Summary of Turbulence Data From Rivers, Conveyance Channels, and Laboratory Flumes

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TURBULENCE IN WATER

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SYMBOLS

Symbol	*Definition*
A	Area of flow cross section, in (feet)^2.
B_e	Effective band width.
$C/\sqrt{g}$	Chézy discharge coefficient, $\overline{V}/U_*$.
C_s	Concentration of suspended sediment, in milligrams per liter.
C_t	Concentration of total bed material, in milligrams per liter.
D	Total depth of flow in a vertical, in feet.
$\overline{D}$	Average depth of flow, in feet.
d_{16}	Particle size for which 16 percent of the sediment, by weight, is finer, in millimeters.
d_{50}	Median particle size of suspended sediment, in millimeters.
D_{50}	Median particle size of the bed material, in millimeters.
d_{84}	Particle size for which 84 percent of the sediment, by weight, is finer, in millimeters.
E	Mean voltage, in volts.
$\sqrt{\overline{e^2}}$	Root mean square of the voltage output, in volts.
f	Resistance coefficient.
f_c	Cutoff frequency, in (seconds)$^{-1}$
$F(n)$	Normalized energy spectrum function, in seconds.
$\mathbf{F}$	Froude number, $\overline{V}/\sqrt{g\overline{D}}$.
g	Acceleration of gravity, in feet per second per second.
L_x	Macroscale of turbulence, in feet.
n	Frequency, in (seconds)$^{-1}$.
Q	Discharge of water-sediment mixture, $Q=A\overline{V}$, in cubic feet per second.
R	Hydraulic radius, in feet.
$R(t')$	Autocorrelation function.
$\mathbf{R}$	Reynolds number, $\overline{V}\overline{D}/\nu$.
S	Slope of the energy gradient.
t	Time, in seconds.
t'	Delay time, in seconds.
T_E	Eulerian integral time scale, in seconds.
T	Temperature, in °C.
u	Velocity fluctuation in the x direction, in feet per second.
$\overline{U}$	Local mean velocity, in feet per second.
U_*	Shear velocity, in feet per second.
$\sqrt{\overline{u^2}}$	Longitudinal turbulent intensity, in feet per second.
v	Velocity fluctuation in the y direction, in feet per second.
$\sqrt{\overline{v^2}}$	Vertical turbulent intensity, in feet per second.
$\overline{V}$	Average velocity, Q/A, in feet per second.
$\overline{uv}$	Reynolds stress, in (feet)^2 per (second)^2.
$\sqrt{\overline{w^2}}$	Lateral turbulent intensity, in feet per second.
W	Flume or channel width, in feet.
Y	Depth above the bed, in feet.
γ	Specific weight of water, in pounds per cubic foot.
μ	Dynamic viscosity, in pounds-seconds per square foot.
ν	Kinematic viscosity, in square feet per second.
ρ	Mass density of water, in slugs per cubic foot.
σ	A measure of sediment particle size gradation, $\frac{1}{2}\left(\frac{d_{50}}{d_{16}}+\frac{d_{84}}{d_{50}}\right)$.
τ	Shear stress force on bed, in pounds per square foot.
ω	Fall velocity of d_{50}, in feet per second.
λ_x	Microscale of turbulence, in feet.

ENGLISH-METRIC CONVERSION TABLE

Principal items	*English unit*	*Factor*	*Metric unit*
Depth of flow Length and width of flume Particle size Hydraulic radius	ft	0.3048 30.48 304.8	m cm mm
Area of cross section	sq ft	929.0 .09290	cm^2 m^2
Velocity of flow Fall velocity of particles	ft per sec	0.3048 30.48	m/sec cm/sec
Velocity of bed configuration	ft per min	0.005080 .5080 .01829	m/sec cm/sec km/hr
Water discharge	cu ft per sec (cfs)	0.02832 2.832×10^4	m^3/sec cm^3/sec
Sediment discharge	lb per sec per ft	1.488	kg/sec/m
Acceleration of gravity	ft per sec per sec	0.3048 30.48	m/sec/sec cm/sec/sec
Shear stress	lb per sq ft	478.8 0.4882 4.882	dynes/cm^2 g/cm^2 kg/m^2
Kinematic viscosity	sq ft per sec	929.0	cm^2/sec (Stokes)
Dynamic viscosity	lb sec per sq ft	0.04788 .4482	g/cm-sec (Poise) g-sec/cm^2
Specific weight	lb per cu ft	0.01602	g/cm^3
Mass density	slug per cu ft	0.5154	g/cm^3

SUMMARY OF TURBULENCE DATA FROM RIVERS, CONVEYANCE CHANNELS, AND LABORATORY FLUMES

By R. S. McQuivey

ABSTRACT

The primary purpose of this report is to summarize and make available to other investigators some turbulence characteristics of turbulent shear flows obtained by use of hot-film anemometry. Related hydraulic and sediment data were also collected and are included. Data were collected from the study of flow in 20-centimeter-, 2-foot-, 4-foot-, and 8-foot-wide recirculating flumes, at the Colorado State University, over rigid and alluvial boundaries. Alluvial boundary data were also collected in the Atrisco feeder canal near Bernalillo, N. Mex., the Rio Grande conveyance channel near Bernardo, N. Mex., the Columbia River estuary near Astoria, Oreg., the Missouri River near Omaha, Nebr., and the Mississippi River near Vicksburg, Miss.

The data collected and reported include such variables and parameters as the longitudinal and vertical components of the turbulent intensity, the macroscale and microscale of turbulence, the Eulerian integral time scale, the measured turbulent shear stress, the local mean velocities, the slope, the depth, the width, the discharge, the temperature, the suspended-sediment concentration, and the total bed-material discharge. Power spectra, some space-time, and space-correlation relations were obtained but are not included in this report. Also, not all the above characteristics were collected at each location.

Some longitudinal turbulence intensities were obtained from a standard Price current meter and a small propeller meter at three of the field locations. These data are reported along with the hot-film anemometer measurements.

INTRODUCTION

As a part of the research program of the U.S. Geological Survey, several projects have been organized over the years to study the mechanics of water and sediment movement in open-channel flow. Answers to problems on resistance to flow, sediment transport, diffusion, dispersion, reaeration, and related problems were sought. Solutions to these problems are complicated by the multitude of variables and parameters involved and by the complex interdependence of those variables.

Turbulence is a major factor in each of the above-mentioned problems. Certain general items might be mentioned to indicate the effect of turbulence on various flow phenomenon. Sediment transport is controlled largely by turbulence. Both the movement of bed load and the carrying of material in suspension are apparently the result of the action of turbulent eddies in the flowing water. Even the bed forms and the nature and magnitude of resistance to flow in alluvial channels seem to be byproducts of the turbulence mechanism. Another significant phenomenon is that of turbulent mixing. This is simply the ability of turbulence to transfer momentum, heat, and mass from one region of the fluid to another. This depends on how fast eddies move transversely to the stream and their mean travel distance. The movement of eddies is undoubtedly dependent on the turbulence intensity, and their travel depends both on how many are present and on their size.

Only recently has it become possible to measure turbulence in water. The development of constant-temperature anemometry has finally given the experimenter a tool for studying the turbulence phenomenon in water flows. Because of the complexities of the flow and of the experimental equipment involved, many inconsistencies are still present in the reported measurements. Need exists for all types of information on turbulence in water flow, not only to verify existing data, but also to provide new information on various flow conditions. The production of turbulence and its growth, dissipation, and distribution in the flow are fundamental to a sound concept of fluid motion involving friction, drag, and the dispersion and diffusion of heat, mass, and momentum.

The objectives of these experiments were to obtain as much information on turbulence in water under as many different flow conditions as possible. Specifically, the main objective was to be able to measure turbulence in water under a variety of conditions, using hot-film anemometers, and to obtain reasonable and reliable results. Ultimately, the writer hopes to relate the measured turbulence characteristics to the problems of resistance to flow, sediment transport, reaeration, diffusion and dispersion, to verify the equations of motion and energy for open-channel flow, and to develop a scaling parameter for various hydraulic systems. Several of these objectives will be topics of other reports.

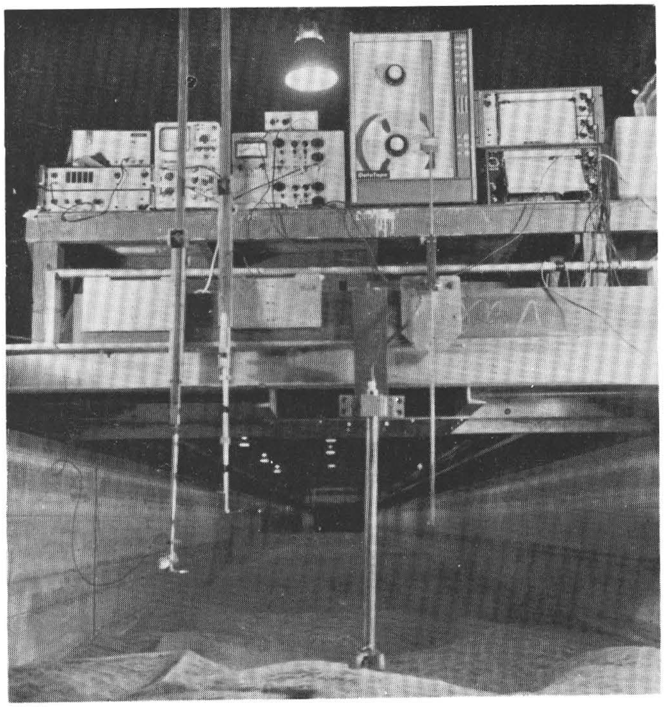
This report is a compilation of turbulence, hydraulic, and sediment data. Data were collected from the study of flow in 20-centimeter-, 2-foot-, 4-foot-, and 8-foot-wide recirculating flumes, at the Colorado State University, over rigid and alluvial boundaries. Alluvial boundary data were also collected in the Atrisco feeder canal near Bernalillo, N. Mex., the Rio Grande conveyance channel near Bernardo, N. Mex., the Columbia River estuary near Astoria, Oreg., the Missouri River near Omaha, Nebr., and the Mississippi River near Vicksburg, Miss.

The data collected and reported include such variables and parameters as the longitudinal and vertical components of the turbulent intensity, the macroscale and microscale of turbulence, the Eulerian integral time scale, the measured turbulent shear stress, the velocity, the depth, the slope, the width, the discharge, the temperature, the suspended-sediment concentrations, and the total bed-material discharge. However, not all these data were collected at each location.

Some longitudinal turbulence intensities were obtained by using a standard Price current meter and a small propeller meter in three of the above field locations. A direct comparison of these intensities with the turbulence intensities measured with the hot-film anemometer is possible.

No detailed analyses, comparisons, or conclusions are included in this report. The data contained are a basis for a series of U.S. Geological Survey reports on turbulence in water.

The writer expresses his gratitude to members of the U.S. Geological Survey research staffs at Fort Collins, Colo., Albuquerque, N. Mex., and Portland, Oreg., and to the Corps of Engineers at Omaha, Nebr., and Vicksburg, Miss., for their support of the project with the proper logistics and for their aid in the collection of data.



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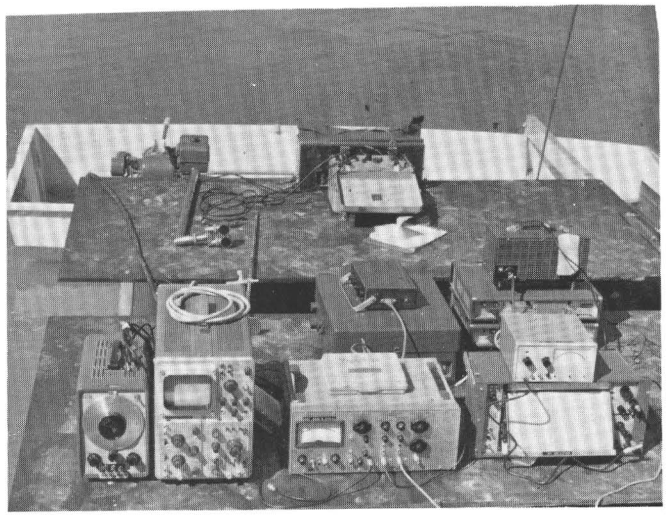


B

FIGURE 1. — Electronic equipment used in obtaining data: *A*, 8-foot-wide flume; *B*, Atrisco feeder canal.

EQUIPMENT

The constant-temperature anemometer is the basic instrument used to obtain the turbulence measurements. However, to obtain the desired turbulence characteristics, additional signal conditioning equipment is required. The electronic equipment used in obtaining the data in the flumes and in the field are shown in figure 1. Figure 2 is a schematic diagram of the equipment.

A variety of equipment was used to obtain the hydraulic and sediment data location. A brief description of the data-collection equipment follows.

CONSTANT-TEMPERATURE ANEMOMETER

The anemometer used in this study is a commercially available constant-temperature compensating unit. When considering the use of an anemometer, two basic considerations should be investigated—the signal to noise ratio and the frequency response. The manufacturer reports that its unit has reasonably undistorted frequency response from 0 to 20 kHz.

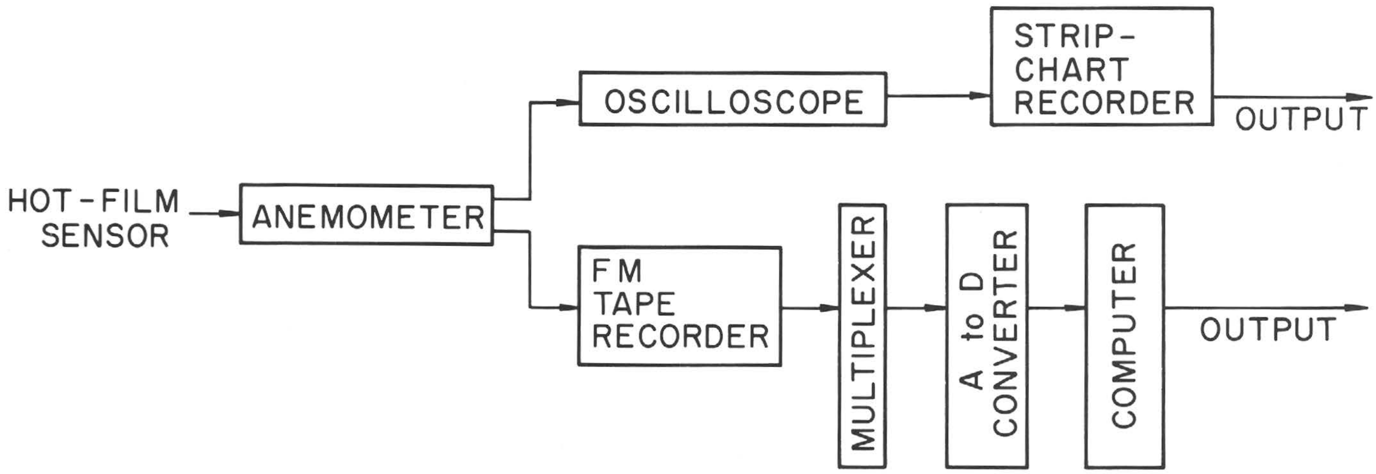


FIGURE 2. — Schematic diagram of the equipment used in obtaining the turbulence data.

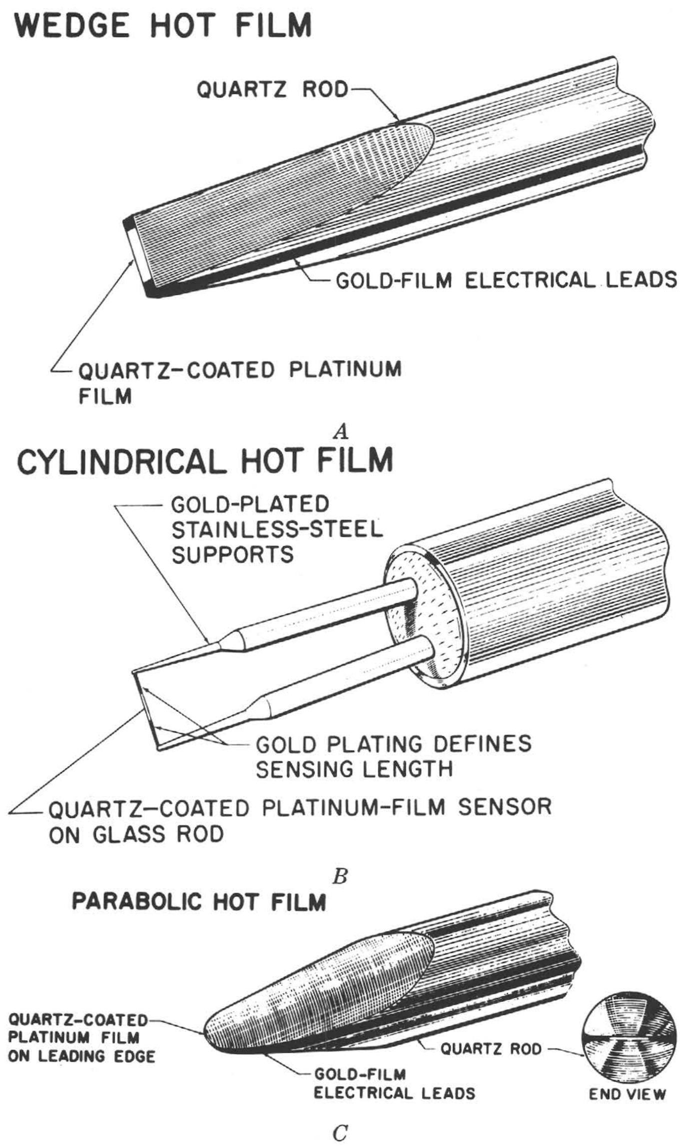


FIGURE 3. — Hot-film sensors used in these studies: *A*, Wedge sensor; *B*, cylindrical sensor; *C*, parabolic sensor.

The signal to noise ratio for the voltage output (several hundred millivolts) and frequency range (0 to 100 Hz) in water flow is certainly no problem. Therefore, no problems are associated with the anemometer itself. To successfully use an anemometer for making a specific fluid-mechanics measurement, the selection of a sensor is, then, of primary importance.

For a detailed explanation and description of hot-film anemometry, the selection and the limitations of hot-film sensors, and the operational procedures, refer to McQuivey (1973).

HOT-FILM SENSORS

The three types of commercially available sensors used in these studies are shown in figure 3. The wedge-shaped hot-film sensor was used only in the 20-centimeter-wide flume studies. The cylindrical-shaped hot-film sensor was used in the 20-centimeter-, 2-foot-, and 8-foot-wide flume studies where foreign matter in the flow could be filtered or screened out. The frequency-response characteristics of the cylindrical sensor makes it the most desirable sensor to use. However, its shape is not desirable because of the tendency of foreign contaminants to wrap around or to collect on it, and the sensor is much too fragile for data collection in natural and sediment-laden channels.

The parabolic-shaped hot-film sensor was used almost exclusively in the 4-foot- and 8-foot-wide flume studies, as well as in all the field studies. Because of its shape it remains fairly clean of foreign matter, and it is fairly resistant to breakage. During collection of the data presented in this report, only three parabolic sensors were broken. One was broken due to careless handling, and two were snapped off the sensor holders by large tree branches.

Damage to hot-film sensors caused by colliding sediment particles should be mentioned. The abrasion removes the quartz coating from the sensor after about 15 hours of continuous operation. Once this coating is removed and the platinum film is exposed, the sensor must be replaced. The quartz coating was worn off of three sensors during the data collection over the alluvial boundaries.

SIGNAL-CONDITIONING EQUIPMENT

The anemometer system has incorporated with it a certain amount of necessary signal-conditioning equipment. The most common additional electronic device is a voltmeter to measure the rms (root mean square) average of the output voltage of the anemometer. This output from the rms voltmeter and the unconditioned output of the anemometer were recorded on a dual-channel strip-chart recorder to give both a visual record and an analog record. The anemometer output and a reference signal from a standard signal generator of known frequency and amplitude were recorded on an FM (frequency modulated) magnetic tape recorder. The output of the anemometer as recorded on the FM tape recorder was monitored visually on an oscilloscope at all times. This allowed the operator to know when a recording was in progress and what was being recorded. This analog record from the FM tape recorder was later digitized, and a digital analysis was performed to obtain the desired statistical turbulence characteristics. For a more detailed description of the supporting electronic equipment and the statistical turbulence characteristics, refer to McQuivey (1973).

MEAN-VELOCITY MEASURING EQUIPMENT

Four different velocity measuring devices were used to obtain the local mean velocity in these studies. The local mean velocity in the 20-centimeter-, 2-foot-, and 4-foot-wide flumes was measured with a calibrated ⅛-inch-diameter pitot tube, shown in figure 4 at the right, along with the hot-film sensor. The differential pressure was measured by using a commercially available pressure transducer and transducer indicator.

