

Prepared in cooperation with the  
**GRAND CANYON MONITORING AND RESEARCH CENTER**

**Flow Velocity and Sediment Data Collected  
During 1990 and 1991 at National Canyon,  
Colorado River, Arizona**

**Data Series 246**

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

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# **Flow Velocity and Sediment Data Collected During 1990 and 1991 at National Canyon, Colorado River, Arizona**

By Nancy J. Hornewer and Stephen M. Wiele

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## Conversion Factors

Multiply	By	To obtain
	Length	
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Flow rate	
cubic foot per second (ft <sup>3</sup> /s)	0.02832	cubic meter per second (m <sup>3</sup> /s)

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# Flow Velocity and Sediment Data Collected During 1990 and 1991 at National Canyon, Colorado River, Arizona

By Nancy J. Hornewer and Stephen M. Wiele

## Abstract

During 1990 and 1991, a series of research flows were released from Glen Canyon Dam. Data collected at the streamflow-gaging station on the Colorado River above National Canyon near Supai from that period have been compiled and entered into the U.S. Geological Survey database. The data consist of measurements of suspended-sediment concentration and sand sizes in suspension, sand sizes of streambed sediment, and velocity of the Colorado River above National Canyon near Supai streamflow-gaging site. Velocity and sediment data are available upon request from the Arizona Water Science Center and from the U.S. Geological Survey water-quality database (<http://waterdata.usgs.gov/az/nwis/qw>).

## Introduction

During 1990 and 1991, a series of research flows were released from Glen Canyon Dam (figure 1). The releases were part of a series of studies done in cooperation with the U.S. Bureau of Reclamation and the U.S. Geological Survey (USGS) to determine the effect of releases from the dam on the river corridor between Glen Canyon Dam (river mile -15.5) and Lake Mead (river mile 276.5). Locations along the river are indicated by river mile (RM) below Lees Ferry, which is designated RM 0, (Breedlove and Mietz, 2002). During the releases, suspended sediment and bed material were sampled to study sediment transport at the Colorado River above National Canyon near Supai (USGS gage number 09404120) streamflow-gaging station (referred to as the National gage in this report), located at RM 166. Velocity and sediment data are available upon request from the Arizona Water Science Center and from the USGS water-quality database (<http://waterdata.usgs.gov/az/nwis/qw>).

## Purpose and Scope

This report presents the availability of suspended-sediment concentration and sand sizes in suspension, sand sizes of streambed sediment, and velocity data collected at

the National gage, 166 miles below Lees Ferry (182 miles below Glen Canyon Dam) on the Colorado River, during the research flows in 1990 and 1991. Field work consisted of measuring velocity profiles and collecting suspended-sediment and bed-sediment samples. The units used in this report are the units in which the data are stored in the database and are also the units used by Grand Canyon researchers and managers.

