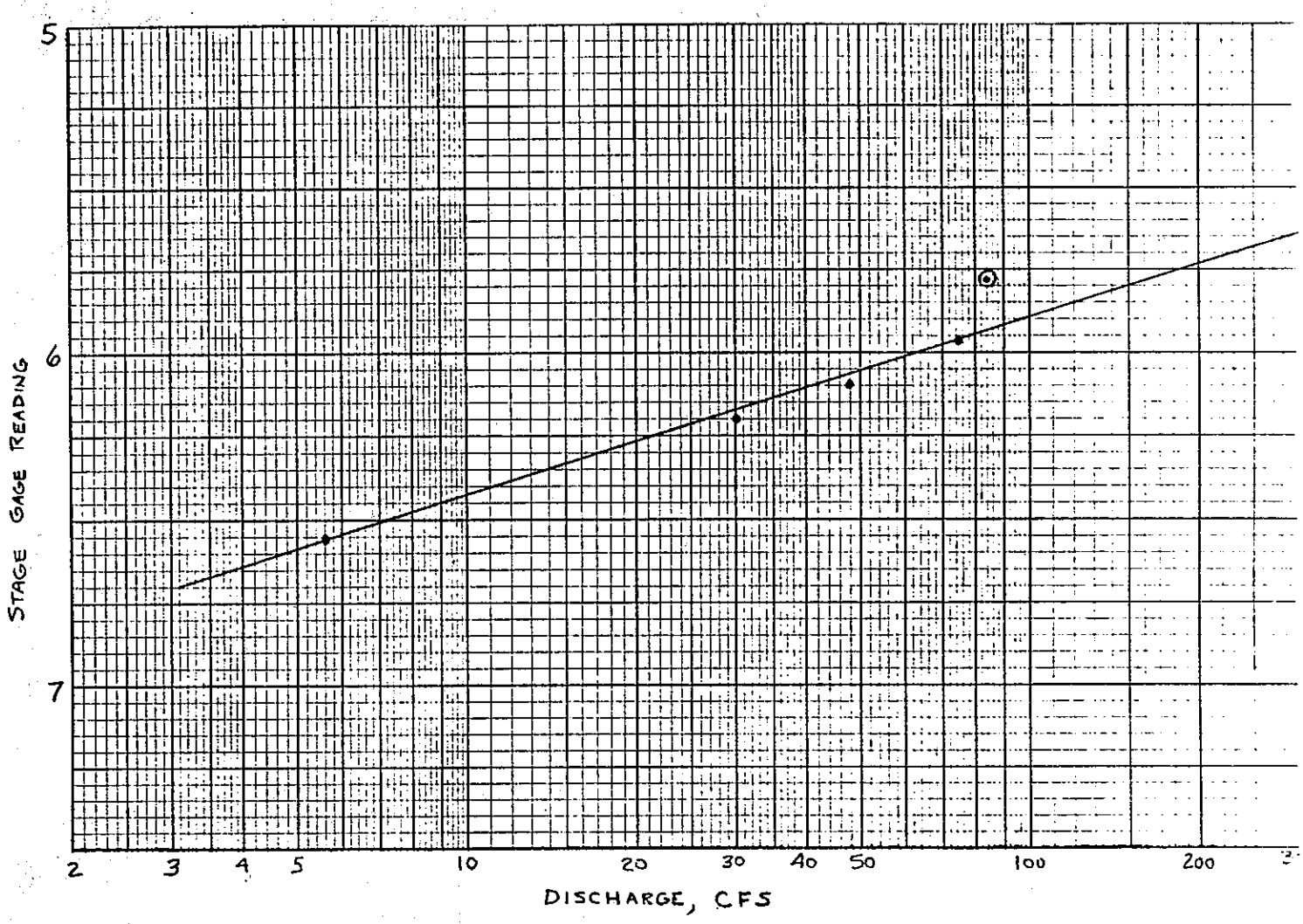
FIG. 5

#56 GENERAL CREEK



Stage Reading vs. Discharge

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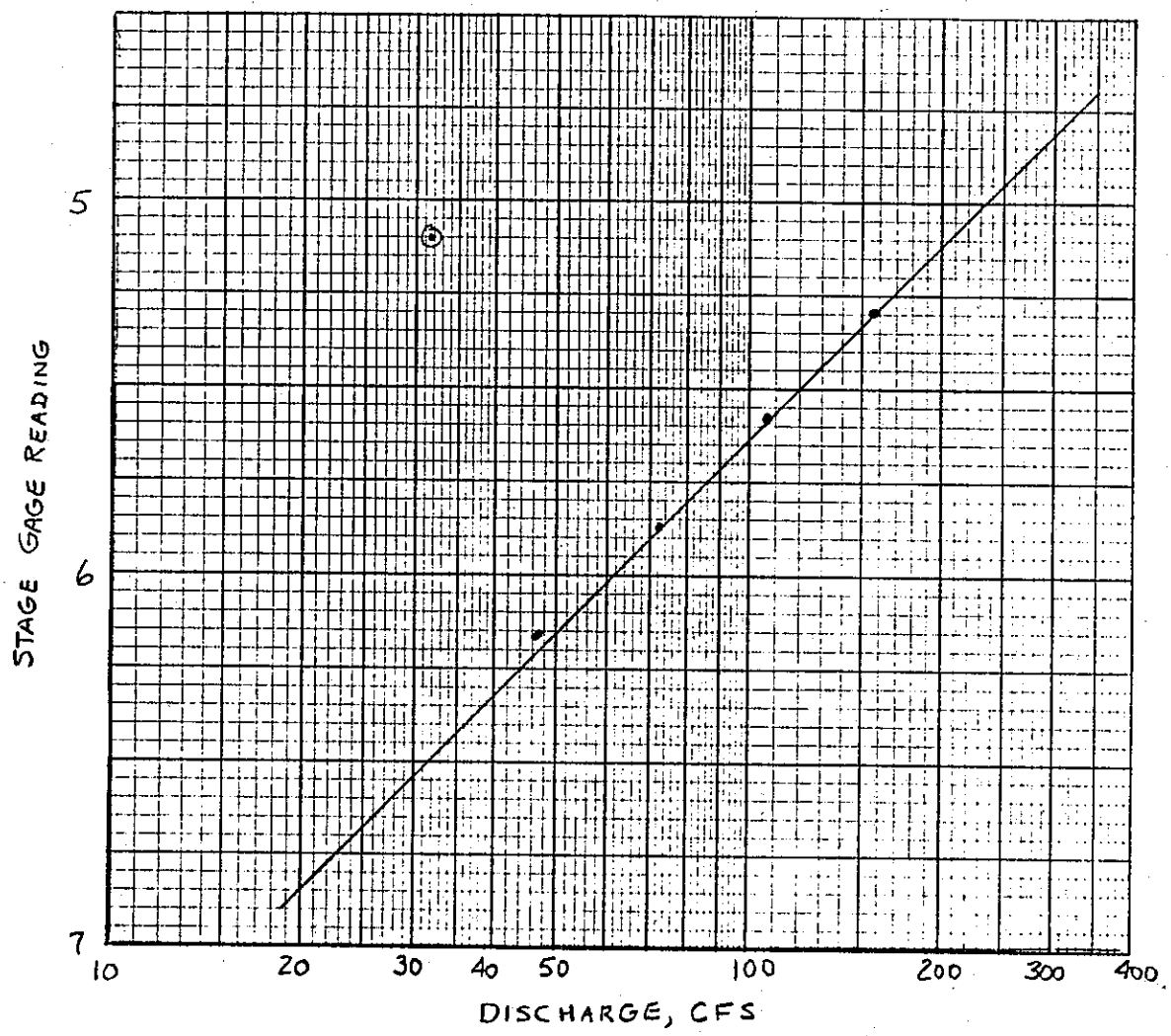
FIG. 6

WARD CREEK



Stage Reading vs. Discharge

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FIG. 7

#2 BURTON CREEK

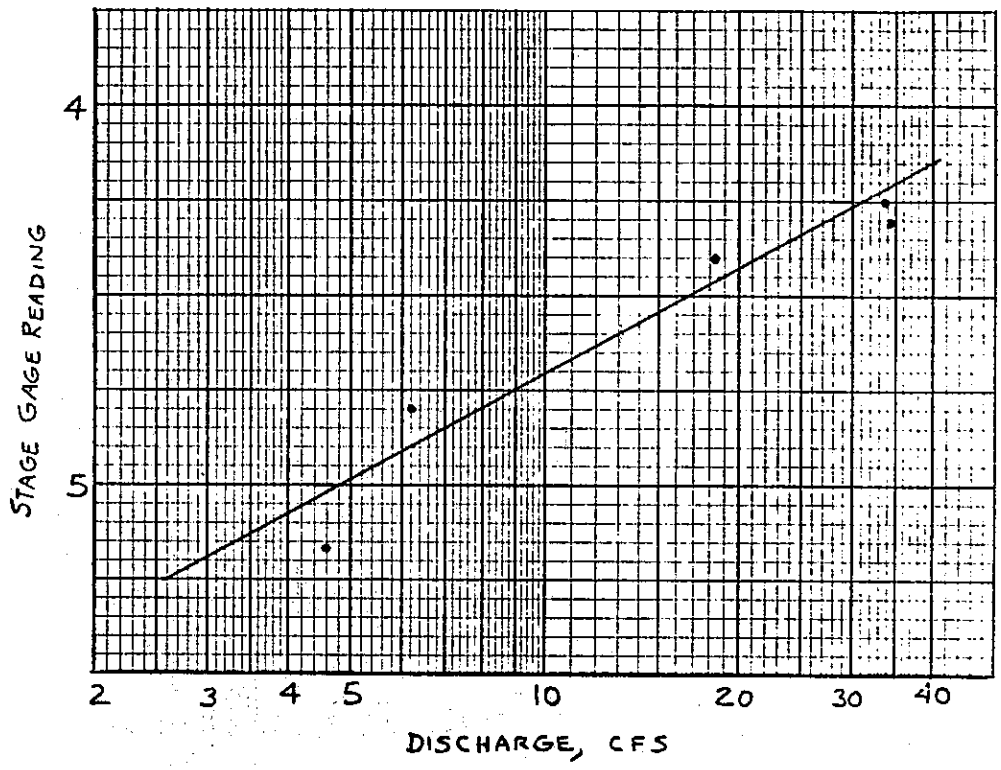
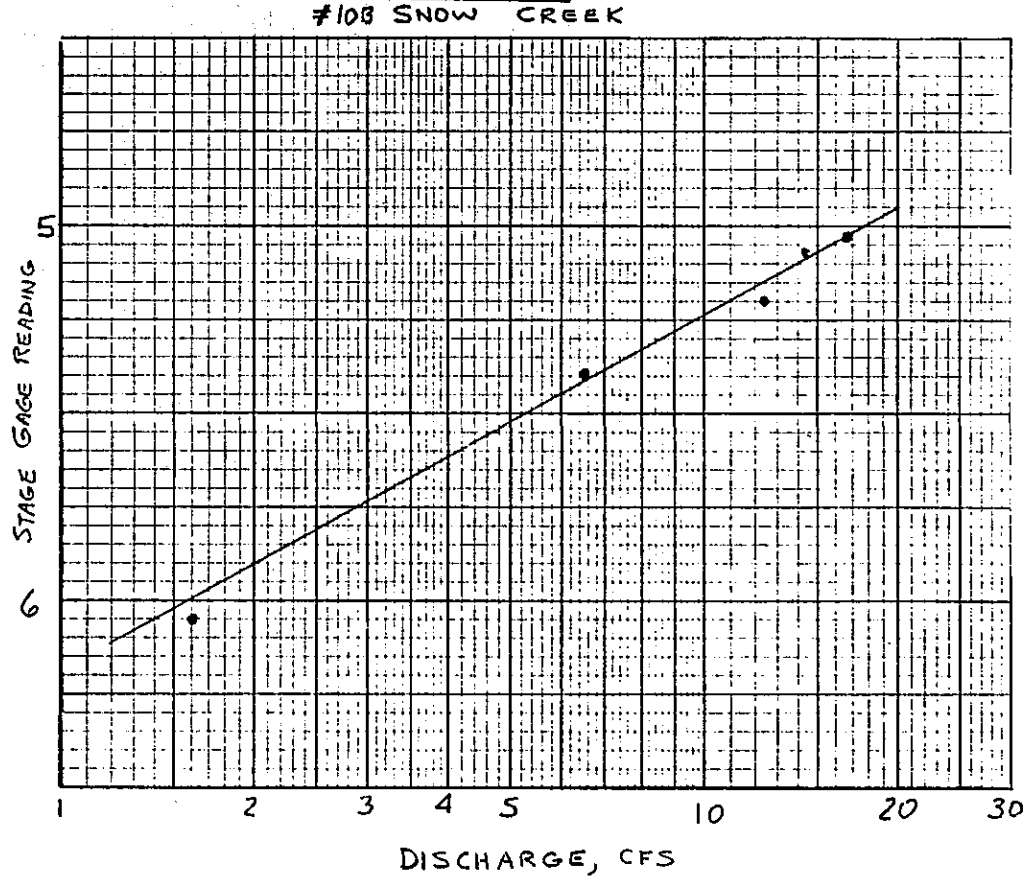


FIG. 8

#108 SNOW CREEK



Stage Reading vs. Discharge

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Stream Characteristics

Relationships between the gage height readings, mean depth of flow, and cross-sectional area were determined. These relationships are shown in Figures 9 through 15.

Thus, for any gage height reading, knowledge of the streamflow area is readily determined. This information assists in interpreting sediment transport conditions in a particular reach. Sediment deposits on the streambed are a function of the transport capability of the streamflow.

Another useful aspect of developing a relation between gage height readings and stream cross-sectional area is to evaluate the location of the gage in terms of knowing the accuracy or sensitivities of the readings. The slope of the curves, Δ gage height/Δ cross-sectional area x 100%, indicates the sensitivity of the gage reading to incremental changes (fluctuations) in streamflow. For curves with a slope in the range 1-2%, small changes in the gage height reflect significant changes in cross-sectional area. Steeper sloping curves, on the order of 4-10%, reflect less critical readings required to estimate the cross-sectional area. For most of the gages in the study, the impact of streamflow on the stream gage posed a difficulty in reading closer than 0.1 foot. Snow Creek was an exception. Here, the velocity was generally under 1 foot per second.

The following chart shows the curve slope derived from gage height readings versus cross-sectional area:

Stream		(Δ gage height/Δ area) x 100%
43	Trout Creek	4.8
44A	Upper Truckee River	1.0
44B	Upper Truckee River	1.5
56	General Creek	5.7
63	Ward Creek	4.2
2	Burton Creek	8.3
10B	Snow Creek	7.5

As indicated by the above chart, estimates of streamflow for 44A and 44B Upper Truckee River were difficult to determine due to the sensitive nature of gage readings and the fluctuation of the water level at the gage from impact.

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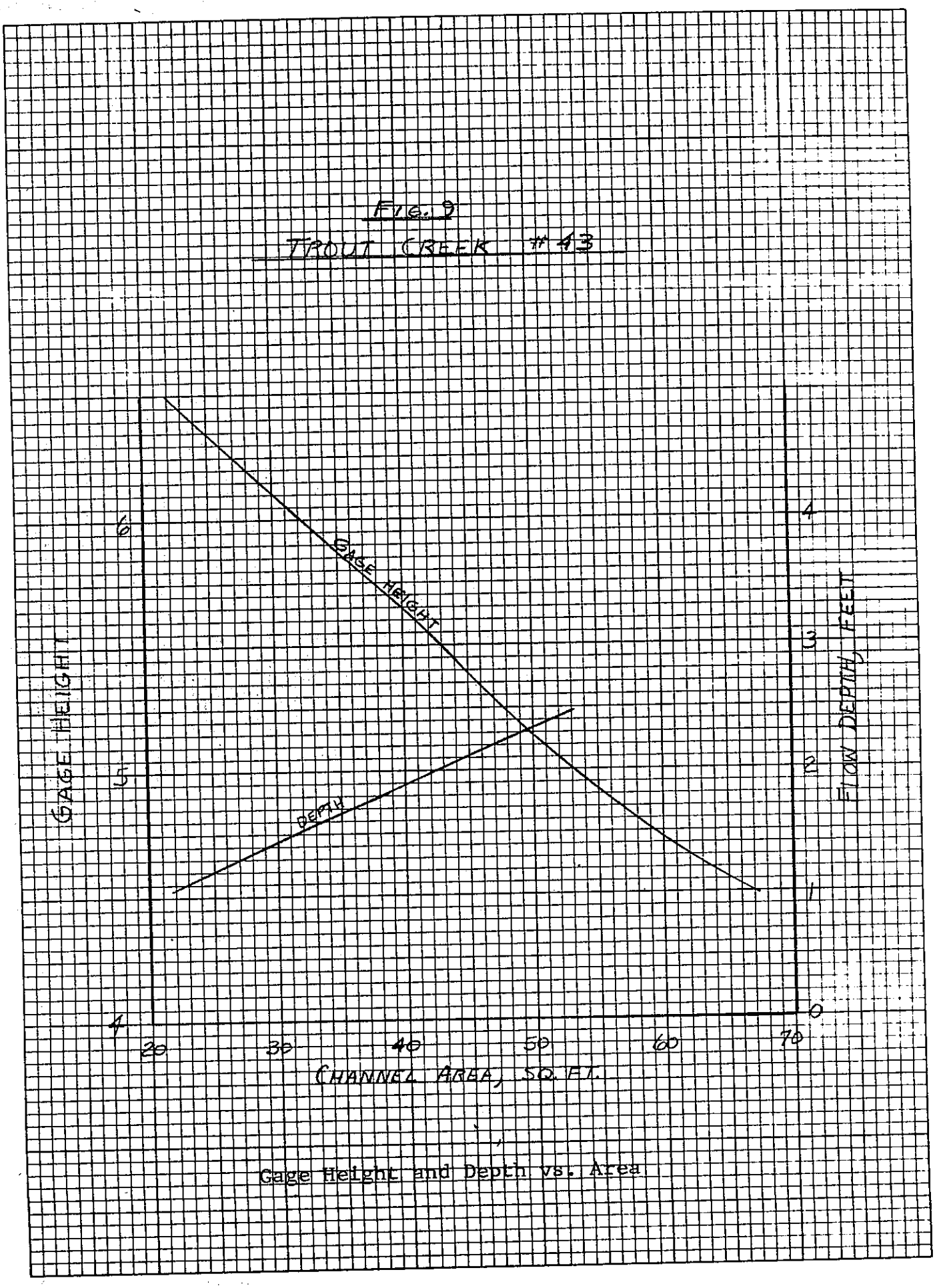

Gage Height and Depth vs. Area

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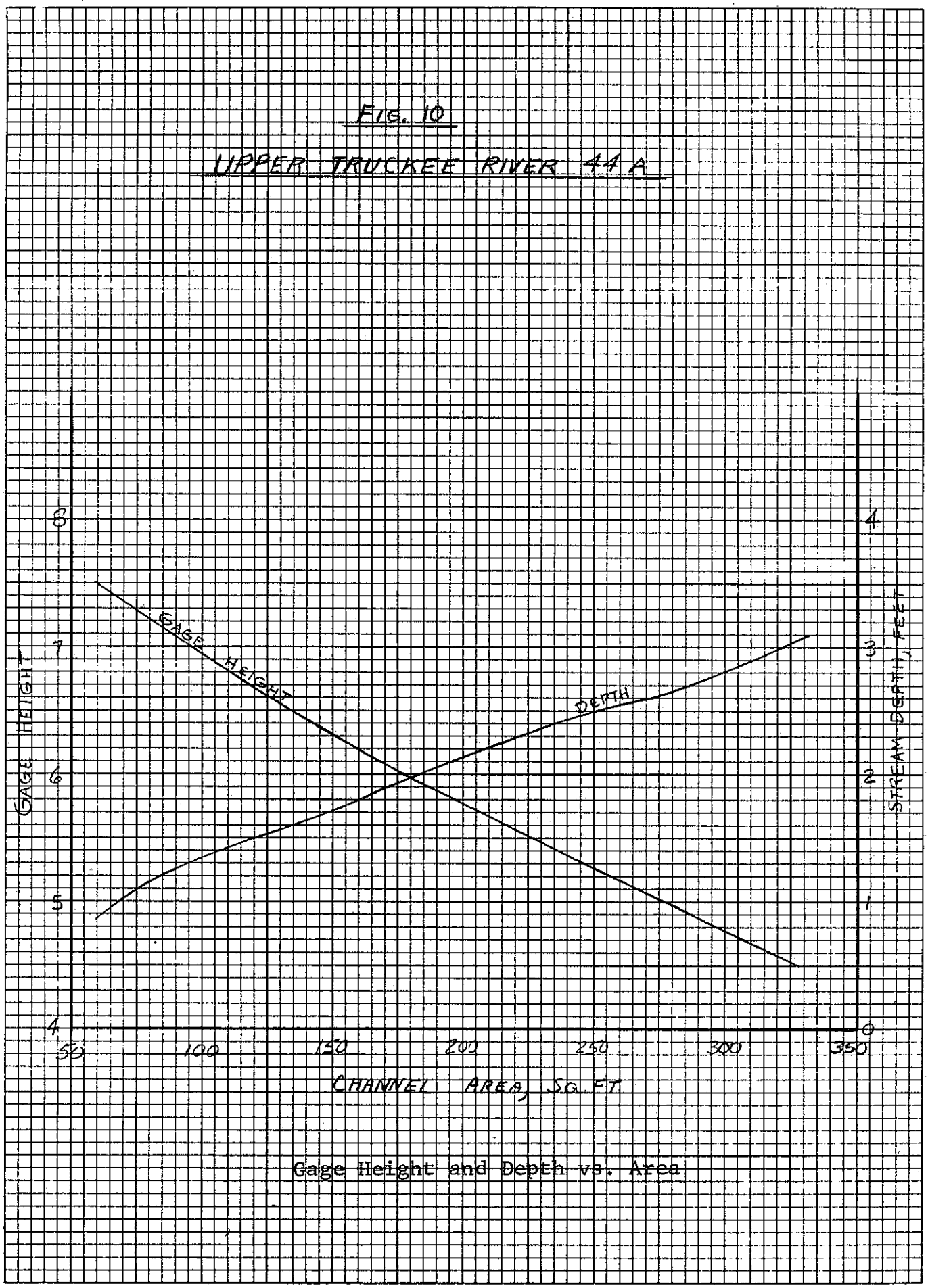

Gage Height and Depth vs. Area

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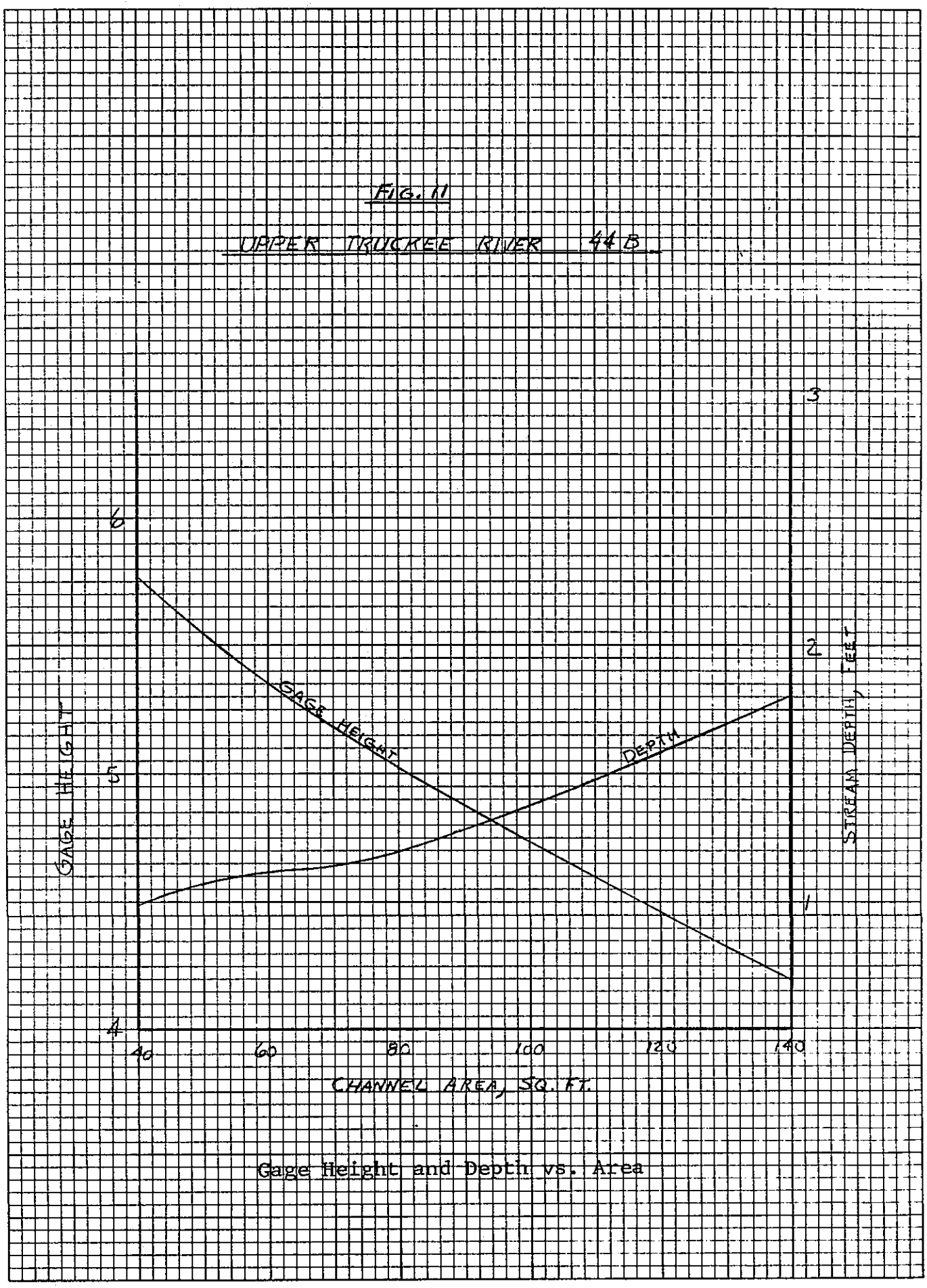

Gage Height and Depth vs. Area

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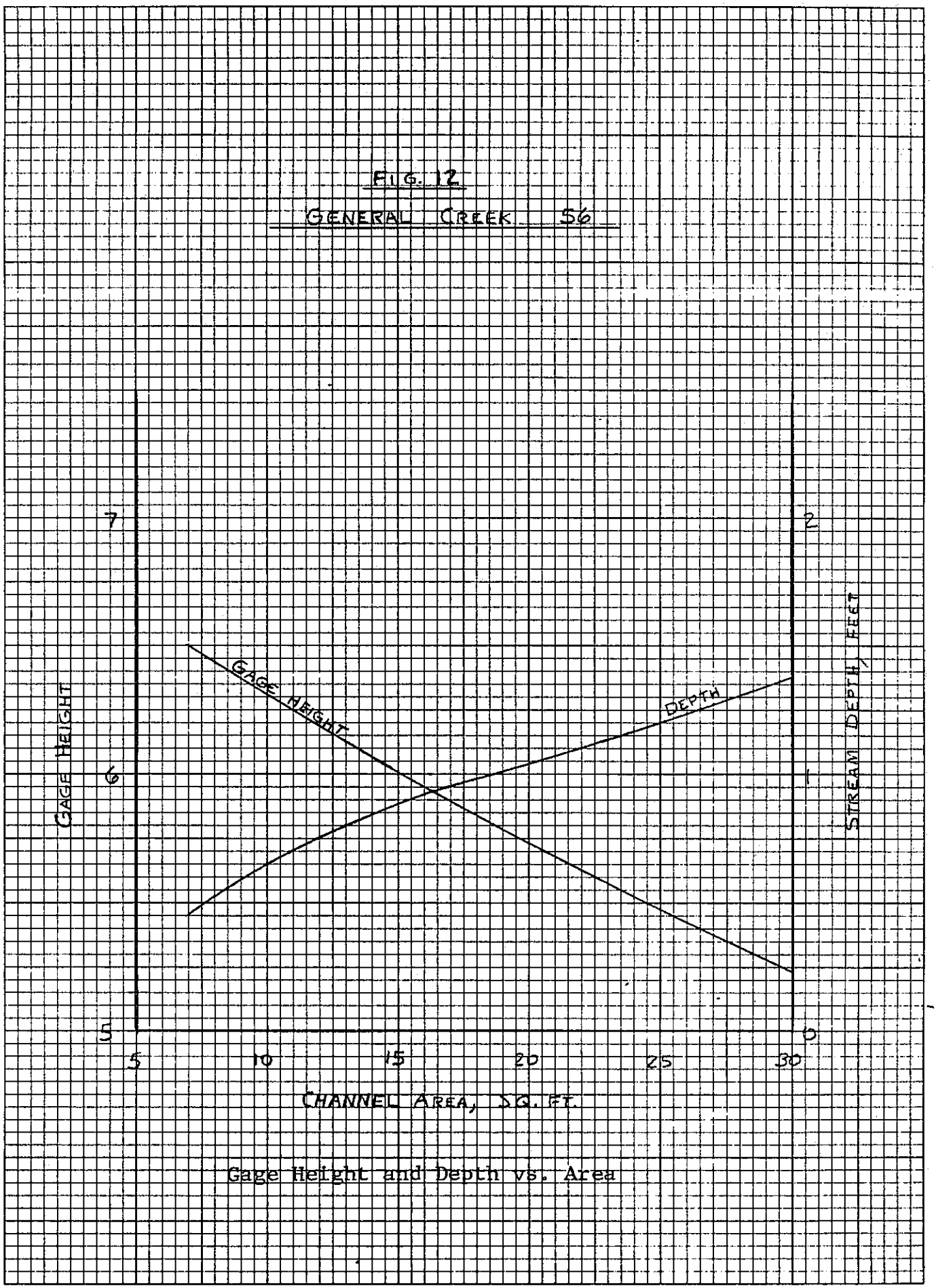