The local mean velocity taken in the 8-foot-wide flume and the Atrisco feeder canal and some of the velocity data in the Rio Grande conveyance channel were obtained with a small modified propeller meter. The propellers used were standard Ott minor propellers. The shaft had fastened to it a 30-toothed gear which produces 30 pulses per revolution of the shaft. The meter parts and propellers are shown in figure 5. The 1–3 propeller was used in these studies. A detailed description of the meter and the associated electronics was reported by Bennett (1968). The meter was also used to measure longitudinal turbulence intensities in the above-mentioned channels.

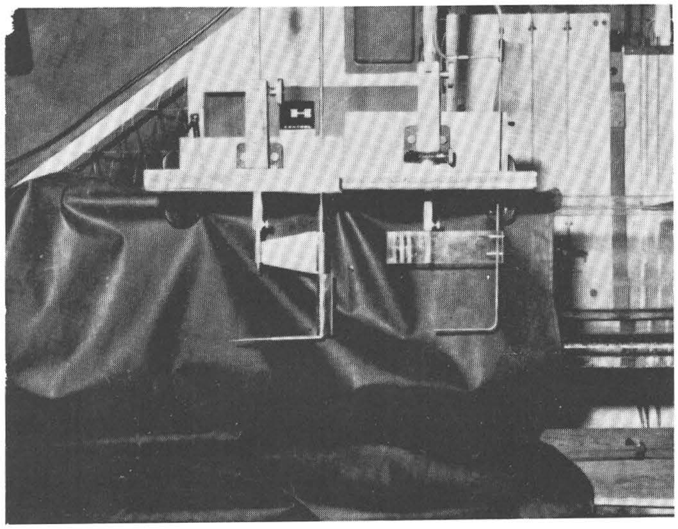


FIGURE 4. — Pitot tube and hot-film sensor arrangement used in the 20-centimeter-wide flume study.

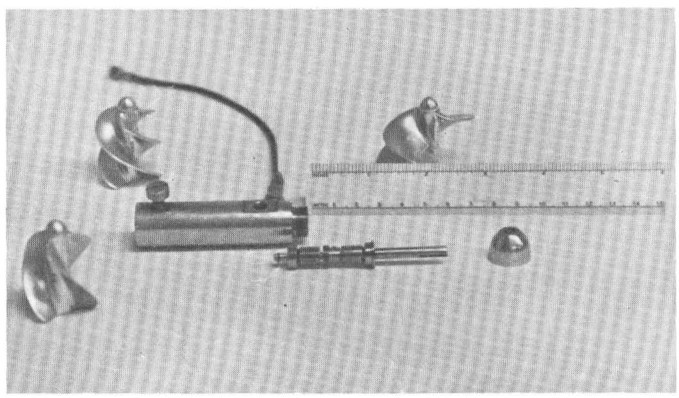


FIGURE 5. — Modified propeller meter used to obtain local mean velocity and turbulence intensity during the 8-foot-wide flume, Atrisco feeder canal, and Rio Grande conveyance channel studies.

A comparison of the turbulence intensities obtained with the meter and the hot-film anemometer system is found in table 12.

In the Rio Grande conveyance channel, where the bed forms were changing fairly fast, a stack of standard Price current meters were used to obtain simultaneous local mean velocities at five points in a vertical profile. The velocities at each point were obtained with five of the current meters mounted on a single rod, as shown in figure 6. The impulses from the current meters were recorded by means of a multiple digital counter. Tests in a towing tank showed that the stacking of meters on a single rod did not appreciably affect the current-meter ratings.

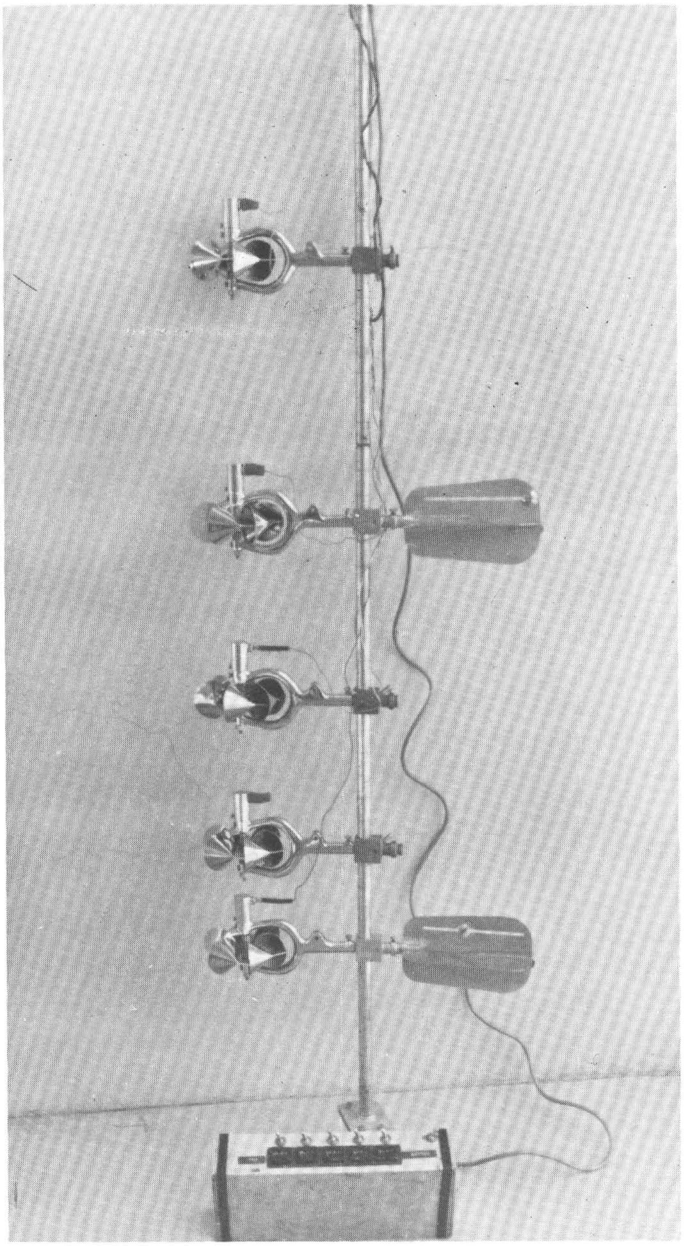


FIGURE 6. — Stack of current meters and digital counter used during the Rio Grande conveyance channel study.

During the study on the Columbia River estuary, a large Ott propeller meter was used to obtain local mean velocities (fig. 7). Obtaining local mean-velocity profiles in an estuary can be fairly complicated and requires special equipment and data-reduction procedures. Prych, Hubbell, and Glenn (1967) described the instrumentation and the data-reduction procedure used in measuring the local mean velocity, direction of flow, and discharge.

The standard Price current meter was used to obtain local mean velocities in the Missouri and Mississippi River studies. The arrangements of the sounding weight, current meter, and hot-film sensor are shown in figure 8.

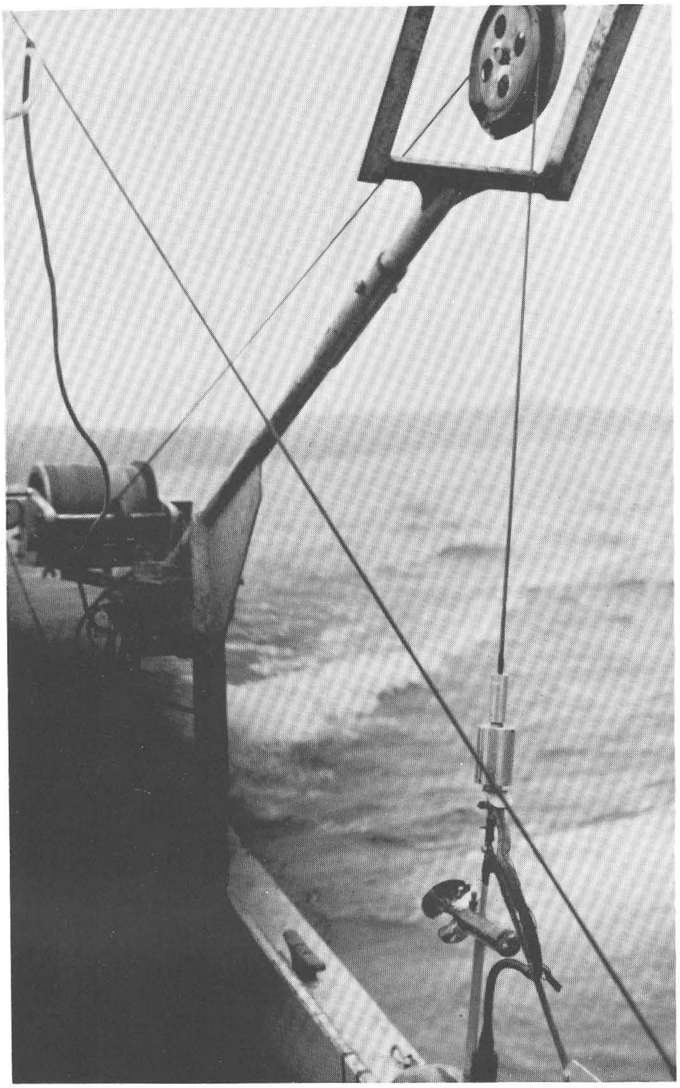
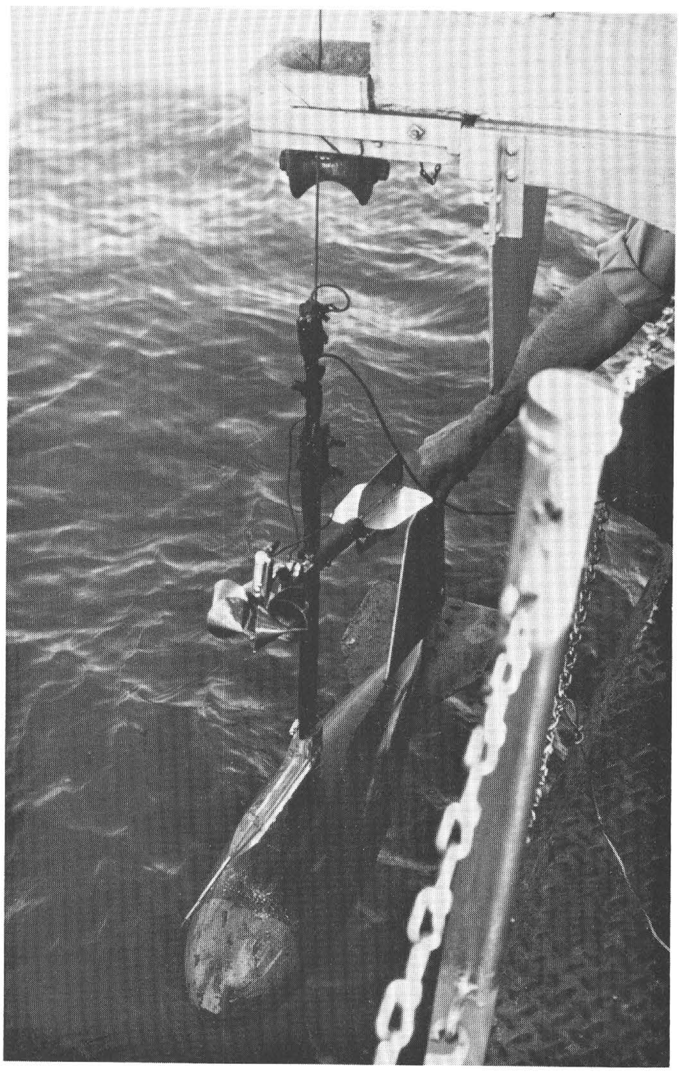


FIGURE 7. — Large propeller meter used in obtaining local mean velocity during the Columbia River study.

The hot-film sensor is about 8 inches in front of and about 8 inches above the sounding weight. The sounding weight and current meter did not influence the flow as it passed the hot-film sensor.

In conjunction with measuring local mean velocities in the Mississippi River with a current meter (fig. 8*B*), the output of the current meter (one pulse per revolution of the shaft) was recorded on an oscillograph. This chart trace, or record, was later digitized and the longitudinal turbulence intensities calculated. A comparison of the turbulence intensities obtained with the current meter and the hot-film anemometer system is given in table 12.

A



B

FIGURE 8. — Current meter and hot-film sensor arrangement for: *A*, Missouri River study; *B*, Mississippi River Study.

SONIC DEPTH SOUNDERS

Two commercially available sonic depth sounders were used extensively to determine the general bed configuration in the longitudinal direction throughout the distance studied in the 8-foot-wide flume and in the field studies. One sounder was used in depths of less than 6 feet, and the other in depths of more than 6 feet. This record of the bed configuration served a multitude of purposes. For example, the average depth could be computed very easily from the record. In the flume experiments the water surface and the bed slopes could be determined from the record. For most of the experiments the record was digitized, and a statistical analysis of the bed configuration was performed. The sounders were also used to locate the crests and troughs of dunes so that data could be collected in a consistent manner by following the desired features.

BED- AND SUSPENDED-SEDIMENT SAMPLERS

Bed-sediment samples were taken with a hand-operated core sampler where the channel depths were less than about 5 feet. A standard US BM–54 was used in rivers deeper than 5 feet. A representative sample was obtained by taking many samples throughout the flume or reach.

Point suspended-sediment samples were taken in several different ways. Samples were obtained in the 8-foot-wide flume by using a siphon sampler. The local mean velocity at a point was obtained from the small propeller meter. The siphon head was then set to siphon at the average local mean stream velocity. Gallon samples of sediment and water mixture were then collected.

A DH–48 hand sampler was used in the Atrisco feeder canal and the first Rio Grande conveyance channel studies. A pumping point-type suspended-sediment sampler was tested on the last conveyance channel study. This system is still undergoing modifications and improvements, but basically it samples at stream velocity. Its electronics are capable of following the low-frequency (less than one cycle per second) changes in flow velocity. The sediment samples obtained with this device were probably the best collected, and the big advantage of this system is that samples can be obtained within about 0.05 foot above the bed. Gallon samples of sediment and water mixture were collected.

A pump-type sampler developed by the Omaha District, Corps of Engineers, was used to collect suspended-sediment samples on the Missouri River. The local mean velocity was determined from a standard Price current meter, and a variable-speed pump was set to pump at the local mean stream velocity. The

A

B

FIGURE 9. — Suspended-sediment sampler and equipment used during the Missouri River study: *A*, Pump; *B*, sampler.

basic sampler was a standard US P–46 with a suction line from the nozzle to the pump. Gallon samples of sediment and water mixture were collected. The pump and sampler are shown in figure 9.

A sampler developed by D. W. Hubbell's group, U.S. Geological Survey, was used to obtain suspended-sediment samples on the Columbia River estuary. The sampler is a vacuum system which lifts the sediment and water mixture up into 6-gallon containers in a boat (fig. 10). A large Ott meter is used to determine the local mean velocity at a point in the flow and then the vacuum system is set to pump the sample at mean stream velocity. The sampler was originally a US P–50.

A standard US P–46 suspended-sediment sampler was used to collect suspended-sediment samples during the Mississippi River study. A crew on another

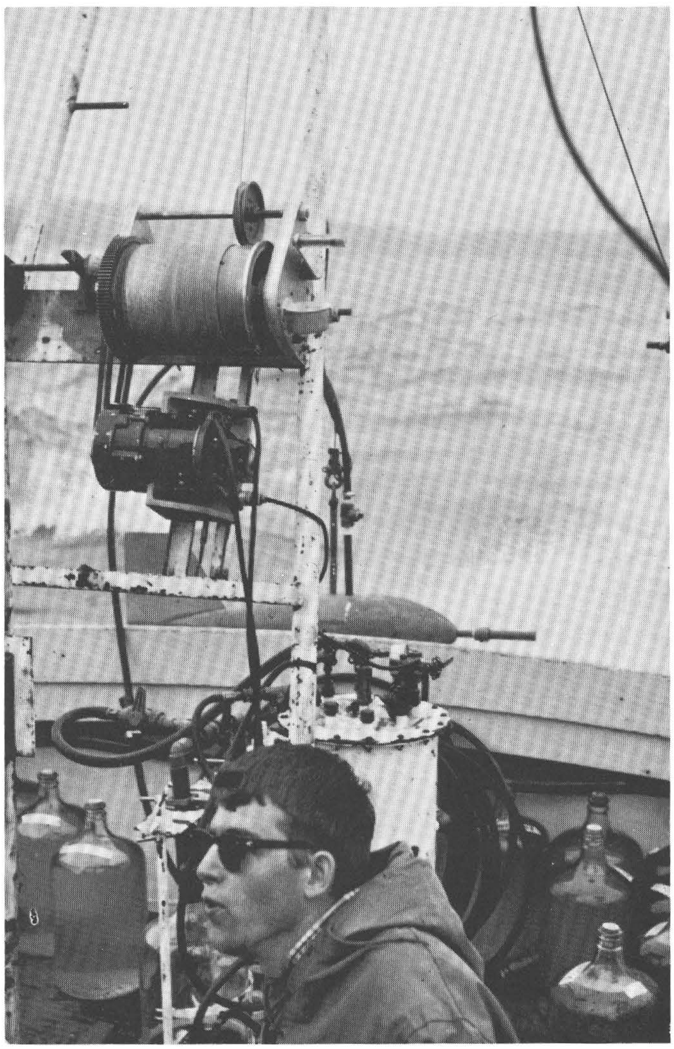


FIGURE 10. — Suspended-sediment sampler used during the Columbia River study.

boat moved to the same location to measure the turbulence and local mean velocities. This crew collected samples of sediment and water mixture in pint bottles, which are much too small to get a representative sample for such a large river.

OPERATING PROCEDURE AND DATA REDUCTION

The hot-film sensors were first calibrated in the 20-centimeter-wide flume for mean flow velocities from about 0.3 to 7.0 feet per second and at several overheat ratios (from 1.10 to 1.06). This defined an adequate voltage/velocity relation for each sensor that accounted for the temperature range in the flume and in the field and the voltage drift, due to foreign contaminants that might collect on the sensor. These calibration curves were then used later in the data reduction process. (See McQuivey, 1973.)

The equipment was assembled at the study site. This included the anemometer, supporting electronic equipment, and the equipment necessary to collect the sediment data and the mean hydraulic parameters.

An almost uniform procedure was used in collecting the data. The first step was to measure the local mean velocity in the flow at the desired point. This was obtained by a pitot tube, current meter, or propeller meter. The velocity was averaged at least every 3 minutes at each measuring point in the flow. The hot-film sensor was then moved to the same location that the local mean velocity was measured. The output voltage from the hot-film anemometer was recorded on FM magnetic tape for 3 minutes for the flume studies and for 4 minutes for the river studies. The output voltage from the anemometer and the rms voltmeter were also recorded on an analog strip-chart recorder. The signal that was recorded on the FM magnetic tape recorder was also observed visually on an oscilloscope. This informed the individual taking the data what was being recorded.

Many times, while the local mean velocity and turbulence data were being collected, other crews were obtaining the sediment data and mean hydraulic parameters.

The FM magnetic tapes were later digitized by employing a multiplexer and an analog to digital converter which was made available by the National Bureau of Standards at Boulder, Colo. The digital voltage output was stored on digital magnetic tape in a format compatible with the CDC-6400 computer system at Colorado State University. The mean and the root mean square of the fluctuations, the autocorrelation function, the space-time correlations, and the power spectra were obtained as computer printout.

A similar independent analysis of the data was done by the General Electric Co. at the National Aeronautics and Space Administration's Mississippi Test Facility for the U.S. Geological Survey. The statistical evaluation system gave the values of the mean, standard deviation, and the skewness and flatness factor for each time series.

This program has the option to calculate and plot the number of zero crossings; the probability density and empirical density; the autocorrelation; the cross correlation; the power spectral density; the cross-spectral density; and the phase angle for one or two time series.

The software documentation was described by McQuivey (1973).

Previous work had indicated that virtually all the power in the turbulence power spectrum is contained in frequencies of less than 100 cycles per second. This would dictate a digitizing sampling interval of 0.005 second. By playing the FM magnetic tapes into the digitizer at double the recording speed and digitizing at 1,000 samples per second, a real-time sample interval of 0.002 second was obtained. The programed analysis was then set up to take only every fifth digitized point, or a sampling interval of 0.01 second. This gave a cutoff frequency, f_c, of 50 cycles per second, an effective band width, B_e, of 0.2 cycle per second, and 20 degrees of freedom. Thus, at 90-percent confidence level, the true power spectrum can be between 0.62 and 1.42 times the computed value. For more details refer to McQuivey (1973).

The intensity of turbulence was not obtained directly from the digital computer analysis because one calibration curve could not be used due to temperature variations and drift due to contamination buildup on the sensor. The local mean velocity at each measured point and the mean voltage were used to plot the velocity-voltage calibration. From this graph, an overheat ratio was determined. Then going to a plot of $dE/d\overline{U}$ versus velocity for various overheat ratios and knowing the mean velocity and the overheat ratio, a sensitivity, $dE/d\overline{U}$, could be determined. Then the relation

$$\sqrt{\overline{e^2}}=\frac{dE}{d\overline{U}}\sqrt{\overline{u^2}} \qquad (1)$$

could be used to determine the intensity of turbulence, where $\sqrt{\overline{e^2}}$ is the digitally obtained root mean square of the voltage fluctuations, $dE/d\overline{U}$

is the sensitivity, and $\sqrt{\overline{u^2}}$ is the root mean square of the velocity fluctuations, where E is mean voltage, and $\overline{U}$ is local mean velocity.