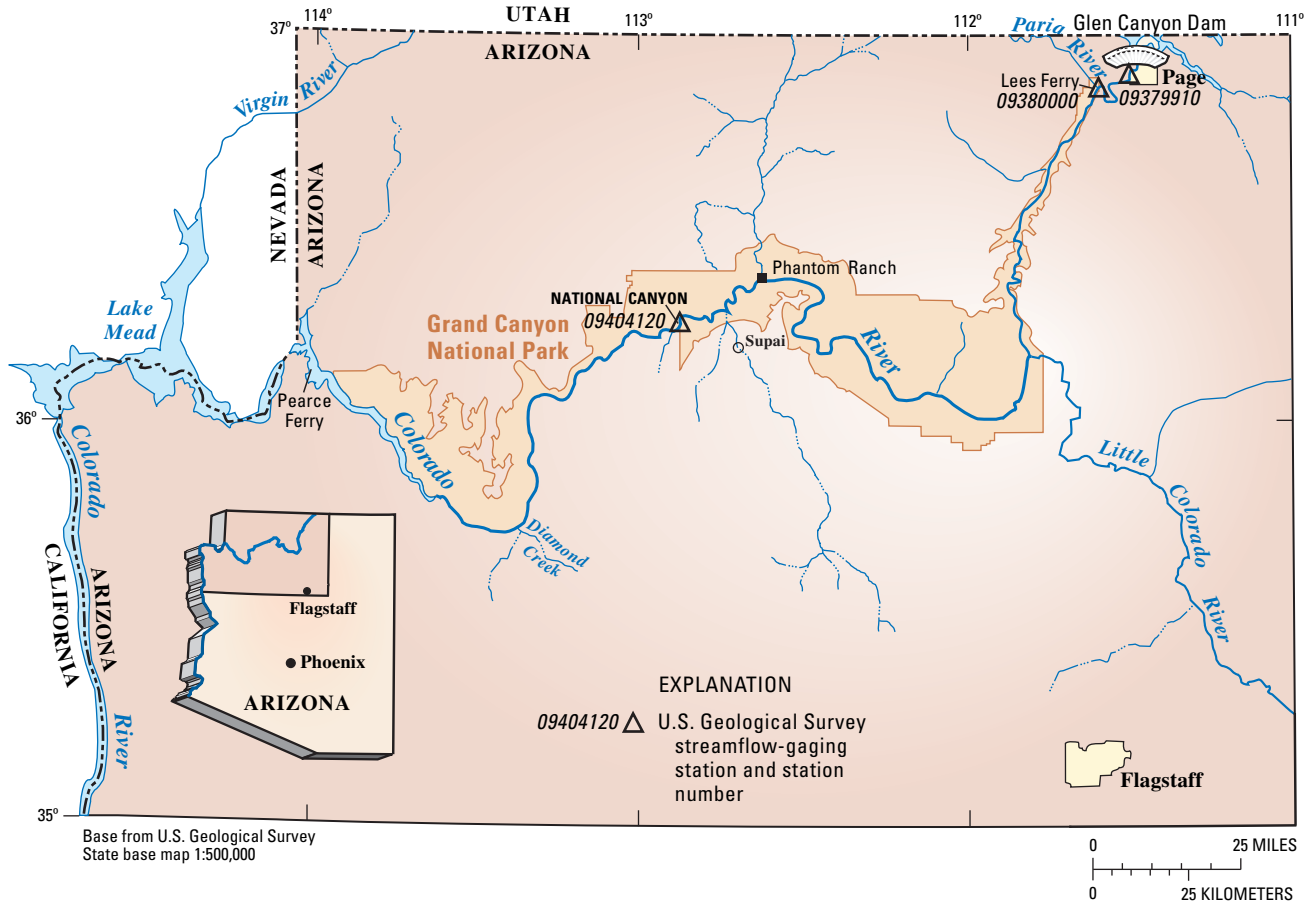
## Acknowledgments

Julia Graf, John Gray, Greg Fisk, and Bob Hart (USGS) provided information regarding field methods used during the data collection. Ted Melis and Scott Wright of the USGS Grand Canyon Monitoring and Research Center (GCMRC) supported this report and the GCMRC provided funding for publication. The Bureau of Reclamation through the Glen Canyon Environmental Studies funded the data collection and sample analysis. Finally, much credit and appreciation is owed to the many individuals who worked diligently and arduously to collect sediment samples during the 1990–1991 research flows.

## Description of the National Gage Study Area

The reach in which the National Canyon streamflow-gaging station was located is relatively straight and of uniform width compared to most of the rest of the Colorado River in Grand Canyon. The channel is deeply entrenched in bedrock, and the channel margins are lined with talus slopes. The debris fan at the mouth of National Canyon, 0.25 mile downstream from the streamflow-gaging station, forms a hydraulic control for the mainstem Colorado River in the sampling section for the discharges released during the research flows. The channel bottom typically was covered with a sand layer with dunes during 1990 and 1991 (Christiansen, 1993). The National gage was operated between July 31, 1983, and April 18, 1993, and again from March 7, 1996, through April 25, 1996.

