UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

COPPER RIVER HYDRAULICS STUDY AT MILLION DOLLAR BRIDGE, ALASKA

By

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[1]State of Alaska, Department of Transportation
and Public Facilities.

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CONTENTS

ILLUSTRATIONS

TABLE

FACTORS FOR CONVERTING ENGLISH UNITS TO INTERNATIONAL SYSTEM (SI) UNITS

Multiply English units	by	To obtain SI units
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)
cubic foot per second (ft^3/s)	.02832	cubic meter per second (m^3/s)

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INTRODUCTION

The State of Alaska, Department of Transportation and Public Facilities, and the United States Department of the Interior, Geological Survey, Anchorage, made a hydraulic investigation on the Copper River in the vicinity of the Million Dollar Bridge and Miles Lake on July 12-13, 1978, for the design of a proposed new bridge.

The following types of data were collected: water discharge, cross-sectional bed profiles, longitudinal bed profiles, water-surface elevations, bathymetry, point velocity, and direction of surface flow. Horizontal and vertical control was established at control end points.

Basic data and computations supporting the information presented in this report are in the files of the U.S. Geological Survey, Anchorage, and the State of Alaska, Department of Transportation and Public Facilities, Juneau.

OBJECTIVES

1. To define the hydraulic conditions in the vicinity of the Million Dollar Bridge to be used for the design of a new bridge.

2. To determine lake and river bed elevations in the vicinity of the Million Dollar Bridge.

3. To determine the cross-sectional configuration for proposed new alignments and the Million Dollar Bridge.

4. To report the maximum observed velocity at the time of the study for proposed new alignments and the Million Dollar Bridge.

5. To measure water discharge at the Million Dollar Bridge.

6. To obtain water-surface elevations (mean sea level datum) at the new alignments and at the Million Dollar Bridge for the purpose of computing slope and roughness.

SITE DESCRIPTION

The Million Dollar Bridge and Miles Lake study site is located about 36 miles northeast of Cordova, at mile 59 Copper River Highway, and 30 miles upstream from the mouth (fig. 1). The Copper River at Million Dollar Bridge drains an area of 24,200 square miles and flows through the 1,570-foot bridge crossing at the outlet of Miles Lake. The Copper River makes an abrupt bend 0.5 mile downstream from the bridge and impinges against the face of the Childs Glacier for 2 miles. The stage-discharge relation at the Million Dollar Bridge may be affected by ice breaking off from the face of Childs Glacier, which could constrict the river or change the control section. The channel bed at the bridge is composed of gravel and boulders (O'Neel and Hawkins, 1910; Tarr and Martin, 1914). The water-surface slope through the bridge section on July 13, 1978, during the time the discharge measurement was being made was 0.00160 foot/foot based on a water-surface profile along the left bank.

HISTORY OF DATA COLLECTION

History, observations and descriptions of glaciology, hydrology, and meteorology in the vicinity of the Million Dollar Bridge dating from 1850 to 1913 are described by Tarr and Martin (1914). Records of river conditions and meteorological data were collected at the Million Dollar Bridge site on the Copper River from August 1907 to 1910 (O'Neel and Hawkins, 1910). Water-stage records were obtained daily near the site from 1907 to 1910. Water-stage and discharge measurements were made at the Million Dollar Bridge in 1913 (Ellsworth and Davenport, 1915).