The yawed-film technique used to obtain the turbulent shear stress, and the vertical intensity of turbulence was employed only under the most ideal laboratory conditions. A complete description of this technique and its limitations was given by McQuivey (1973).

The turbulence characteristics obtained from the data reduction are explained or defined in the following section. The hydraulic and sediment data collection and data-reduction procedures are discussed in the section on description of individual studies. The hydraulic and sediment parameters are explained and defined in the following section.

DESCRIPTION OF EXPERIMENTAL VARIABLES AND PARAMETERS

The following kinds of data are reported in tables 1–12 and are defined and described under four general areas, as follows:

1. Basic hydraulic data
   - Water surface and energy slopes
   - Width of flumes and channels
   - Water discharge
   - Water temperature
   - Depth at a vertical
   - Average depth of a cross section
   - Relative depth
   - Mean velocity
   - Velocity profile
2. Turbulence characteristics
   - Longitudinal turbulence intensity
   - Vertical turbulence intensity
   - Relative turbulence intensity
   - Eulerian integral time scale
   - Macroscale of turbulence
   - Microscale of turbulence
   - Measured turbulent shear stress
   - Calculated turbulent shear stress
   - Relative turbulent shear stress
   - Energy spectra
3. Sediment data
   - Suspended-sediment concentration
   - Size and gradation of sediment
   - Fall velocity
   - Total bed-material discharge
4. Other parameters and observations
   - Shear velocity
   - Shear stress at the bed
   - Kinematic viscosity
   - Reynolds number
   - Froude number
   - Chézy discharge coefficient
   - Bed configuration

WATER SURFACE AND ENERGY SLOPES

The water-surface slopes for flow in the 20-centimeter-wide flume were determined from a series of piezometer tubes. Piezometer taps were located at 1-meter intervals along the centerline of the flume bed. These taps were connected to the piezometer tubes with plastic tubing of equal lengths. The water levels in the tubes were a representation of the water-surface elevation along the flume.

Water-surface slopes for the 2-foot-, 4-foot-, and 8-foot-wide flumes were measured with a point gage and an engineer's level at 5-foot intervals along the centerline. The measured water-surface elevations and the corresponding stations of the flume for a working reach were used to compute a least-squares line of the water-surface slope. The mean water-surface slope of each run was determined by averaging the corresponding slopes of the least-squares lines. The least-squares line for the energy-grade line was computed from the values which were obtained by adding the local velocity head, $Q^2/2g(WD)^2$, to the corresponding water-surface elevations. The mean slope of the energy-grade line, called the energy slope, of each run was determined by averaging the corresponding slopes of the least-squares lines.

Water-surface slopes in the field studies were determined by observing the water-surface elevation by employing surveying methods. This procedure and the accuracy varied somewhat from field study to field study, but the final results are presumed to be within acceptable limits.

WIDTH OF FLUMES AND CHANNELS

The flume widths were known, and the field channel widths were measured with a surveyor's chain in channels less than 100 feet wide. In the larger river systems, the channel width was determined by surveying methods, usually stadia.

WATER DISCHARGE

The water discharges in the flumes were determined in the return-flow lines of the recirculating flumes with calibrated orifice meters connected to water-air manometers. The orifice meters were located in the lines to avoid the possible effect of sand deposits on the calibration.

Water discharge actually means the discharge of the water and sediment mixture. A concentration of 50,000 milligrams per liter of sediment means that about 5 percent of the water and sediment mixture is sediment by weight, and nearly 2 percent of the mixture is sediment by volume.

The discharge during the Atrisco feeder canal study was obtained by the wading-current-meter method about every 2 hours. The discharge remained constant during the data-collection period.

The Rio Grande conveyance channel discharge was measured upstream from the study reach at the control structure. During both runs, the discharge changed considerably. The discharge was determined from the stage-discharge relation at the control structure at the time of each run.

The discharge measurement during the Columbia River estuary study was made using the moving-boat method. This is described in detail in the "Techniques of Water-Resources Investigations of the United States Geological Survey," Book 3, Chapter A11.

The discharge of the Missouri River was measured by the U.S. Geological Survey at the Omaha bridge with a current meter.

The discharge of the Mississippi River was measured from a boat with current meters. Because of the size of the river, many vertical sections were required, and each discharge measurement required 1 day.

WATER TEMPERATURE

The water temperatures, in degrees centigrade, were measured to the nearest one-tenth of a degree with a mercury thermometer. The temperature reported was based on an average of about 10 readings obtained during data collection. For some of the river studies, there was a considerable change in temperature during the data-collection phase.

DEPTH AT A VERTICAL

The depth at a vertical was determined by measuring it with a sounding weight and reel system in the deep rivers, a wading rod in the shallow channels, and a point gage in the flumes, while obtaining the local mean velocities and turbulence data. In the places where the bed forms were moving, a sonic depth sounder was used to follow the desired features, such as the crests and troughs of dunes.

For flow over the rigid boundaries, the depth of a vertical was determined by a volumetric approach. The roughness elements were considered solids and the rest of the volume to the tops of the roughness elements were considered voids. The depth at a vertical was then taken as the depth from the water surface to an imaginary bottom elevation, as if the roughness elements completely filled the bottom up to the imaginary bottom.

AVERAGE DEPTH OF CROSS SECTION

The average depth in the flumes over the rigid boundaries is the same as the total depth of a vertical. For flow over sand beds in the flumes and conveyance channels, the average depth of flow was determined by observing the difference in elevation between the water surface and the sand bed with a point gage or by using the sonic depth sounder down the entire centerline of the channel. As many intervals as desired could be averaged to obtain an average depth. For flow in the rivers, the average depth is the mean depth at a cross section obtained by a sounding weight.

RELATIVE DEPTH

The relative depth is the depth above the channel bottom divided by the total depth at the vertical of interest.

CROSS-SECTIONAL AVERAGE VELOCITY

The mean velocity reported was determined from the observed values of discharge (Q), average depth ($\overline{D}$), and the width (W) by use of the continuity equation,

$$\overline{V}=\frac{Q}{A}=\frac{Q}{\overline{D}\times W}. \tag{2}$$

MEAN-VELOCITY PROFILE

The mean-velocity profile data were obtained by a variety of instruments. In the 20-centimeter-, 2-foot-, and 4-foot-wide flumes a pitot tube, pressure transducer, and transducer indicator were used. Standard current meters and the propeller meter were used for the other studies. The velocity profiles were taken primarily to aid in the turbulence-data reduction. In fact, in order to evaluate the turbulence data, the local mean velocity had to be measured at every point turbulence measurements were made. Generally, the local mean velocity was measured and then the hot-film sensor was moved to that same location and the turbulence data were taken. Some of the velocity profiles changed very fast as the bed forms moved downstream. For this reason, the stack of current meters were used to get an entire velocity profile at once. However, in most of the other velocity profiles, the bed configuration was not moving so fast, and an hour could be spent getting the necessary velocity and turbulence data. Most of the point velocities were averaged over 3 to 5 minutes.

LONGITUDINAL TURBULENCE INTENSITY

One of the best physical pictures of turbulence is obtained by recording the longitudinal velocity fluctuations at various points in the section of a channel. The longitudinal intensity of turbulence is defined as the standard deviation of the fluctuations from the mean and is called the root-mean-squared values of the fluctuating velocity in the streamwise direction, which can be expressed as follows:

$$u=\sqrt{\overline{u^2}}. \tag{3}$$

This component of turbulence is the easiest to measure. The hot-film sensor is oriented so that it senses the local mean velocity, $\overline{U}$, and its fluctuating component, $\sqrt{\overline{u^2}}$, to the first order. From a vector diagram of the mean velocity and the three fluctuating components, it is easy to see how $\sqrt{\overline{u^2}}$ can be obtained and why the other two components, ($\sqrt{\overline{v^2}}$ $\sqrt{\overline{w^2}}$), become only of second-order importance. The fluctuating component $\sqrt{\overline{u^2}}$ was also obtained in the 20-centimeter- and 2-foot-wide flumes from a yawed-film technique. The procedure has been explained in detail by McQuivey (1973). The values of $\sqrt{\overline{u^2}}$ obtained by orienting the hot-film sensor in the standard way and the yawed-film technique were within the expected accuracy of ±10 percent.

This longitudinal component of the turbulence intensity is also obtained with the standard Price current and propeller meters.

Note, too, that the turbulence measurements given in this report are probably only accurate to ±10 percent of the expected values. This percentage of accuracy is not uncommon with all turbulence measurements reported.

VERTICAL TURBULENCE INTENSITY

The vertical turbulence intensity is defined as the standard deviation of the vertical fluctuations from the mean and is called the root-mean-squared value of the fluctuating velocity in the vertical direction—that is,

$$v=\sqrt{\overline{v^2}}. \tag{4}$$

This component of the turbulence was determined from the yawed-film technique. Measurements were made only in the 20-centimeter- and 2-foot-wide flumes where all the conditions were as ideal as possible. This component of turbulence is very difficult to measure in the field with present equipment and techniques.

RELATIVE TURBULENCE INTENSITY

The intensity, root-mean-squared value, or standard deviation of the velocity fluctuations is usually expressed as a ratio or percentage of the mean flow velocity or the local mean velocity, as follows:

$$\frac{\sqrt{\overline{u^2}}}{\overline{V}} \text{ or } \frac{\sqrt{\overline{u^2}}}{\overline{U}}. \tag{5}$$

Another useful way to express the relative intensity of turbulence is by nondimensionalizing the intensity with the shear velocity (defined later) which can be expressed as:

$$\frac{\sqrt{\overline{u^2}}}{U_*} \text{ or } \frac{\sqrt{\overline{v^2}}}{U_*}. \tag{6}$$

EULERIAN INTEGRAL TIME SCALE

The Eulerian integral time scale is defined as the area under the autocorrelation curve

$$\int_0^\infty R(t')dt'=T_E, \tag{7}$$

where $R(t')$ is the autocorrelation function defined as

$$\frac{\overline{u(t)\,u(t+t')}}{\sqrt{\overline{u^2}}\sqrt{\overline{u^2}}}=R(t'), \tag{8}$$

where (t) is time and (t') is the delay time. Physically, the output of the anemometer, $u(t)$, is correlated with itself by delaying the time by an amount t'. Therefore, an autocorrelation curve is defined where $R(t')=1$ at time $t'=0$, and t' is increased until $R(t')=0$. The area under this curve is then the Eulerian integral time scale. This scale provides an estimate of the average eddy size associated with the flow.

In some instances where $R(t')$ did not reach zero, the data points were plotted on a curve of the log $R(t')$ versus t'. Then a linear best-fit curve was established through the data points, and the area was obtained by integrating the equation of the line. This was done particularly for the Mississippi River data.

MACROSCALE OF TURBULENCE

To get an indication of a mean eddy size in the direction of the flow, the macroscale of turbulence was defined as

$$L_x=\overline{U}\int_0^\infty R(t')dt', \tag{9}$$

where $\overline{U}$ is the local mean velocity, and $R(t')$ is the autocorrelation function. This scale, or mean eddy size definition, is a good approximation so long as the velocity is uniform—that is, $dx=\overline{U}\,dt$.

MICROSCALE OF TURBULENCE

The microscale of turbulence is a measure of the smallest eddies that are responsible for the dissipation of energy. The microscale relation is developed from the cosine transform of the autocorrelation function, and is given by

$$\frac{1}{\lambda_x^2}=\frac{4\pi^2}{(\overline{U})^2}\int_0^\infty n^2F(n)\,dn, \tag{10a}$$

where $\overline{U}$ is the local mean velocity, n is the frequency, and $F(n)$ is the normalized energy spectrum function and will be discussed later.

The microscale may be calculated directly by assuming a normal and independent distribution for u from the following relation:

$$\frac{1}{\lambda_x}=\frac{\pi}{\overline{U}} \text{ (Average number of zero crossings of } u \text{ per second).} \quad (10b)$$

It is known that the distribution of u is closely a Gaussian one, even in turbulent shear flows. For the preliminary measurements of λ_x reported presently, no corrections were applied for small deviations from the normal distribution.

CALCULATED TURBULENT SHEAR STRESS

Turbulent shear flows are described by the continuity equation, the Navier-Stokes equations of motion, and the energy equation, with additional terms in the velocity due to the turbulent fluctuations. The special case of fully developed turbulent open-channel flow, where the viscous and dynamic processes have reached a statistically stable state imposed by the rigid boundaries, was set up in the 20-centimeter-wide flume. Considering these conditions and for flow of a two-dimensional nature, the mean Navier-Stokes equation of motion in the x direction becomes

$$-\rho\overline{uv}=\gamma DS(1-Y/D)-\mu\frac{d\overline{U}}{dy}, \quad (11)$$

where $\rho\,\overline{uv}$ is the Reynolds turbulent shear force, ρ is the water mass density, γ is the specific weight of water, and μ is the dynamic viscosity. Knowing the slope, S, depth, D, and the velocity profile, the turbulent shear stress can be calculated.

MEASURED TURBULENT SHEAR STRESS

From the yawed-film technique the Reynolds stress, $\overline{uv}$, was determined. This allowed a direct evaluation of the turbulent shear stress and does allow a direct comparison between the measured and calculated values. A detailed description of this measurement was given by McQuivey (1973).

RELATIVE TURBULENT SHEAR STRESS

The Reynolds stresses are sometimes expressed as a function or ratio of the local mean velocity, mean velocity, or the shear velocity:

$$\frac{\overline{uv}}{(\overline{U})^2}, \text{ or } \frac{\overline{uv}}{(\overline{V})^2}, \text{ or } \frac{\overline{uv}}{(U_*)^2}. \quad (12)$$

ENERGY SPECTRA

The energy spectrum provides information on how the energy is distributed in relation to the frequency. According to Kolmogoroff's theory, energy enters the spectrum through the larger eddies and is then transferred through the spectrum to the smaller eddies, where it is finally dissipated. In turbulent shear flows, it is not known how the one-dimensional function is related to the three-dimensional spectrum function. However, the one-dimensional spectrum function is still assumed to be an integral effect of the three-dimensional spectrum function. Despite these and other experimental difficulties, the study of the energy spectra may lead to very interesting conclusions.

The fractional energy content, $F(n)$, is defined as

$$\int_0^\infty F(n)\,dn=1, \quad (13)$$

where $F(n)$ is a Fourier cosine transformation of $R(t')$:

$$F(n)=4(\sqrt{\overline{u^2}})^2\int_0^\infty R(t')\,dt'\cos 2\pi n t'. \quad (14)$$

Power spectra were obtained at many points in the flow for all the different studies. These results were discussed and presented by McQuivey (1973).

SUSPENDED-SEDIMENT CONCENTRATION

Suspended-sediment concentration is defined as the ratio of the weight of solids to the weight of the water and sediment mixture. The samples were collected at local mean stream velocity. The samples, collected at various sites, varied in size (amount) from 6 gallons to 1 pint. The size of the samples is probably the most important consideration, so far as accuracy in testing is concerned.

The suspended-sediment samples are probably as good as any that were taken. Concerted effort was made to collect each sample at mean stream velocity. The sampler, developed by the U.S. Geological Survey, adjusted the intake velocity for low-frequency changes and should therefore give very good results.

SIZE AND GRADATION OF SEDIMENT

The mean particle size and (or) the gradation distribution in terms of fall diameter of each suspended-sediment and bed-material discharge sample, and each bed-material sample was determined by drying the total sample, splitting it into a workable size where necessary, and then analyzing it in the visual-accumulation tube (U.S. Inter-Agency Committee on Water Resources, 1957a). Each bed-material sample consisted of several samples taken at random from the beds of channels or flumes. In the studies where fine sediment was present, the fine sediment was washed out of the sample before the sample was dried, split, and analyzed.

The gradation (σ) was determined by the equation

$$\sigma=\frac{1}{2}\left(\frac{d_{50}}{d_{16}}+\frac{d_{84}}{d_{50}}\right), \quad (15)$$

in which d_{50} is the median size, and d_{16} and d_{84} are the respective sizes for which 16 and 84 percent of the sample is finer than the indicated size.

FALL VELOCITY

The fall velocity, as defined and discussed in Report 12 of the U.S. Inter-Agency Committee on Water Resources (1957b), is recorded in the tables for which suspended-sediment samples were collected. The fall velocity recorded is for the median size of the entire suspended-sediment sample collected at a point in the flow. It is recorded in feet per second, so that it can be compared later with the turbulence intensity, which is also recorded in feet per second.

TOTAL BED-MATERIAL DISCHARGE

The concentration of total sediment discharge was obtained with a width-depth integrating sampler located at the nappe, where the flow dropped from the 8-foot-wide flume into the tailbox. After uniform flow was established, more than 30 samples were taken at about 1-hour intervals. This gave a good statistical average of the total sediment discharge for each established flow condition.

SHEAR VELOCITY

Shear velocity is defined as $\sqrt{gRS}$, or $\sqrt{\tau/\rho}$, where g is the gravitational constant, R is the hydraulic radius, and S is the water-surface or energy slope.

SHEAR STRESS AT THE BED

The shear stress or tractive force at the bed is a parameter commonly used as a measure of the intensity of forces related to resistance to flow and transport of sediment particles. It is computed by the formula

$$\tau=\gamma DS, \quad (16)$$

where D is the depth at a particular vertical, S is the water-surface or energy slope, and γ is the specific weight of water.

KINEMATIC VISCOSITY

The kinematic viscosity of the water and sediment mixture was determined from the temperature of the water and appropriate standard tables.

REYNOLDS NUMBER

The Reynolds number is a ratio of the viscous forces to the total inertial forces in the channel. It is defined as

$$\mathbf{R}=\frac{\overline{V}\overline{D}\rho}{\mu}, \text{ or } \frac{\overline{V}\overline{D}}{\nu}. \quad (17)$$

It is commonly used as a measure of the effect of viscosity on the flow pattern.

FROUDE NUMBER

The effect of gravity on the flow pattern is commonly related to the Froude number, which is the ratio of the gravity force to the total inertial force. As commonly used and reported herein,

$$\mathbf{F}=\frac{\overline{V}}{\sqrt{g\overline{D}}}. \quad (18)$$

CHEZY DISCHARGE COEFFICIENT

Parameters related to average resistance to flow in channels are based on the variables S, D, and $\overline{V}$. The dimensionless Chézy discharge coefficient is defined as

$$\frac{C}{\sqrt{g}}=\frac{\overline{V}}{U_*}, \text{ or } \frac{\overline{V}}{\sqrt{g\overline{D}S}}. \quad (19)$$

Note that the discharge coefficient is the inverse of resistance, where the resistance coefficient is defined as

$$f=\frac{8g\overline{D}S}{(\overline{V})^2}. \quad (20)$$

BED CONFIGURATION

The general bed configurations were determined visually in the 20-centimeter-wide flume, and a sonic depth sounder was used extensively in the 8-foot-wide flume and in the field. The sounder chart records were later digitized, and a statistical analysis was completed to determine the bed-form statistics.

The general description, such as ripples, dunes, and flat bed, is given in the "Basic Data" section.

DESCRIPTION OF INDIVIDUAL STUDIES

This section of the report documents general observations of the flow field and operational procedures during the collection of the data. This includes a description of each study site, the roughness and bed configurations, the flow characteristics, operational procedures and techniques, and any variation in the data collection procedure between the various studies. A brief statement is included to explain the objective of each study. Many photographs are included to show the study sites, roughness or bed forms, and data collection. References and objectives are given in each section to relate the data to that taken in conjunction with other studies.