Gage Height and Depth vs. Area

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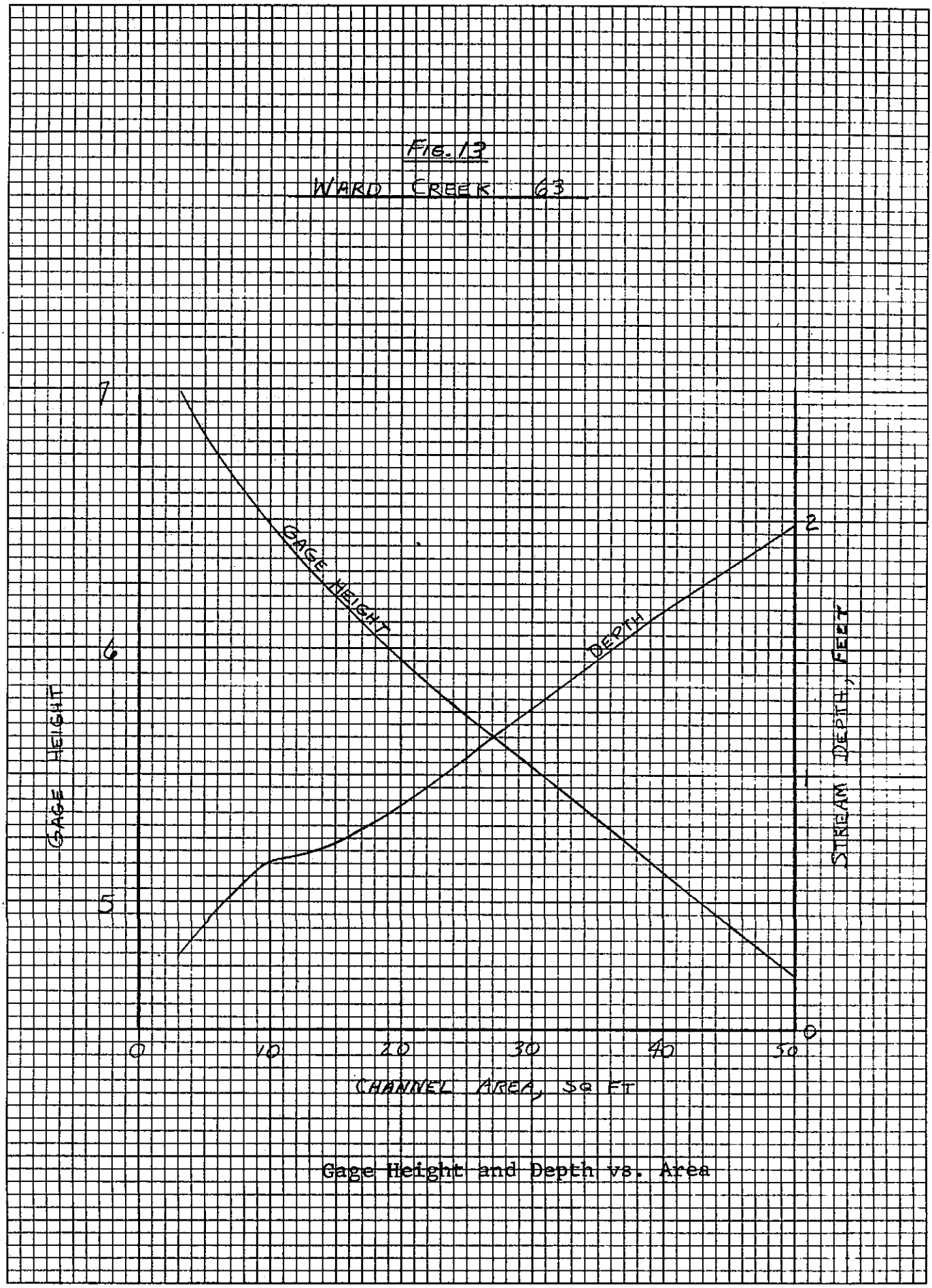

Gage Height and Depth vs. Area

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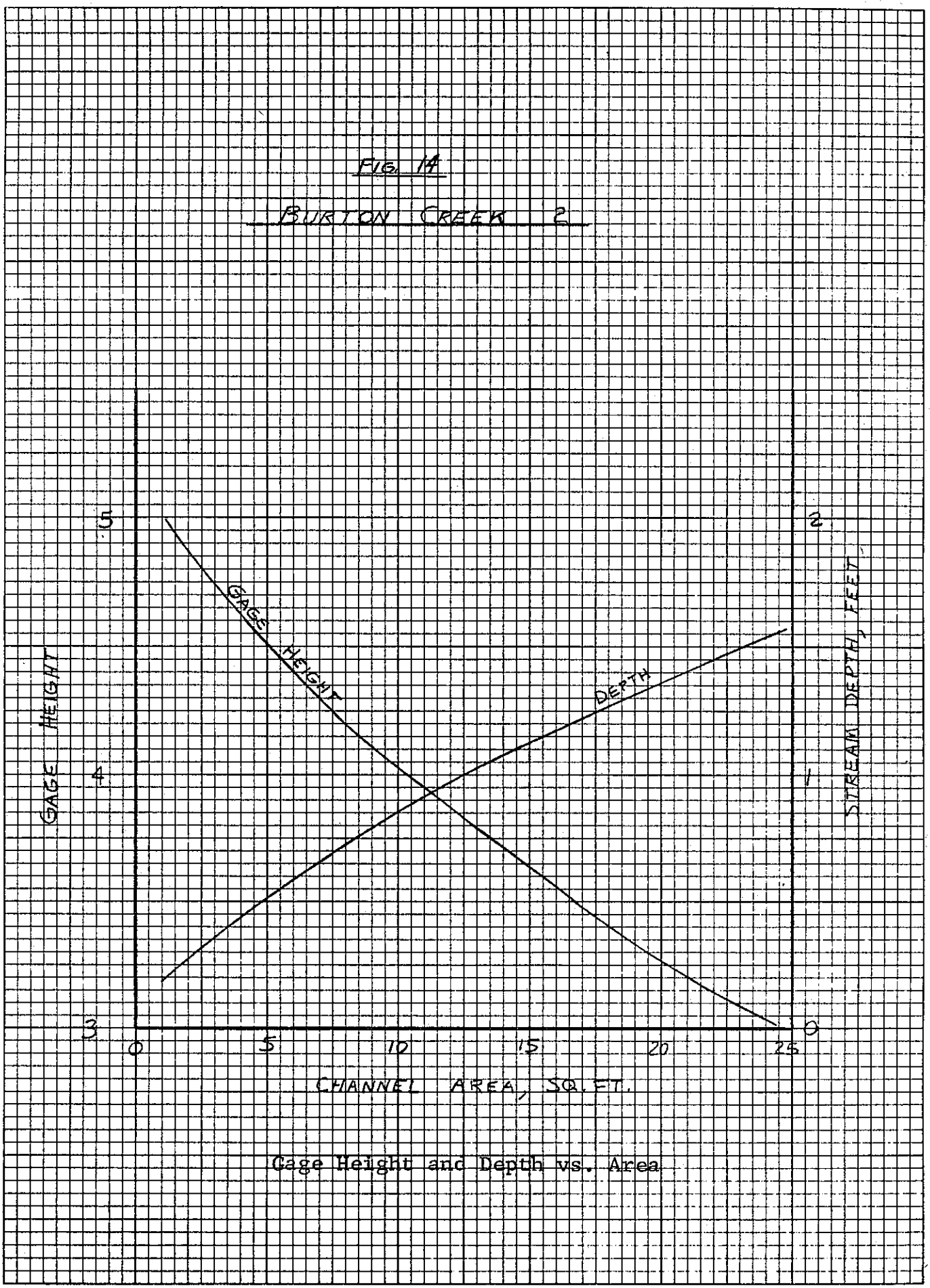

Gage Height and Depth vs. Area

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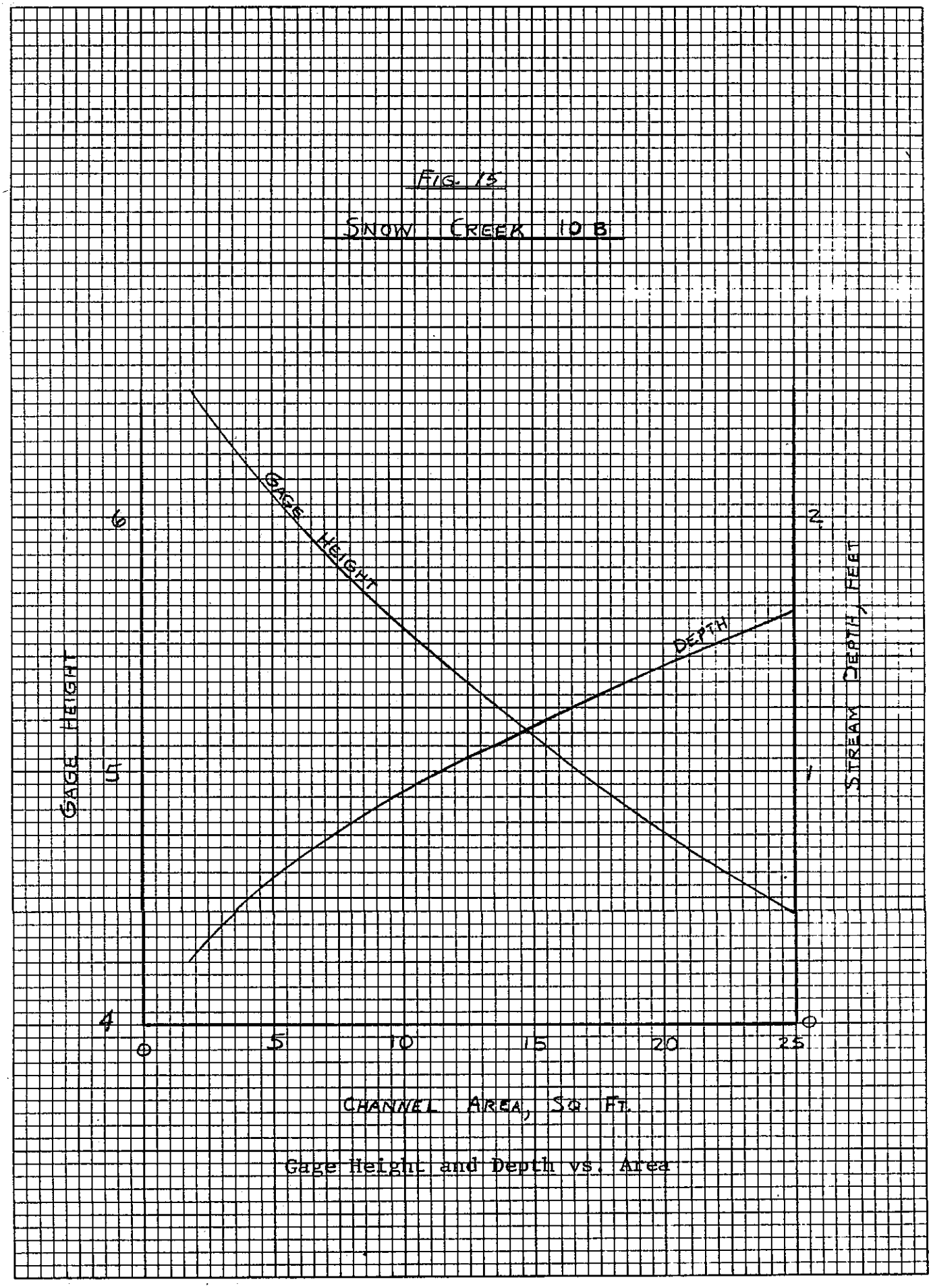

Gage Height and Depth vs. Area

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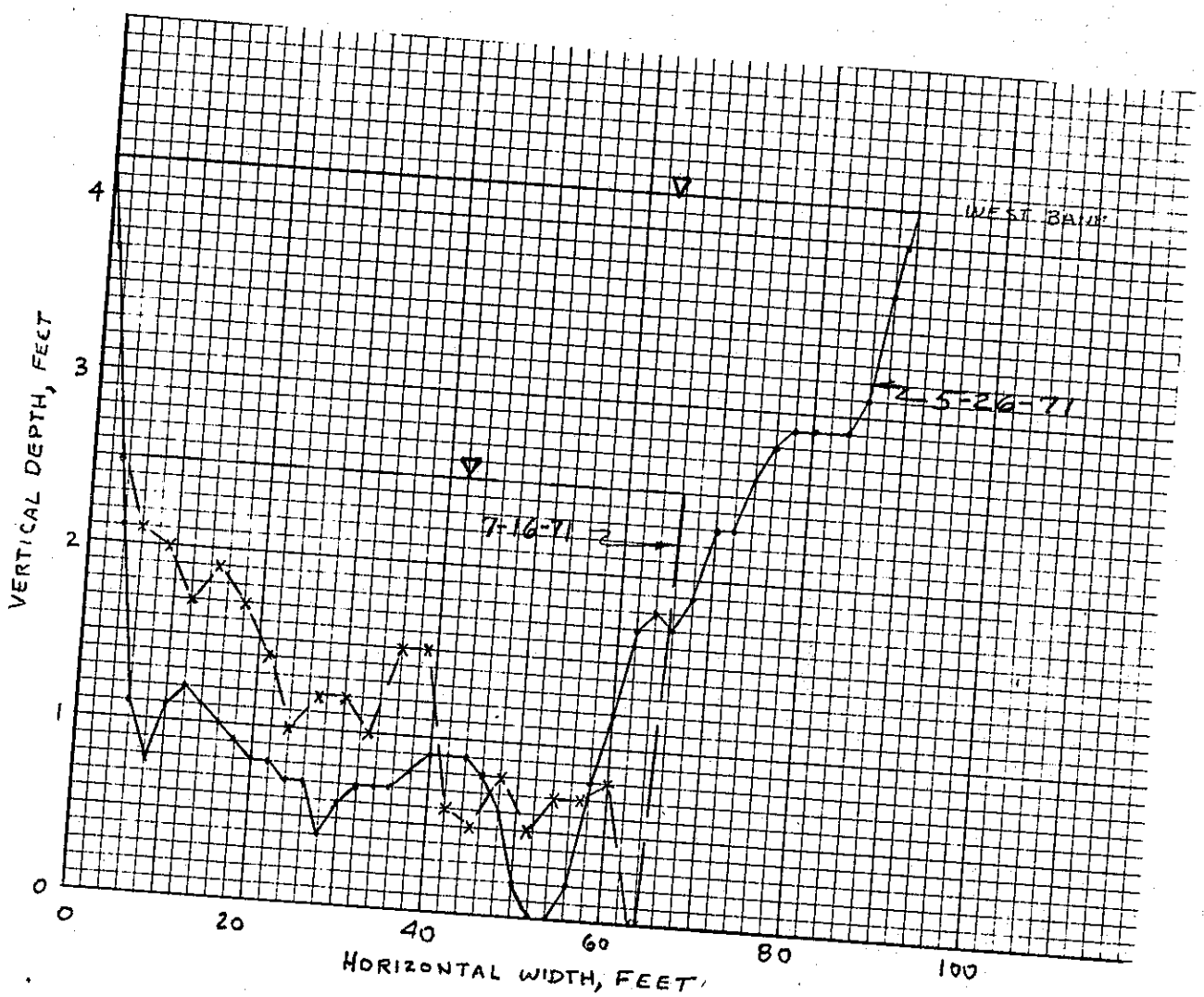
FIG. 16

CHANNEL CONFIGURATION

#44A UPPER TRUCKEE RIVER



MEASUREMENT TAKEN MAY 26, 1971

MEASUREMENT TAKEN JULY 16, 1971

WATER SURFACE

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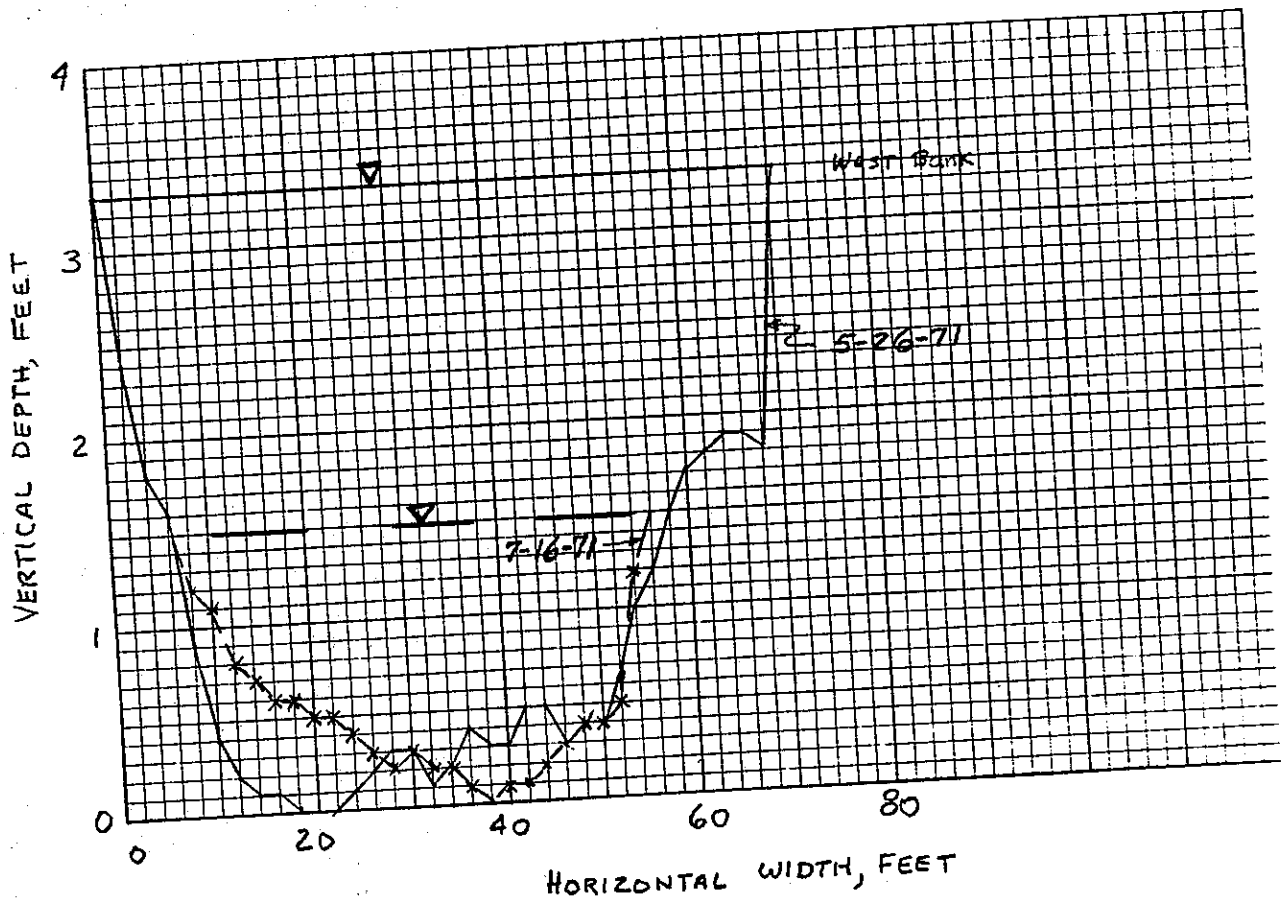
FIG. 17

CHANNEL CONFIGURATION

#44B UPPER TRUCKEE RIVER



MEASUREMENT TAKEN MAY 26, 1971

MEASUREMENT TAKEN JULY 16, 1971

WATER SURFACE

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For all of the measured streams except 44A and 44B Upper Truckee River, the channel bottom remained fairly constant during the study. However, the channel bed at 44A and 44B did change significantly as shown in Figures 16 and 17. The change affected the correlation for the stage height-discharge curves. For instance, at 44A Upper Truckee River, gage readings taken in July would read higher for less flow than readings taken in May. This effect was taken into account in developing the stage-discharge curve.

24-Hour Flow Measurements

Diurnal flow measurements were taken in March and again in May to determine runoff characteristics within a 24-hour period. It was found that the peak runoff generally occurred between 6:00 p.m. and 6:00 a.m. Figures 18 through 21 graphically depict the runoff fluctuations as measured on specific dates. The fluctuation is typical of snowmelt runoff areas.

During the course of the study the stream gages were read by maintenance personnel between 4:00 p.m. and 6:00 p.m. This period of observation was within the average, or mean flow for the day in most cases.

The fluctuations in the daily runoff were the direct result of snowmelt. Peak runoff occurred in most watersheds during the period of May to June.

Runoff Hydrographs

The graphs on pages 35 to 45 present the daily streamflow observations for the period of March through July 1, 1971. Also shown are the suspended sediment load and temperature records.

Hydrologic analyses of the streamflow data show the following watershed yields:

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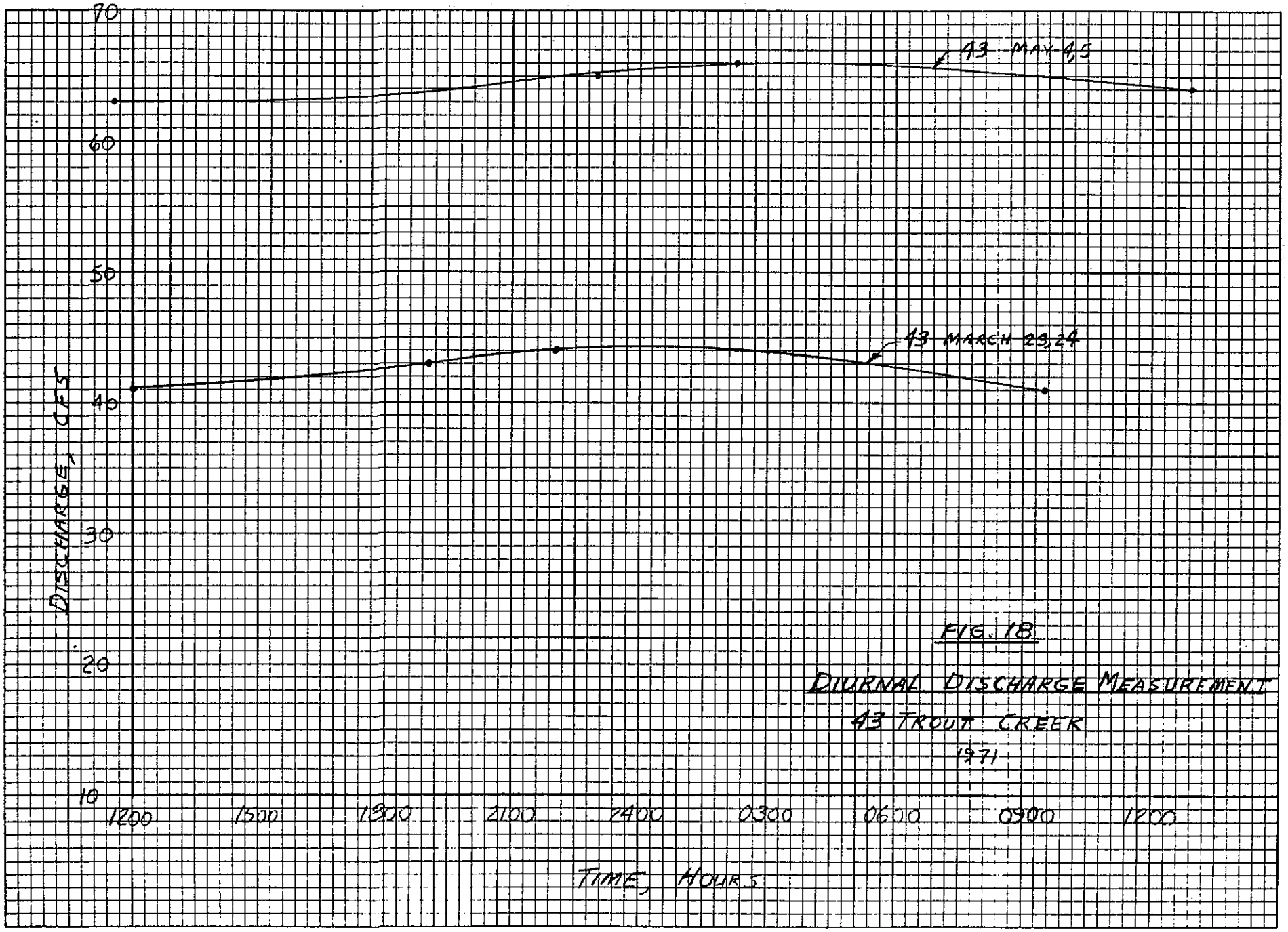

FIG. 18

DIURNAL DISCHARGE MEASUREMENT

43 TROUT CREEK

1971

MER DEPT
RBH 7/71

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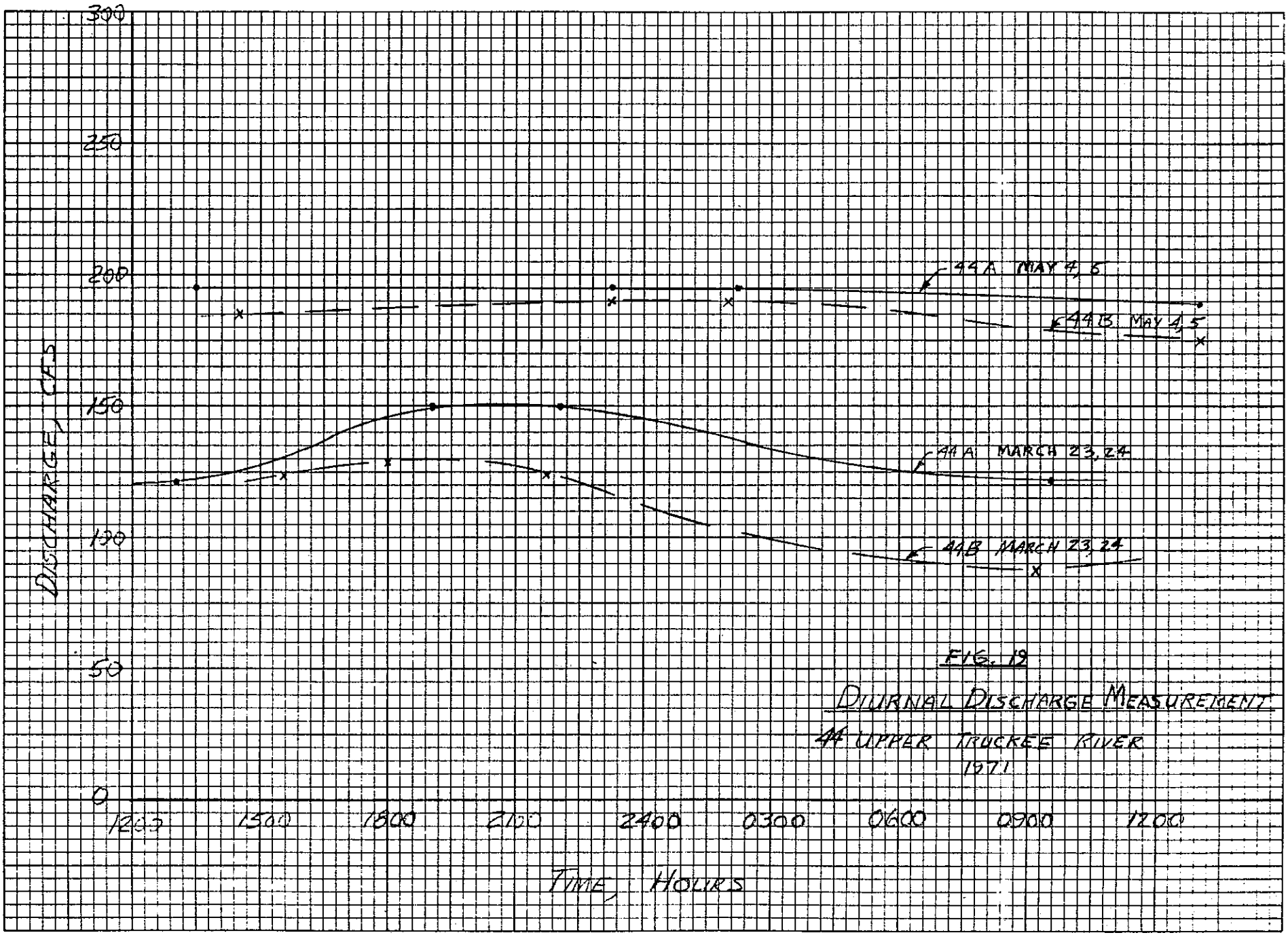