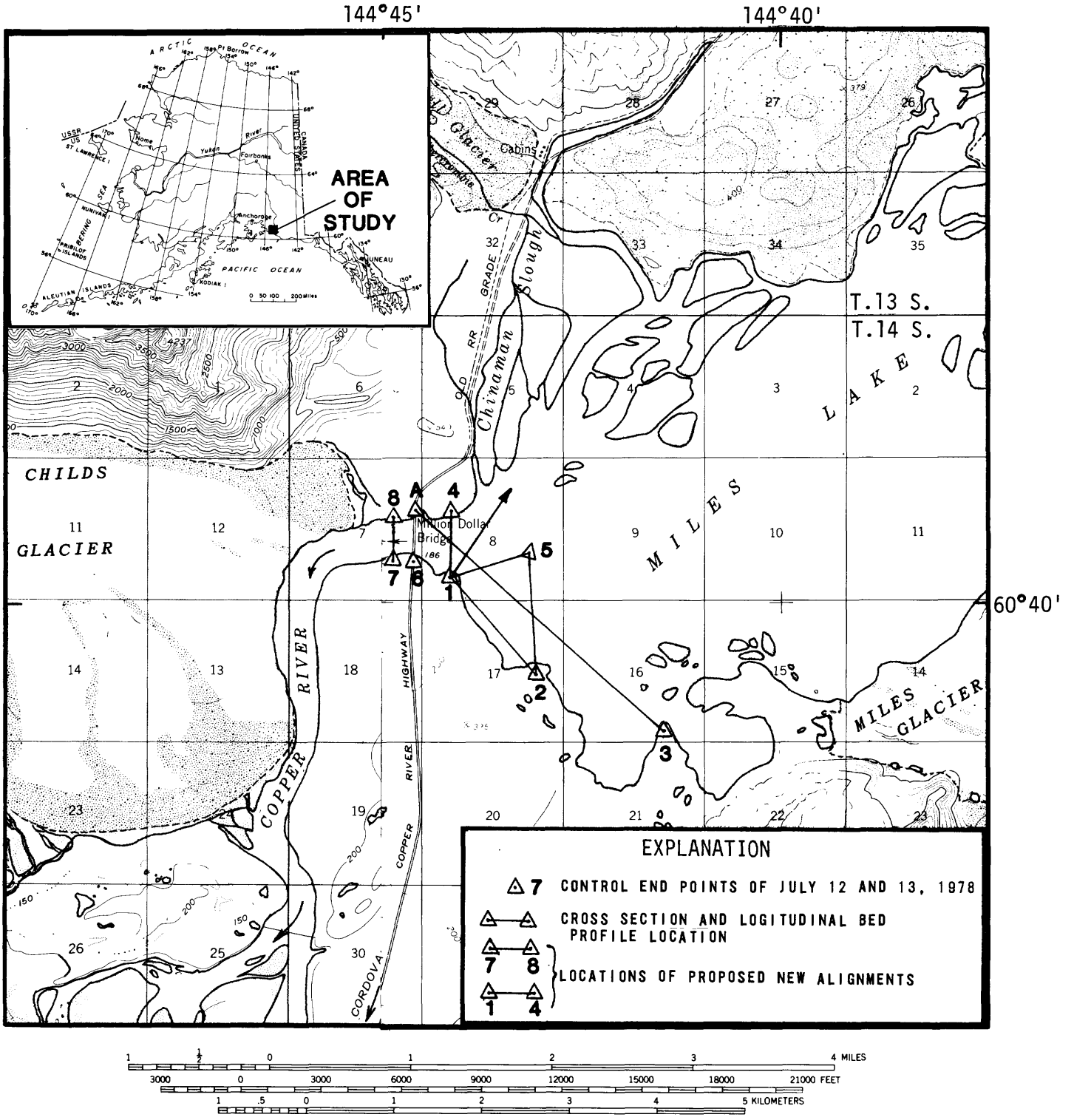
Observations, photographs, and descriptions of Miles and Childs Glaciers were made in 1931 by Wentworth and Ray (1936); American Geographical Society parties of 1957, 1959, 1961, and 1968; W. M. Laird in 1962 and 1964; and S. J. Tuthill in 1965. Aerial photographs were taken by Bradford Washburn in 1938; the U.S. Air Force in 1950 and 1957; A. Post in 1960, 1963-66, 1966, 1968, and 1971; and the American Geographical Society parties of 1964, 1966, and 1968.