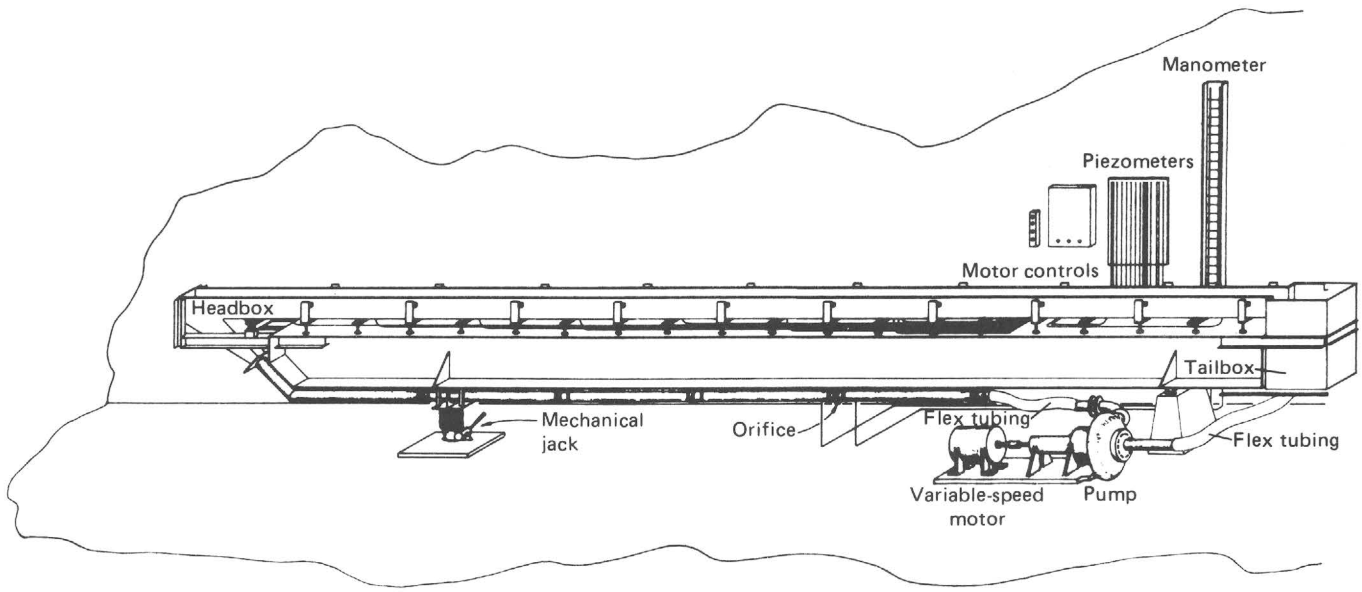


FIGURE 11. — Schematic diagram of the 20-centimeter-wide flume at Colorado State University.

20-CENTIMETER-WIDE FLUME, RIGID BOUNDARY

The experiments were performed in an open-surface recirculating flume made of Lucite. The channel was 10 meters long and had a cross section 20 centimeters wide by 20 centimeters deep. The slope of the channel could be varied from 0 to 0.085. An overall sketch of the flume is shown in figure 11. For a more detailed description of the flume refer to the report of Rathbun, Guy, and Richardson (1969).

During the first study two boundary roughnesses were used. The Lucite floor of the channel provided a hydrodynamically smooth boundary. Sheets of aluminum coated with a layer of 0.173-inch-diameter lead shot packed at maximum density provided a hydrodynamically rough boundary. This roughness is shown in figure 12.

The depth of flow over the lead shot was measured from a point slightly below the top of the lead shot. This mean bed elevation was determined by balancing the volume of the lead shot with the volume of the voids above the lead-shot centerline and to the top of the shot. The flow conditions were sufficient to provide fully developed turbulent flow at a test section 8.5 meters downstream from the headbox. The two-dimensionality of the flow at the test section was checked by a velocity survey taken with the small pitot tube.

The data were then collected in the test section at the centerline of the flume. Cylindrical hot-film sensors were used to obtain most of the data; however, the wedge-shaped sensor was also used. The small pitot tube was used to obtain the local mean velocities.

The primary experimental objective of this study

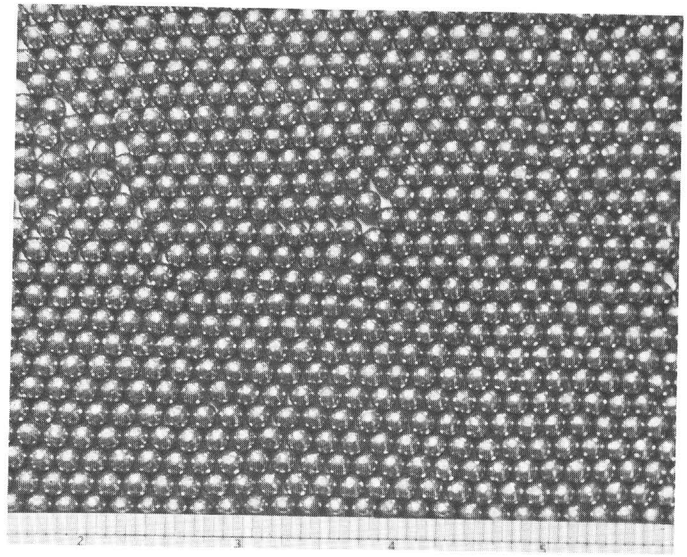


FIGURE 12. — Lead-shot roughness used in the 20-centimeter-wide flume study.

was to develop the techniques and procedures involved in making turbulence measurements that could be reproduced in not only filtered systems (removing all foreign contaminants that might become attached to the hot-film sensor), but also sediment-laden channels. Therefore, a method was developed to measure turbulence in open channels that carried sediment and other types of foreign matter.

The experimental objectives for flow over the rough and smooth boundaries were to measure the longitudinal and vertical components of the turbulence intensity, the turbulent shear stress, and to see if these measurements verified the two-dimensional equation of motion in open-channel flow. The yawed-film technique was used to obtain these measurements. Estimates of the energy balance were also obtained. By measuring the production of energy and estimating the amount of energy dissipated, the amount of energy diffused could be calculated. Other turbulence characteristics obtained include the macroscale and microscale of turbulence, the Eulerian integral time scale, and energy spectra at various positions in the flow field.

Several hot-film sensors were also used at this time to evaluate their performance and repeatability. A detailed description of the procedures and results can be found in a report by McQuivey (1967).

The basic data collected over the two rigid boundaries for several different flow conditions along with the mean hydraulic parameters are reported in table 1a and b.

Table 1c ("Basic Data" section) summarizes the basic data collected in the 20-centimeter-wide flume over a ¾-inch rock roughness for nine different flow conditions. These data were collected in conjunction with a study of the reaeration process in open-channel flows. The reaeration process in a stream is characterized by its surface reaeration coefficient. Turbulence is a major factor in this mass-transfer phenomenon. The results of this study will be reported in other publications.

20-CENTIMETER-WIDE FLUME, ALLUVIAL BOUNDARY

The first turbulence measurements over an alluvial boundary were carried out in this flume. Two natural sand sizes were used; one with a $d_{50} = 0.38$ mm and $\sigma = 1.69$, and another with a $d_{50} = 0.19$ mm and $\sigma = 1.42$. The longitudinal and vertical intensities of turbulence were measured, as well as the turbulent shear stress over the sand beds at incipient motion, over ripples, and flat bed with sediment moving. Flow in the flume over the ripple bed is shown in figure 13.

The primary objective of these experiments was to study the turbulence characteristics for flow over alluvial boundaries, to verify the two-dimensional Navier-Stokes equation of motion in the x direction, to study the production, dissipation, and diffusion of the turbulent energy, and to compare the various scales of turbulence and the power spectra at various places in the flow.

The data were collected in the test section at the centerline of the flow, where the flow was fully developed and two dimensional. The cylindrical hot-film sensor was used to obtain all the turbulence data. The small pitot tube was used to obtain the local mean velocities.

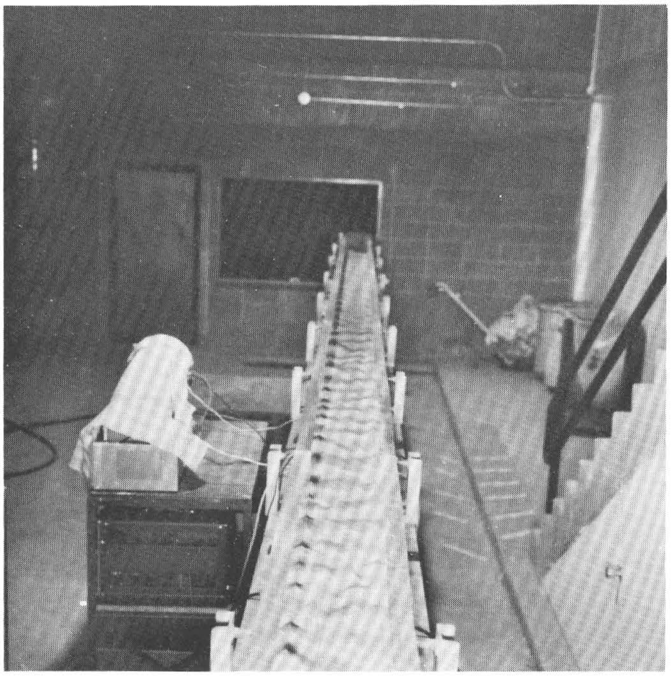


FIGURE 13. — Ripples formed in the 20-centimeter-wide flume.

Sheets of aluminum were coated with liquid fiberglass resin, followed by a uniform thickness of the 0.19 mm sand on one set and 0.38 mm sand on another set. The aluminum sheets were then placed in the flume on top of a ⅛-inch layer of foam rubber. The flow conditions were set up to simulate a flat-bed condition, with the appropriate slope, depth, and discharge.

The turbulence characteristics were measured over the fixed roughnesses without sediment moving. Sediment of the same size as that attached to the aluminum sheets was then added to the flow, to the extent that it moved through the system at a maximum transport rate without deposition on the bed occurring. The same measurements were then repeated.

The turbulence characteristics were also measured over both sand beds (natural) at the point of incipient motion and for natural flat beds. The natural flat-bed results could then be compared with the artificial flat bed results.

The main objective of this study was to determine the effect of the moving sediment on the turbulence characteristics and the mean flow parameters.

The turbulence characteristics and hydraulic parameters collected over the alluvial boundary for several different flow conditions are reported in table 2.

2-FOOT-WIDE FLUME, BLOCK ROUGHNESS

The flume used in this experiment was a recirculating flume 60 feet long, 2 feet wide, and 2.5 feet

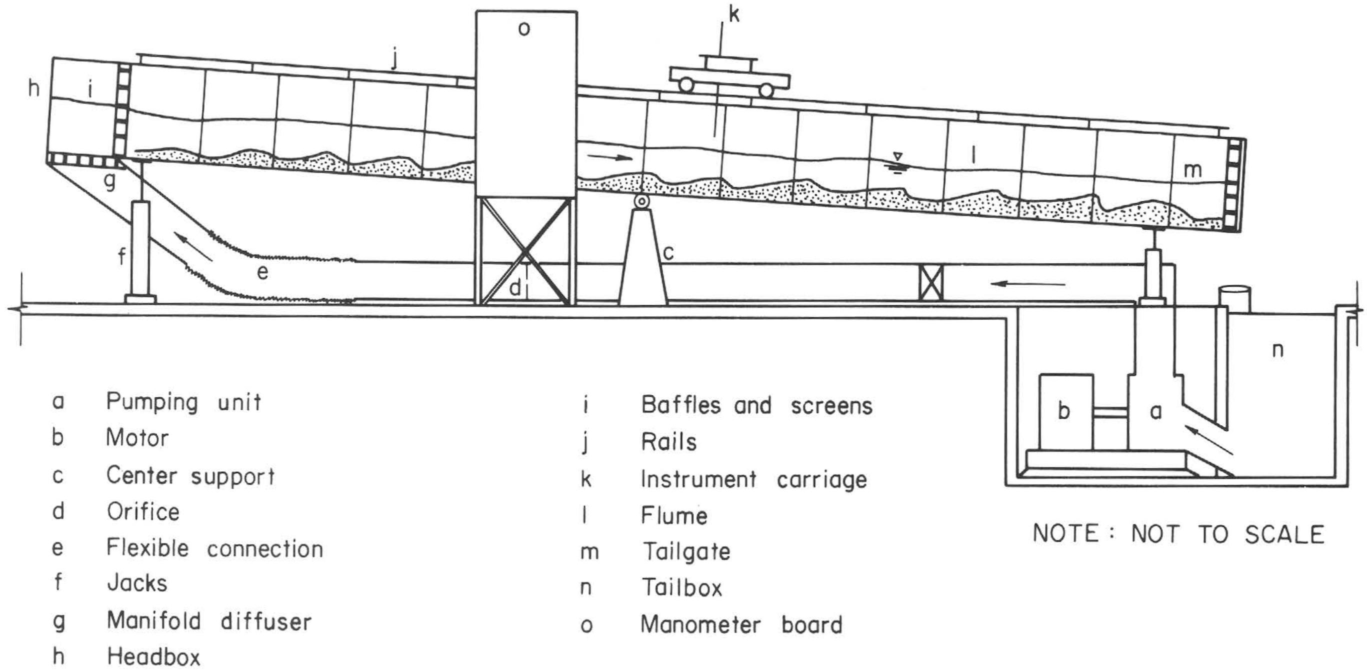


FIGURE 14. — Schematic diagram of the 2-foot-wide flume at Colorado State University.

deep. The side walls were made of 0.5-inch Lucite, and the floor was made of 0.25-inch stainless-steel plate. The discharge could be adjusted from 0 to 8 cubic feet per second, and the slope from horizontal to 0.10. A schematic diagram of this flume is shown in figure 14.

The turbulence data collected over the rigid boundary was taken in conjunction with a study of dispersion and diffusion. The roughness consisted of wooden blocks glued to the stainless-steel floor. Three different heights of blocks were used. The spacing of the blocks was the same for the three block heights. The size and spacing of the blocks are shown in figure 15. Figure 16 shows the blocks after they were placed in the flume. A standard swimming-pool filter and a set of screens were placed just downstream of the headbox to filter the flow, to remove all foreign contaminants, and to straighten out the flow, eliminating any irregular flow conditions caused by the entrance conditions.

The turbulence data were collected 40 feet downstream from the headbox, where the flow was fully developed. The cylindrical hot-film sensor was used to collect all the turbulence data. The small pitot tube was used to obtain the local mean velocities. The data were collected at the channel centerline.

The turbulence characteristics were obtained primarily to relate them with dispersion and diffusion characteristics. It was hoped that the percentage of dispersion and diffusion due to turbulence could be determined.

The turbulence characteristics obtained included the longitudinal intensity of turbulence, the Eulerian integral time scale, the macroscale of turbulence, and space-time correlation relations in the x-, y-, and z-coordinate directions. These data along with the mean hydraulic parameters for nine flow conditions are given in table 3a.

Additional data were later taken over the same roughness elements and at the approximate same flow conditions. The objectives of this study were to study the development of flow in a flume and to study more specifically the turbulence characteristics as the turbulent boundary layer developed. Turbulence data were collected at 5-foot intervals down the length of the flume at the channel centerline and between the centerline and the wall. Velocity profiles were taken at every 3-inch interval across the entire channel width and at every longitudinal measuring section. These data are summarized in table 3b.

The yawed-film technique was used to obtain measurements of the vertical velocity fluctuations and the turbulent shear stress over the block roughnesses at various stations down the flume. These data along with the mean hydraulic parameters for six flow conditions are given in table 3c.

4-FOOT-WIDE FLUME, ROCK ROUGHNESS

The flume used in this experiment was a nonrecirculating flume 120 feet long, 4 feet wide, and 2 feet deep. The interior of the flume is surfaced with plywood coated with fiber glass, except for a 24-foot

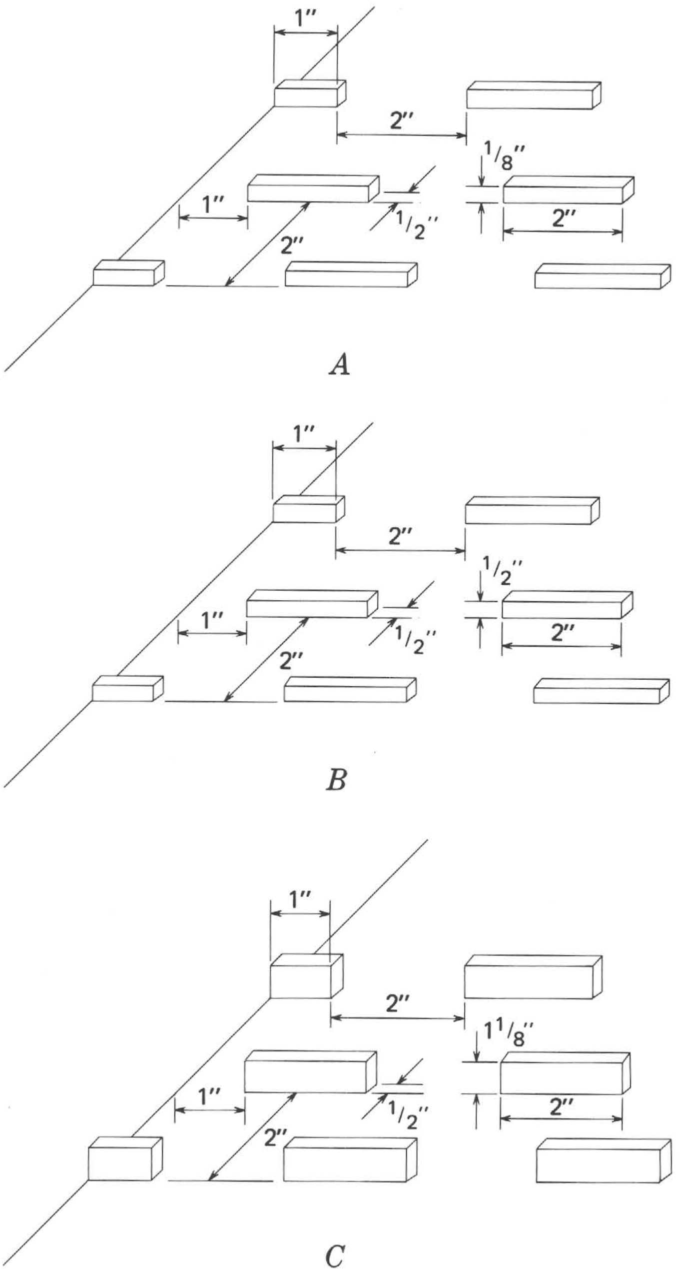


FIGURE 15. — Block roughnesses and spacing pattern used in the 2-foot-wide flume: *A*, ⅛ inch high; *B*, ½ inch high; and *C*, 1⅛ inches high.

section of the left sidewall which is of Lucite. The discharge could be regulated from zero flow up to the maximum capacity of the flume, which is about 30 cubic feet per second. The slope could be adjusted from horizontal to about 0.03. A schematic diagram of this flume is shown in figure 17.

The turbulence data collected in the 4-foot-wide flume were taken in conjunction with a study of thermal pollution, dispersion, and diffusion. The fiber-glass–plywood construction provided a hydrodynamically smooth boundary. The second boundary

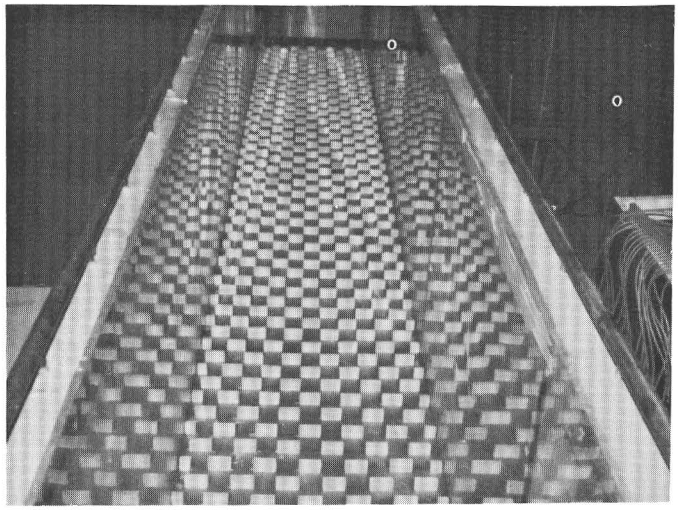


FIGURE 16. — Block roughness in the 2-foot-wide flume.

was ¾-inch rock. The ¾-inch rock was removed, and 1½-inch rock provided the third roughness. The fourth roughness included the 1½-inch roughness with 4- to 6-inch rock placed 6 to 8 inches apart. Two of these boundary conditions are shown in figure 18. The depth of the rock roughness placed was approximately that of the mean diameters.

A series of four grids was placed just downstream from the headbox to straighten out the flow, eliminating any irregular flow conditions caused by the entrance conditions. A fifth grid was floated on the water surface to act as a wave suppressor.

The turbulence data were collected 75 feet downstream from the headbox, where the flow was fully developed. The parabolic-shaped hot-film sensor was used to collect all the turbulence data. The small pitot tube was used to obtain the local mean velocities. The data were collected at the channel centerline and halfway between the centerline and the wall.

The turbulence characteristics were obtained primarily to relate them with the dispersion and diffusion of a heated jet discharging into the flow. It was again hoped that the percentage of dispersion and diffusion due to turbulence could be determined.

The turbulence characteristics obtained included the longitudinal intensity of turbulence, the Eulerian integral time scale, the microscale of turbulence, and space-time correlation relations in the x-, y-, and z-coordinate directions. These data along with the mean hydraulic parameters for 12 flow conditions are given in table 4.