FIG. 19

DIURNAL DISCHARGE MEASUREMENT

44 UPPER TRUCKEE RIVER

1971

MER DEPT.
RBH 7/71

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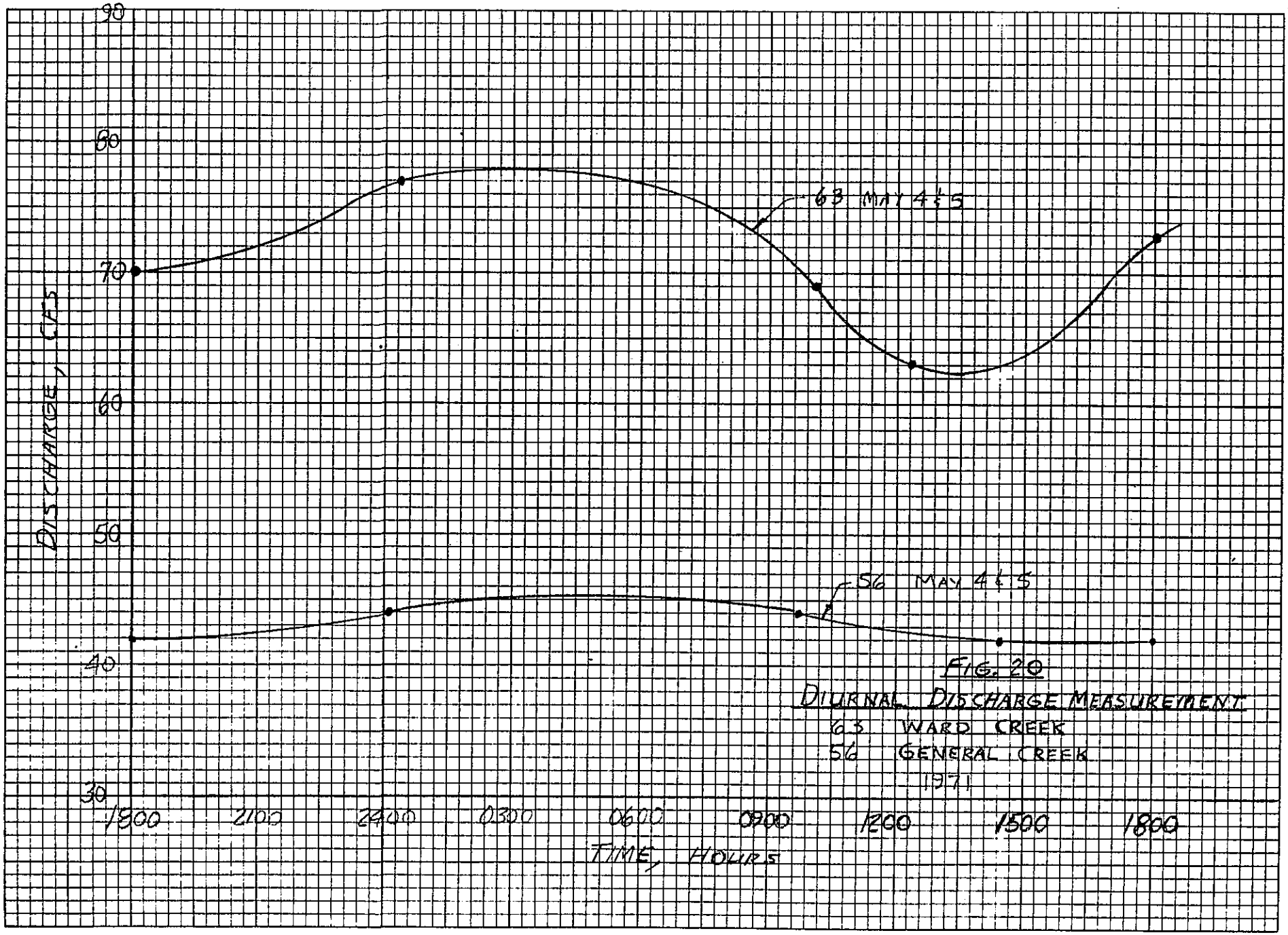

FIG. 20
DIURNAL DISCHARGE MEASUREMENT
63 WARD CREEK
56 GENERAL CREEK
1971

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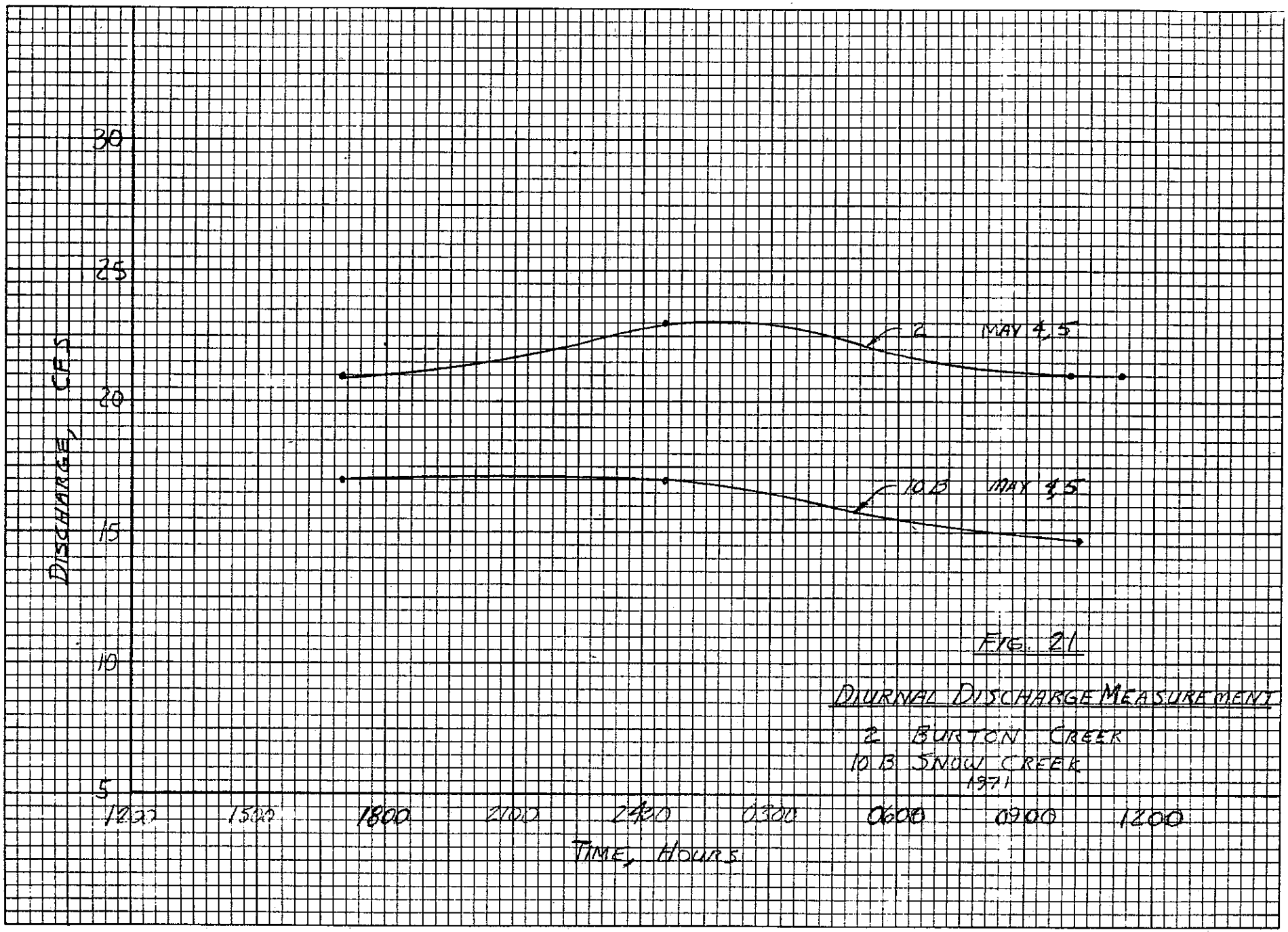

FIG. 21

DIURNAL DISCHARGE MEASUREMENT
2 BURTON CREEK
10 B SNOW CREEK
1971

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Streamflow Data

Stream		Mean Daily Flow (cfs)			
		Mar.	Apr.	May	June
43	Trout Creek	49	57	79	126
49A	Upper Truckee River	156	161	326	443
44B	Upper Truckee River	144	153	305	339
44D	Upper Truckee River	59	84	225	311
53	Lonely Gulch			7	12
56	General Creek	18	31	123	106
62	Blackwood Creek	38	53	152	179
63	Ward Creek	44	53	119	148
2	Burton Creek	8	11	59	10
10B	Snow Creek	5	10	17	4

		Runoff Yield (ac-ft)				
		Mar.	Apr.	May	June	Total
43	Trout Creek	882	3,410	4,880	7,562	16,734
49A	Upper Truckee River	2,808	9,688	20,212	26,570	59,278
44B	Upper Truckee River	2,586	9,142	18,896	20,322	50,946
44D	Upper Truckee River	1,058	5,010	13,810	14,942	34,820
53	Lonely Gulch			441	720	1,161
56	General Creek	322	1,858	7,610	6,364	16,154
62	Blackwood Creek	684	3,180	9,340	10,680	23,884
63	Ward Creek	792	3,178	7,392	8,876	20,238
2	Burton Creek	142	668	3,632	596	5,038
10B	Snow Creek	91	590	1,038	238	1,957

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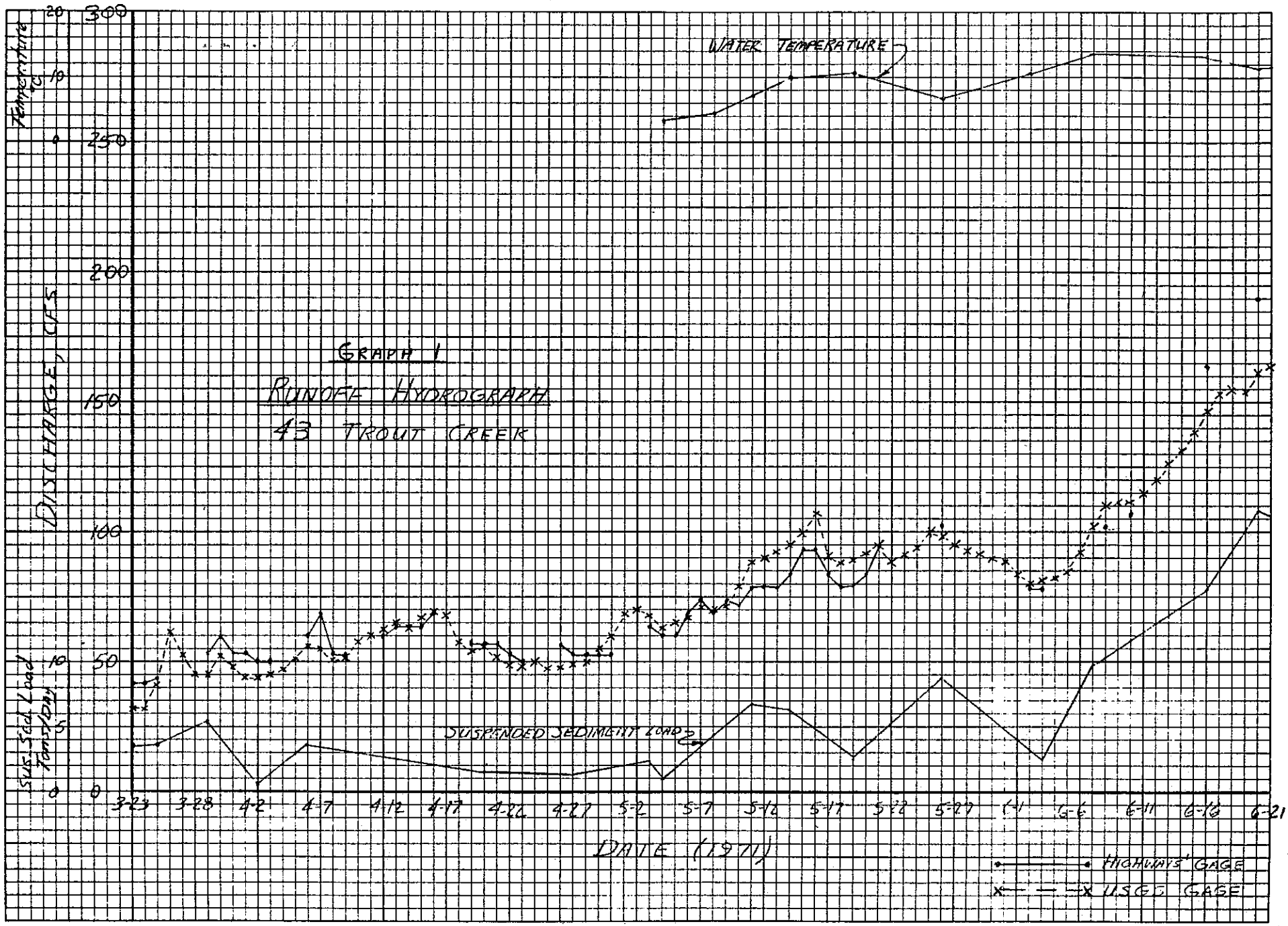

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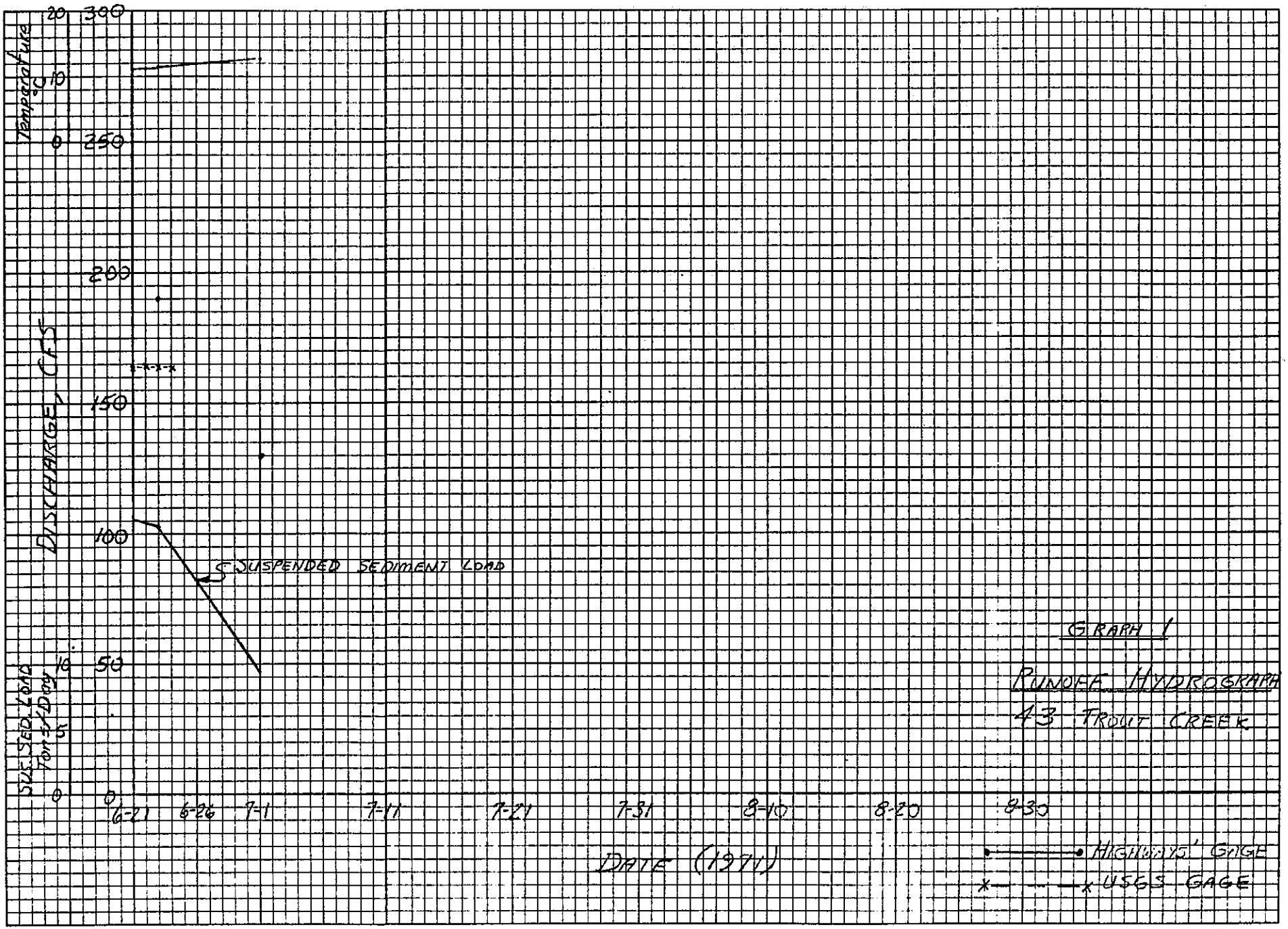

GRAPH 1

RUNOFF HYDROGRAPH

43 TROUT CREEK

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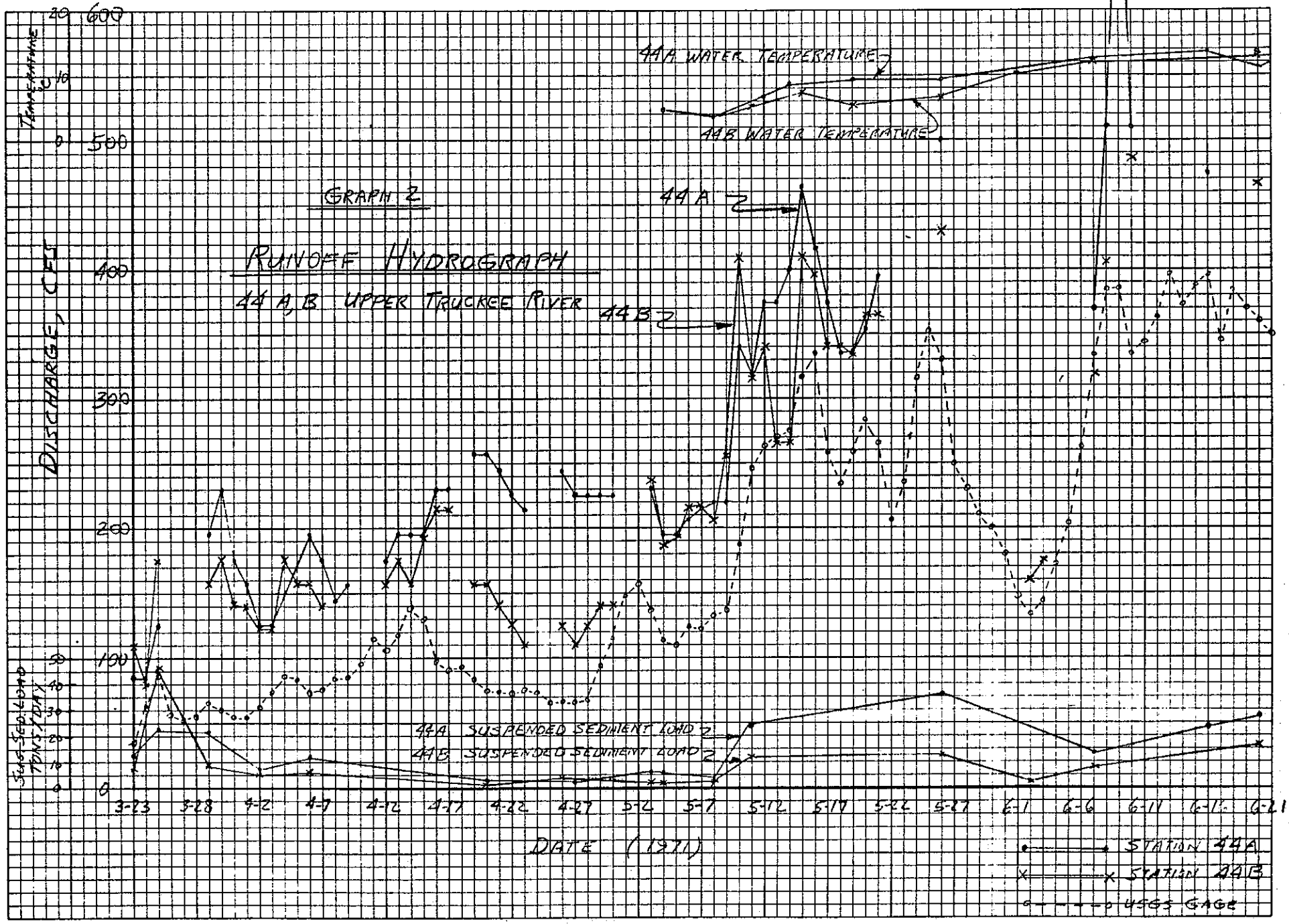

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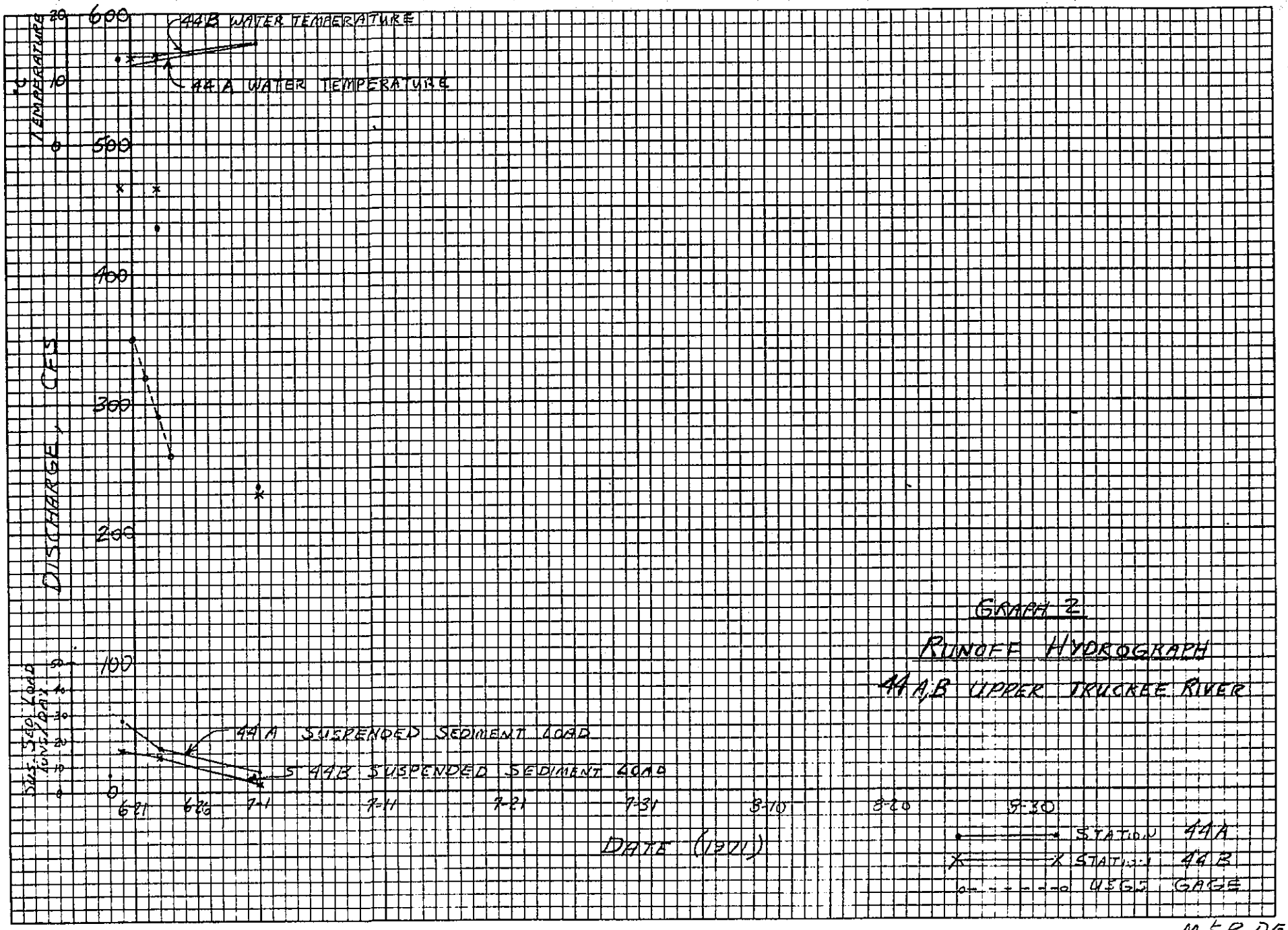

GRAPH 2

RUNOFF HYDROGRAPH

44 A,B UPPER TRUCKEE RIVER

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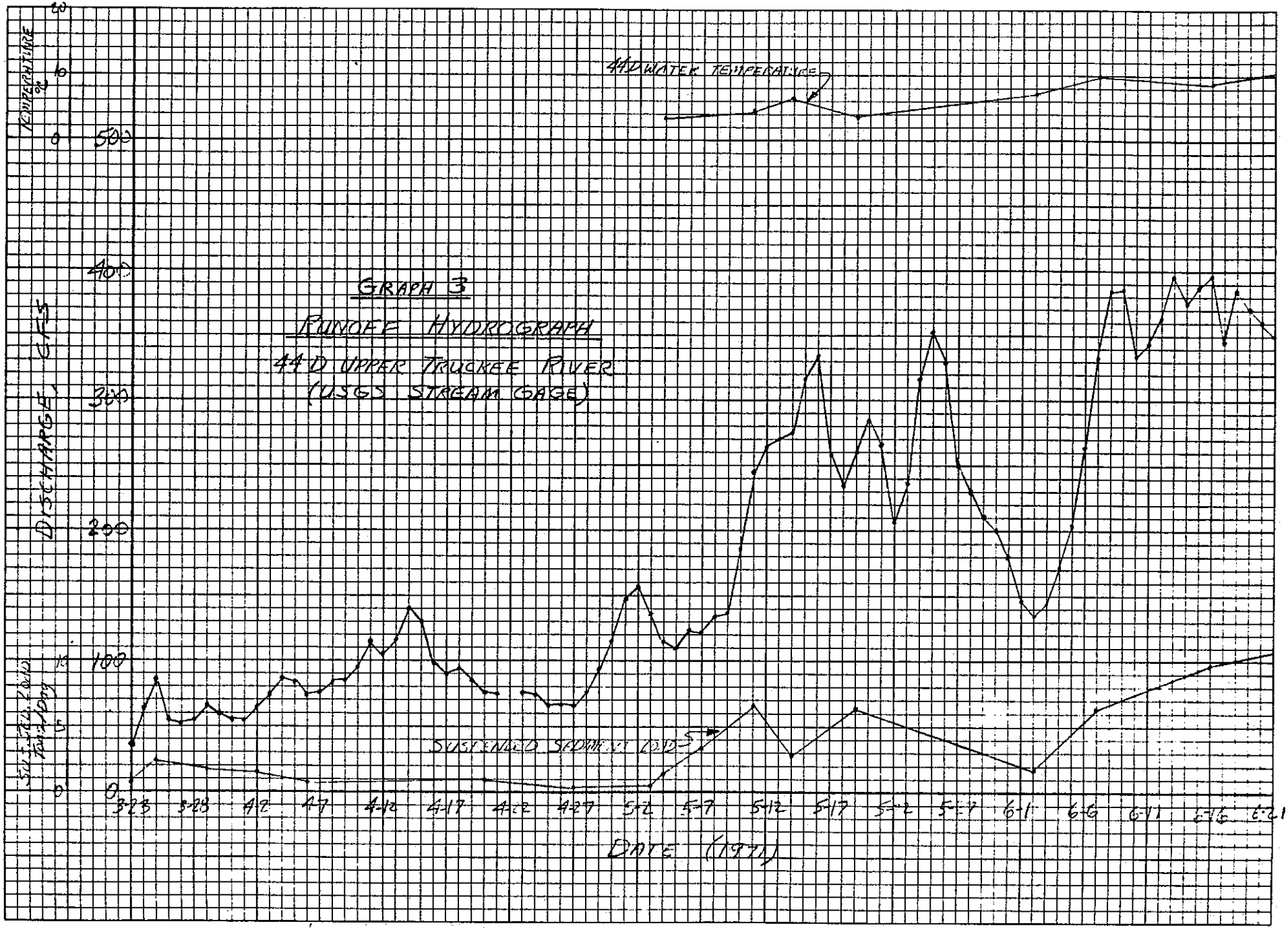