## 2 Flow, Velocity Profiles, Suspended and Bed Sediment Samples, and Sample Analysis, National Canyon, Colorado River



**Figure 1.** Location of National Canyon study area on the Colorado River in Grand Canyon, Arizona.



## Releases from Glen Canyon Dam

The research releases in 1990 and 1991 consisted of steady or fluctuating flows preceded and followed by steady flows lasting 3 days. The releases were designated with letters A-F (figure 2). Sediment was sampled and analyzed for releases as follows: A, December 17, 1990–December 27, 1990; B, December 31, 1990–January 10, 1991; C, January 28, 1991–February 7, 1991; D, May 6, 1991–May 16, 1991; E, May 20, 1991–May 30, 1991; F, July 1, 1991–July 11, 1991; and G, July 15, 1991–July 25, 1991. Discharge records for flows A, B, C, D, E, F, and G from the Colorado River below Glen Canyon Dam streamflow-gaging station (USGS gage number 09379910) and National gage are available upon request from the Arizona Water Science Center.

## Flow, Velocity Profiles, Suspended and Bed Sediment Samples, and Sample Analysis

The number of cross sections, point-velocity measurements, and types and total numbers of sediment samples collected and analyzed for each of the research flows are shown in table 1. Discharge at National gage was computed following standard USGS procedures from a record of stage and a stage-discharge rating curve developed with the method described by Rantz and others (1982a, 1982b) and Rote and others, 1997.

J.B. Graf (hydrologist, U.S. Geological Survey, written commun., 1991) described the suspended sediment sampling and velocity profile measurements:

*During the highest flows in the 1991 measurements, samples were collected and velocity measurements made at 11 locations across the channel. These were at stations 60, 75, 95, 110, 130, 145, 160, 175, 190, 210, and 225. The locations were selected to define*

*sections of approximately equal discharge. At each station, samples were collected and measurements made at points 0.5, 1.5, 3.0, 6.0, 12.0 ft from the channel bottom and at a point about 2 ft below the water surface. If flow depth exceeded 24 ft, an additional sample was collected at a point 18 ft from the channel bottom. For most sample suites, 77 samples or velocity measurements were then collected (7 points at 11 stations). Point velocity measurements were made at each point where a suspended-sample was collected.*

The station locations noted above are in feet, referenced from the left bank. It took approximately 1–2 hours to collect a full set of suspended-sediment samples or point-velocity measurements from all station points across the channel (referred to as 1 cross section). The spacing between station locations was determined at 11,500 cfs to approximate the equal-discharge-increment (EDI) method (Richard Siedeman, hydrologist, U.S. Geological Survey, written commun., 1991; EDI method described by Guy and Norman, 1970). Sediment samples were collected and velocity measurements were made from a cableway. A P61 sampler and methods described by Edwards and Glysson (1999) were used to collect suspended-sediment samples.

Suspended-sediment samples were analyzed by the USGS Sediment Laboratory at Cascades Volcano Observatory. The samples were sieved to separate sand (> 0.0625 mm) from silt (< 0.0625 mm), and the sand-size distribution was determined with a visual-accumulation tube (Guy, 1969).

Bed sediment was sampled with a BM-54 sampler at stations about 15 ft apart (Richard Siedeman, hydrologist, U.S. Geological Survey, written commun., 1991). Samples were analyzed at the USGS National Research Program Sediment Lab in Tucson, Arizona.