During the summer and fall of 1969, the Hydraulics Branch of the Bridge Design Section of the Alaska Department of Highways conducted a hydraulic study of the Copper River from mile 27 to the Million Dollar Bridge (Alaska Department of Highways, 1970).

METHODS OF STUDY

The survey of cross-sectional and longitudinal profile end points for horizontal and vertical control and of water-surface elevations was done by a Department of Transportation survey crew. Control end points were tied to the Alaska State Plane Co-ordinate System. The survey was run using mean sea level datum.

Soundings to the streambed to determine cross-sectional profiles and longitudinal profiles were obtained with a recording fathometer from a moving boat. The transducer used with the fathometer produced a 8° beam width and was mounted in the bottom of the boat.



CONTOUR INTERVAL 100 FEET
DOTTED LINES REPRESENT 50-FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Figure 1.--Copper River hydraulic study area at Million Dollar Bridge, Alaska.

Alignment along the cross-sectional and longitudinal profiles was constantly monitored by theodolite sightings along the profile being run between two established control end points. Stationing along cross-section and longitudinal profiles was obtained by shooting instantaneous azimuths from two control points located opposite each other along the profile.

Water discharge and point velocities were measured using standard U.S. Geological Survey equipment and techniques. The discharge measurement was made near the downstream side of the Million Dollar Bridge, and stationing was maintained from the downstream side of the bridge. Point velocities were observed at 0.2 and 0.8 of the total depth in section "Y" and near the downstream side of the bridge, and the greatest values are shown in table 1 as maximum observed velocity. The direction of surface flow was observed using a current meter at section "Y" and near the downstream side of the bridge, and is plotted along a base line on sheet 1. The direction of surface flow was verified by aerial photography taken on August 16, 1973. Water-surface profiles were run while the discharge measurement was made.

PRESENTATION OF DATA

Sheet 1 is a bathymetric map showing river and lake-bed elevations; water-surface elevations; and the location of cross-sectional profiles, longitudinal profiles, and velocity observation points.

Channel cross-sections, longitudinal bed profiles, water-surface profiles, and point velocities are shown on sheet 2.

A discharge of 215,000 cubic feet per second was measured July 13, 1978, from a boat near the downstream side of the Million Dollar Bridge, and point velocities were also measured in cross section "Y" upstream from the bridge (table 1).

The average water-surface slope of 0.00160 foot/foot was computed between the bridge and section 7-8 using the surveyed water-surface elevations along the left bank and assuming the same profile along the right bank. The average water-surface slope of 0.00101 foot/foot between section 1-4 and the bridge was computed using the average of the surveyed water-surface profiles along both banks. This slope was not used in the computation of the Manning "n" roughness coefficient because the profile represents a rapidly changing area from a lake to a river.

The average value of the Manning "n" roughness coefficient of n = 0.036 was computed for a discharge of 215,000 cubic feet per second using the average water-surface slope along the left bank between the bridge and section 7-8; velocity head coefficient is considered to be 1.00, and the hydraulic properties of the reach are as defined by the bridge section and section 7-8. Manning "n" was computed using methods given by Barnes (1967).

Table 1.--Hydraulic properties in the vicinity of the Million Dollar Bridge, July 13, 1978

Section	Water-surface elevation (ft)	Discharge (ft^3/s)	Area (ft^2)	Top width (ft)	Mean depth (ft)	Hydraulic radius (ft)	Mean velocity (ft/s)	Maximum observed velocity (ft/s)	Distance between sections (ft)	Fall between sections (ft)	Slope between sections (ft/ft)
1-4	135.48	215,000	41,700	2,060	20.2	20.13	5.16	6.3	--	--	--
Bridge	133.92	215,000	29,300	1,490	19.7	19.61	7.34	11.0	1,540	1.56	.00101
7-8	132.77	215,000	22,700	1,280	17.7	17.64	9.47	--	720	1.15	.00160

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