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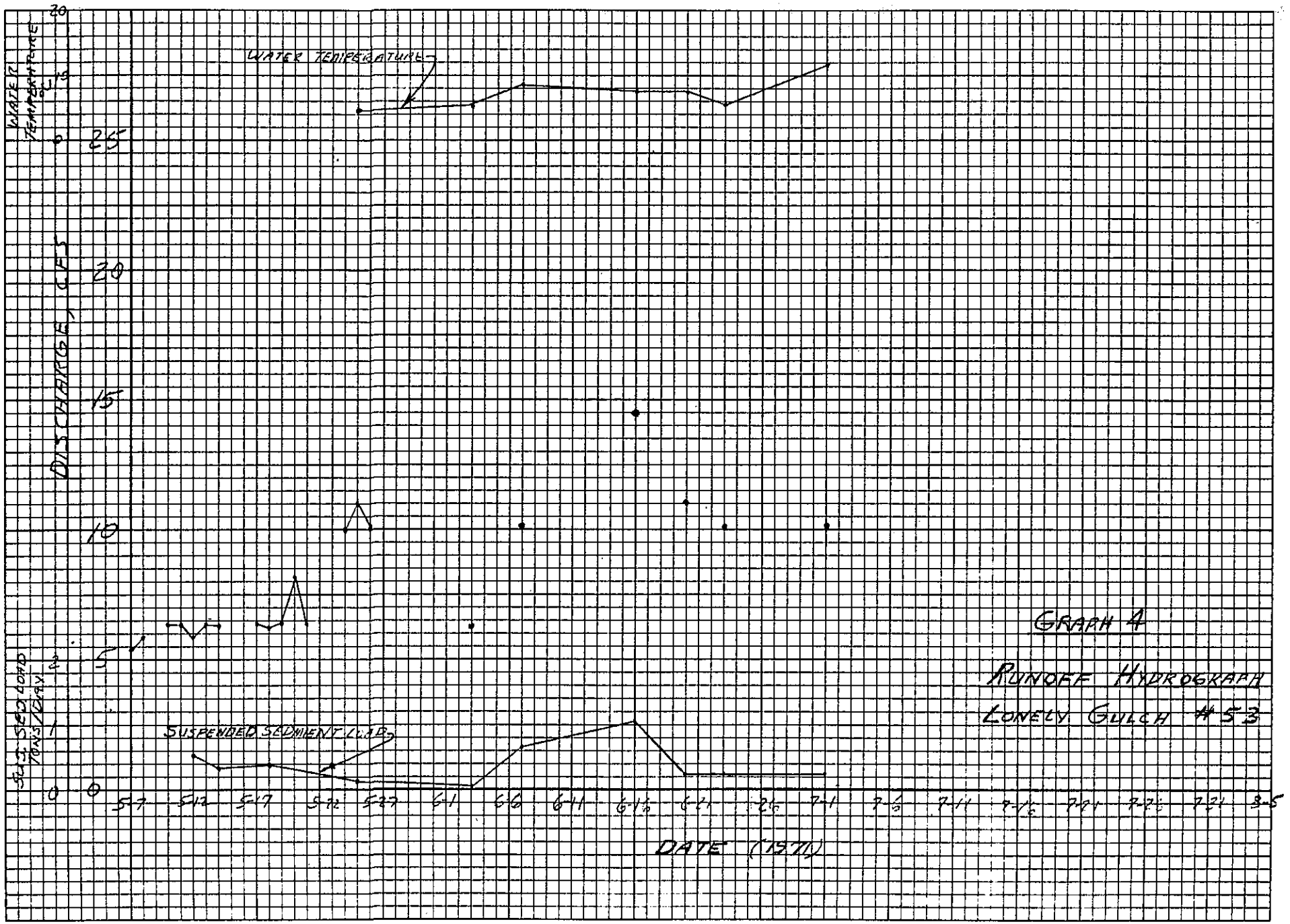

GRAPH 4

RUNOFF HYDROGRAPH

LONELY GULCH #53

MER DEPT
RPH 7/71

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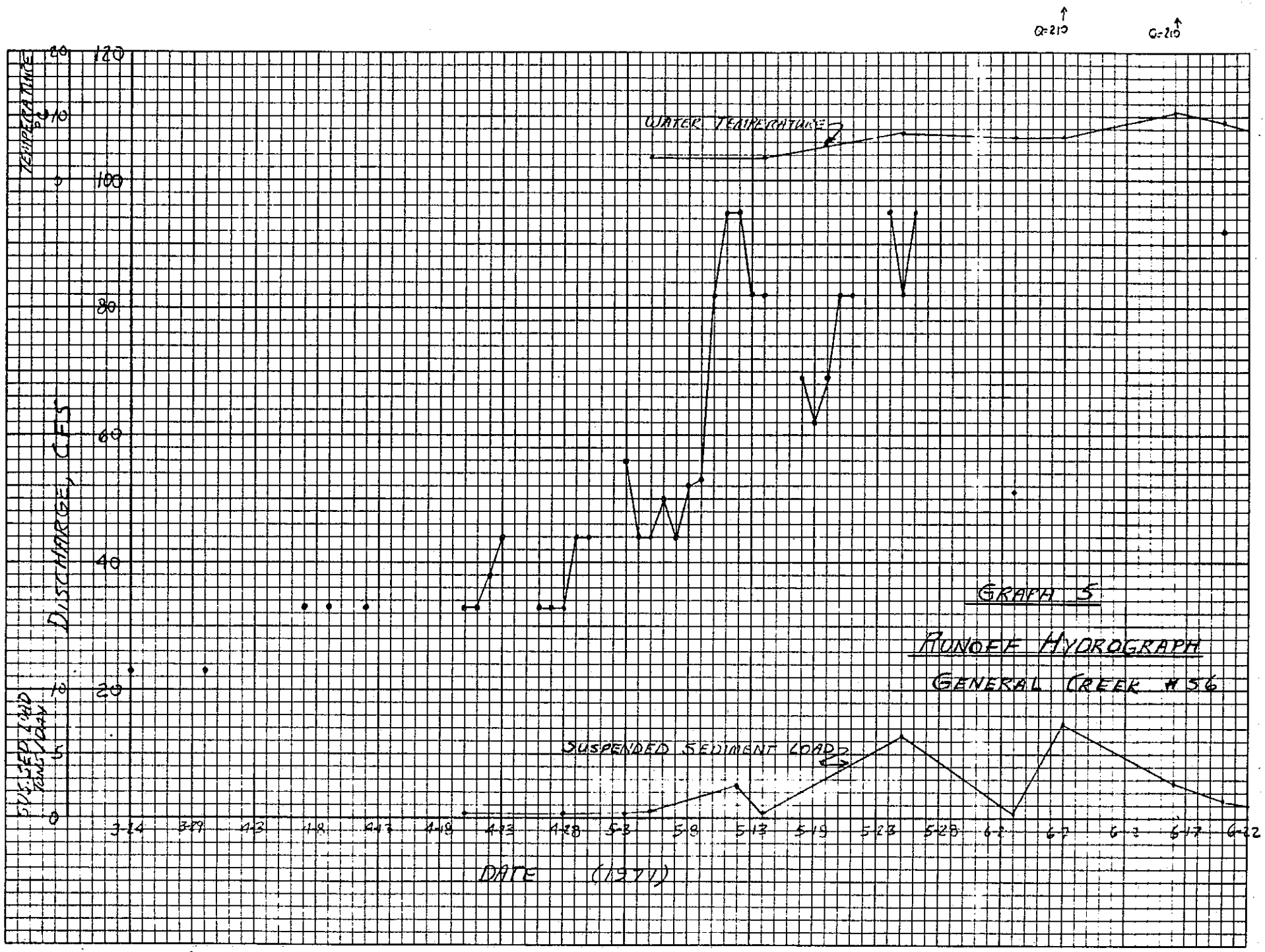

DEPT
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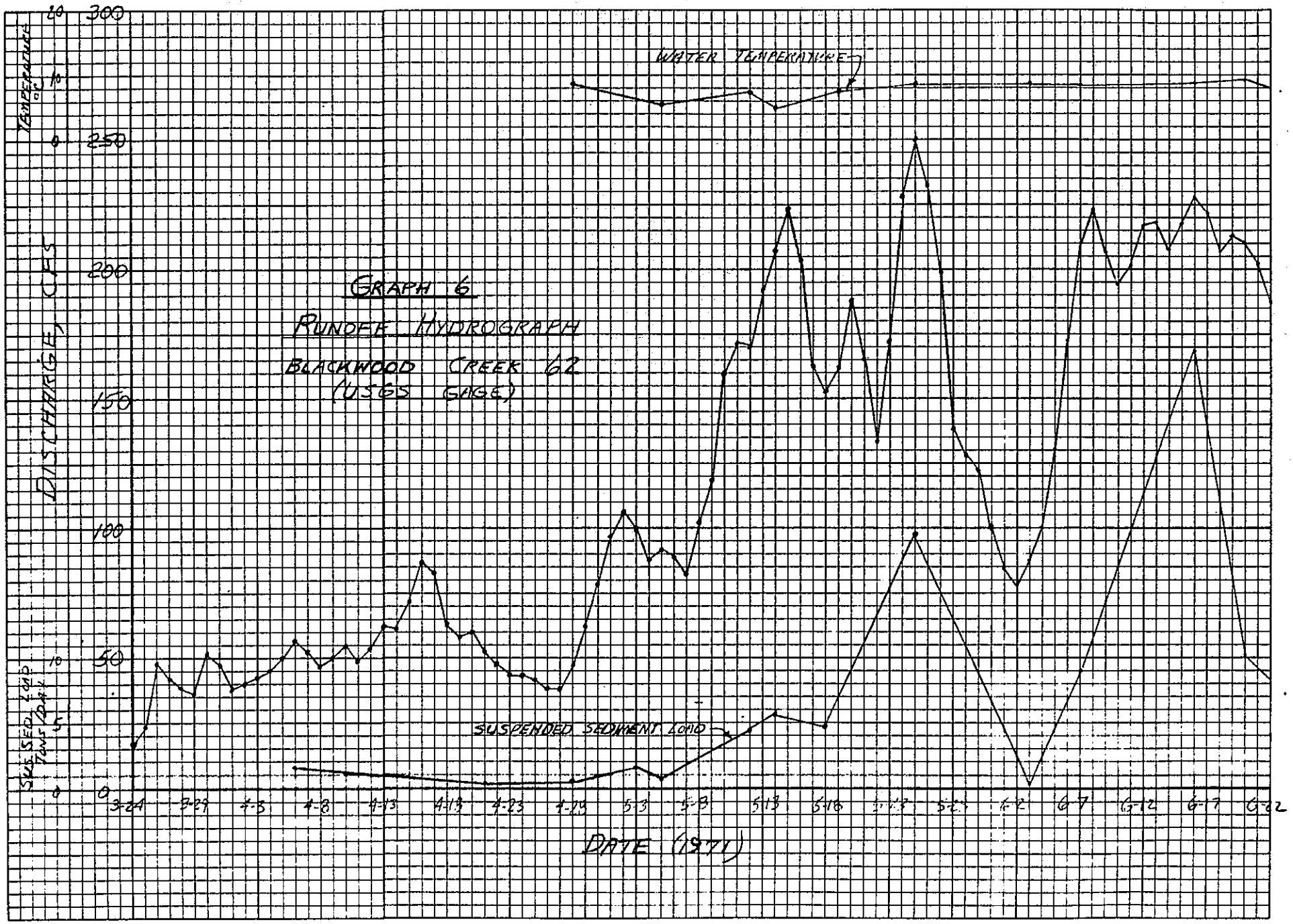

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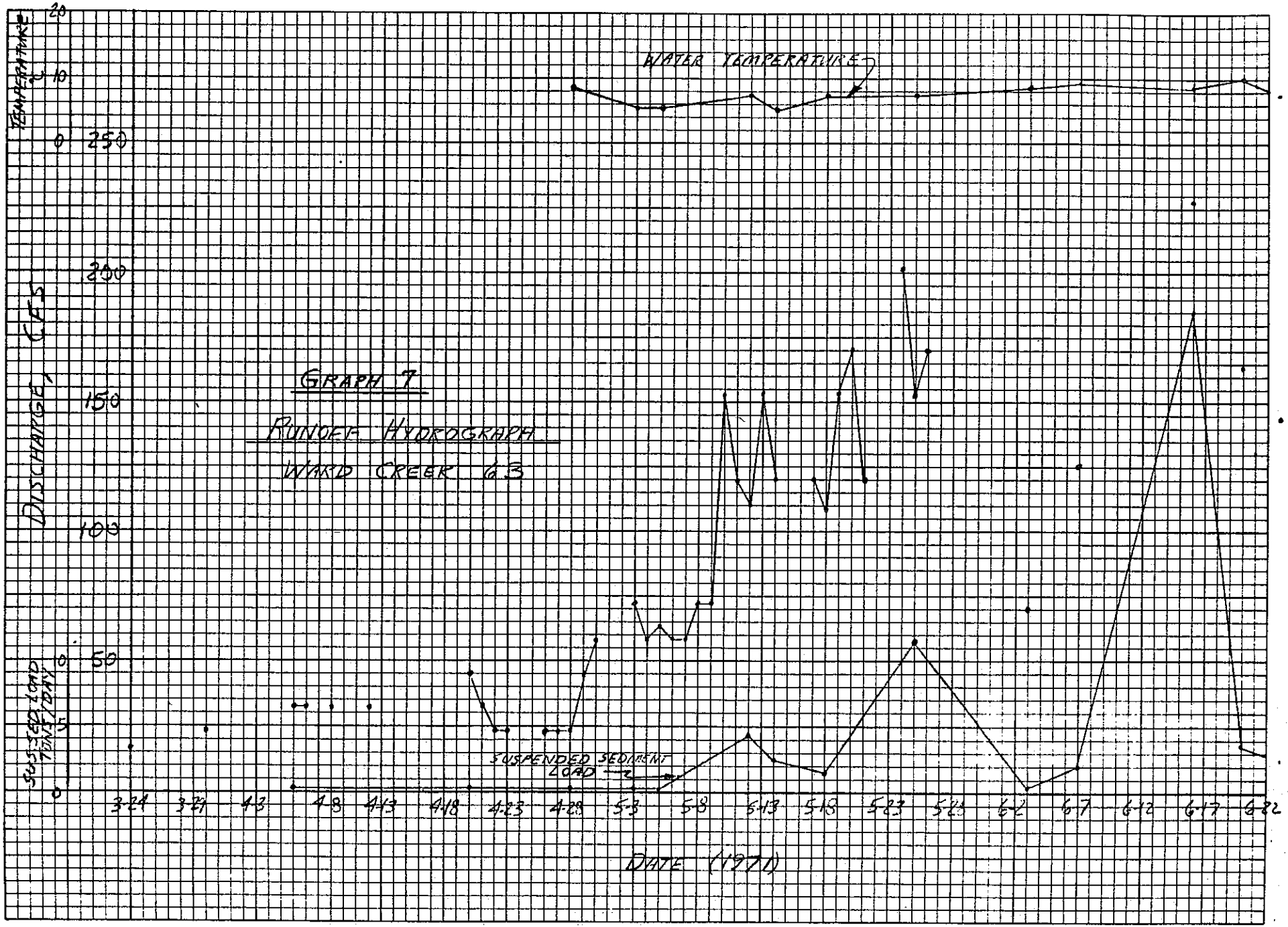

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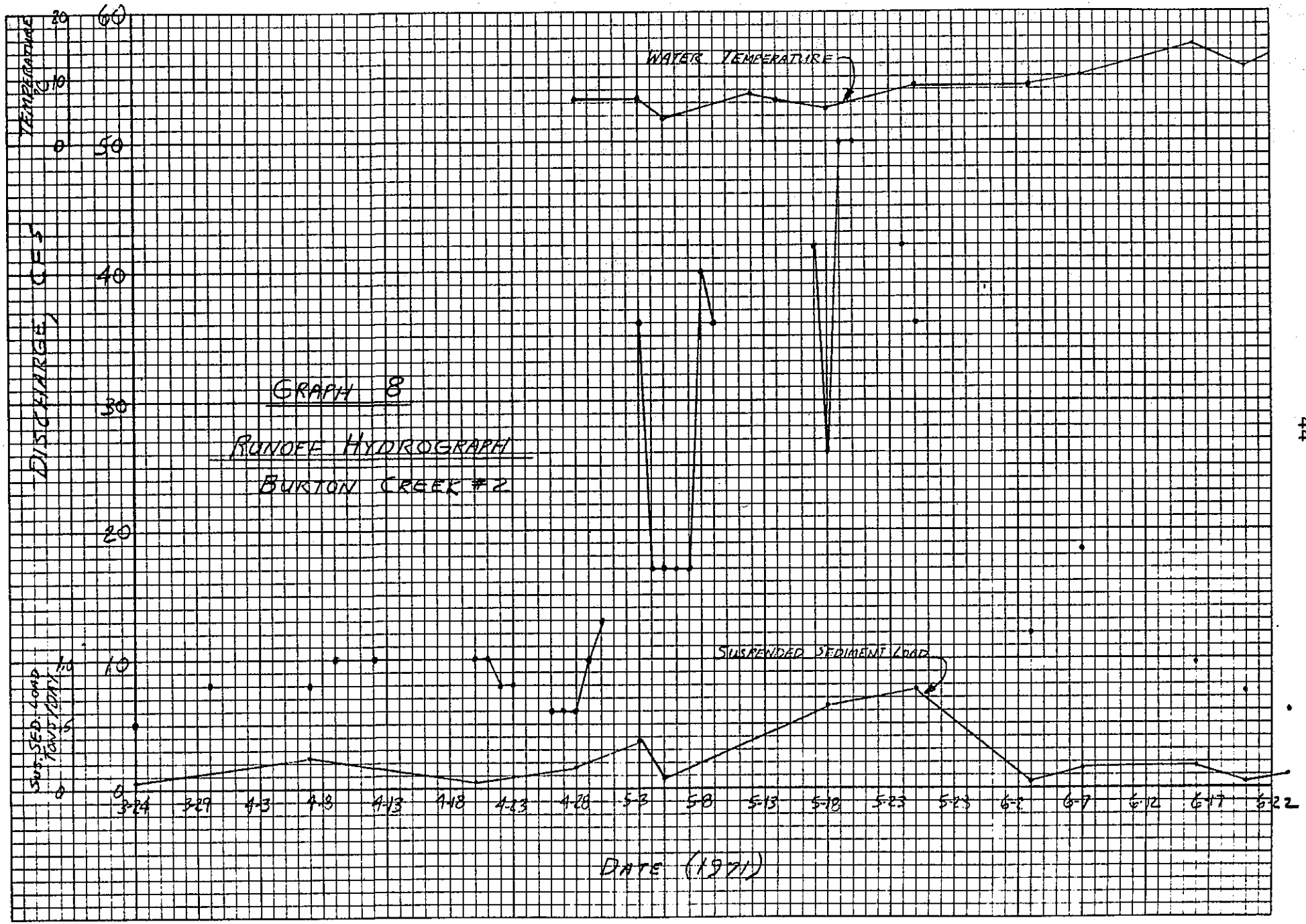

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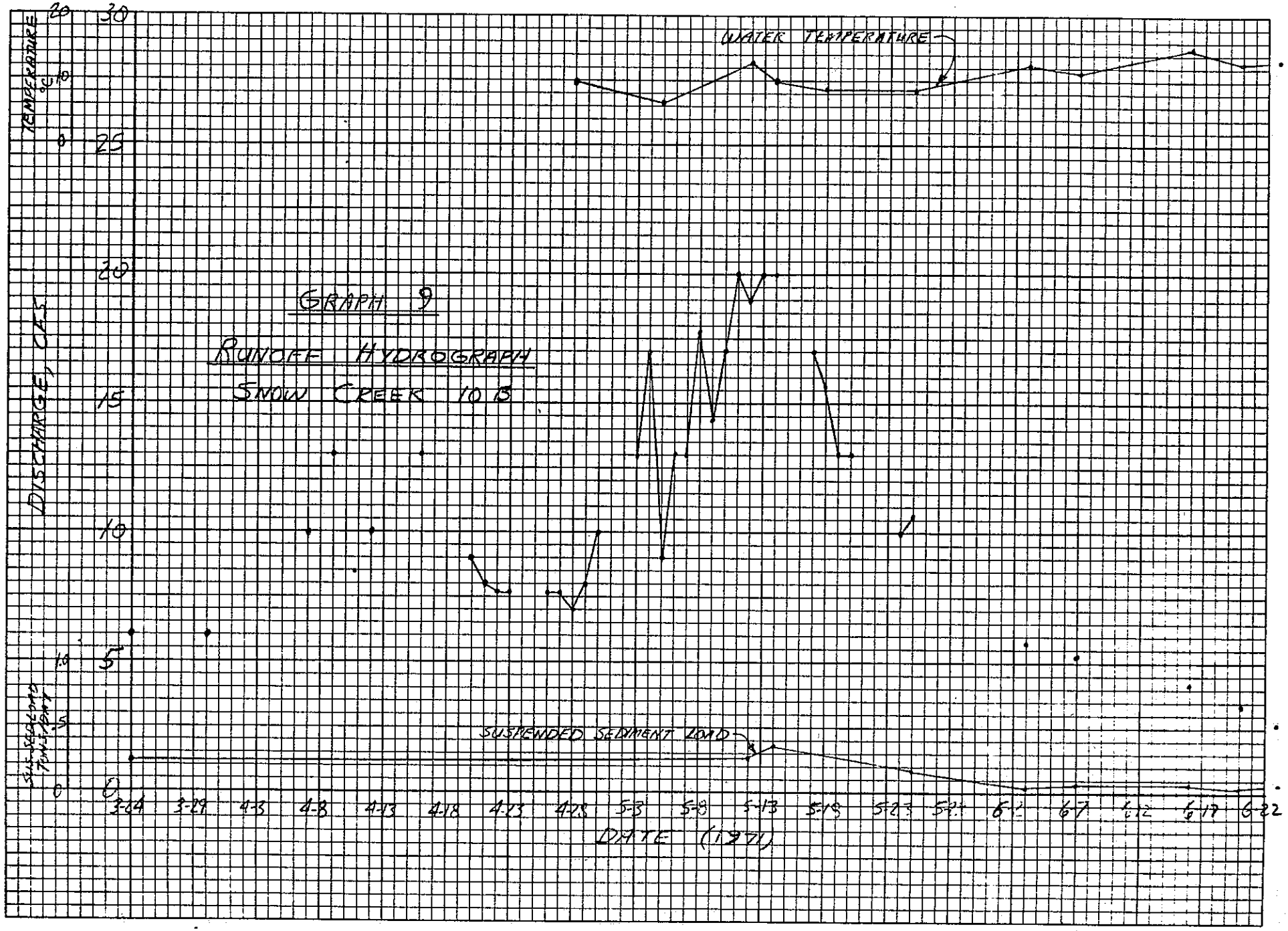

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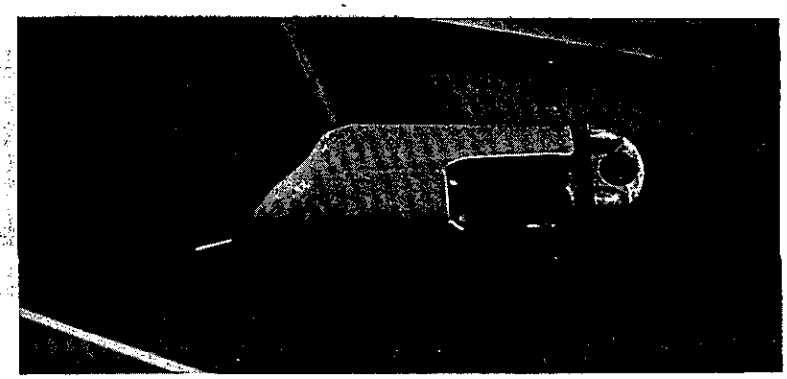
Suspended Sediment

Sampling Techniques

Suspended sediment samples were collected periodically at each of the sampling locations. Prescribed sampling techniques of the U.S. Geological Survey 1/ were used to procure samples.

A US-DH 48 depth-integrating suspended sediment sampler with a 3/8" nozzle was used to collect the suspended samples in one pint milk bottles. The samples were collected by moving the sampler through a vertical section of the stream at a uniform rate. Depending on the stream velocity, a pint jar was generally filled in a 20-second period (corresponding to a 4 fps stream velocity).

The District 03 Materials Laboratory in Marysville analyzed the suspended sediment samples using U.S.G.S. laboratory analysis procedures 2/. The method consists of filtering the fluid through an asbestos mat filter and weighing the dried residue. The results are reported in mg/l of concentrated suspended sediment.



U.S. DH-48 Depth-Integrating Suspended Sediment Sampler.

1/ Field Methods for Measurement of Fluvial Sediment, U.S. Geological Survey.

2/ "Laboratory Theory and Methods for Sediment Analysis", U.S. Geological Survey.

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Sediment Discharge

The suspended sediment concentrations are reported in Table 1 through 10.

The U.S. Geological Survey instantaneous suspended sediment computer program was uitilized to determine suspended sediment discharge in tons/day. Tables 11 through 20 report the rates as computed. These figures represent total suspended sediment discharge from all sources.

The sediment discharge from highway sources was determined by a field examination of road slopes. The results of that study are reported in a separate report titled "Slope Erosion Transects-Lake Tahoe Basin," July 1971 (Materials and Research Department Report No. 657078-1). The results of the slope erosion study are presented as cubic yards of eroded material available for transport to the tributaries of Lake Tahoe. To compare these results with the suspended sediment discharge totals reported by this study, it was necessary to convert the slope erosion cubic yards to "tons" of sediment. A factor of 1.5 tons/cy was used for the material based on studies performed by other agencies[1/].

1/ "Sedimentation and Erosion in the Upper Truckee River and Trout Creek Watershed," California Division of Soil Conservation, July 1969.