4 Flow, Velocity Profiles, Suspended and Bed Sediment Samples, and Sample Analysis, National Canyon, Colorado River

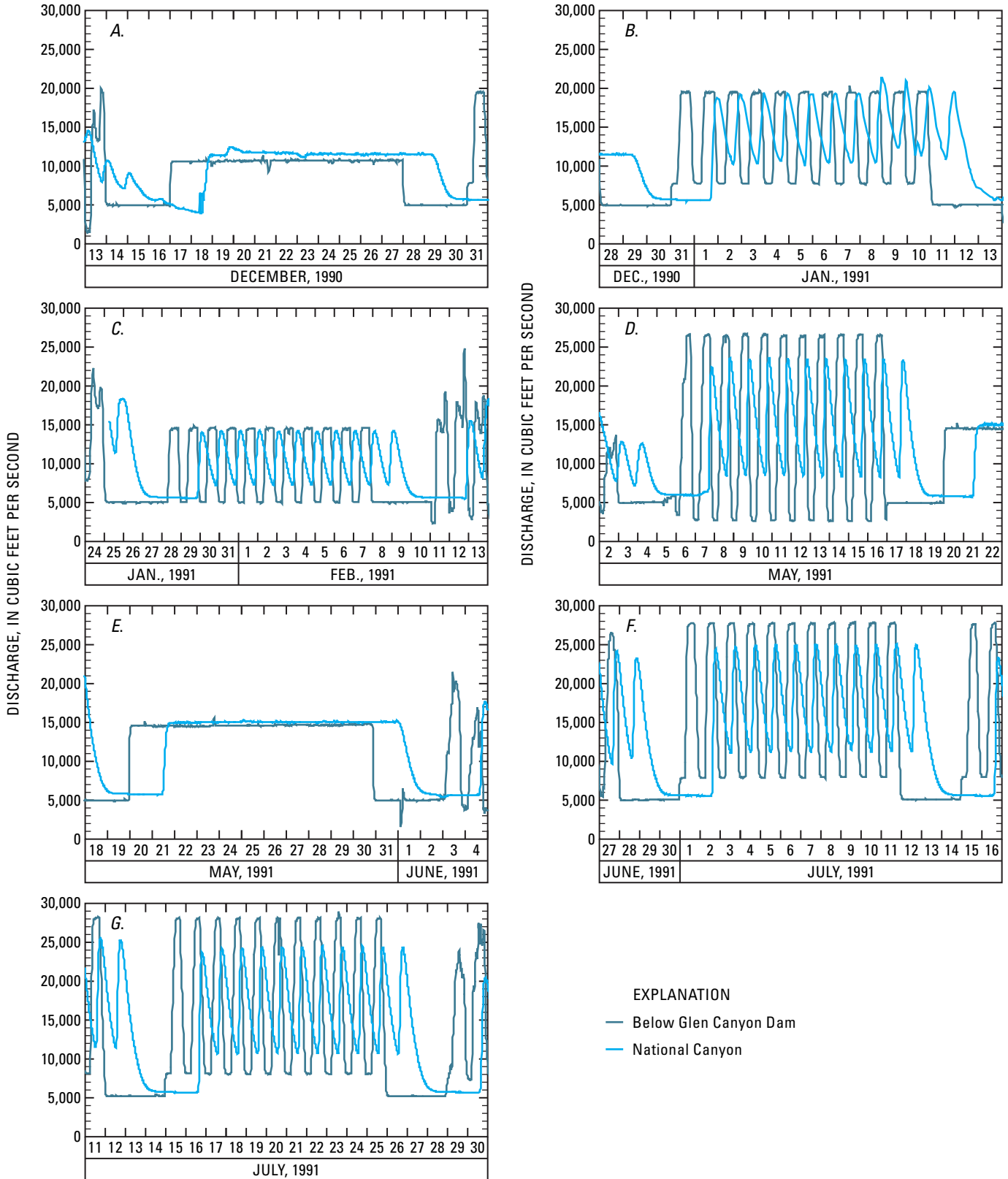


Figure 2. Hydrographs of discharge at U.S. Geological Survey streamflow-gaging stations Colorado River below Glen Canyon Dam (gage number 09379910) and Colorado River above National Canyon near Supai (gage number 09404120) during Research Flows A-F.

**Table 1.** Number of cross sections, point-velocity measurements, and types and total numbers of sediment samples collected and analyzed from seven research flows in 1990 and 1991.

[---, no data]

	Number of cross sections	Total number of samples	Number of cross sections	Total number of samples	Number of cross sections	Total number of samples	Number of cross sections	Total number of samples	Number of cross sections	Total number of samples	Number of cross sections	Total number of samples	Number of cross sections	Total number of samples
<b>Data</b>														
<b>Flow</b>	<b>A</b>		<b>B</b>		<b>C</b>		<b>D</b>		<b>E</b>		<b>F</b>		<b>G</b>	
<b>Velocity</b> (point measurements)	2	60	25	472	13	382	18	644	7	297	17	1,179	17	1,157
<b>Suspended sediment–split</b> (analyzed for sand/silt split)	---	---	---	---	19	428	---	---	---	---	7	510	8	492
<b>Suspended sediment–full</b> (analyzed for grain size distribution)	---	---	---	---	3	54	2	65	---	---	---	---	12	695
<b>Bed sediment</b>	2	10	4	38	2	11	---	---	4	33	---	---	---	---

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