8-FOOT-WIDE FLUME, BLOCK ROUGHNESS

These experiments were conducted in a 200-foot-long recirculating flume with an 8-foot-wide by 4-foot-deep rectangular cross section. The interior of

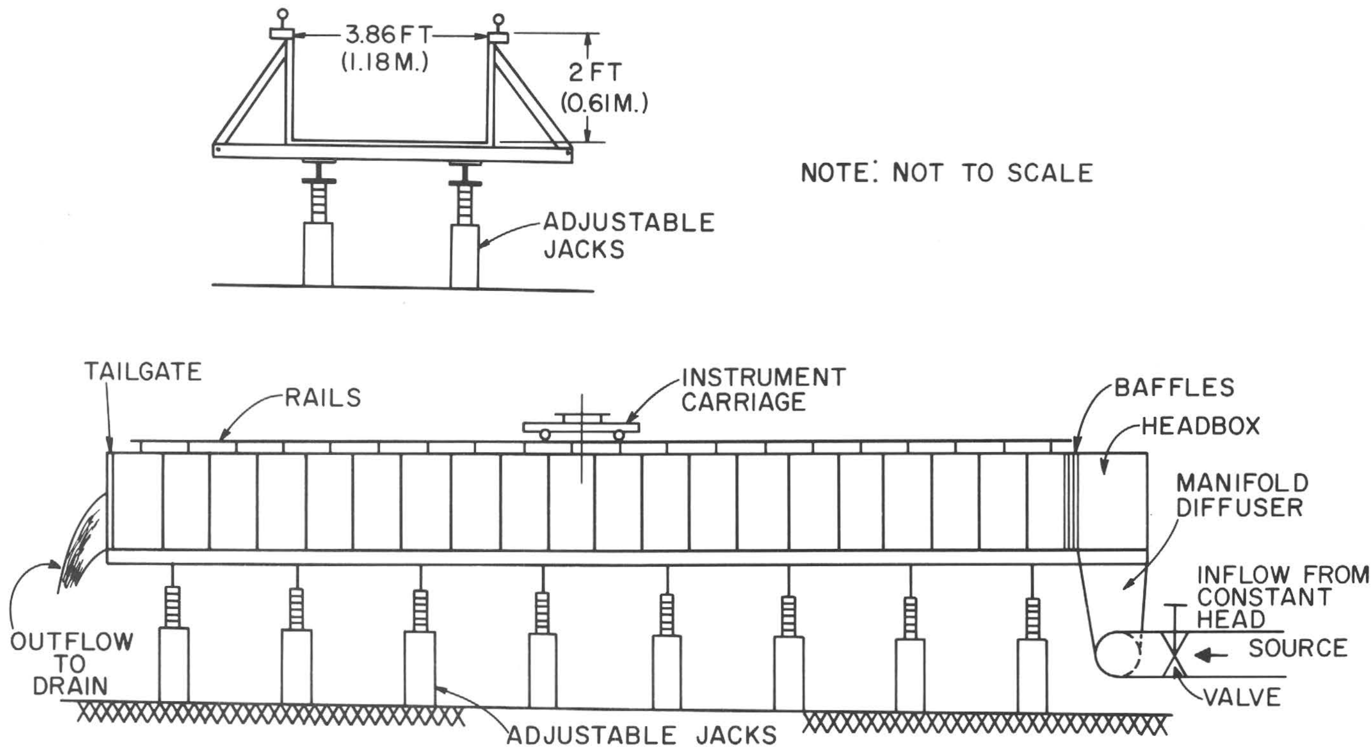
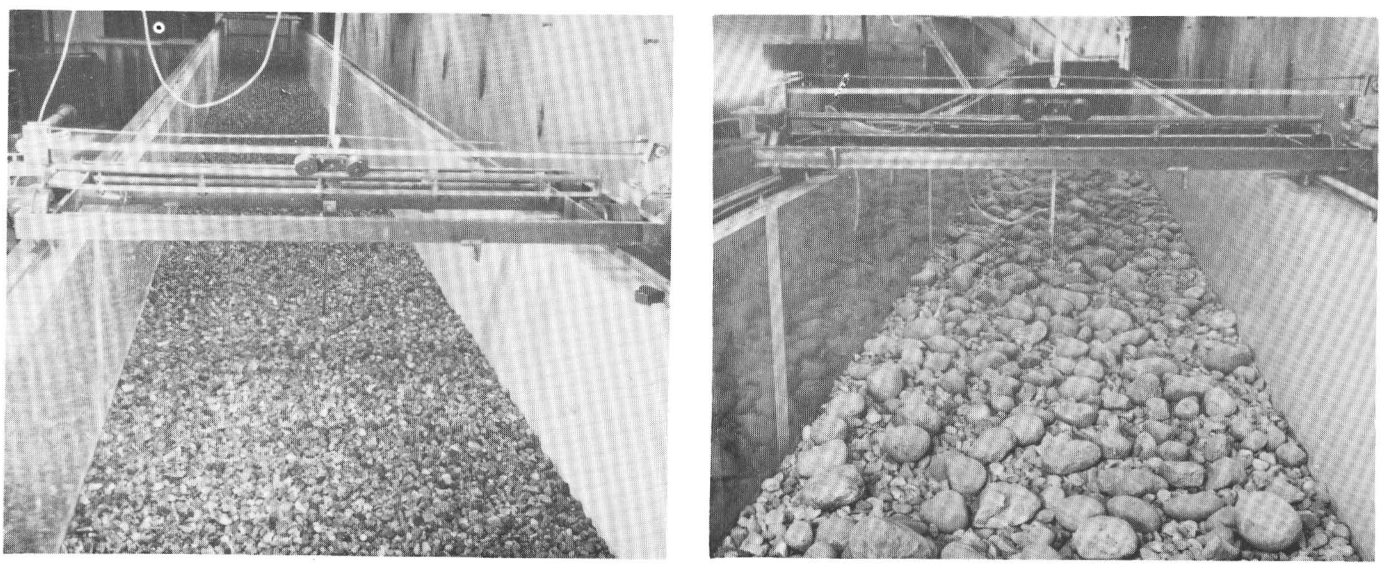


FIGURE 17. — Schematic diagram of the 4-foot-wide flume at Colorado State University.



A *B*

FIGURE 18. — Boundary roughnesses in the 4-foot-wide flume: *A*, ¾-inch rock; *B*, riverbed.

the flume is surfaced with aluminum, except for a 72-foot section of the left sidewall, which is of Lucite. The pumping system consists of three pumps, 30, 60, and 120 horsepower, with maximum discharge of 12, 28, and 40 cubic feet per second, respectively. The flume is mounted on adjustable screw jacks driven by syncronous motors with which the slope can be adjusted very easily and quickly from horizontal to 0.03. Figure 19 shows a schematic diagram of the flume.

The turbulence data collected over the rigid boundary in the 8-foot-wide flume was taken in conjunction with the study of Jobson (1968) on vertical mass transfer in open-channel flow. The roughness consisted of wooden blocks glued to the aluminum floor. The size and spacing of the block are shown

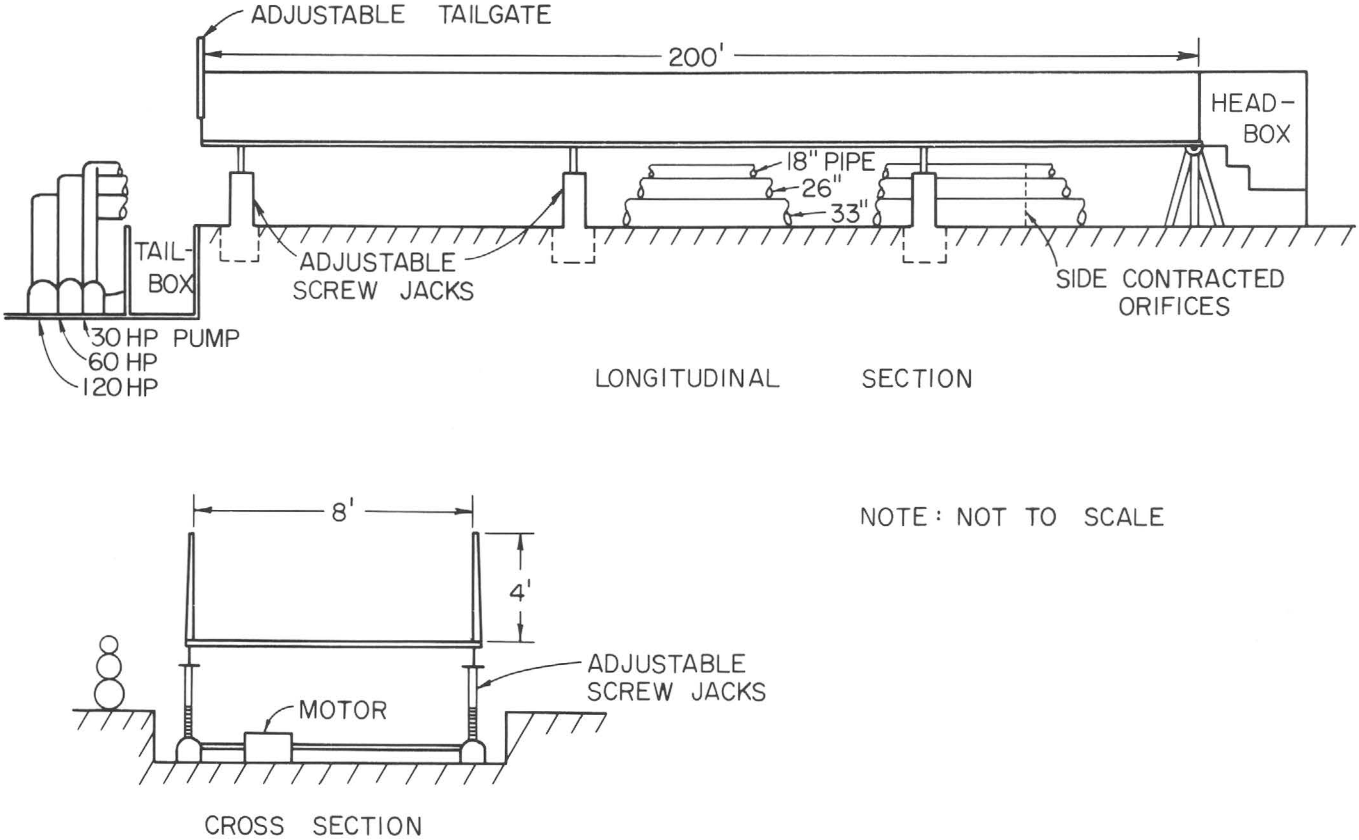


FIGURE 19. — Schematic diagram of the 8-foot-wide flume at Colorado State University.

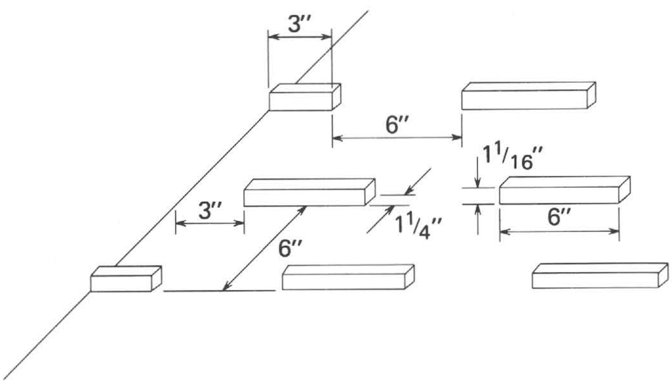


FIGURE 20. — Block roughness and spacing pattern used in the 8-foot-wide flume.

in figure 20. Figure 21 shows the blocks after they were placed in the flume and a honeycomb section was placed near the headbox to straighten out the flow and eliminate any irregular flow conditions caused by the entrance conditions.

The turbulence measurements were taken for two reasons. First, it was hoped that the measurements could be related to the vertical transfer coefficient, and, second, they were taken at frequent intervals along the channel to determine where the boundary layer became fully developed. The turbulence mea-

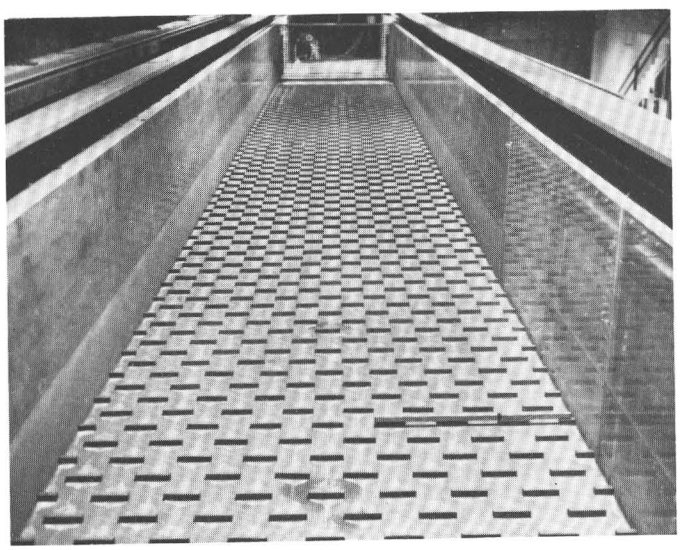


FIGURE 21.—Block roughness and honeycomb section installed near headbox of 8-foot-wide flume.

surements were obtained with both the cylindrical-shaped hot-film sensor and the parabolic-shaped sensor. The parabolic hot-film sensor was used to obtain most of the data. The turbulence characteristics obtained included the longitudinal intensity of turbulence, the Eulerian integral time scale, the macroscale of turbulence, the velocity profiles, and the related mean hydraulic parameters. These data are given in table 5.

Jobson (1968) investigated three flow conditions at a constant depth during his study. Data in the present report include two other flow conditions; one where the depth was one-half of his depth, and the other, twice the depth used by Jobson.

The procedure was to measure the local mean velocity at a point with the small modified Ott meter and, then, to place the hot-film sensor at that same point and obtain the turbulence measurements. The data were taken 1.5 feet from the wall and along the channel centerline on a vertical line extending upward from the middle of a rectangular opening formed by four roughness elements.

8-FOOT-WIDE FLUME, ALLUVIAL BOUNDARY

The experiments on flow over an alluvial boundary in the big flume were started after the roughness elements were removed. The bed material used was a natural river sand from the Rio Grande conveyance channel near Bernardo, N. Mex. The average of 20 samples analyzed, using the visual-accumulation tube, indicated that the median fall diameter, d_{50}, was 0.25 mm, and the gradation, σ, was 1.44.

A series of 33 different flow conditions were studied. The average depth varied from about 1 to 2.8 feet, and the discharge varied from about 15 to 75 cubic feet per second. The mean velocity, Q/A, ranged from about 1.8 to 6.5 feet per second. Turbulence data were only taken over a selected number of flow conditions.

After operating the flume for several days at a particular depth and discharge, equilibrium was established for each run. Then, for at least 30 hours, the water-surface slope, the discharge of water and sediment mixture, the water temperature, a bed profile, the mean depth, and the total sediment discharge were recorded every hour to obtain a good statistical average of each variable. During this time the turbulence data, velocity profiles, and suspended-sediment data were being collected. Suspended-sediment samples were obtained with a 1/4-inch siphon set to siphon at the local mean velocity. When data were desired over a crest or trough of a dune that was moving, the sonic depth sounder was used to position the data-collection equipment over the crest or trough as it migrated downstream.

The general bed configurations over which turbulence data were collected are shown in the following photographs. Figure 22 shows a ripple-bed configuration. The turbulence data were taken about 120 feet downstream from the headbox and at the centerline of the flume. Figure 23 shows a flat-bed condition. For another flat-bed run, data were taken at several stations downstream from the headbox to see if the flow was fully developed. The velocity profiles,

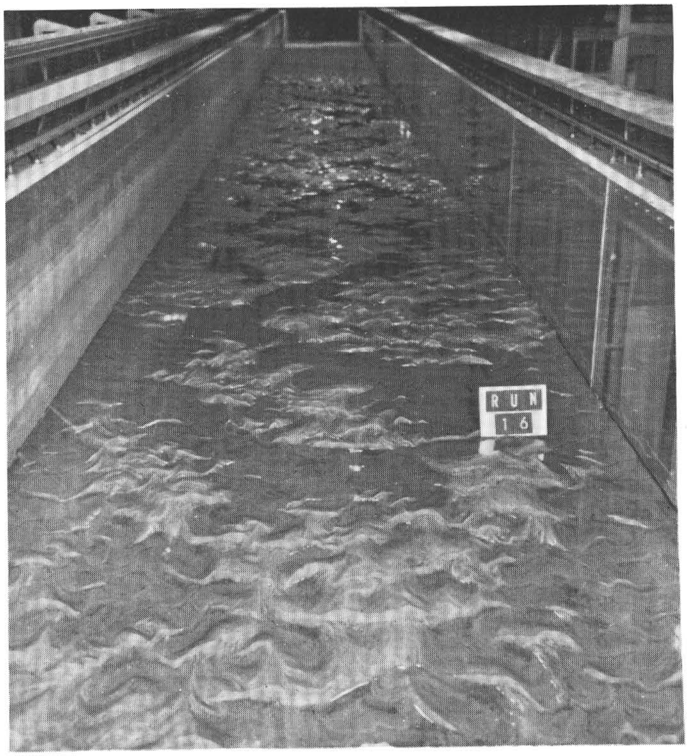


FIGURE 22. — Typical ripple bed in the 8-foot-wide flume.

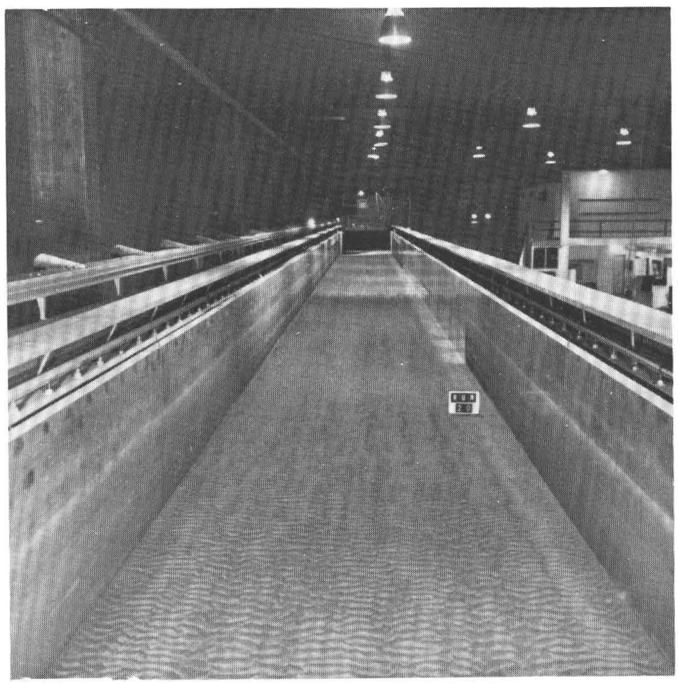


FIGURE 23. — Typical flat bed in the 8-foot-wide flume.