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TABLE 1

Tributary Data

LOCATION: Trout Creek #43

Date 1971	Gage Height (ft)	Flow (cfs)	Depth (ft)	Area (ft^2)	Mean Velocity (fps)	Temp °C	Turbidity	Sus Sed Conc mg/l
3/23	6.2	42	1.3	28	1.5	3.3	13	29
24	6.2	42	1.3	28	1.5			
25	6.1	44	1.4	30	1.5	3.3	25	31
26								
27								
28								
29	5.8	53	1.7	37	1.4	3.3	15	37
30	5.6	60	1.9	41	1.5			
31	5.8	53	1.7	37	1.4			
4/ 1	5.8	53	1.7	37	1.4			
2	5.9	50	1.6	34	1.5	3.3	6.3	4
3	5.9	50	1.6	34	1.5			
4								
5								
6	5.6	60	1.9	41	1.5	3.3	8.7	23
7	5.4	69	2.1	45	1.5			
8	5.8	53	1.7	37	1.4			
9	5.8	53	1.7	37	1.4			
10								
11								
12	5.6	60	1.9	41	1.5			
13	5.5	64	2.0	43	1.5			
14	5.5	64	2.0	43	1.5			
15	5.5	64	2.0	43	1.5			
16	5.4	69	2.1	45	1.5			
17								
18								
19	5.7	56	1.8	39	1.4			
20	5.7	56	1.8	39	1.4	3.3	5	10
21	5.7	56	1.8	39	1.4			
22	5.8	53	1.7	37	1.4			
23	5.9	50	1.6	34	1.5			
24								
25								
26	5.7	56	1.8	39	1.4			
27	5.8	53	1.7	37	1.4	3.3	4	8
28	5.8	53	1.7	37	1.4			
29	5.8	53	1.7	37	1.4			
30	5.8	53	1.7	37	1.4			
5/ 1								
2								
3	5.5	64	2.0	43	1.5	3.3	5.5	12
4	5.6	60	1.9	41	1.5	3.6	5	6
5	5.6	60	1.9	41	1.5			

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TABLE I

Tributary Data (contd)

LOCATION: Trout Creek #43

Date 1971	Gage Height (ft)	Flow (cfs)	Depth (ft)	Area (ft^2)	Mean Velocity (fps)	Temp °C	Turb-idity	Sus Sed Conc mg/l
5/ 6	5.4	69	2.1	45	1.5			
7	5.31	74	2.2	47	1.6			
8	5.4	69	2.1	45	1.5	4.2	4.2	22
9	5.31	74	2.2	47	1.6			
10	5.36	71	2.2	46	1.5			
11	5.23	78	2.3	48	1.6	7.2	1.0	32
12	5.2	79	2.3	49	1.6			
13	5.2	79	2.3	49	1.6			
14	5.10	84	2.4	51	1.6	10.0	5.5	27
15	4.94	93	2.5	54	1.7			
16	4.95	93	2.5	54	1.7			
17	5.10	84	2.4	51	1.6			
18	5.2	79	2.3	49	1.6			
19	5.17	80	2.3	50	1.6	10.6	3.5	13
20	5.10	84	2.4	51	1.6			
21	4.9	95	2.4	55	1.7			
22								
23								
24								
25								
26	4.78	102	2.4	58	1.8	6.7	4.5	32
27								
28								
29								
30								
31								
6/ 1								
2	5.23	78	2.5	48	1.6	10.6	3	11
3	5.21	78	2.3	49	1.6			
4								
5								
6								
7	5.01	93	2.5	53	1.8	13.9	4.3	39
8	4.79	102	2.4	58	1.8			
9								
10	4.67	106	2.3	60	1.8			
11								
12								
13								
14								
15								
16	4.18	164	3.6	80	2.0	13.3	5.2	35
17								
18								
19								

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TABLE I

Tributary Data (contd)

LOCATION: Trout Creek #43

Date 1971	Gage Height (ft)	Flow (cfs)	Depth (ft)	Area (ft^2)	Mean Velocity (fps)	Temp °C	Turb-idity	Sus Sed Conc mg/l
6/20	3.90	190	3.9	90	2.1	11.1	5.5	42
21								
22								
23	3.90	190	3.9	90	2.1	11.7	5.2	40
24								
25								
26								
27								
28								
29								
30								
7/ 1	4.50	130	3.0	67	1.9	12.8	5.0	27

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TABLE 2

Tributary Data

LOCATION: Upper Truckee River #44A

Date 1971	Gage Height (ft)	Flow (cfs)	Depth (ft)	Area (ft^2)	Mean Velocity (fps)	Temp °C	Turb-idity	Sus Sed Conc mg/l
3/23	7.1	110	1.3	90	1.2	3.3	21	59
24	7.1	110	1.3	90	1.2	3.3	44	70
25	6.8	138	1.4	110	1.2			
26								
27						3.3	18	40
28								
29	6.4	187	1.7	145	1.3			
30	6.2	218	1.8	160	1.4			
31	6.5	173	1.6	135	1.3			
4/ 1	6.6	160	1.5	125	1.3	3.3	4.5	18
2	6.8	138	1.4	110	1.3			
3	6.8	138	1.4	110	1.3			
4						3.3	8.8	22
5								
6	6.4	187	1.7	145	1.3			
7	6.5	173	1.6	135	1.3			
8	6.7	149	1.5	120	1.2			
9	6.6	160	1.5	125	1.3			
10								
11								
12	6.5	173	1.6	135	1.3			
13	6.4	187	1.7	145	1.3			
14	6.4	187	1.7	145	1.3			
15	6.4	187	1.7	145	1.3			
16	6.2	218	1.8	160	1.4			
17	6.2	218	1.8	160	1.4			
18								
19	6.6	160	1.5	125	1.3	3.3	2.4	6
20	6.6	160	1.5	125	1.3	3.3		
21	6.7	149	1.5	120	1.2			
22	6.8	138	1.4	110	1.2			
23	6.9	128	1.4	105	1.2			
24								
25								
26	6.7	149	1.5	120	1.2	3.3	4.5	7
27	6.8	138	1.4	110	1.2			
28	6.8	138	1.4	110	1.2			
29	6.8	138	1.4	110	1.2			
30	6.8	138	1.4	110	1.2			
5/ 1								
2						3.3	2.5	9
3	6.2	218	1.8	160	1.4	4.2	4.0	10
4	6.4	187	1.7	145	1.3			
5	6.4	187	1.7	145	1.3			

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TABLE 2

LOCATION: Upper Truckee River #44A

Tributary Data (contd)

Date 1971	Gage Height (ft)	Flow (cfs)	Depth (ft)	Area (ft^2)	Mean Velocity (fps)	Temp °C	Turb-idity	Sus Sed Conc mg/l
5/ 6	6.32	199	1.7	150	1.4			
7	6.29	204	1.7	155	1.4			
8	6.27	208	1.8	155	1.4			
9	6.27	208	1.8	155	1.4	3.9	3.1	7
10	5.65	331	2.3	215	1.6			
11	5.76	305	2.2	205	1.6			
12	5.5	373	2.3	225	1.7	6.6	6.5	29
13	5.5	373	2.3	225	1.7			
14	5.38	410	2.4	240	1.9			
15	5.08	520	2.6	270	1.9	8.3		15
16	5.3	440	2.5	245	1.8			
17	5.5	374	2.3	245	1.5			
18	5.7	320	2.2	210	1.5			
19	5.69	322	2.2	210	1.5			
20	5.6	345	2.3	220	1.5	9.4		11
21	5.4	402	2.4	235	1.7			
22								
23								
24								
25								
26	4.91	590	2.7	285	2.1	9.4	3.0	22
27								
28								
29								
30								
31								
6/ 1								
2	6.55	165	1.6	133	1.2	10.6	2.1	5
3								
4								
5								
6								
7	5.52	370	2.3	225	1.6			
8	5.1	510	2.6	270	1.9	12.2	3.4	14
9	4.65	720	3.0	315	2.3			
10	5.1	510	2.6	270	1.9			
11								
12								
13								
14								
15								
16								
17	5.20	475	2.5	255	1.9	13.9	3.0	19
18								
19								

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Table 2.

Tributary Data (contd)

LOCATION: Upper Truckee River #44A

Date 1971	Gage Height (ft)	Flow (cfs)	Depth (ft)	Area (ft^2)	Mean Velocity (fps)	Temp °C	Turb-idity	Sus Sed Conc mg/l
6/20	4.96	565	2.7	280	2.0	11.1	2.9	18
21								
22								
23	5.31	435	2.4	245	1.8	12.7	2.4	14
24								
25								
26								
27								
28								
29								
30								
7/ 1	6.10	235	1.9	170	1.4	15.6	3.4	12

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TABLE 3

Tributary Data

LOCATION: Upper Truckee River #44B

Date 1971	Gage Height (ft)	Flow (cfs)	Depth (ft)	Area (ft^2)	Mean Velocity (fps)	Temp °C	Turbidity	Sus Sed Conc mg/l
3/23	5.7	114	1.0	43	2.5	3.3	11	25
24	5.9	105	0.9	35	3.0			
25	5.3	170	1.1	63	2.8	3.3	40	98
26								
27								
28								
29	5.4	158	1.1	58	2.7	3.3	7.5	21
30	5.3	170	1.1	63	2.8			
31	5.5	145	1.1	52	2.7			
4/ 1	5.5	145	1.1	52	2.7			
2	5.6	135	1.05	48	2.8	3.3	2.3	15
3	5.6	135	1.05	48	2.8			
4								
5								
6	5.3	170	1.1	63	2.8	3.3	2.6	12
7	5.4	158	1.1	58	2.7			
8	5.4	158	1.1	58	2.7			
9	5.5	145	1.1	52	2.7			
10								
11								
12	5.4	158	1.1	58	2.7			
13	5.3	170	1.1	63	2.8			
14	5.4	158	1.1	58	2.7			
15	5.2	185	1.15	69	2.7			
16	5.1	200	1.15	75	2.7			
17	5.1	200	1.15	75	2.7			
18								
19	5.4	158	1.1	58	2.7			
20	5.4	158	1.1	58	2.7	3.3	1.3	3
21	5.5	145	1.1	52	2.7			
22	5.6	135	1.05	48	2.8			
23	5.7	114	1.0	43	2.5			
24								
25								
26	5.6	135	1.05	48	2.8			
27	5.7	114	1.0	43	2.5	3.3	2.0	15
28	5.6	135	1.05	48	2.8			
29	5.5	145	1.1	52	2.7			
30	5.5	145	1.1	52	2.7			
5/ 1								
2								
3	5.0	218	1.2	81	2.7	3.3	1.5	4
4	5.25	178	1.15	66	2.7	4.4	1.5	3
5	5.2	185	1.15	69	2.7			

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TABLE 3
Tributary Data (contd)

LOCATION: Upper Truckee River #44B

Date 1971	Gage Height (ft)	Flow (cfs)	Depth (ft)	Area (ft^2)	Mean Velocity (fps)	Temp °C	Turbidity JTU	Sus Sed Conc mg/l
5/ 6	5.1	200	1.15	75	2.7			
7	5.09	201	1.15	75	2.7			
8	5.15	190	1.20	72	2.7	3.9	1.4	7.0
9	4.91	231	1.25	88	2.6			
10	4.18	420	1.85	131	3.2			
11	4.61	298	1.48	109	2.8	5.6	4.0	15
12	4.50	326	1.55	117	2.8			
13	4.4	352	1.63	124	2.8			
14	4.4	352	1.63	124	2.8	7.8	3.5	14
15	4.19	418	1.85	131	3.2			
16	4.25	400	1.75	136	2.9			
17	4.5	326	1.55	117	2.8			
18	4.5	326	1.55	117	2.8			
19	4.53	318	1.5	114	2.8	5.8	1.5	8
20	4.4	352	1.63	124	2.8			
21	4.4	352	1.63	124	2.8			
22								
23								
24								
25								
26	4.10	450	1.9	148	3.0	6.7	3.2	11
27								
28								
29								
30								
31								
6/ 1								
2	5.37	160	1.1	56	2.8	10.5	1.2	3
3	5.27	175	1.13	65	2.7			
4								
5								
6								
7	4.52	320	1.6	112	2.8	12.2	2.5	10
8	4.20	405	1.83	140	2.9			
9								
10	4.00	485	2.0	155	3.1			
11								
12								
13								
14								
15								
16								
17								
18								
19								

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TABLE

Tributary Data (contd)

LOCATION: Upper Truckee River #44B

Date 1971	Gage Height (ft)	Flow (cfs)	Depth (ft)	Area (ft^2)	Mean Velocity (fps)	Temp °C	Turb-idity	Sus Sed Conc mg/l
6/20	4.05	468	1.9	150	3.1	12.8	2.0	12
21								
22								
23	4.05	468	1.9	150	3.1	12.8	1.9	11
24								
25								
26								
27								
28								
29								
30								
7/ 1	4.92	230	1.2	85	2.7	15.6	2.3	6

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TABLE 4

Tributary Data

LOCATION: Upper Truckee River #44D

Date 1971	Gage Height (ft)	Flow (cfs)	Depth (ft)	Area (ft^2)	Mean Velocity (fps)	Temp °C	Turb-idity	Sus Sed Conc mg/l
3/23		35					5	9
24		61						
25		86					4.5	10
26		58						
27		51						
28		55						
29		67					1.7	10
30		60						
31		56						
4/ 1		56						
2		62					.8	9
3		73						
4		88						
5		82						
6		71					1.3	4
7		76						
8		84						
9		85						
10		96						
11		115						
12		107					4.0	
13		118						
14		140						
15		130						
16		99						
17		90						
18		92						
19		82						
20		75					1.5	5
21		73						
22								
23		75						
24		73						
25		67						
26		68						
27		68					2.5	1
28		69						
29		94						
30		117						
5/ 1		149						
2		158						
3		137					1	1
4		113				3.9	1.5	5
5		110						

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TABLE
Tributary Data (contd)

LOCATION: Upper Truckee River #44D

Date 1971	Gage Height (ft)	Flow (cfs)	Depth (ft)	Area (ft^2)	Mean Velocity (fps)	Temp °C	Turbidity	Sus Sed Conc mg/l
5/ 6		123						
7		121					1.6	10
8		133						
9		139						
10		187						
11		245				4.5	3.0	10
12		264						
13		270						
14		275				6.7	2.0	4
15		318						
16		334						
17		259						
18		233						
19		260				3.9	0.9	9
20		284						
21		266						
22		208						
23		237						
24		318						
25		351						
26		330						
27		250						
28		230						
29		210						
30		200						
31		180						
6/ 1		148						
2		133				7.8	1.5	5
3		143						
4		171						
5		203						
6		262						
7		333				10.0	2.5	7
8		382						
9		385						
10		334						
11		342						
12		362						
13		396						
14		373						
15		389						
16		396				8.9	2.0	9
17		345						
18		384						
19		370						

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TABLE 4

Tributary Data (contd)

LOCATION: Upper Truckee River #44D

Date 1971	Gage Height (ft)	Flow (cfs)	Depth (ft)	Area (ft^2)	Mean Velocity (fps)	Temp °C	Turb-idity	Sus Sed Conc mg/l
6/20		360						
21		350						
22		320						
23		290				11.7	1.3	14
24		260						
25								
26								
27								
28								
29								
30								
7/ 1						13.9	2.0	10

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Tributary Data

LOCATION: Lonely Gulch #53

Date 1971	Gage Height (ft)	Flow (cfs)	Depth (ft)	Area (ft^2)	Mean Velocity (fps)	Temp °C	Turb-idity	Sus Sed Conc mg/l
3/23								
24								
25								
26								
27								
28								
29								
30								
31								
4/ 1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
5/ 1								
2								
3								
4								
5								

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TABLE 5

Triburary Data (contd)

LOCATION: Lonely Gulch #53

Date 1971	Gage Height (ft)	Flow (cfs)	Depth (ft)	Area (ft^2)	Mean Velocity (fps)	Temp °C	Turb-idity	Sus Sed Conc mg/l
5/ 6								
7	5.78	5.4						
8	5.75	5.8						
9								
10	5.7	6.4						
11	5.7	6.4						
12	5.74	5.9					15	32
13	5.7	6.4						
14	5.71	6.3					3	16
15								
16								
17	5.7	6.4						
18	5.72	6.2					5.4	18
19	5.7	6.4						
20	5.6	8.1						
21	5.7	6.4						
22								
23								
24	5.5	10.0						
25	5.45	11.0				4.4	5.2	6
26	5.5	10.0						
27								
28								
29								
30								
31								
6/ 1								
2								
3	5.72	6.2				5.6	0.8	5
4								
5								
6								
7	5.50	10.1				8.3	2.0	3.1
8								
9								
10								
11								
12								
13								
14								
15								
16	5.35	14.5				7.2	3.0	27
17								
18								
19								

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TABLE 5

Triburary Data (contd)

LOCATION: Lonely Gulch #53

Date 1971	Gage Height (ft)	Flow (cfs)	Depth (ft)	Area (ft^2)	Mean Velocity (fps)	Temp °C	Turb-idity	Sus Sed Conc mg/l
6/20	5.45	11.0				7.2	1.0	8
21								
22								
23	5.52	10.0				5.6	0.7	9
24								
25								
26								
27								
28								
29								
30								
7/ 1	5.50	10.1				11.7	1.5	9

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TABLE 6

Tributary Data

LOCATION: General Creek #56

Date 1971	Gage Height (ft)	Flow (cfs)	Depth (ft)	Area (ft^2)	Mean Velocity (fps)	Temp °C	Turbidity	Sus Sed Conc mg/l
3/23								
24	6.3	17.5	0.67	10.3	1.7			
25								
26								
27								
28								
29								
30	6.3	17.5	0.67	10.3	1.7			
31								
4/ 1								
2								
3								
4								
5								
6								
7	6.2	27	0.75	11.7	2.3			
8								
9	6.2	27	0.75	11.7	2.3			
10								
11								
12	6.2	27	0.75	11.7	2.3			
13								
14								
15								
16								
17								
18								
19								
20	6.2	27	0.75	11.7	2.3			1.0
21	6.2	27	0.75	11.7	2.3			
22	6.15	33	0.77	12.5	2.6			
23	6.10	41	0.83	13.5	3.0			
24								
25								
26	6.2	27	0.75	11.7	2.3			
27	6.2	27	0.75	11.7	2.3			
28	6.2	27	0.75	11.7	2.3		0.6	1.0
29	6.1	41	0.83	13.5	3.0			
30	6.1	41	0.83	13.5	3.0			
5/ 1								
2								
3	6.0	63	0.88	15.0	4.2		0.5	1.0
4	6.1	41	0.83	13.5	3.0			
5	6.1	41	0.83	13.5	3.0	3.9	1.5	4.0

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TABLE 6

Tributary Data (contd)

LOCATION: General Creek #56

Date 1971	Gage Height (ft)	Flow (cfs)	Depth (ft)	Area (ft^2)	Mean Velocity (fps)	Temp °C	Turb-idity	Sus Sed Conc mg/l
5/ 6	6.05	51	0.85	14.3	3.6			
7	6.1	41	0.83	13.5	3.0			
8	6.03	55	0.86	14.5	3.8			
9	6.02	57	0.87	14.7	3.9			
10	5.80	150	1.00	18.7	8.0			
11	5.70	230	1.07	20.7	11.1			
12	5.7	230	1.07	20.7	11.1		1.0	4.0
13	5.8	150	1.00	18.7	8.0			
14	5.79	155	1.00	18.7	8.0	3.9	1.0	1.0
15								
16								
17	5.9	98	0.95	17.0	5.8			
18	5.96	75	0.83	16.0	4.7			
19	5.9	98	0.95	17.0	5.8			
20	5.80	150	1.00	18.7	8.0			
21	5.80	150	1.00	18.7	8.0			
22								
23								
24	5.70	230	1.07	20.7	11.1			
25	5.79	155	1.00	18.7	8.3	7.2	0.7	15.0
26	5.70	230	1.07	20.7	11.1			
27								
28								
29								
30								
31								
6/ 1								
2								
3	6.05	51	0.8	14	3.6	6.1	0.4	1
4								
5								
6								
7	5.72	210	1.05	20	10.5	6.7	1.5	13
8								
9								
10								
11								
12								
13								
14								
15								
16	5.72	210	1.05	20	10.5	10.6	5.0	5
17								
18								
19								

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TABLE 6

Tributary Data (contd)

LOCATION: General Creek #56

Date 1971	Gage Height (ft)	Flow (cfs)	Depth (ft)	Area (ft^2)	Mean Velocity (fps)	Temp °C	Turb-idity	Sus Sed Conc mg/l
6/20	5.91	92	0.92	16.5	5.6	9.4	0.5	5
21								
22								
23	6.02	58	0.86	14.5	4.0	7.2		
24								
25								
26								
27								
28								
29								
30								
7/ 1	6.32	16	0.62	9.5	1.7	13.4	0.6	0

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TABLE 7

Tributary Data

LOCATION: Blackwood Creek #62

Date 1971	Gage Height (ft)	Flow (cfs)	Depth (ft)	Area (ft^2)	Mean Velocity (fps)	Temp °C	Turb-idity	Sus Sed Conc mg/l
3/23								
24		16						
25		24						
26		48						
27		42						
28		39						
29		36						
30		52						
31		47						
4/ 1		38						
2		40						
3		42						
4		45						
5		50						
6		56					1.1	10
7		52						
8		46						
9		50						
10		55						
11		49						
12		54						
13		62						
14		61						
15		71						
16		86						
17		82						
18		63						
19		58						
20		60					1.4	1
21		52						
22		47						
23		44						
24		44						
25		41						
26		38						
27		38						
28		47				8.6	0.8	5
29		62						
30		79						
5/ 1		96						
2		106						
3		100					1.5	6
4		87						
5		91				5.6	2.0	4

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TABLE 7

Tributary Data (contd)

LOCATION: Blackwood Creek #62

Date 1971	Gage Height (ft)	Flow (cfs)	Depth (ft)	Area (ft^2)	Mean Velocity (fps)	Temp °C	Turb-idity	Sus Sed Conc mg/l
5/ 6		89						
7		83						
8		102						
9		119						
10		160						
11		171						
12		170				7.2	4.0	9
13		192						
14		207				5.0	2.5	10
15		224						
16		204						
17		162						
18		152				7.8	0.8	12
19		162						
20		188						
21		165						
22		134						
23		172						
24		229						
25		250				8.3	2.4	29
26		232						
27		174						
28		137						
29		127						
30		122						
31		100						
6/ 1		85						
2		78						
3		87				8.3	0.8	1
4		100						
5		130						
6		172						
7		210				8.9	2.0	16
8		223						
9		206						
10		194						
11		201						
12		216						
13		218						
14		208						
15		217						
16		228				8.9	5.0	55
17		222						
18		206						
19		213						

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56 1971

TABLE 16

56 GENERAL CREEK DOWNSTREAM HWY 89

INSTANTANEOUS SUSPENDED SEDIMENT, WATER YEAR OCTOBER 1970 TO SEPTEMBER 1971

DATE	TIME	DISCHARGE (CFS)	CONCEN-TRATION (MG/L)	SUSPENDED SEDIMENT DISCHARGE (TONS/DAY)	DATE	TIME	DISCHARGE (CFS)	CONCEN-TRATION (MG/L)	SUSPENDED SEDIMENT DISCHARGE (TONS/DAY)
APR 20, 1971	1440	27	1	.07	MAY 25.....	1445	155	15	6.3
APR 28.....	1030	27	1	.07	JUN 3.....	1210	51	1	.14
MAY 3.....	1200	63	1	.17	JUN 7.....	1310	210	13	7.4
MAY 5.....	1430	41	4	.44	JUN 16.....	1720	210	5	2.8
MAY 12.....	1400	230	4	2.5	JUN 20.....	1240	92	5	1.2
MAY 14.....	1055	155	1	.42	JUL 1.....	1545	16	0	0

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TABLE 17

62 BLACKWOOD CR DOWNSTREAM HWY 89

INSTANTANEOUS SUSPENDED SEDIMENT, WATER YEAR OCTOBER 1970 TO SEPTEMBER 1971

DATE	TIME	DISCHARGE (CFS)	CONCEN-TRATION (MG/L)	SUSPENDED SEDIMENT DISCHARGE (TONS/DAY)	DATE	TIME	DISCHARGE (CFS)	CONCEN-TRATION (MG/L)	SUSPENDED SEDIMENT DISCHARGE (TONS/DAY)
APR 6, 1971	1140	56	10	1.5	MAY 25.....	1425	250	29	20
APR 20.....	1100	60	1	.16	JUN 3.....	1225	87	1	.23
APR 28.....	1630	47	5	.63	JUN 7.....	1240	210	16	9.1
MAY 3.....	1215	100	6	1.6	JUN 16.....	1740	228	55	34
MAY 5.....	1245	91	4	.98	JUN 20.....	1225	210	18	10
MAY 12.....	1415	170	9	4.1	JUN 23.....	1115	176	15	7.1
MAY 14.....	1105	207	10	5.6	JUL 1.....	1530	110	22	6.5
MAY 18.....	1430	152	12	4.9					

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TABLE 18

63 WARD CREEK DOWNSTREAM HWY 89

INSTANTANEOUS SUSPENDED SEDIMENT, WATER YEAR OCTOBER 1970 TO SEPTEMBER 1971

DATE	TIME	DISCHARGE (CFS)	CONCEN-TRATION (MG/L)	SUSPENDED SEDIMENT DISCHARGE (TONS/DAY)	DATE	TIME	DISCHARGE (CFS)	CONCEN-TRATION (MG/L)	SUSPENDED SEDIMENT DISCHARGE (TONS/DAY)
APR 6, 1971	1200	53	7	1.0	MAY 25.....	1415	152	28	11
APR 20.....	1045	60	1	.16	JUN 3.....	1240	77	1	.21
APR 28.....	1500	47	1	.13	JUN 7.....	1230	125	6	2.0
MAY 3.....	1230	79	4	.85	JUN 16.....	1750	228	60	37
MAY 5.....	1200	72	3	.58	JUN 20.....	1210	164	8	3.5
MAY 12.....	1425	104	14	3.9	JUN 23.....	1125	144	3	1.2
MAY 14.....	1115	118	7	2.2	JUL 7.....	1215	68	3	.55
MAY 18.....	1330	105	5	1.4					

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TABLE 19

2 BURTON CREEK DOWNSTREAM HWY 28

INSTANTANEOUS SUSPENDED SEDIMENT, WATER YEAR OCTOBER 1970 TO SEPTEMBER 1971

DATE	TIME	DISCHARGE (CFS)	CONCEN-TRATION (MG/L)	SUSPENDED SEDIMENT DISCHARGE (TONS/DAY)	DATE	TIME	DISCHARGE (CFS)	CONCEN-TRATION (MG/L)	SUSPENDED SEDIMENT DISCHARGE (TONS/DAY)
MAR 24, 1971		5.0	4	.05	MAY 18.....	1115	27	9	.66
APR 7.....		10	10	.27	MAY 25.....	1205	31	8	.67
APR 20.....		13	2	.07	JUN 3.....	1300	12	1	.03
APR 28.....	1430	8.0	11	.24	JUN 7.....	1200	18	3	.15
MAY 3.....	1240	31	4	.33	JUN 16.....	1850	10	7	.19
MAY 5.....	1120	23	2	.12	JUN 20.....	1145	7.0	2	.04
MAY 12.....	1440	150	7	2.8	JUN 23.....	1150	6.0	3	.05
MAY 14.....	1140	64	12	2.1	JUL 1.....	1500	5.0	1	.01

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TABLE 20

10B SNOW CREEK DOWNSTREAM HWY 28

INSTANTANEOUS SUSPENDED SEDIMENT, WATER YEAR OCTOBER 1970 TO SEPTEMBER 1971

DATE	TIME	DISCHARGE (CFS)	CONCEN-TRATION (MG/L)	SUSPENDED SEDIMENT DISCHARGE (TONS/DAY)	DATE	TIME	DISCHARGE (CFS)	CONCEN-TRATION (MG/L)	SUSPENDED SEDIMENT DISCHARGE (TONS/DAY)
MAR 24, 1971	1330	5.3	13	.19	JUN 7.....	1115	5.3	6	.09
MAY 12.....	1500	21	5	.28	JUN 16.....	1905	4.1	6	.07
MAY 14.....	1200	23	7	.43	JUN 20.....	1050	3.4	2	.02
MAY 25.....	1045	12	6	.19	JUN 23.....	1210	2.6	7	.05
JUN 3.....	1330	5.6	2	.03	JUL 1.....	1430	2.1	2	.01

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The following table lists the annual tons of sediment from eroding highway slopes that reach streams and are available for transport:

Sediment from Highway Slopes

Tributary		Annual cu.yd. of sediment	Annuals tons of sediment
43	Trout Creek	0	0
44A	Upper Truckee River	144	216
44B	Upper Truckee River	144	216
44C	Upper Truckee River	143	214
44D	Upper Truckee River	115	173
53	Lonely Gulch	0.2	0.3
56	General Creek	1	1.5
62	Blackwood Creek	0	0
63	Ward Creek	7	10.5
2	Burton Creek	0.5	0.8
10B	Snow Creek (Hwy 267)	6	9

These quantities were derived from estimates of slope erosion. Measurements of actual sediment transport in roadway drainage facilities were not taken.

Sediment Rating Curves

The suspended sediment discharge rates were plotted versus streamflow discharge. The resultant points on the log-log plot represent a general sediment rating curve of the type 1/:

$$G_{ssm} = PQ^j$$

A linear regression analysis was performed to determine the best fit for the sediment rating curve. The results are shown in Figures 22 through 31. Sediment rates are determined from the graph by entering values of mean monthly flows. Monthly flows tend to eliminate fluctuations in daily discharges. The equations for a log-log plot for each tributary are shown in the table on page 99.

1/ Hydraulics of Sediment Transport, Walter H. Graf, pg. 235

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FIG. 22

SUSPENDED MATERIAL RATING CURVE FOR TROUT CREEK

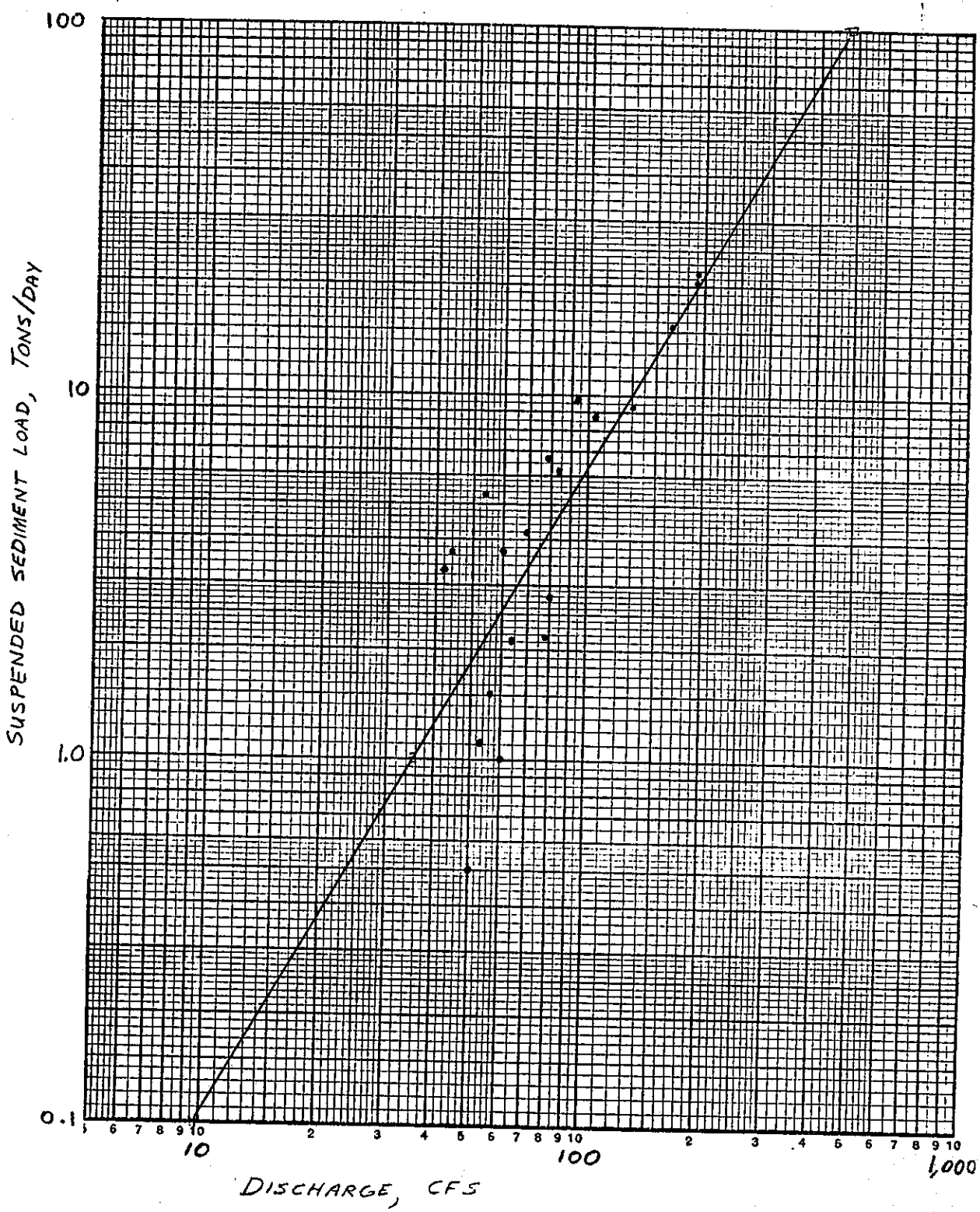

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FIG. 23

SUSPENDED MATERIAL RATING CURVE FOR UPPER TRUCKEE RIVER 44 A

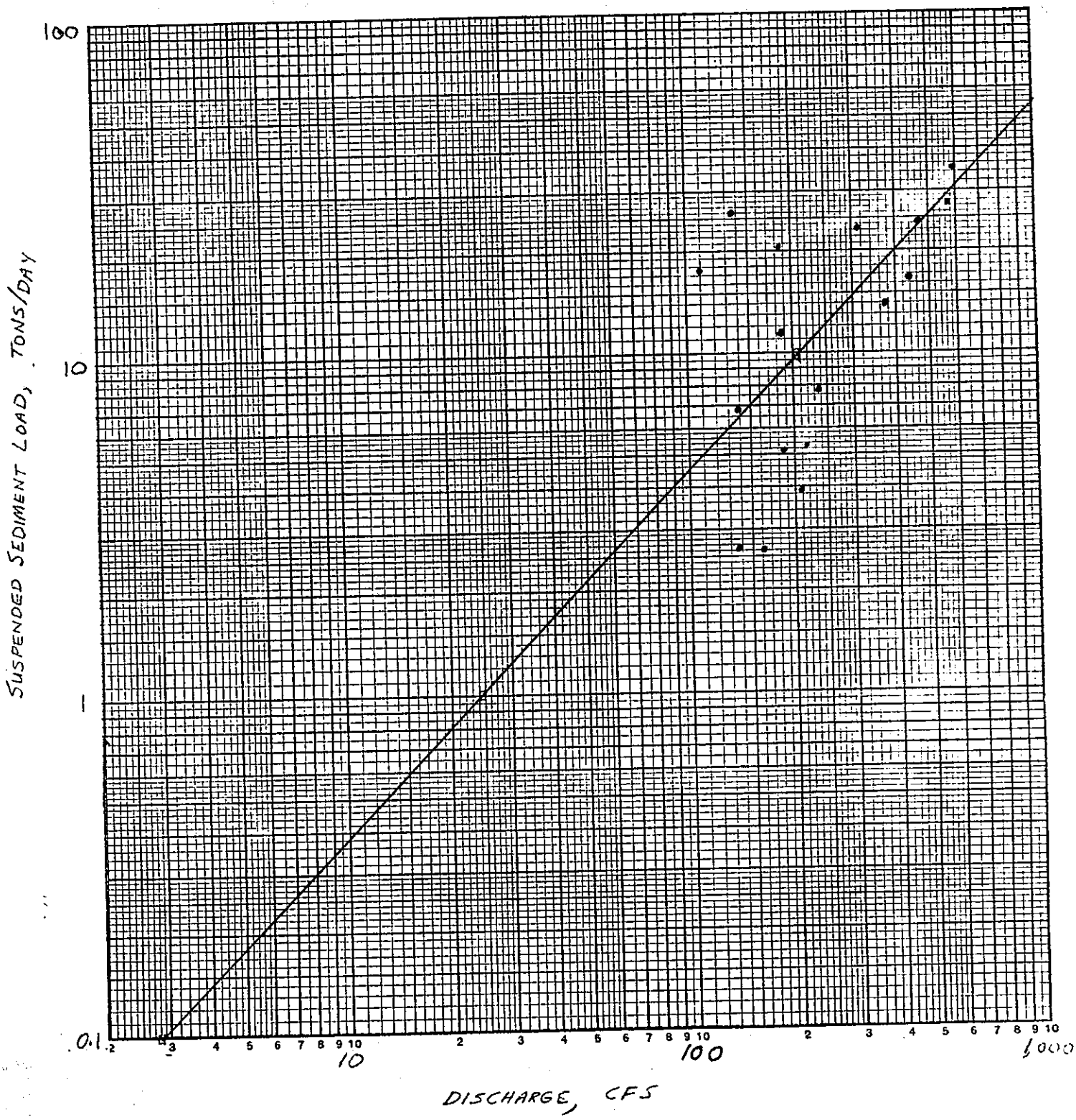

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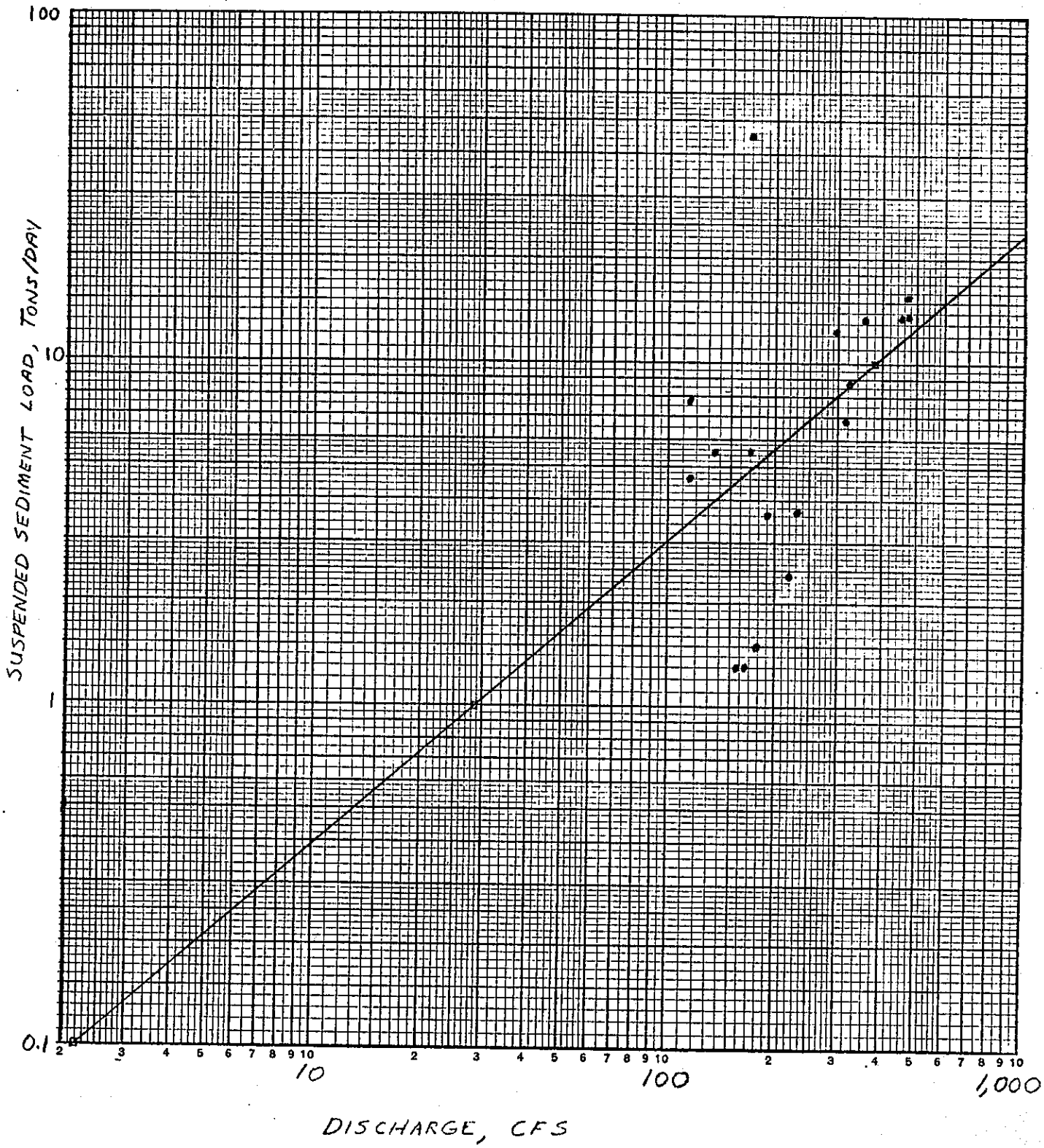
FIG. 24

SUSPENDED MATERIAL RATING CURVE FOR UPPER TRUCKEE RIVER (44B)



LOGARITHMIC 46 7403 IN U.S.A.