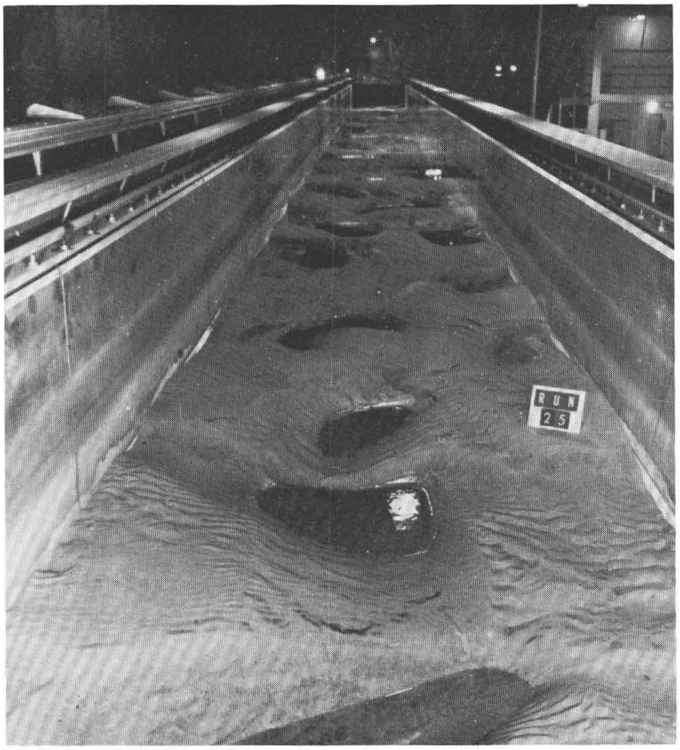


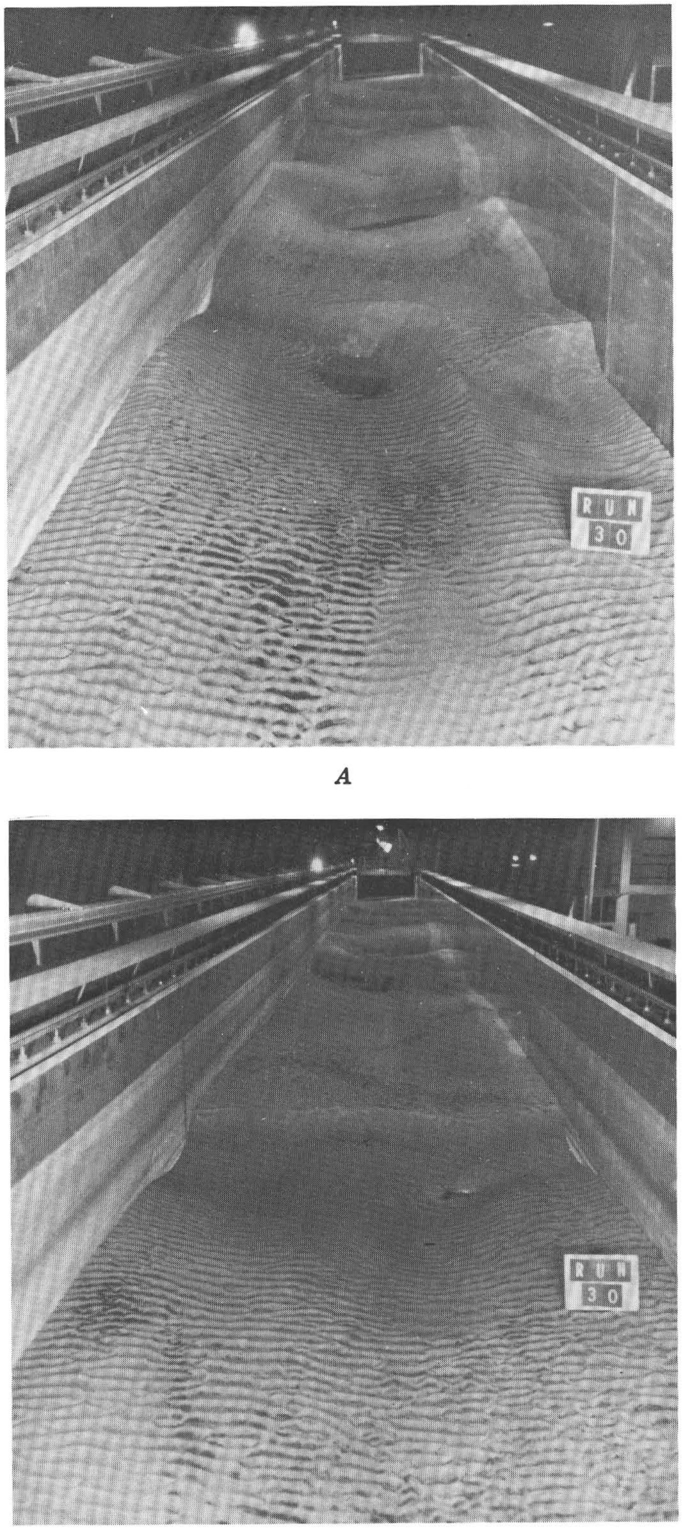
FIGURE 24.—Typical three-dimensional dune bed in the 8-foot-wide flume.

turbulence intensity profiles and suspended sediment distributions indicated that down to as much as 100 feet below the headbox the flow was not developed. Figure 24 shows a dune bed configuration. Turbulence data were collected over crests, troughs, and the backs of the dunes. Figure 25 shows that the bed configuration constitutes (a) three-dimensional dunes up near the headbox and (b) long two-dimensional dunes downstream.

The turbulence characteristics, hydraulic parameters, and sediment data are recorded in table 6.

ATRISCO FEEDER CANAL

A reach of the Atrisco feeder canal near Bernalillo, N. Mex., about 15 miles north of Albuquerque, was selected as the first field experimental site. A location map of the study site is shown in figure 26. Several other studies have been completed in the reach, including a transverse and longitudinal mixing experiment and a fluorescent sediment tracer study. Extensive alluvial channel data have been collected there. The channel has a straight alinement for a distance of approximately 12,000 feet. The cross section shown in figure 27 (as viewed upstream) was several thousand feet from the inlet to the canal. The channel is about 58 feet wide, and the average depth was approximately 1.70 feet. The bed forms were small three-dimensional dunes.



A

B

FIGURE 25.—Transitional bed in the 8-foot-wide flume: *A*, Three-dimensional features near headbox; *B*, two-dimentional features near tailbox.

The parabolic-shaped hot-film sensor was used to obtain the turbulence data. Figure 28 shows the hot-

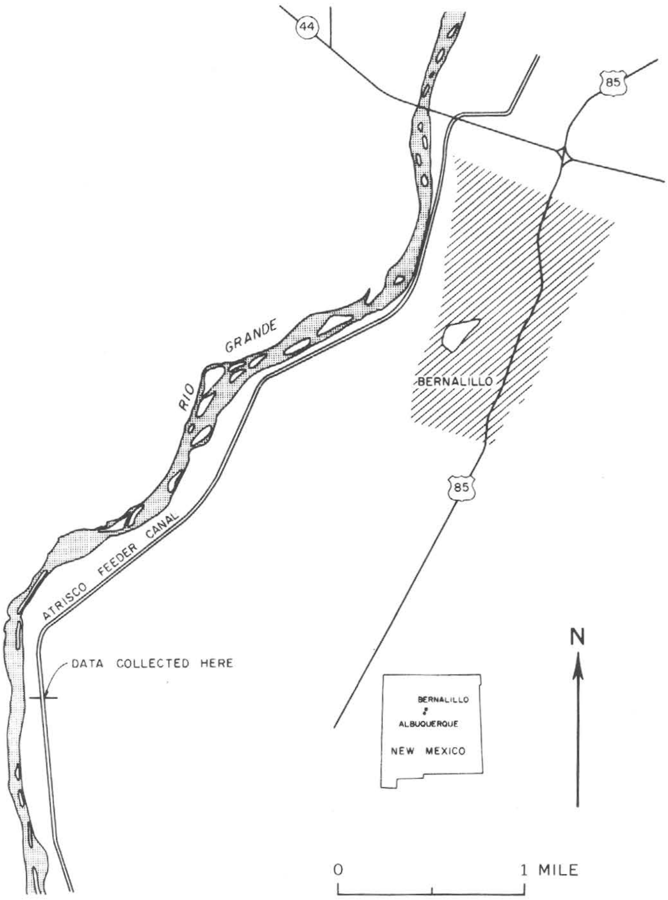


FIGURE 26. — Location of the Atrisco feeder canal.

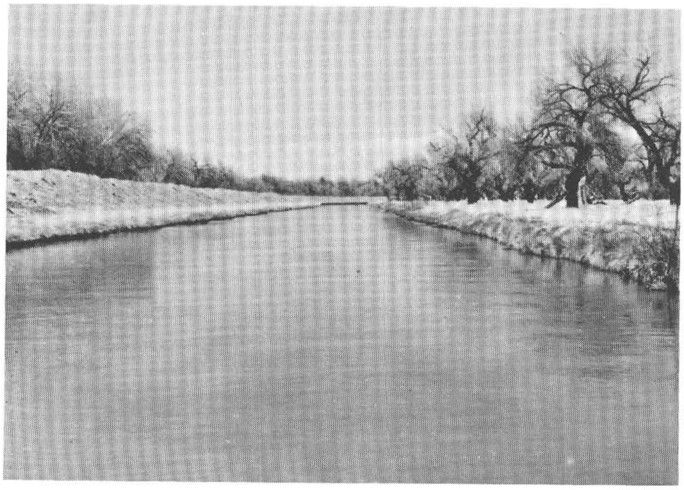


FIGURE 27. — Upstream view of the Atrisco feeder canal, photographed from the study section.

film sensor used in obtaining the turbulence measurements in the field. Six verticals were taken in the cross section defining the distributions of mean velocity (obtained with the small propeller meter),

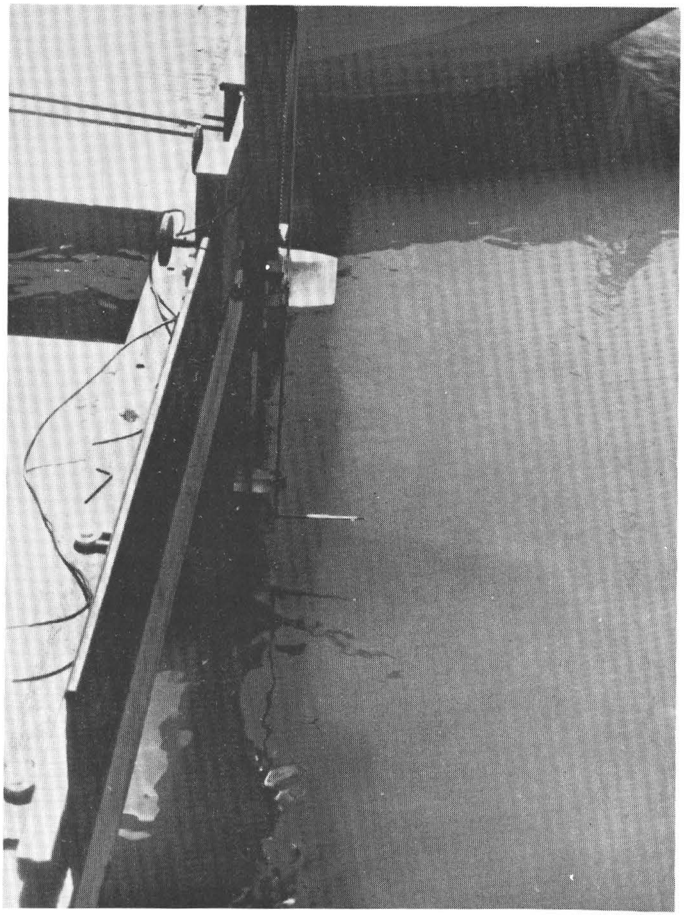


FIGURE 28. — Hot-film sensor used during the Atrisco feeder canal study.

longitudinal intensity of turbulence, Eulerian integral time scale, macroscale of turbulence, and suspended sediment. Bed-sediment samples were collected, and the bed configuration was observed. Turbulence measurements were also obtained with the small propeller meter.

The primary objectives of this study were to obtain some turbulence characteristics in the field and to evaluate the hot-film anemometer as a field instrument. It was also hoped that the turbulence characteristics could be correlated with the hydraulic parameters and the sediment data to better understand the mechanics of the flow.

The hydraulic, sediment-data, and turbulence characteristics obtained are given in table 7.

RIO GRANDE CONVEYANCE CHANNEL

The second experimental reach selected was the Rio Grande conveyance channel near Bernardo, N. Mex., about 70 miles south of Albuquerque. A location map of the study site is shown in figure 29. Extensive alluvial-channel data have been collected at this site. A basic-data report by Culbertson, Scott,

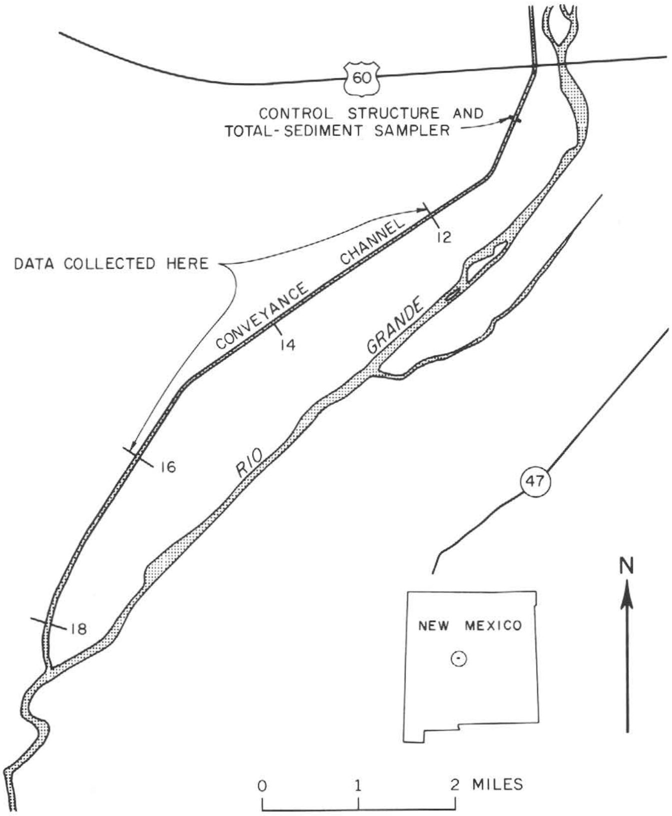


FIGURE 29. — Location of the Rio Grande conveyance channel.

and Bennett (1972) gives a detailed description of the channel and how it operates.

Data were collected from the channel at two different times and at two different locations. The first data were collected in the spring of 1968 at station 12.5. Figure 30 shows a downstream view of the channel. The channel has several sections of straight alinement, with a width of about 70 feet. The depth of flow varies with discharge and bed form.

The bed form was rather large dunes during the first data-collection period. The parabolic hot-film sensor was used to obtain the turbulence data. Six verticals were taken in the cross section defining the distributions of mean velocity, longitudinal turbulence intensity, Eulerian integral time scale, macroscale of turbulence, and suspended sediment.

The next day the above data were collected at one vertical in the flow as fast as possible (about every 15 minutes) while the bed forms moved past the platform. Fifteen verticals were taken to define the variation in the various distributions in relation to time.

The second data-collection period was in the spring of 1970. The test section was at station 16, as shown in figure 29. The test section is shown in figure 31 (upstream view). The bed form was flat, and the suspended-sediment concentrations were fairly large.

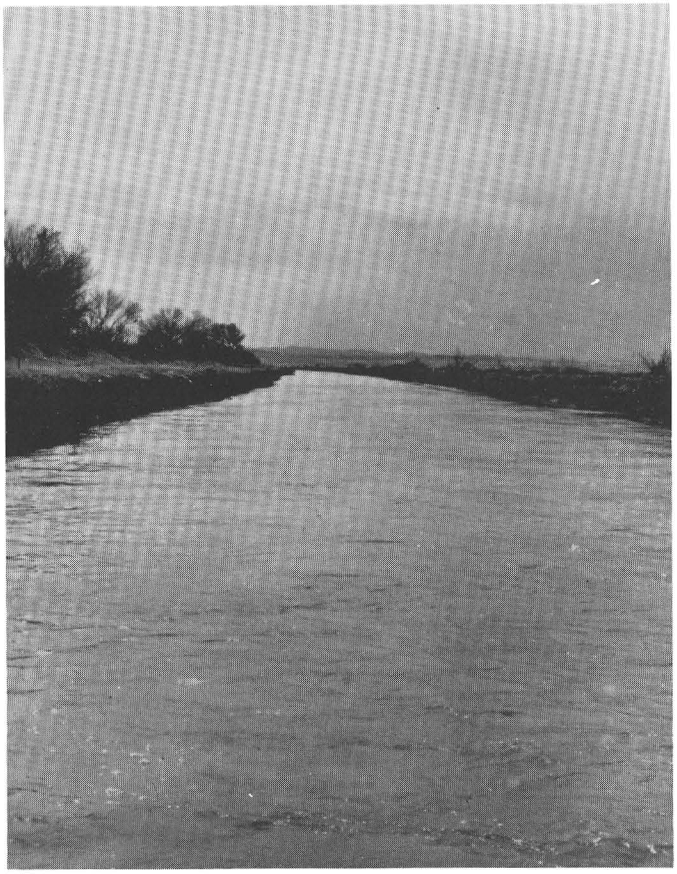


FIGURE 30. — Downstream view of the Rio Grande conveyance channel, as photographed from the 1968 data-collection site (station 12.5).

FIGURE 31. — Upstream view of the Rio Grande conveyance channel, as photographed from the 1970 data-collection site (station 16).

The same equipment was used, and the same basic data were collected. A new pumping point sampler

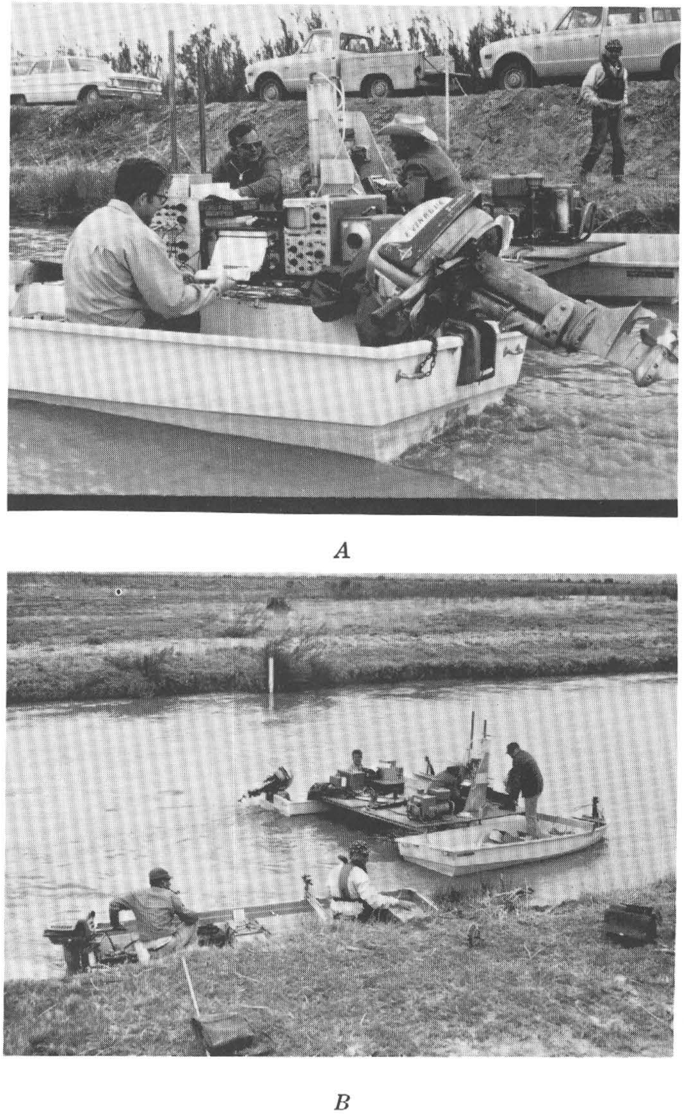


FIGURE 32. — Data collection at the Rio Grande conveyance channel: *A*, Turbulence equipment; *B*, other supportive equipment.

was used to obtain suspended-sediment samples. The data-collection equipment and the people involved are shown in figure 32.

The objective of these experiments was to correlate the turbulence characteristics with the hydraulic parameters and the suspended-sediment data to gain greater insight into the mechanics of the flow.

The hydraulic parameters, sediment data, and turbulence characteristics are reported in table 8.

COLUMBIA RIVER ESTUARY

The next experimental site was the mouth of the Columbia River at Astoria, Oreg., in the estuary. The cross section studied was a few hundred feet upstream from the bridge that goes across the estuary, as shown on the location map in figure 33 and in the photograph in figure 34. The channel is several miles wide at the cross section. The discharge varies with the tidal cycle, which complicates a data-collection program. These data were collected in conjunction with D. W. Hubbell's project.

The procedures used in collecting the data were described by Hubbell and Glenn (1970).

These were the first turbulence measurements made in depths up to 60 feet and where salinity might be a problem. A special probe cable and probe holder were used to make measurements in depths up to 125 feet.

Difficulties with electronic equipment used to obtain the direction of flow and the mean velocity plagued the data collection for 3 days. When all of Hubbell's equipment worked, the turbulence equipment failed to give good clean signals. A grounding problem was the main cause of the noisy signal. Once this problem was solved, one good profile of turbulence data was collected.

Along with the turbulence data, salinity, temperature, and mean velocity data and suspended-sediment samples were collected.

Salinity, large depths, and esturian flow did not seem to be a problem in getting good turbulence data. Turbulence measurements could be made but a great deal of thought and planning would have to go into a data collection program. Flow in estuaries is very complex, and it would be important to know all the variables of interest in order to correlate the turbulence measurements with the flow variables.

The data collected are summarized in table 9.

MISSOURI RIVER

The next experimental reach was selected on the Missouri River, a few miles downstream from Omaha, Nebr. The cross section selected was in a 7-mile study reach between Missouri River miles 609 to 616, as shown in figure 35. The specific cross section where the turbulence measurements were obtained was at river-mile 612.51. Figure 36 shows the channel, viewed downstream from the cross section, and figure 37 shows the channel, as viewed upstream. The Omaha District of the Corps of Engineers has been collecting basic sediment and hydraulic data in the reach for 4 years. (For a summary of their results, see U.S. Army Corps of Engineers, 1968, 1969.)