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FIG. 92.5

SUSPENDED MATERIAL RATING CURVE FOR

UPPER TRUCKEE RIVER 44 D

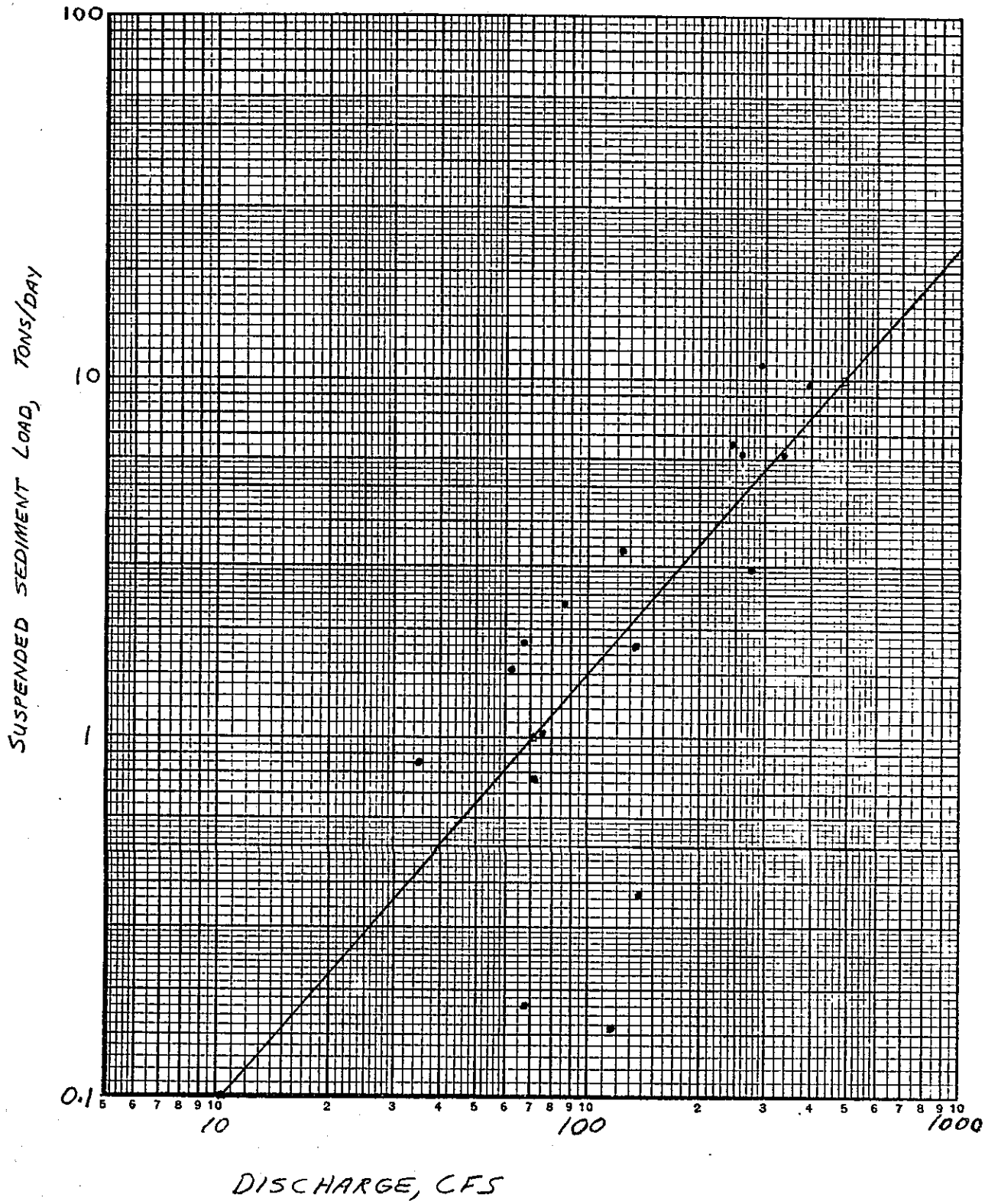

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FIG. 26

SUSPENDED MATERIAL RATING CURVE FOR LONELY GULCH 53

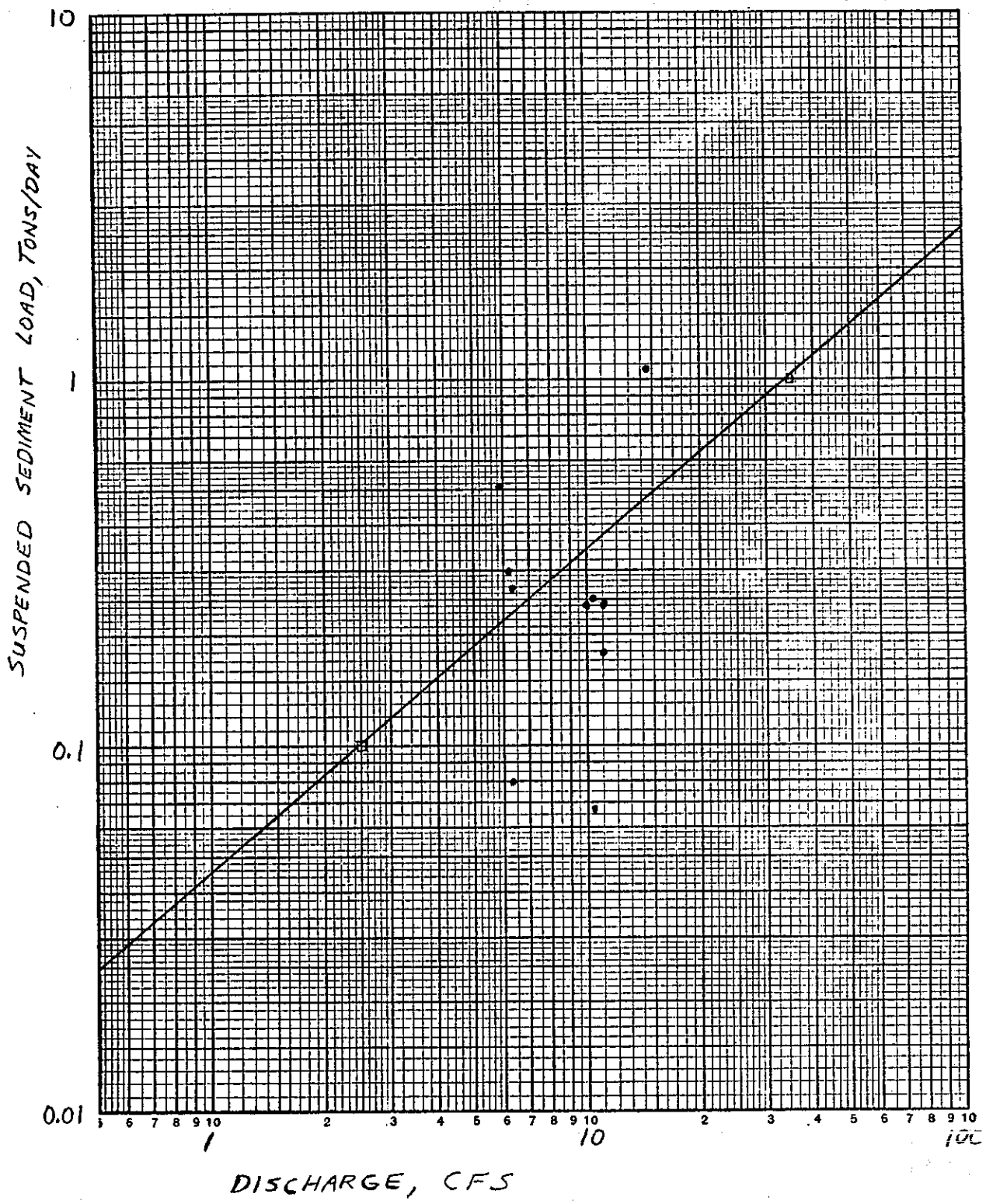

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FIG. 27

SUSPENDED MATERIAL RATING CURVE FOR GENERAL CREEK 56

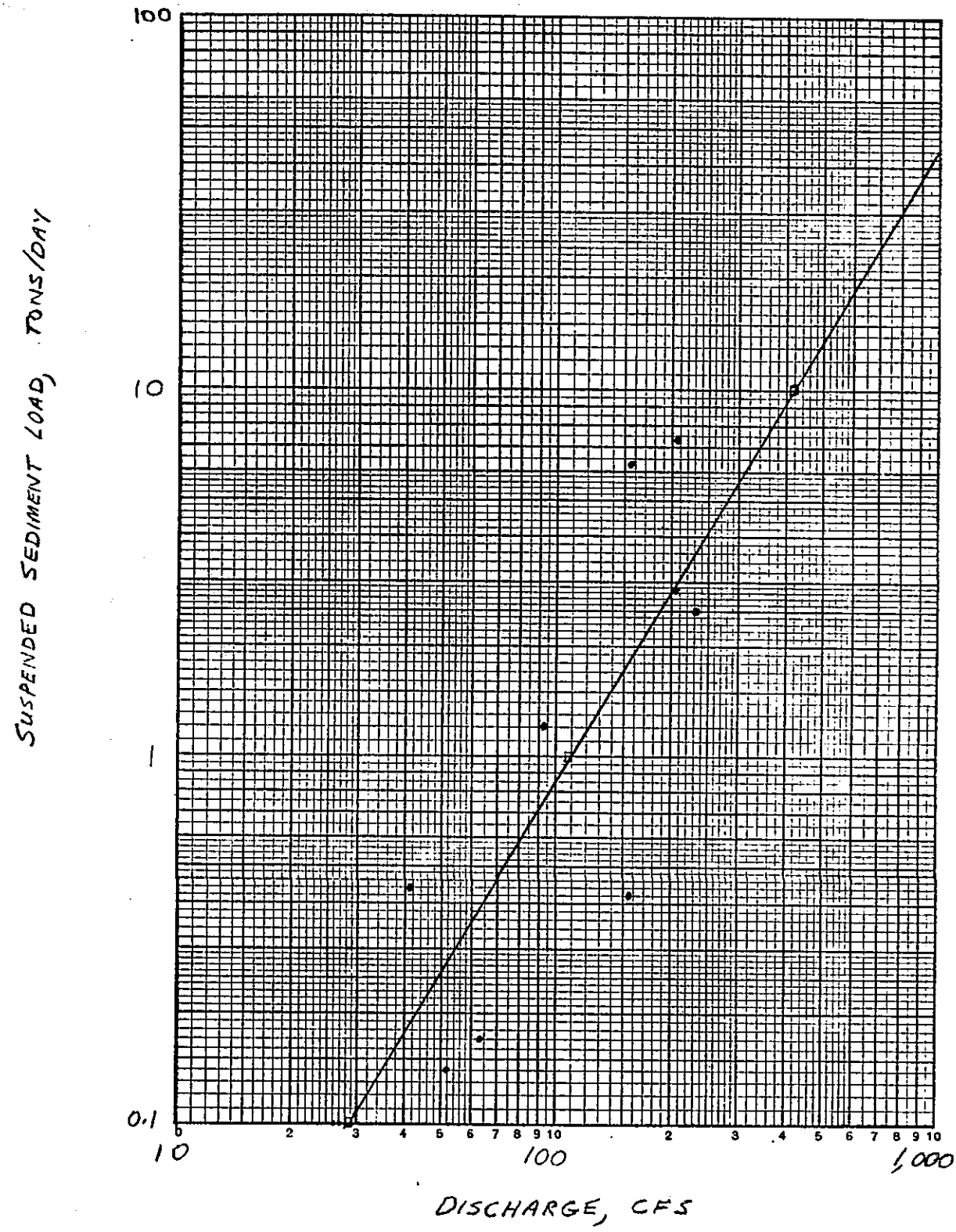

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FIG. 28

SUSPENDED MATERIAL RATING CURVE FOR BLACKWOOD CREEK 62

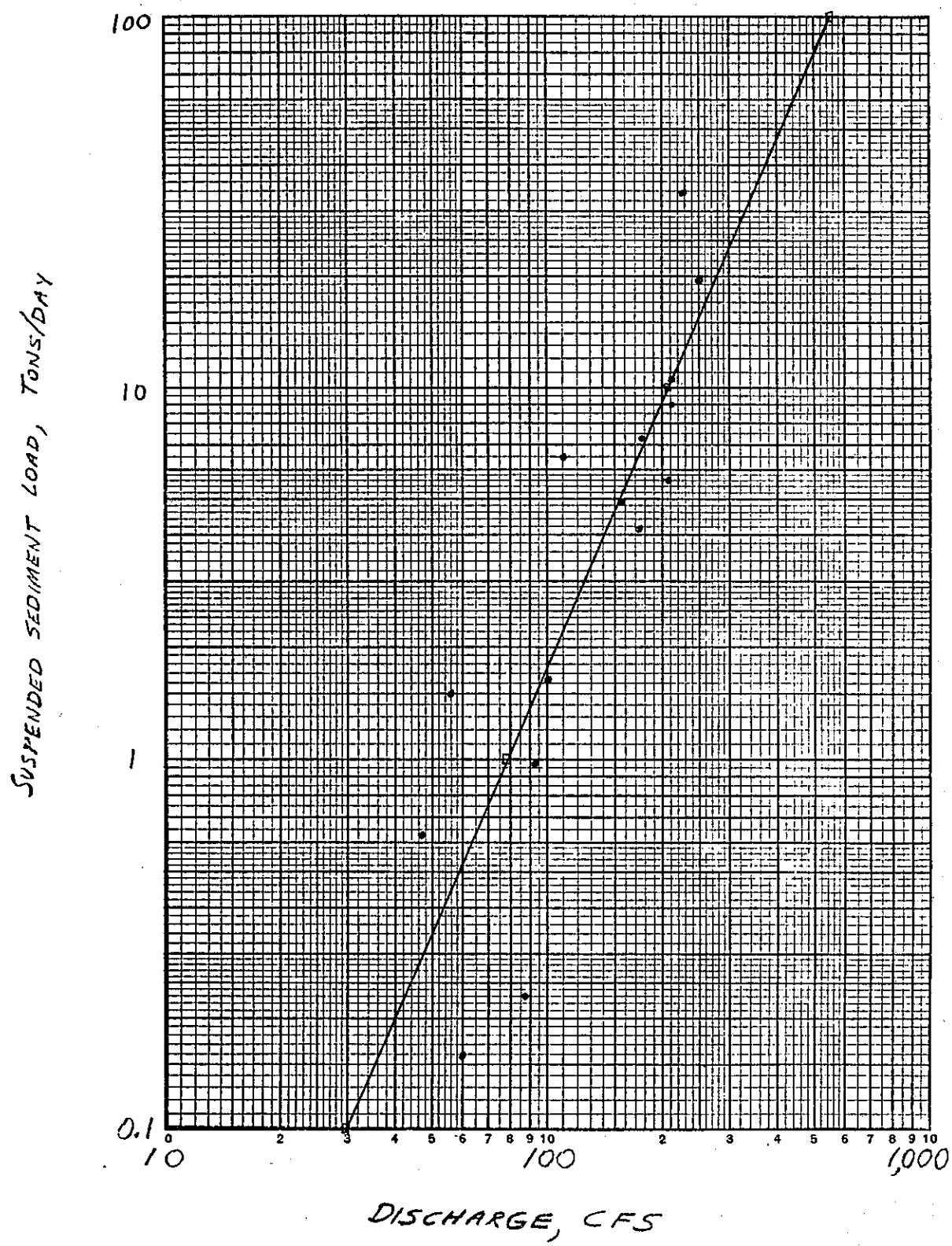

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FIG. 29

SUSPENDED MATERIAL RATING CURVE FOR WARD CREEK 63

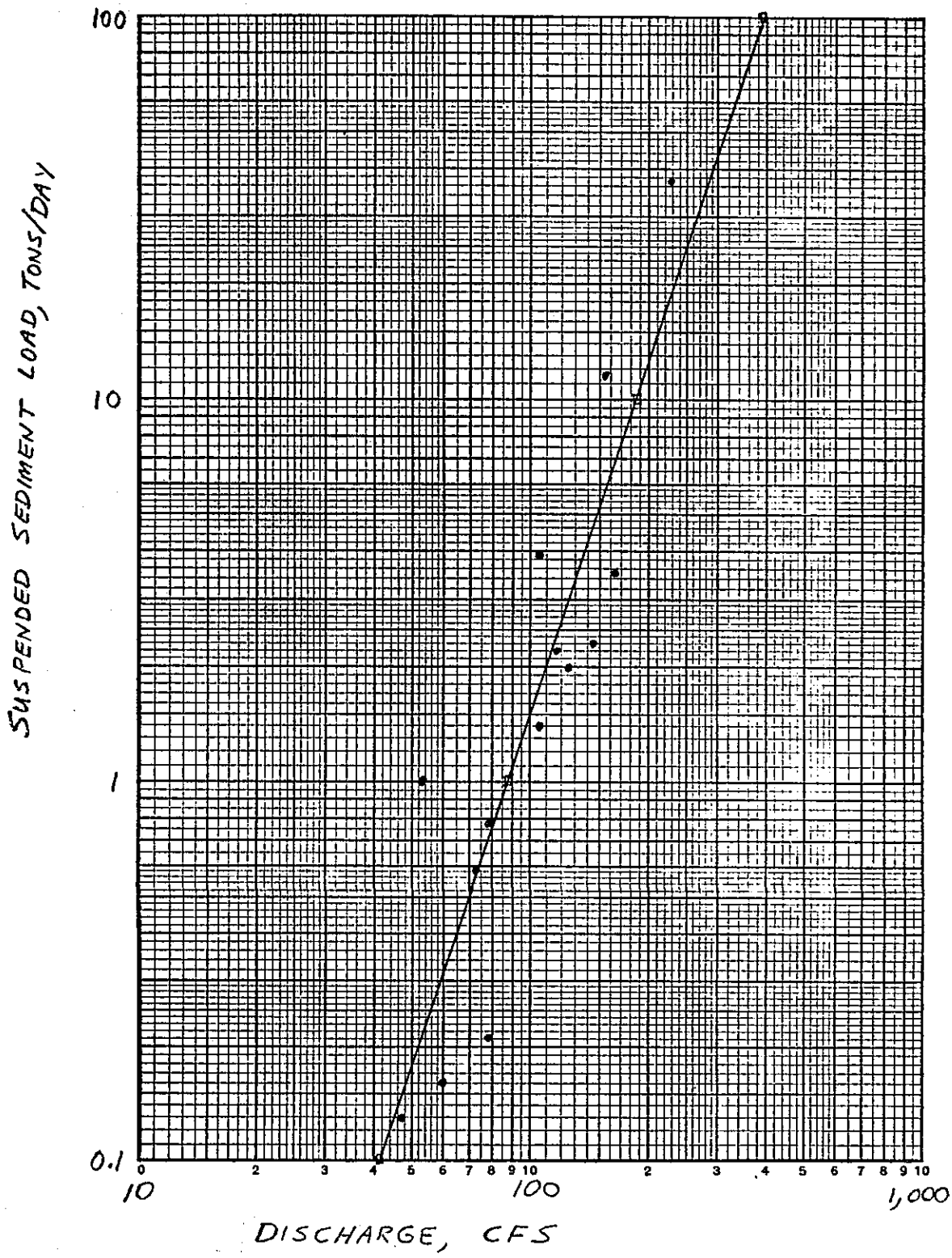

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FIG. 30

SUSPENDED MATERIAL RATING CURVE FOR BURTON CREEK 2

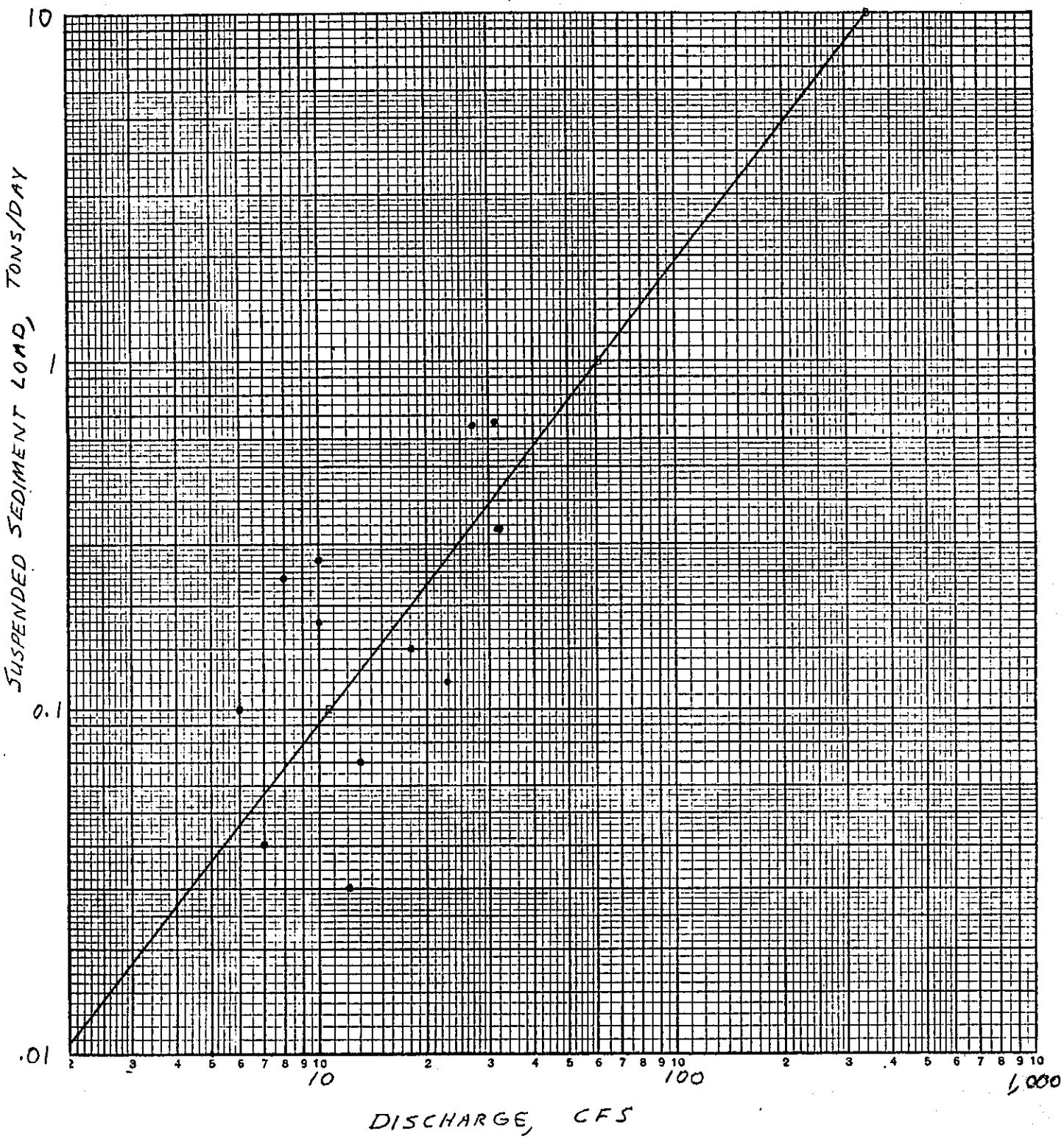

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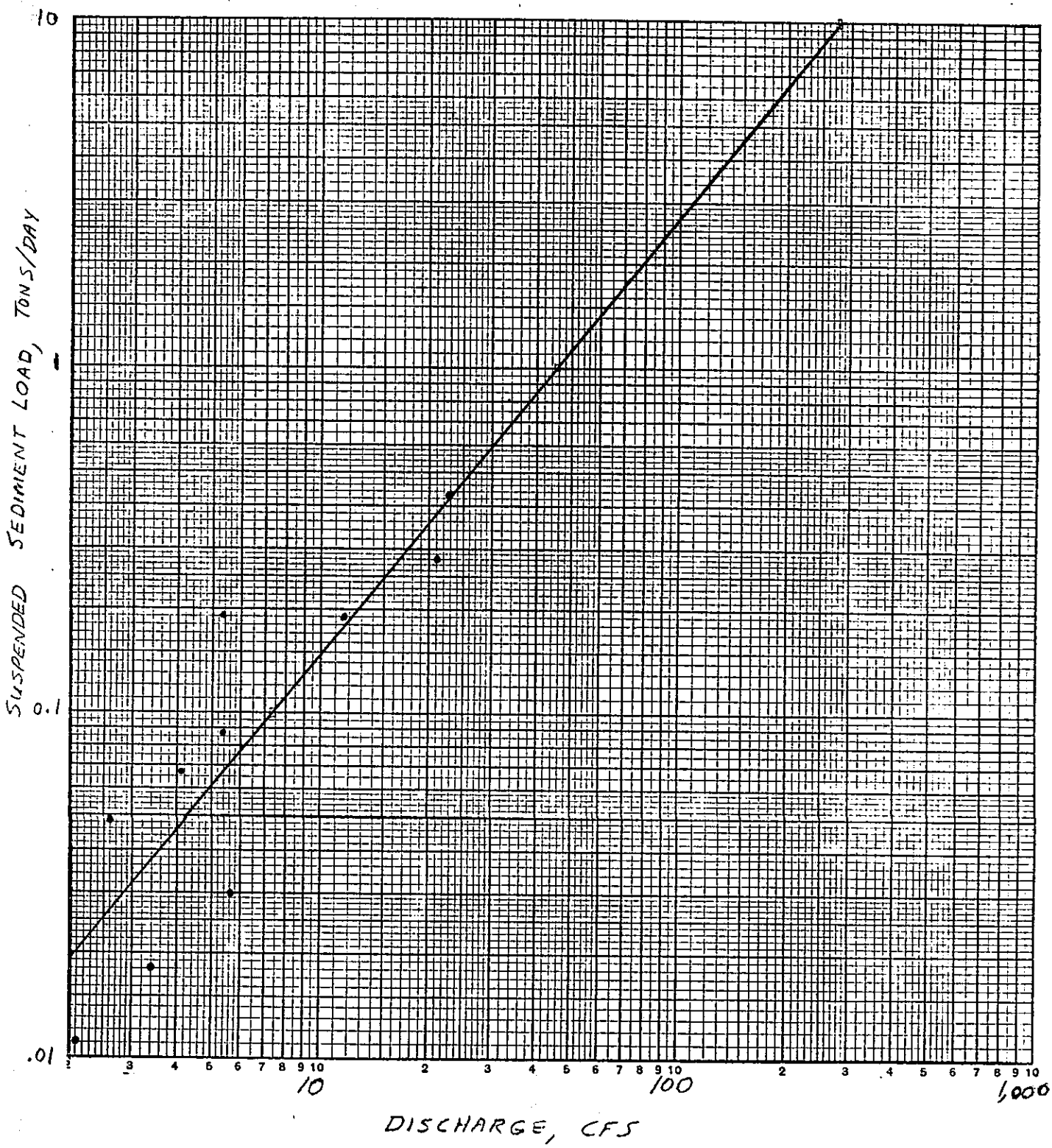
FIG. 31

SUSPENDED MATERIAL RATING CURVE FOR SNOW CREEK 10B



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Equations for Suspended Sediment
Rate Curves

Tributary	Sediment Rate Equation (Log)	Correlation Coefficient
43 Trout Creek	Y = -2.7242 + 1.76746 X	0.80
44A Upper Truckee River	Y = -1.48976 + 1.07538 X	0.60
44B Upper Truckee River	Y = -1.30322 + 0.891783 X	0.44
44D Upper Truckee River	Y = -2.21088 + 1.19727 X	0.76
53 Lonely Gulch	Y = -1.34869 + 0.87848 X	0.39
56 General Creek	Y = -3.545 + 1.73876 X	0.86
62 Blackwood Creek	Y = -4.49851 + 2.37165 X	0.85
63 Ward Creek	Y = -5.94957 + 3.06214 X	0.89
2 Burton Creek	Y = -2.37495 + 1.33418 X	0.69
10B Snow Creek	Y = -2.1041 + 1.27325 X	0.86

The correlation coefficient indicates the degree to which the data relates to the assimilated curve. The measured data for 44A Upper Truckee River, 44B Upper Truckee River, 53 Lonely Gulch, and 2 Burton Creek does not correlate well with the developed sediment rating curve. Additional data over a longer period of observation would possibly produce a closer correlation.

Sediment Discharge Quantities

The quantity of sediment discharged from each tributary that was monitored was determined from the sediment rating curve using the mean monthly flow. Using this method allows for daily fluctuations in sediment concentrations and diurnal flow deviations. This procedure was used for suspended sediment analysis on the Powder River as reported by Leopold, et al.[1]

The following table presents the sediment discharge quantities for the various mean monthly flows as determined in the table on page 34. The period of record is from March 23 to July 1, 1971.

---

[1] "Hydraulics of Sediment Transport," Walter H. Graf, pg. 236.

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Sediment Discharge

Watershed	Monthly Sediment Discharge (tons) Mar.	Apr.	May	June	Total Sed.Disch. (tons)
43 Trout Creek	16.2	69.0	130.0	288.0	503.2
44A Upper Truckee River	65.8	228.0	495.0	675.0	1,463.8
44B Upper Truckee River	37.8	135.0	251.0	267.0	690.8
44D Upper Truckee River	7.2	36.0	124.0	177.0	344.2
53 Lonely Gulch			7.6	12.0	19.6
56 General Creek	0.5	3.3	37.1	28.8	69.7
62 Blackwood Creek	1.6	11.7	152.0	210.0	375.3
63 Ward Creek	1.1	6.6	77.5	155.0	240.2
2 Burton Creek	0.6	3.0	29.7	2.7	36.0
10B Snow Creek	0.5	4.4	9.0	1.4	15.3

Sediment Size Analysis

Suspended sediment samples were taken on May 18 and 19 on Trout Creek, Upper Truckee (2 locations), Lonely Gulch, General Creek, Blackwood Creek, Ward Creek, Burton Creek, and Snow Creek. The 5 pint samples were taken using a DH-48 depth integrating suspended sediment sampler. Samples were taken at evenly spaced verticals across the stream width.

The U.S. Geological Survey Sedimentation Laboratory in Sacramento performed the size analysis on the sediment. The wet sieve procedure was followed.[1/] The following table indicates the relative percentage of the sand and silt-clay portion of the sediment. The sand size was taken as those particles having a diameter of 0.0625 mm or larger.

1/ "Laboratory Theory and Methods for Sediment Analysis," U.S. Geological Survey.

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Suspended Sediment Size Analysis

	Location	Suspended Sediment % Sand	Suspended Sediment % Silt & Clay
43	Trout Creek	99.7	0.3
44A	Upper Truckee River	86.8	13.2
44B	Upper Truckee River	89.6	10.4
53	Lonely Gulch	93.7	6.3
56	General Creek	93.8	6.2
62	Blackwood Creek	91.4	8.6
63	Ward Creek	80.4	19.6
2	Burton Creek	90.3	9.7
10B	Snow Creek	69.6	30.4

The sediment samples analyzed were taken during snowmelt runoff.

Ward and Snow Creeks indicate a high percentage of fine material. This compares closely with the recent USGS findings on the Incline Village Area.[1] In the Incline Village area report, the sand-silt:clay ratios were 68% - 32% for the annual total.

All of these areas, Ward Creek, Snow Creek, and Incline Village area are under recent construction activity, which could account for the higher incidence of material in the <0.0625 mm diameter size range.

The grain size distribution is shown on the plates on page 102 through 106.

The steep sloping curves indicate concentrated sizes of sediment particles whereas the flat sloping curves depict well-graded sediment samples.

[1] Glancy, Patrick A. "A Reconnaissance of Streamflow and Fluvial Sediment Transport," Incline Village Area, Lake Tahoe, Nevada. USGS 1971.

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GRAIN SIZE DISTRIBUTION DIAGRAM

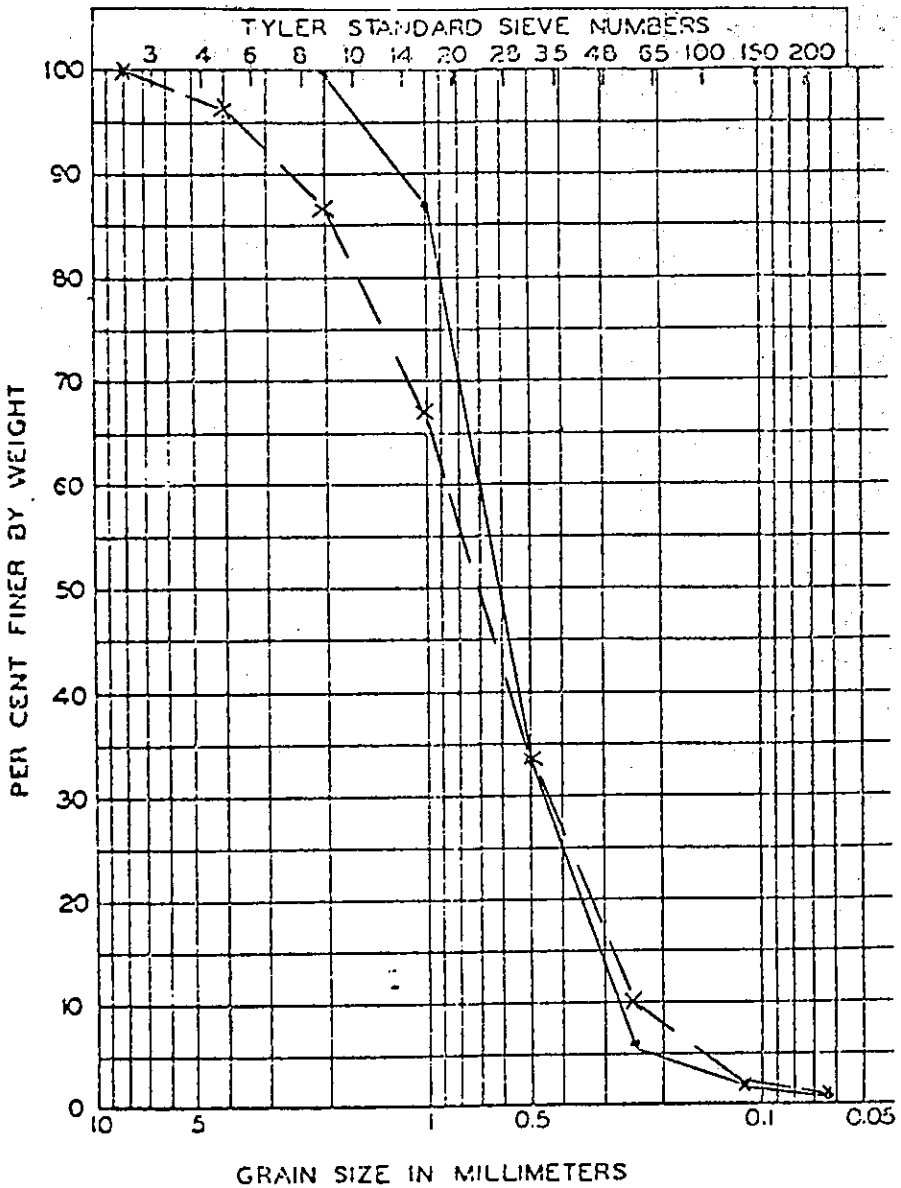

PLATE 1

43 TROUT CREEK

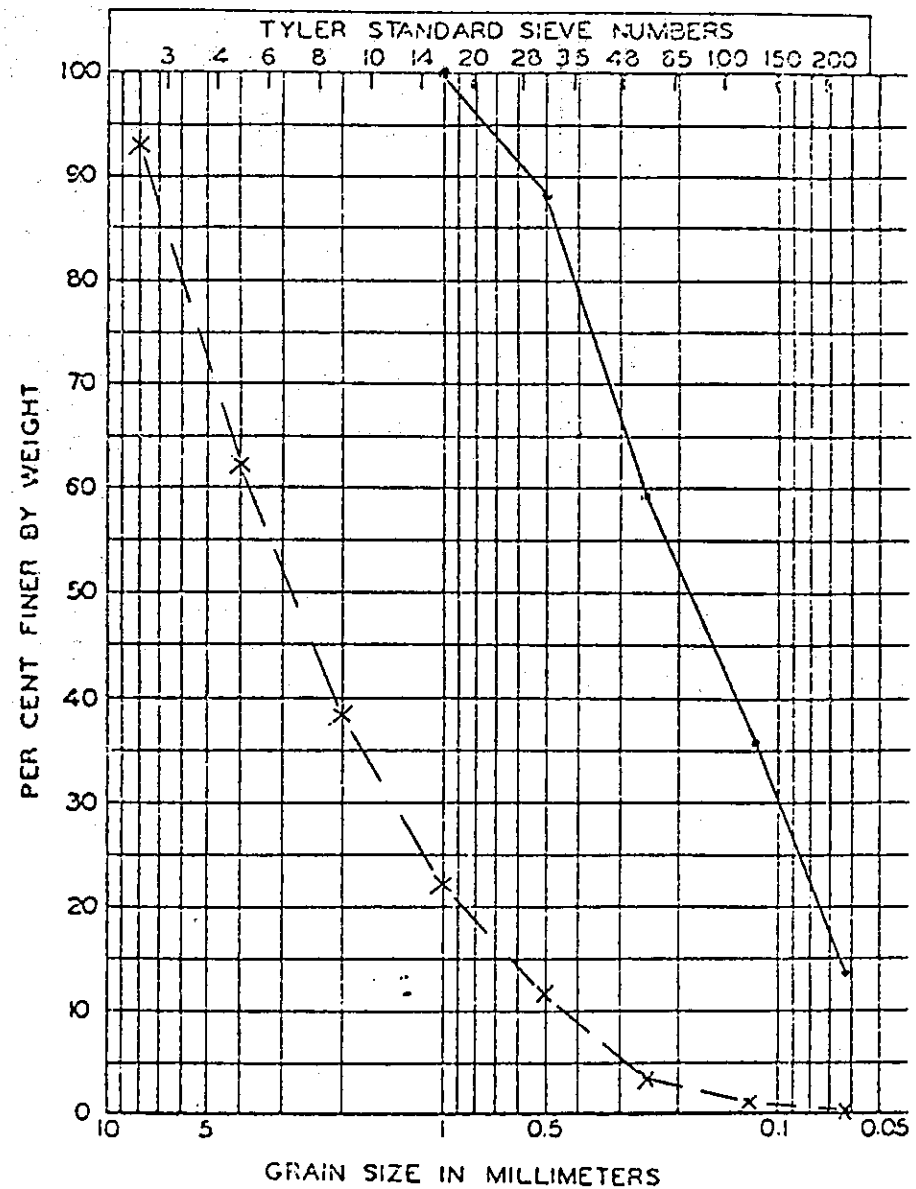

PLATE 2

44A UPPER TRUCKEE RIVER

SUSPENDED SEDIMENT

BED MATERIAL

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GRAIN SIZE DISTRIBUTION DIAGRAM

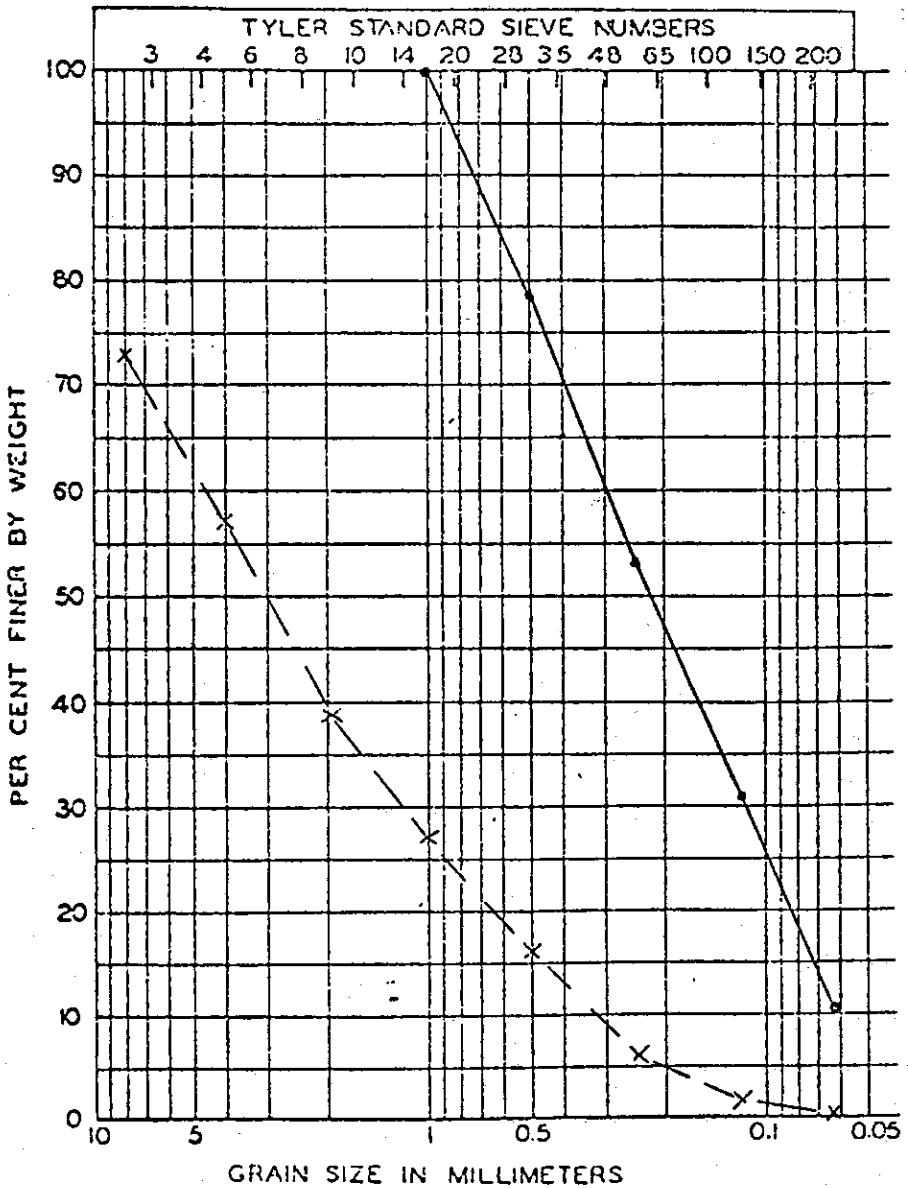

PLATE 3

44 B UPPER TRUCKEE RIVER

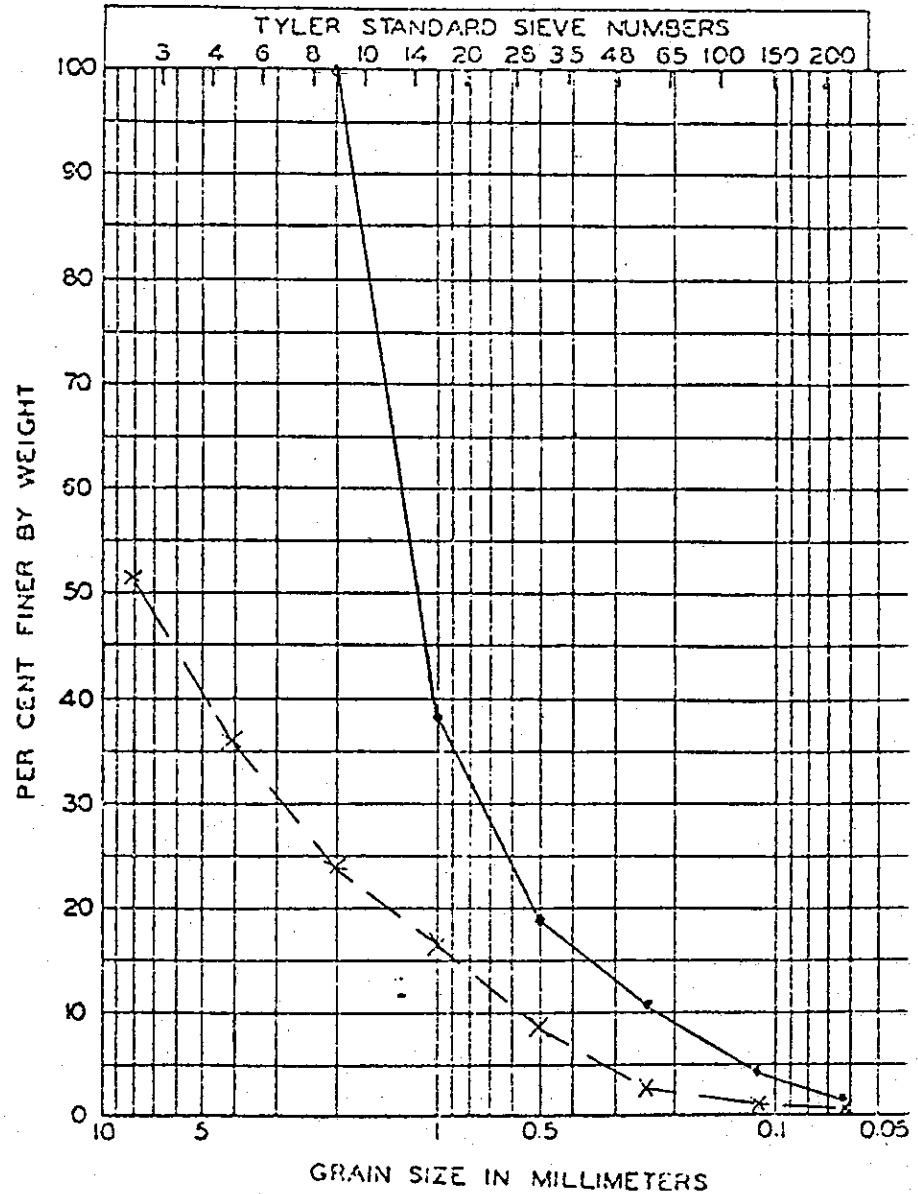

PLATE 4

44 D UPPER TRUCKEE RIVER

SUSPENDED SEDIMENT
BED MATERIAL

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GRAIN SIZE DISTRIBUTION DIAGRAM

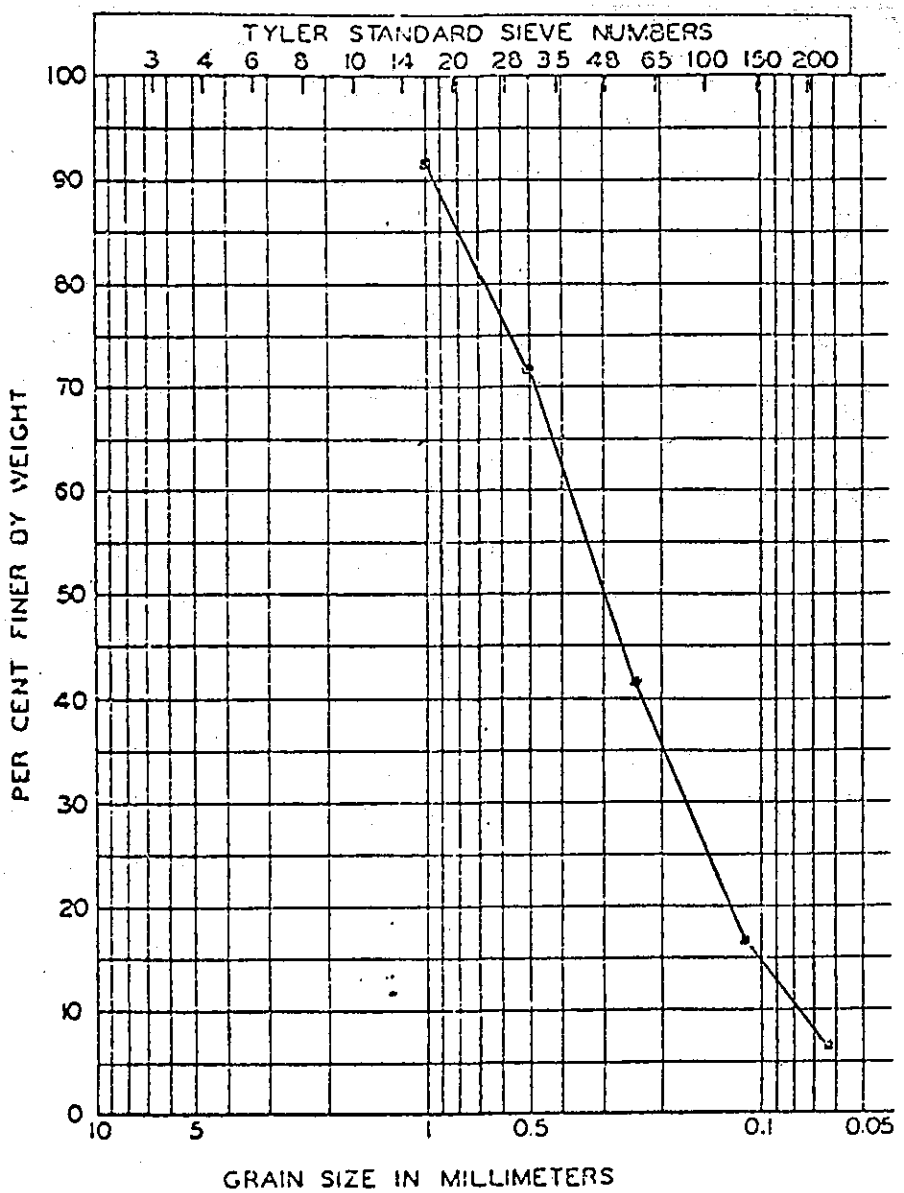

PLATE 5

53 LONELY GULCH

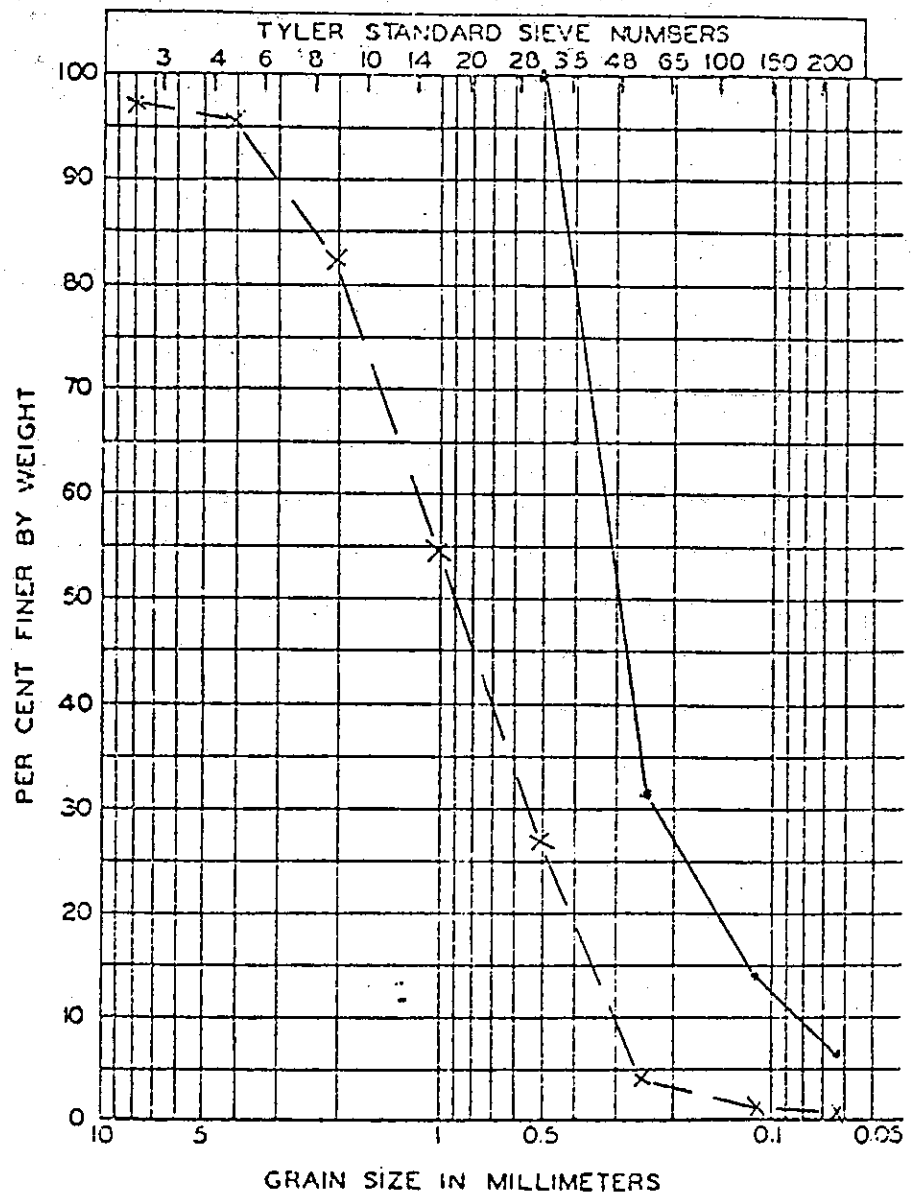

PLATE 6

56 GENERAL CREEK

SUSPENDED SEDIMENT

BED MATERIAL

GRAIN SIZE DISTRIBUTION DIAGRAM

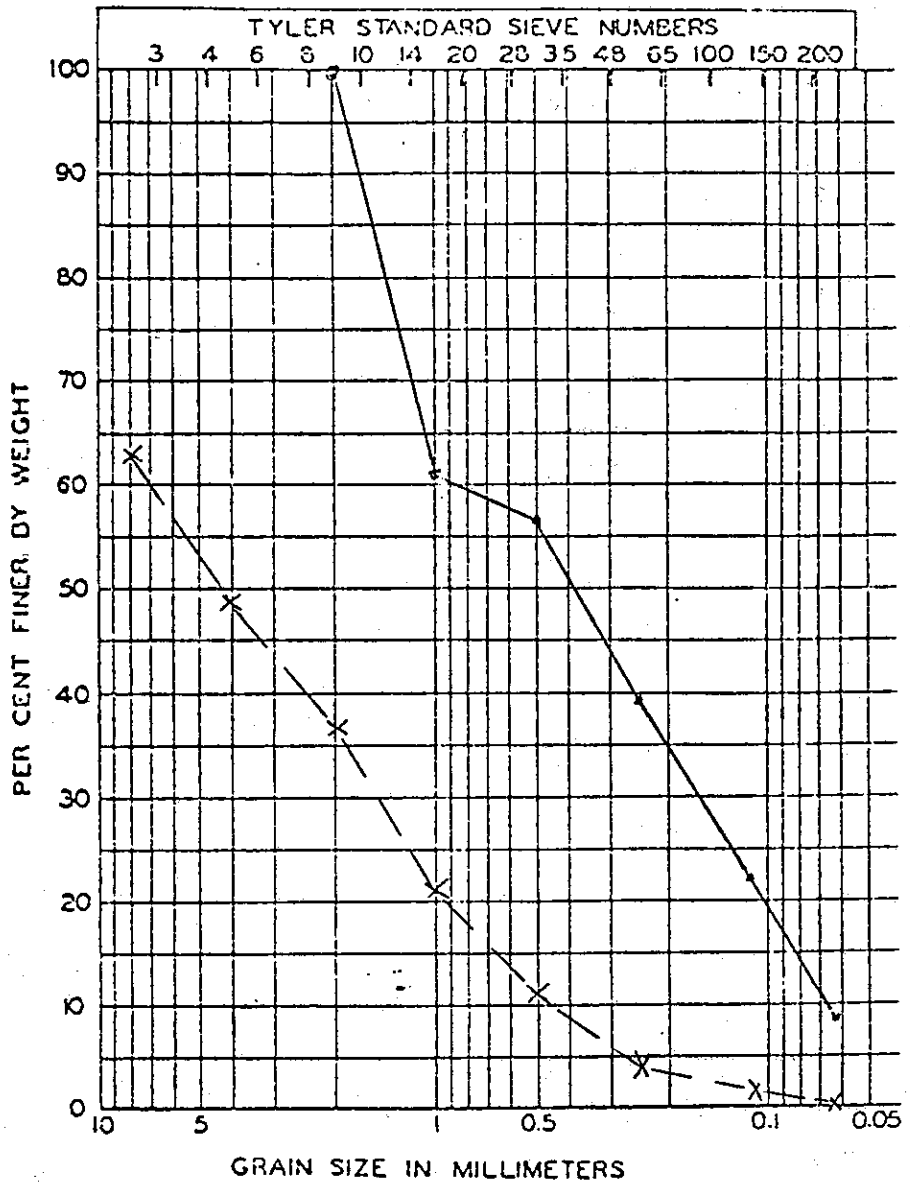

PLATE 7

62 BLACKWOOD CREEK

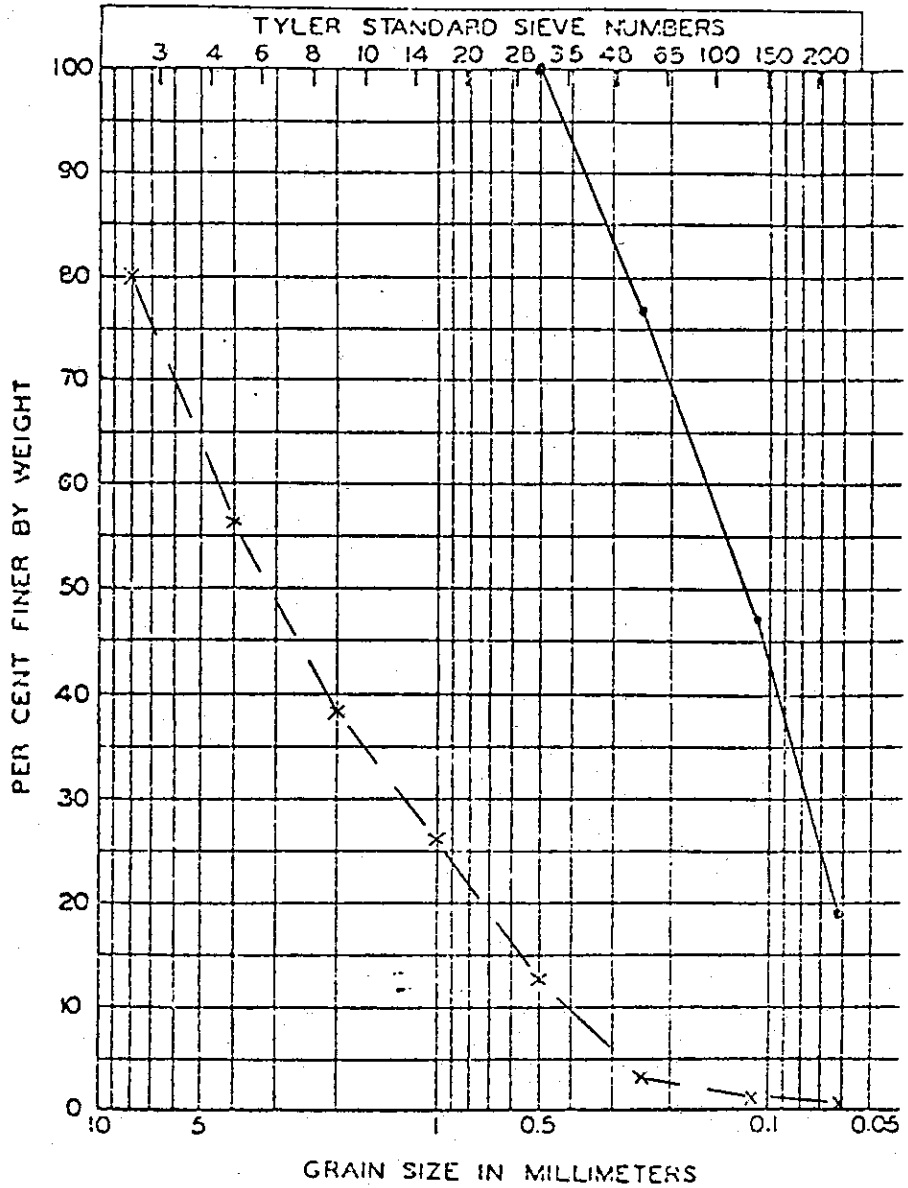

PLATE 8

63 WARD CREEK

SUSPENDED SEDIMENT

BED MATERIAL

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GRAIN SIZE DISTRIBUTION DIAGRAM

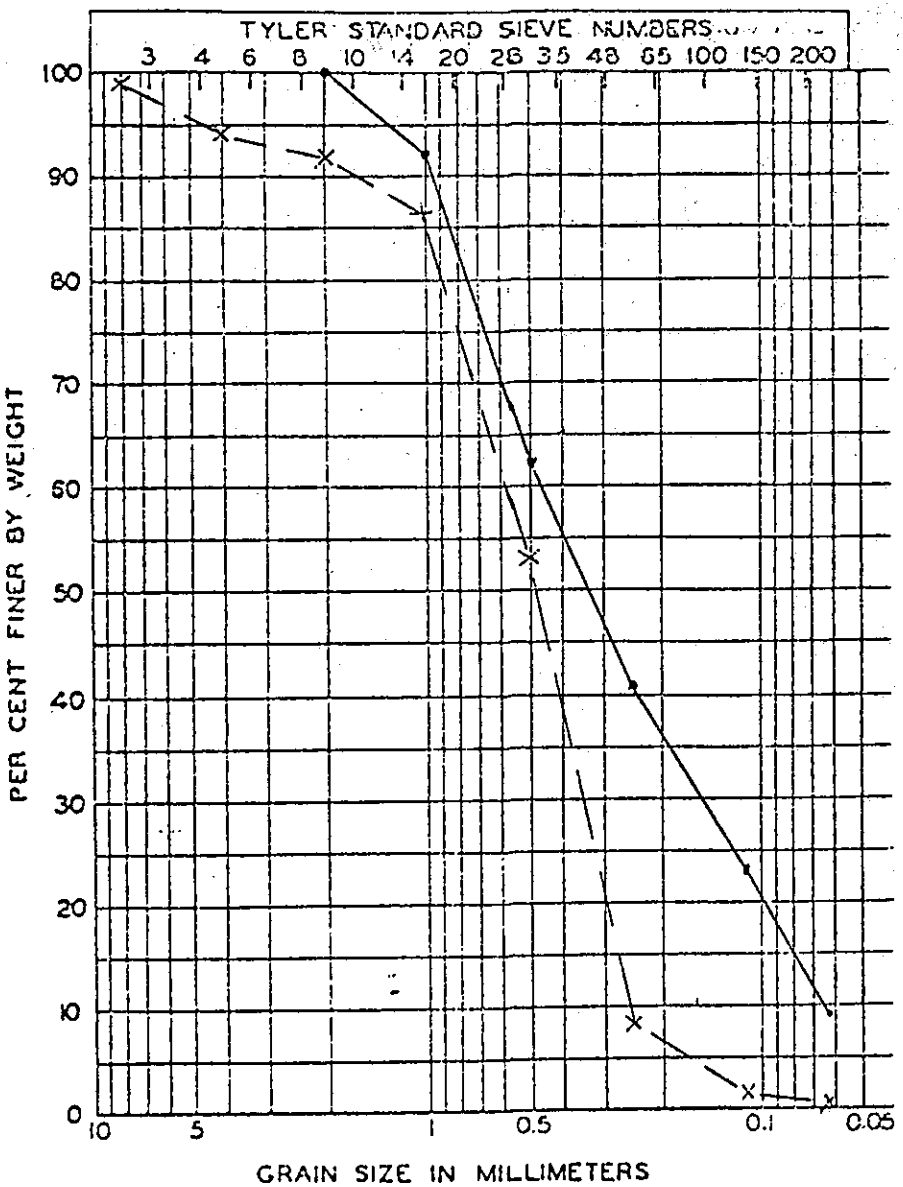

PLATE 9

2 BURTON CREEK

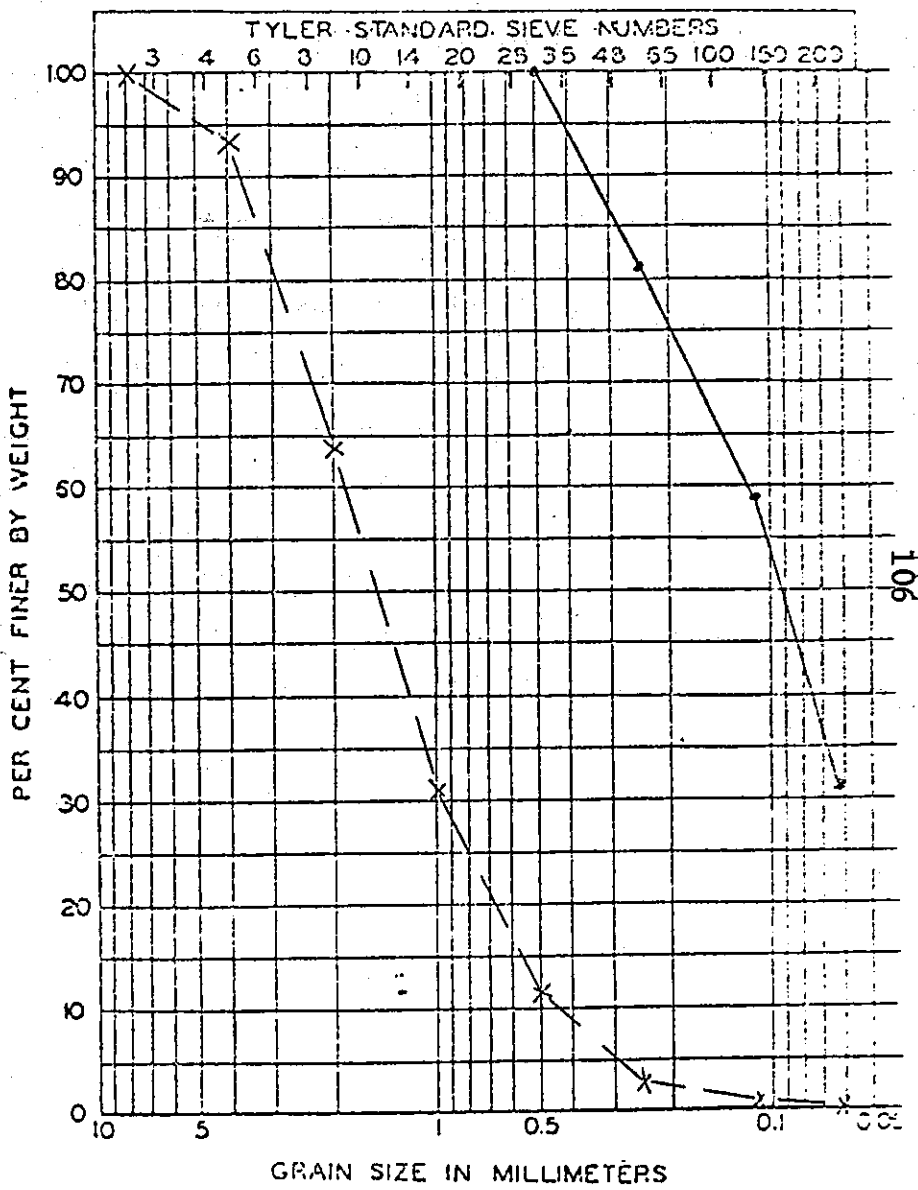

PLATE 10

10 B SNOW CREEK

●——● SUSPENDED SEDIMENT

×—— ——× BED MATERIAL

Bed Load

Bed Material Size Analysis

Bed material samples were taken for size analysis on Trout Creek and Upper Truckee River on March 23, 1971. Similar samples were taken on General Creek, Blackwood Creek, Ward Creek, Burton Creek, and Snow Creek on April 28, 1971. A bed material analysis on Lonely Gulch was not taken.

The size analyses of the bed material samples were performed at the U.S. Geological Survey Sedimentation Laboratory in Sacramento. The wet sieve method was used.[1/]

The results show that the bed material was consistently coarser than the suspended sediment which is generally the case. For Trout Creek, however, the bed material nearly was the same size as the suspended sediment material in the size range below 0.500 mm diameter.

The following table shows the percentages of sand and silt-clay for the bed material.

Bed Material Size Analysis

	Location	Bed Material % Sand	Bed Material % Silt-Clay
43	Trout Creek	99.8	0.2
44A	Upper Truckee River	99.8	0.2
44B	Upper Truckee River	99.8	0.2
53	Lonely Gulch	--	--
56	General Creek	99.9	0.1
62	Blackwood Creek	99.4	0.6
63	Ward Creek	99.8	0.2
2	Burton Creek	99.9	0.1
10B	Snow Creek	99.7	0.3

1/ "Laboratory Theory and Methods for Sediment Analysis," U.S. Geological Survey

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The grain size distribution for each stream is given in plates on page 102 through 106 and the mean diameter and diameter which 90 percent of the sizes are finer are given in the following table:

Sediment Diameter Analysis

	Location	Bed Material D_{90}	Bed Material D_{mean}	Suspended Sediment D_{90}	Suspended Sediment D_{mean}
43	Trout Creek	2.73 mm	1.09mm	1.25mm	0.67mm
44A	Upper Truckee River	7.64	3.55	0.56	0.25
44B	Upper Truckee River	20.96	6.38	0.77	0.30
44D	Upper Truckee River	27.29	10.80	1.84	1.05
53	Lonely Gulch			0.96	0.42
56	General Creek	3.17	1.46	0.46	0.28
62	Blackwood Creek	23.40	7.74	1.75	0.69
63	Ward Creek	12.94	4.86	0.40	0.16
2	Burton Creek	27.37	11.89	0.96	0.44
10B	Snow Creek	4.27	1.69	0.37	0.13

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APPENDIX

Location Map

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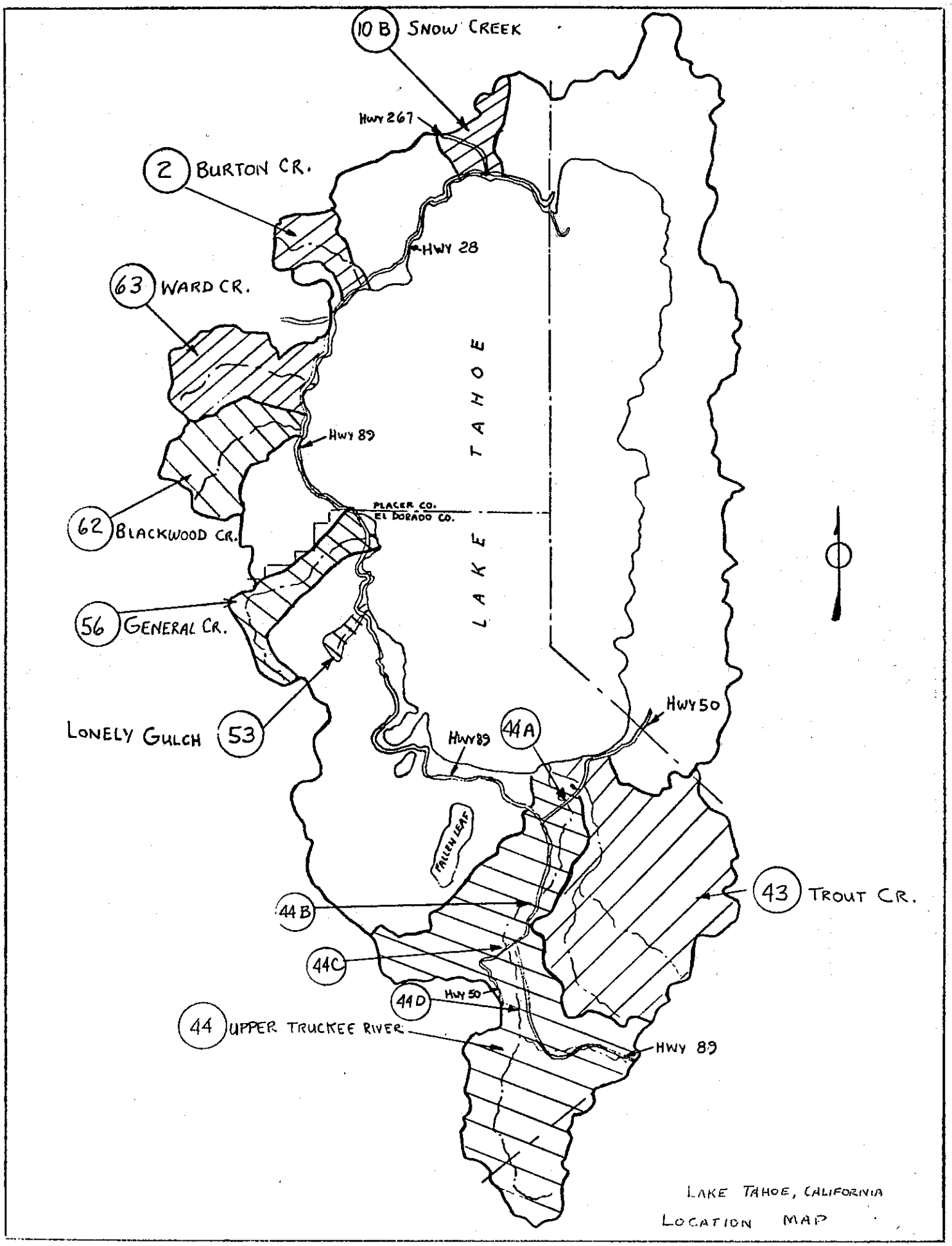

LAKE TAHOE, CALIFORNIA
LOCATION MAP

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