Data were collected at two different times. The first set of data was collected in September of 1968. The bed forms were long two-dimensional dunes. The equipment was assembled in a boat. The boat was positioned in the cross section by means of a stadia rod in the boat and a transit on the riverbank. The boat was then anchored in the river at the desired

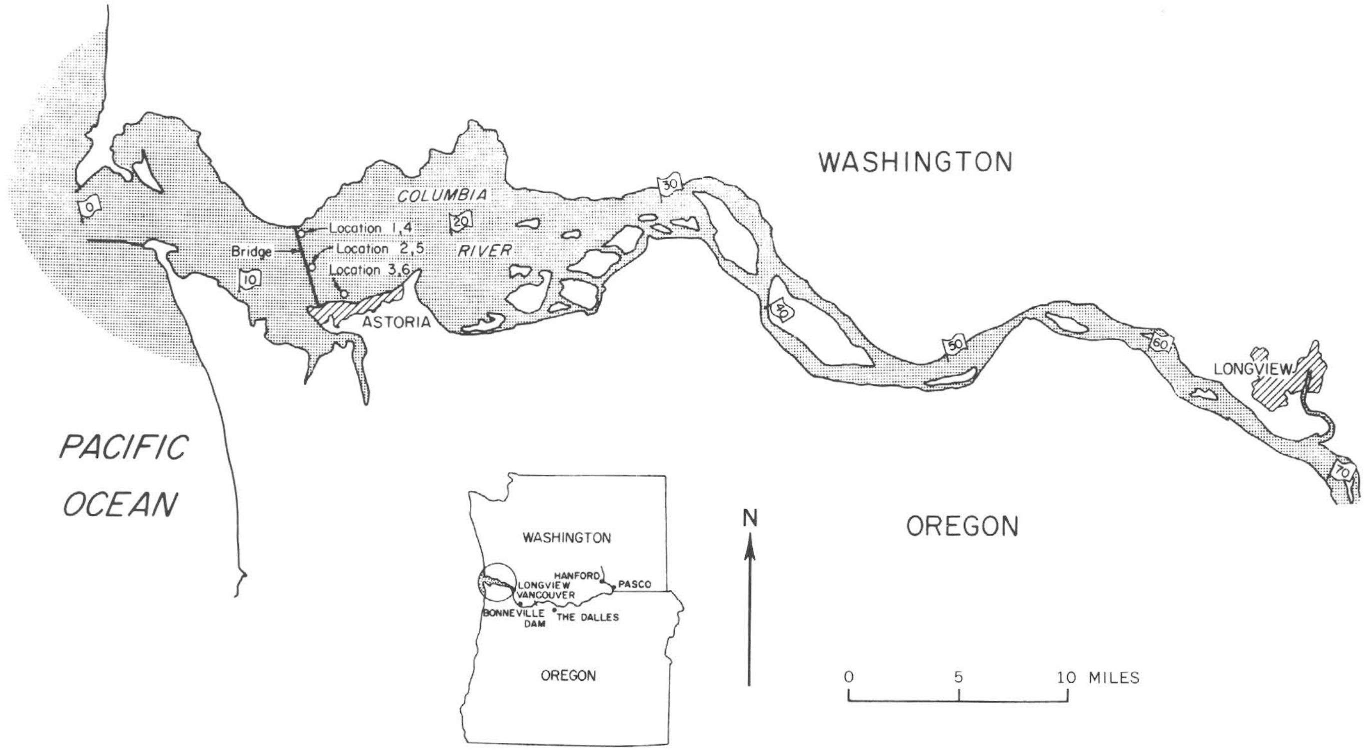


FIGURE 33. — Location of the Columbia River estuary study.

FIGURE 34. — Southward cross-section view of the Columbia River estuary.

location. Five verticals were taken in the cross section. The parabolic hot-film sensor was used to obtain the turbulence measurements, and six data points were collected in a vertical. At each vertical, sufficient data were collected to define distributions of mean velocity, longitudinal turbulence intensity, Eulerian integral time scale, macroscale of turbulence, and suspended sediment. Bed-sediment samples, the bed configuration, and other hydraulic parameters were collected by Corps personnel.

The second set of data was collected in November of that same year, when the bed was nearly flat. Data were taken at three verticals in the same cross section, and the same types of data were collected.

The objective of this study was to correlate the sediment data and hydraulic parameters with the turbulence characteristics. The basic data are given in table 10.

MISSISSIPPI RIVER

The last field site was the Milliken Bend section of the Mississippi River, just upstream from Vicksburg, Miss. The section of the river in which data were collected is indicated in figure 38. The turbulence, local mean velocities, and suspended-sediment data were collected at river-miles 444.0, 443.2, 441.6, and 440.0. Two typical cross sections of the river are shown in figures 39 and 40.

Four crews in four boats collected the data. One crew measured the discharge, one crew obtained bed- and suspended-sediment samples, another crew obtained bed form information, and the other crew obtained the local mean velocities and the turbulence data. Anchoring the boats was an impossibility because of the large amount of barge traffic. Therefore, the position was held by the boat operator. Positioning of the boats was determined by surveying the distance between the boat and visible triangulation stations on the riverbank.

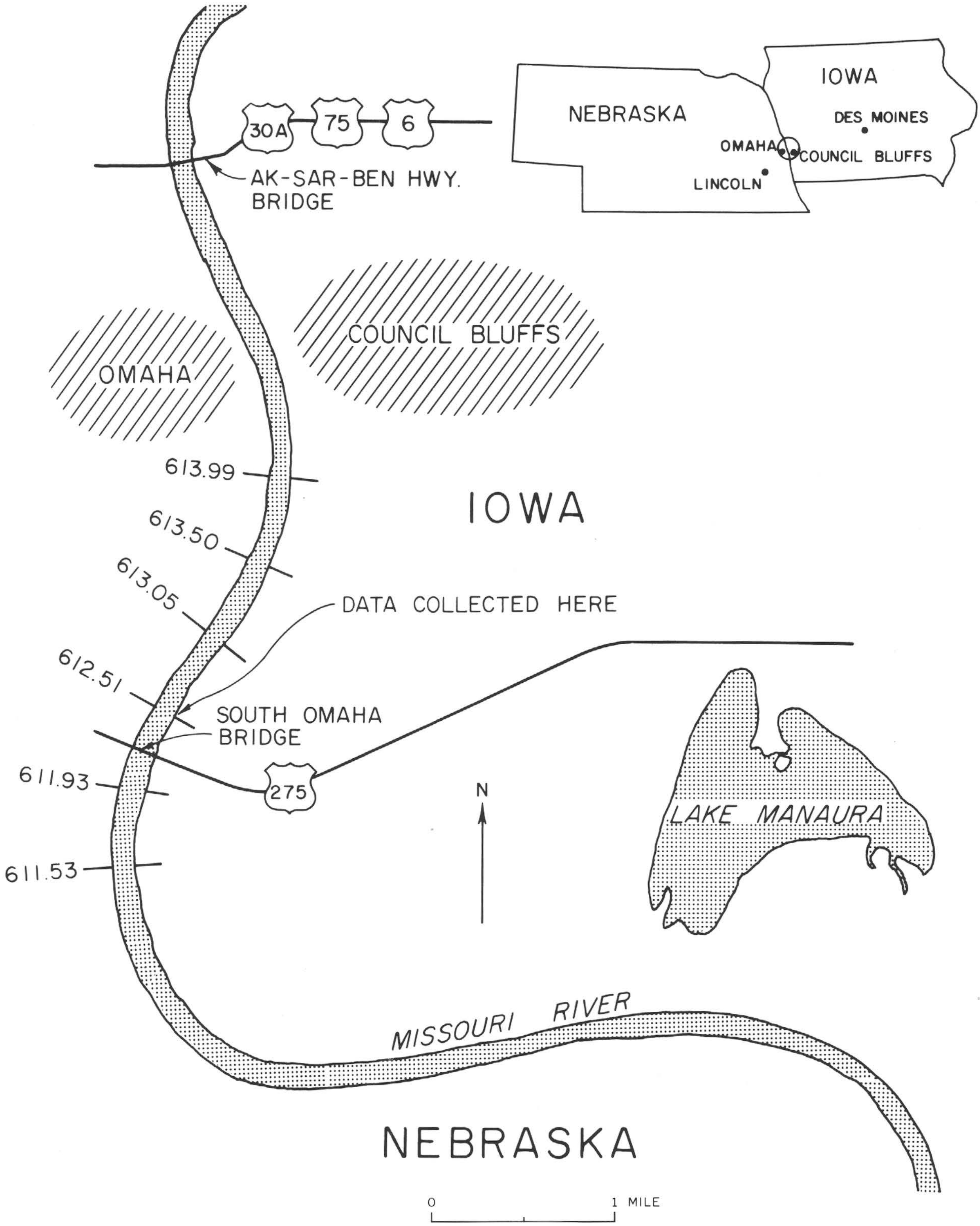


FIGURE 35. — Location of the Missouri River study.

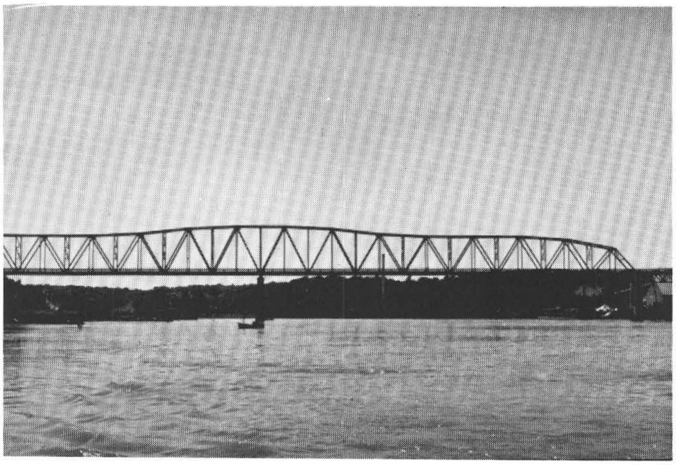


FIGURE 36. — Downstream view of the Missouri River, as photographed from the study section.

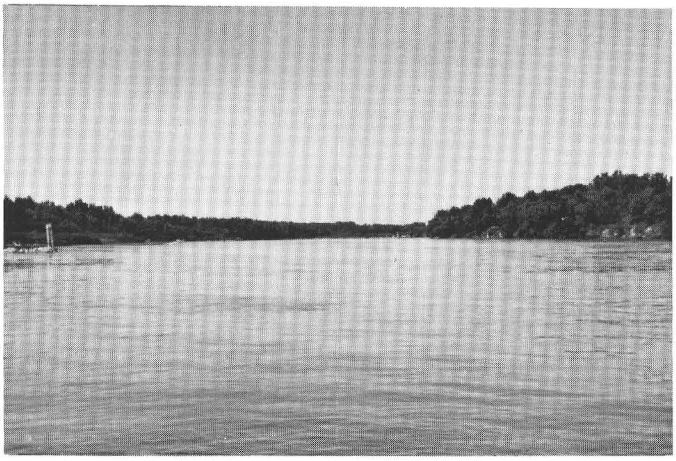


FIGURE 37. — Upstream view of the Missouri River, as photographed from the study section.

The turbulence measurements were obtained with the parabolic-shaped hot-film sensor. The local mean velocities were obtained with a standard Price current meter. Three vertical distributions of the local mean velocity, longitudinal turbulence intensity, suspended sediment, Eulerian integral time scale, and the macroscale of turbulence were obtained at each cross section. The turbulence data and local mean velocities were averaged over 4 minutes, which is probably not a long enough time in a river system of that size. The suspended-sediment samples were collected in 1-pint containers. The length of time used to collect a 1-pint container of water and sediment mixture was about 10 seconds, which is not a long enough time to collect a representative sample. In

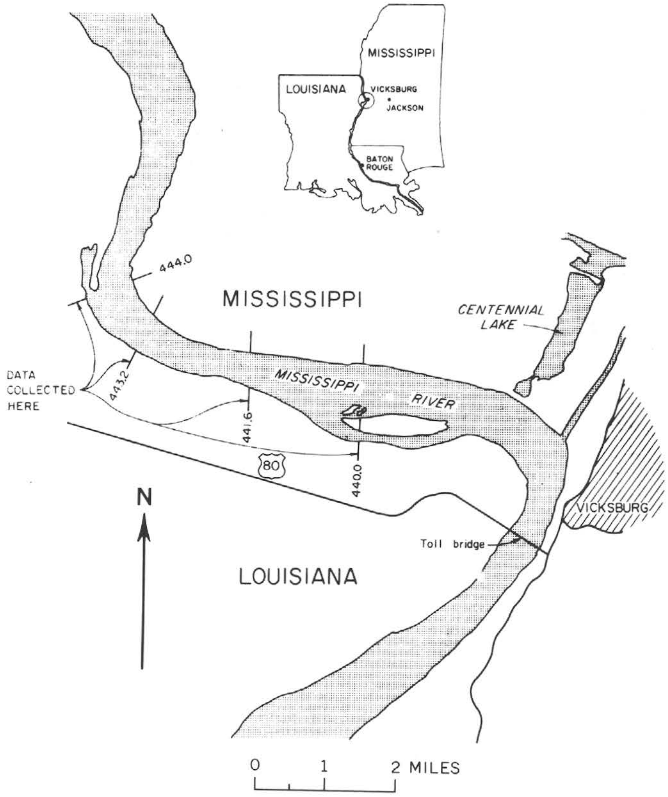


FIGURE 38. — Location of the Mississippi River study.

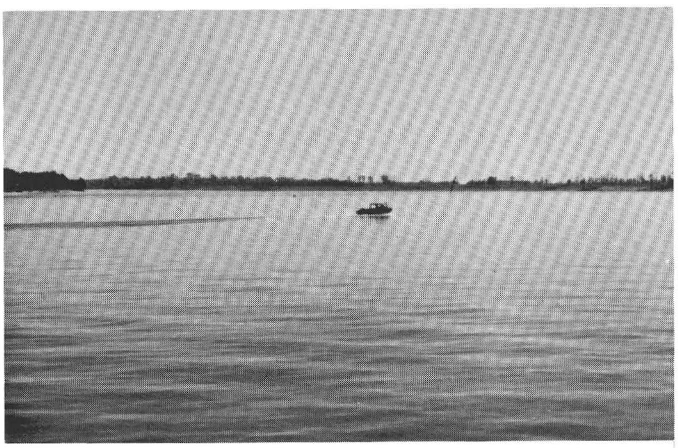


FIGURE 39. — Upstream view of the Mississippi River, from study section 444.0.

some verticals the suspended-sediment data collection was repeated, and it's easy to see from the wide range in the data why these samples were not very meaningful.

The objective of this study was to correlate the turbulence characteristics with the mean hydraulic

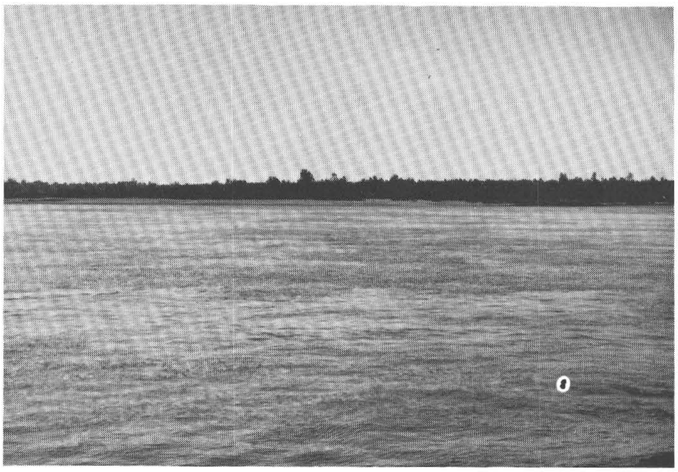


FIGURE 40. — Cross section of the Mississippi River at study section 441.6.

parameters and the sediment data. The data are recorded in table 11.

CURRENT METER RESULTS

At the cross sections of the Atrisco feeder canal and the first data-collection site on the Rio Grande conveyance channel, the local mean velocities were obtained with the small modified propeller meter. The 1–3 Ott propeller was used. The digital output from the propeller meter was changed to an analog signal by a digital-to-analog converter. This output was recorded on the FM magnetic-tape recorder. These data were analyzed by digitizing the data as explained in the "Operating Procedure and Data Reduction" section, and from a computer analysis, the longitudinal turbulence intensity was obtained. A detailed description of the equipment and data-reduction procedure for the data collected with the small propeller meter is given by Bennett and McQuivey (1970). Table 12a and b summarizes the turbulence intensities obtained with the propeller meter and the hot-film anemometer at the Atrisco and Rio Grande conveyance sites.

Table 12c summarizes the longitudinal turbulence intensity values obtained with the standard Price current meter used at sections 441.6 and 444.0 during the Mississippi River study, as well as the results obtained with the hot-film anemometer. The current meter impulses were recorded on an oscillograph for 4 minutes at each point in the flow. This record was later digitized and the longitudinal intensity calculated.

REFERENCES

Bennett, J. P., 1968, Turbulence measurement with a propeller flowmeter: U.S. Geol. Survey open-file report, 171 p.

Bennett, J. P., and McQuivey, R. S., 1970, Comparison of a propeller flowmeter with a hot-film anemometer in measuring turbulence in movable-boundary open-channel flows: U.S. Geol. Survey Prof. Paper 700–B, p. B254–B262.

Culbertson, J. K., Scott, C. H., and Bennett, J. P., 1972, Summary of basic data, Rio Grande conveyance channel, New Mexico, 1965–69: U.S. Geol. Survey Prof. Paper 562–J, 49 p.

Hubbell, D. W., and Glenn, J. L., 1970, Distribution of radionuclides and sediments in the Columbia River estuary: U.S. Geol. Survey open-file report, 130 p.

Jobson, H. E., 1968, Vertical mass transfer in open-channel flow: U.S. Geol. Survey open-file report, 204 p.

McQuivey, R. S., 1967, Turbulence in a hydrodynamically rough and smooth open-channel flow: U.S. Geol. Survey open-file report, 105 p.

———1973, Principles and measuring techniques of turbulence characteristics in open-channel flows: U.S. Geol. Survey Prof. Paper 802–A, 82 p.

Prych, E. A., Hubbell, D. W., and Glenn, J. L., 1967, New esturine measurement equipment and techniques: Am. Soc. Civil Engineers Proc., v. 93, no. WW2, p. 41–46.

Rathbun, R. E., Guy, H. P., and Richardson, E. V., 1969, Response of a laboratory alluvial channel to changes of hydraulic and sediment-transport variables: U.S. Geol. Survey Prof. Paper 562–D, 32 p.

U.S. Army Corps of Engineers, 1968, Missouri River channel regime studies: M.R.D. Sediment Ser. 13A, U.S. Army Engineers District [Omaha], 53 p.

———1969, Missouri River channel regime studies: M.R.D. Sediment Ser. 13B, U.S. Army Engineers District [Omaha], 76 p.

U.S. Inter-Agency Committee on Water Resources, 1957a, The development and calibration of the visual-accumulation tube: Minneapolis, Minn., St. Anthony Falls Hydraulics Lab., Rept. 11, 109 p.

———1957b, Some fundamentals of particle size analysis: Minneapolis, Minn., St. Anthony Falls Hydraulics Lab., Rept. 12, 55 p.

BASIC DATA

TABLE 1a. — *20-centimeter-wide flume, rigid boundary*

Mean flow parameters and variables		Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$
Smooth boundary, channel centerline, cylindrical hot-film sensor						
$S = 0.89\times10^{-3}$	$U_* = 0.046$ fps	0.786	1.010	0.0559	0.0554	1.215
$W = 0.632$ ft	$\tau = 0.0053$ lb/ft^2	.615	.980	.0660	.0674	1.435
$Q = 0.054$ cfs	$\nu = 0.920\times10^{-5}$ ft^2/sec	.445	.945	.0714	.0756	1.552
$T = 27.2$ °C	R = 9,300	.359	.910	.0786	.0864	1.709
$D = 0.096$ ft	F = 0.506	.274	.860	.0821	.0955	1.785
$\overline{V} = 0.89$ fps	$C/\sqrt{g} = 19.35$	.189	.807	.0921	.1141	2.002
		.104	.702	.1087	.1548	2.363
		.063	.625	.1195	.1912	2.598
		.041	.565	.1296	.2294	2.817
$S = 1.70\times10^{-3}$	$U_* = 0.0648$ fps	.937	1.503	.0592	.0394	.914
$W = 0.632$ ft	$\tau = 0.0106$ lb/ft^2	.775	1.462	.0656	.0449	1.012
$Q = 0.087$ cfs	$\nu = 0.920\times10^{-5}$ ft^2/sec	.614	1.418	.0752	.0530	1.160
$T = 27.2$ °C	R = 15,000	.452	1.354	.0878	.0648	1.355
$D = 0.101$ ft	F = 0.76	.372	1.310	.0987	.0753	1.523
$\overline{V} = 1.365$ fps	$C/\sqrt{g} = 21.10$	.290	1.253	.1110	.0886	1.713
		.208	1.194	.1200	.1005	1.852
		.129	1.090	.1320	.1211	2.037
		.071	.965	.1480	.1534	2.284
		.045	.873	.1670	.1913	2.577
$S = 3.30\times10^{-3}$	$U_* = 0.089$ fps	.887	2.230	.0857	.0384	.963
$W = 0.632$ ft	$\tau = 0.019$ lb/ft^2	.713	2.160	.1027	.0476	1.154
$Q = 0.118$ cfs	$\nu = 0.909\times10^{-5}$ ft^2/sec	.539	2.070	.1140	.0551	1.281
$T = 27.8$ °C	R = 20,500	.364	1.930	.1266	.0656	1.422
$D = 0.094$ ft	F = 1.14	.278	1.830	.1391	.0760	1.563
$\overline{V} = 1.98$ fps	$C/\sqrt{g} = 22.30$	.191	1.700	.1632	.0960	1.834
		.104	1.510	.1806	.1196	2.029
		.055	1.400	.2121	.1515	2.383
Smooth boundary, channel centerline, wedge hot-film sensor						
$S = 0.87\times10^{-3}$	$U_* = 0.0456$ fps	.811	1.005	.0470	.0370	1.031
$W = 0.632$ ft	$\tau = 0.0047$ lb/ft^2	.643	.976	.0520	.0430	1.140
$Q = 0.054$ cfs	$\nu = 1.01\times10^{-5}$ ft^2/sec	.475	.937	.0587	.0520	1.287
$T = 23.3$ °C	R = 8,500	.306	.888	.0688	.0660	1.509
$D = 0.097$ ft	F = 0.50	.222	.781	.0775	.0770	1.700
$\overline{V} = 0.88$ fps	$C/\sqrt{g} = 19.35$	.138	.730	.0874	.0900	1.917
		.054	.581	.1050	.1560	2.303
		.037	.525	.1100	.1760	2.412
$S = 1.82\times10^{-3}$	$U_* = 0.0664$ fps	.885	1.483	.0506	.0260	.762
$W = 0.632$ ft	$\tau = 0.011$ lb/ft^2	.719	1.447	.0611	.0330	.920
$Q = 0.085$ cfs	$\nu = 1.01\times10^{-5}$ ft^2/sec	.551	1.404	.0702	.0400	1.057
$T = 23.3$ °C	R = 13,300	.386	1.322	.0782	.0480	1.178
$D = 0.099$ ft	F = 0.76	.302	1.277	.0850	.0550	1.295
$\overline{V} = 1.36$ fps	$C/\sqrt{g} = 20.50$	.219	1.208	.0952	.0650	1.434
		.136	1.126	.1056	.0780	1.590
		.053	.947	.1370	.1250	2.063
		.033	.870	.1531	.1580	2.306
$S = 3.30\times10^{-3}$	$U_* = 0.0904$ fps	.902	2.158	.0572	.0270	.632
$W = 0.632$ ft	$\tau = 0.021$ lb/ft^2	.824	2.123	.0628	.0300	.694
$Q = 0.121$ cfs	$\nu = 1.01\times10^{-5}$ ft^2/sec	.663	2.061	.0702	.0340	.776
$T = 23.3$ °C	R = 19,000	.502	1.974	.0849	.0430	.939
$D = 0.101$ ft	F = 1.05	.341	1.856	.0997	.0540	1.103
$\overline{V} = 1.90$ fps	$C/\sqrt{g} = 21.00$	.260	1.781	.1033	.0580	1.143
		.180	1.665	.1195	.0680	1.322
		.100	1.498	.1522	.0850	1.684
		.052	1.298	.1787	.122	1.977
		.032	1.153	.1982	.163	2.192

Mean flow parameters and variables		Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$
Shot roughness, channel centerline, cylindrical hot-film sensor						
$S = 1.80\times10^{-3}$	$U_* = 0.0670$ fps	0.810	1.090	0.0686	0.0629	1.024
$W = 0.632$ ft	$\tau = 0.011$ lb/ft^2	.647	1.040	.0790	.0760	1.179
$Q = 0.062$ cfs	$\nu = 1.00\times10^{-5}$ ft^2/sec	.484	.970	.0932	.0961	1.391
$T = 23.9$ °C	R = 9,400	.320	.880	.1082	.1230	1.615
$D = 0.102$ ft	F = 0.52	.238	.835	.1211	.1450	1.808
$\overline{V} = 0.930$ fps	$C/\sqrt{g} = 13.85$	.167	.735	.1303	.1773	1.945
		.121	.660	.1381	.2092	2.061
		.075	.560	.1541	.2752	2.300
		.056	.500	.1623	.3246	2.422
		.026	.380	.2092	.5811	3.122
$S = 5.07\times10^{-3}$	$U_* = 0.111$ fps	.995	1.940	.1036	.0534	.935
$W = 0.632$ ft	$\tau = 0.031$ lb/ft^2	.828	1.870	.1183	.0633	1.068
$Q = 0.099$ cfs	$\nu = 1.01\times10^{-5}$ ft^2/sec	.662	1.790	.1237	.0691	1.113
$T = 23.6$ °C	R = 14,800	.491	1.680	.1357	.0808	1.222
$D = 0.099$ ft	F = 0.86	.331	1.530	.1603	.1048	1.444
$\overline{V} = 1.58$ fps	$C/\sqrt{g} = 13.50$	.245	1.420	.1836	.1293	1.654
		.165	1.270	.2070	.1630	1.865
		.083	1.010	.2430	.2406	2.189
		.056	.860	.2741	.3187	2.469
		.033	.660	.3225	.4886	2.905
$S = 9.52\times10^{-3}$	$U_* = 0.153$ fps	.755	2.570	.1418	.0552	.928
$W = 0.632$ ft	$\tau = 0.056$ lb/ft^2	.602	2.460	.1530	.0623	1.000
$Q = 0.128$ cfs	$\nu = 1.01\times10^{-5}$ ft^2/sec	.452	2.330	.1702	.0731	1.113
$T = 23.3$ °C	R = 19,500	.301	2.120	.1940	.0915	1.268
$D = 0.101$ ft	F = 1.08	.226	1.960	.2290	.1163	1.497
$\overline{V} = 1.99$ fps	$C/\sqrt{g} = 12.40$	.151	1.760	.2570	.1460	1.680
		.076	1.420	.3170	.2232	2.072
		.035	1.220	.3870	.3170	2.529
		.030	.960	.4250	.4427	2.778
Shot roughness, channel centerline, wedge hot-film sensor						
$S = 1.80\times10^{-3}$	$U_* = 0.068$ fps	.795	1.082	.0512	.0473	.752
$W = 0.632$ ft	$\tau = 0.012$ lb/ft^2	.642	1.038	.0633	.0610	.930
$Q = 0.065$ cfs	$\nu = 1.04\times10^{-5}$ ft^2/sec	.490	.980	.0745	.0760	1.096
$T = 24.4$ °C	R = 10,200	.336	.902	.0873	.0968	1.284
$D = 0.107$ ft	F = 0.50	.260	.848	.0990	.1167	1.456
$\overline{V} = 0.960$ fps	$C/\sqrt{g} = 13.65$	.183	.774	.1130	.1460	1.662
		.107	.630	.1110	.1762	1.632
		.061	.545	.1480	.2716	2.176
		.052	.510	.1580	.3098	2.324
$S = 5.60\times10^{-3}$	$U_* = 0.1193$ fps	.810	1.982	.0740	.0370	.620
$W = 0.632$ ft	$\tau = 0.037$ lb/ft^2	.655	1.903	.0855	.0450	.716
$Q = 0.105$ cfs	$\nu = 1.04\times10^{-5}$ ft^2/sec	.499	1.801	.1086	.0620	.910
$T = 24.4$ °C	R = 16,600	.343	1.658	.1319	.0800	1.105
$D = 0.105$ ft	F = 0.84	.265	1.573	.1458	.0930	1.222
$\overline{V} = 1.58$ fps	$C/\sqrt{g} = 13.00$	.187	1.439	.1592	.1110	1.334
		.109	1.183	.1843	.1560	1.545
		.062	1.030	.2202	.2140	1.846
		.053	.972	.2388	.2460	2.002
$S = 8.44\times10^{-3}$	$U_* = 0.1444$ fps	.840	2.493	.0800	.0320	.554
$W = 0.632$ ft	$\tau = 0.053$ lb/ft^2	.677	2.401	.0960	.0400	.664
$Q = 0.134$ cfs	$\nu = 1.04\times10^{-5}$ ft^2/sec	.517	2.278	.1160	.0510	.803
$T = 24.4$ °C	R = 20,800	.355	2.090	.1440	.0690	.997
$D = 0.101$ ft	F = 1.10	.274	1.976	.1560	.0790	1.080
$\overline{V} = 2.10$ fps	$C/\sqrt{g} = 13.85$	.194	1.824	.1860	.1020	1.288
		.113	1.506	.2120	.1410	1.468
		.065	1.391	.2880	.2070	1.994
		.055	1.250	.3100	.2480	2.147

TABLE 1b. — *20-centimeter-wide flume, rigid boundary, yawed-film results*

Mean flow parameters and variables	Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	$\sqrt{\overline{v^2}}$ (fps)	$\sqrt{\overline{v^2}}/\overline{U}$	$\sqrt{\overline{v^2}}/U_*$	Measured $\rho\,\overline{uv}$ (lbs/ft^2)	Calculated $\rho\,\overline{uv}$ (lbs/ft^2)	$\overline{uv}/\overline{U}^2$	$\overline{uv}/U_*^2$	T_E (sec)	L_x (ft)	λ_x (ft)
Smooth boundary, channel centerline															
$S = 0.48\times10^{-3}$; $U_* = 0.035$ fps															
$W = 0.632$ ft; $\tau = 0.0031$ lb/ft^2	0.564	0.683	0.0505	0.0739	1.443	0.0346	0.0507	0.989	0.00088	0.00134	0.00097	0.3703	0.247	0.169	0.0187
$Q = 0.044$ cfs; $\nu = 1.00\times10^{-5}$ ft^2/sec	.450	.651	.0577	.0886	1.649	.0394	.0605	1.126	.00120	.00170	.00146	.5049	.263	.171	.0223
$T = 23.9$ °C; R = 7,000	.240	.607	.0705	.1161	2.014	.0486	.0801	1.389	.00164	.00234	.00229	.6901	.281	.170	.0196
$D = 0.103$ ft; F = 0.37	.083	.484	.0880	.1818	2.514	.0568	.1174	1.623	.00172	.00283	.00378	.7238	.253	.123	.0162
$\overline{V} = 0.675$ fps; $C/\sqrt{g} = 19.3$															
$S = 1.75\times10^{-3}$; $U_* = 0.0657$ fps	.775	1.460	.0760	.0520	1.157	.0523	.0358	.796	.00206	.00249	.00050	.2460	.203	.287	.0101
$W = 0.632$ ft; $\tau = 0.0110$ lb/ft^2	.452	1.350	.0960	.0711	1.461	.0646	.0478	.983	.00487	.00606	.00138	.5816	.159	.215	.0124
$Q = 0.0874$ cfs; $\nu = 0.920\times10^{-5}$ ft^2/sec	.290	1.260	.1110	.0881	1.690	.0760	.0603	1.157	.00637	.00785	.00207	.7607	.186	.234	.0116
$T = 27.2$ °C; R = 15,000	.208	1.190	.1230	.1034	1.872	.0843	.0708	1.283	.00767	.00876	.00279	.9159	.184	.219	.0103
$D = 0.1013$ ft; F = 0.75	.129	1.090	.1340	.1229	2.040	.0897	.0823	1.365	.00784	.00964	.00340	.9362	.173	.189	.0082
$\overline{V} = 1.36$ fps; $C/\sqrt{g} = 20.7$	.071	.960	.1600	.1666	2.435	.1060	.1104	1.613	.00793	.01028	.00444	.9470	.177	.170	.0071
$S = 3.31\times10^{-3}$; $U_* = 0.089$ fps	.713	2.160	.1080	.0500	1.214	.0737	.0341	.8281	.00450	.00557	.00050	.2928	.112	.242	.0086
$W = 0.632$ ft; $\tau = 0.0194$ lb/ft^2	.539	2.060	.1200	.0583	1.348	.0799	.0388	.8978	.00900	.00895	.00110	.5857	.136	.280	.0111
$Q = 0.1188$ cfs; $\nu = 0.909\times10^{-5}$ ft^2/sec	.364	1.930	.1410	.0731	1.584	.0939	.0487	1.0550	.01090	.01235	.00150	.7093	.154	.297	.0092
$T = 27.8$ °C; R = 20,600	.278	1.840	.1560	.0848	1.753	.1020	.0554	1.1460	.01270	.01402	.00190	.8265	.142	.261	.0103
$D = 0.094$ ft; F = 1.14	.191	1.710	.1650	.0965	1.854	.1050	.0614	1.1800	.01440	.01571	.00250	.9371	.157	.268	.0077
$\overline{V} = 1.99$ fps; $C/\sqrt{g} = 22.3$	.104	1.510	.1940	.1285	2.180	.1290	.0854	1.4490	.01660	.01740	.00380	1.0800	.147	.222	.0053
Shot roughness, channel centerline															
$S = 2.11\times10^{-3}$; $U_* = 0.0743$ fps	.780	1.220	.0837	.0686	1.126	.0564	.0462	.7591	.00330	.00316	.00110	.2290	.132	.161	.0119
$W = 0.632$ ft; $\tau = 0.0144$ lb/ft^2	.513	1.110	.0917	.0826	1.234	.0595	.0536	.8008	.00580	.00699	.00300	.4020	.157	.174	.0135
$Q = 0.073$ cfs; $\nu = 1.07\times10^{-5}$ ft^2/sec	.336	1.020	.1089	.1068	1.466	.0725	.0711	.9758	.00720	.00953	.00360	.4996	.186	.190	.0128
$T = 21.4$ °C; R = 11,900	.225	.950	.1240	.1305	1.669	.0816	.0859	1.0980	.00820	.01112	.00470	.5680	.177	.168	.0117
$D = 0.109$ ft; F = 0.60	.180	.790	.1480	.1873	1.992	.0936	.1185	1.2600	.00940	.01177	.00780	.6520	.142	.112	.0086
$\overline{V} = 1.06$ fps; $C/\sqrt{g} = 14.3$	.085	.630	.1712	.2717	2.304	.1125	.1786	1.5140	.01030	.01313	.01340	.7160	.111	.070	.0057
$S = 6.28\times10^{-3}$; $U_* = 0.130$ fps	.749	2.000	.1330	.0665	1.023	.0830	.0415	.6385	.01090	.01107	.00140	.3325	.087	.175	.0115
$W = 0.632$ ft; $\tau = 0.044$ lb/ft^2	.461	1.840	.1620	.0870	1.246	.0970	.0527	.7462	.01440	.02376	.00220	.4392	.103	.190	.0123
$Q = 0.1205$ cfs; $\nu = 1.06\times10^{-5}$ ft^2/sec	.318	1.720	.1760	.1023	1.354	.1260	.0733	.9692	.01920	.03007	.00330	.5856	.116	.200	.0117
$T = 21.7$ °C; R = 17,400	.212	1.600	.2020	.1263	1.554	.1370	.0856	1.0540	.02400	.03474	.00480	.7320	.114	.182	.0103
$D = 0.1125$ ft; F = 0.85	.201	1.610	.2120	.1317	1.631	.1460	.0907	1.1230	.02600	.03522	.00520	.7930	.111	.179	.0096
$\overline{V} = 1.70$ fps; $C/\sqrt{g} = 13.1$	.113	1.400	.2470	.1764	1.900	.1610	.1150	1.2380	.02850	.03910	.00750	.8693	.108	.151	.0059
$S = 8.54\times10^{-3}$; $U_* = 0.147$ fps	.795	2.500	.1550	.0620	1.053	.0880	.0352	.5986	.01030	.01133	.00080	.2457	.073	.183	.0109
$W = 0.632$ ft; $\tau = 0.055$ lb/ft^2	.636	2.400	.1660	.0693	1.130	.0934	.0389	.6354	.01680	.02012	.00150	.4007	.095	.228	.0107
$Q = 0.1307$ cfs; $\nu = 1.01\times10^{-5}$ ft^2/sec	.477	2.250	.1880	.0836	1.280	.1190	.0529	.8095	.02270	.02890	.00230	.5415	.104	.234	.0105
$T = 23.3$ °C; R = 21,300	.305	2.040	.2020	.0990	1.374	.1410	.0691	.9592	.02860	.03819	.00350	.6822	.112	.228	.0099
$D = 0.1037$ ft; F = 1.13	.161	1.720	.2560	.1488	1.742	.1660	.0965	1.1290	.03720	.04636	.00650	.8874	.102	.175	.0087
$\overline{V} = 2.01$ fps; $C/\sqrt{g} = 13.6$	.083	1.490	.3080	.2067	2.095	.1980	.1329	1.3470	.03910	.05067	.00910	.9327	.091	.136	.0063

TABLE 1c. — *20-centimeter-wide flume, rigid boundary, ¾-inch rock roughness*

Mean Flow Parameters and Variables	Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)
$S = 2.44\times10^{-3}$; $U_* = 0.0866$ fps	0.118	0.400	0.171	0.428	1.971	0.081	0.032	0.0061
$W = 0.656$ ft; $\tau = 0.0146$ lb/ft^2	.252	.620	.187	.302	2.160	.164	.102	.0081
$Q = 0.0742$ cfs; $\nu = 0.967\times10^{-5}$ ft^2/sec	.386	.730	.161	.220	1.860	.192	.140	.0104
$T = 24.9$ °C; R = 8,240	.555	.850	.159	.187	1.835	.228	.194	.0118
$D = 0.135$ ft; F = 0.399	.722	.940	.138	.147	1.593	.186	.175	.0126
$\overline{V} = 0.833$ fps; $C/\sqrt{g} = 9.62$	.891	1.000	.121	.121	1.398	.115	.115	.0136
	.975	1.020	.136	.133	1.565	.209	.213	.0197
2cm Rt ℄	.975	1.070	.117	.109	1.351	.157	.168	.0173
4cm Rt ℄	.975	1.120	.096	.086	1.110	.137	.153	.0156
6cm Rt ℄	.975	1.000	.118	.118	1.362	.075	.075	.0184
8cm Rt ℄	.975	.760	.102	.134	1.176	.041	.031	.0124
$S = 8.18\times10^{-3}$; $U_* = 0.159$ fps	.060	.390	.184	.472	1.157	.043	.017	.0033
$W = 0.656$ ft; $\tau = 0.049$ lb/ft^2	.172	.778	.245	.316	1.530	.038	.030	.0062
$Q = 0.1363$ cfs; $\nu = 0.967\times10^{-5}$ ft^2/sec	.302	.990	.241	.252	1.515	.130	.129	.0076
$T = 24.9$ °C; R = 15,200	.474	1.240	.237	.191	1.490	.102	.126	.0095
$D = 0.136$ ft; F = 0.730	.646	1.410	.223	.158	1.402	.090	.127	.0118
$\overline{V} = 1.530$ fps; $C/\sqrt{g} = 9.61$	.844	1.650	.195	.118	1.226	.120	.198	.0131
	.957	1.720	.192	.111	1.206	--	--	.0145
2cm Rt ℄	.957	1.820	.185	.102	1.163	.110	.200	.0170
4cm Rt ℄	.957	1.920	.155	.081	.975	.030	.058	.0148
6cm Rt ℄	.957	1.730	.153	.089	.963	.037	.064	.0140
8cm Rt ℄	.957	1.320	.138	.105	.868	.049	.065	.0128

TABLE 1c. — *20-centimeter-wide flume, rigid boundary, ¾-inch rock roughness* — Continued

Mean Flow Parameters and Variables		Y/D	$\bar{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\bar{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)
$S = 15.6\times10^{-3}$	$U_* = 0.219$ fps	.146	.850	.335	.394	1.529	.147	.125	.0068
$W = 0.656$ ft	$\tau = 0.093$ lb/ft^2	.244	1.190	.347	.292	1.586	.137	.163	.0086
$Q = 0.1836$ cfs	$\nu = 0.967\times10^{-5}$ ft^2/sec	.366	1.650	.350	.212	1.600	.190	.313	.0114
$T = 24.9$ °C	$R = 20{,}500$	.529	2.000	.304	.152	1.389	.097	.194	.0137
$D = 0.135$ ft	$F = 0.993$	.691	2.280	.276	.121	1.260	.122	.278	.0152
$\bar{V} = 2.070$ fps	$C/\sqrt{g} = 9.44$	.854	2.450	.217	.089	.992	.090	.221	.0164
		.877	2.490	.208	.084	.951	.095	.236	.0176
	2cm Rt ℄	.877	2.530	.230	.091	1.050	.090	.228	.0174
	4cm Rt ℄	.877	2.720	.176	.065	.804	.056	.152	.0172
	6cm Rt ℄	.877	2.540	.164	.065	.750	.100	.254	.0153
	8cm Rt ℄	.877	2.140	.169	.079	.772	.100	.214	.0119
$S = 18.5\times10^{-3}$	$U_* = 0.214$ fps	.225	1.220	.354	.290	1.654	.047	.057	.0076
$W = 0.656$ ft	$\tau = 0.089$ lb/ft^2	.394	1.660	.328	.198	1.533	.075	.124	.0094
$Q = 0.1183$ cfs	$\nu = 0.967\times10^{-5}$ ft^2/sec	.561	1.960	.262	.134	1.224	.044	.086	.0107
$T = 24.9$ °C	$R = 14{,}250$	.730	2.200	.235	.107	1.097	.085	.187	.0127
$D = 0.101$ ft	$F = 0.992$	.933	2.380	.188	.079	.878	.080	.190	.0143
$\bar{V} = 1.790$ fps	$C/\sqrt{g} = 8.36$								
	2cm Rt ℄	.933	2.220	.217	.098	1.015	.108	.240	.0142
	4cm Rt ℄	.921	2.290	.190	.083	.888	.077	.176	.0148
	6cm Rt ℄	.921	2.400	.152	.064	.713	.061	.146	.0136
	8cm Rt ℄	.921	1.900	.163	.086	.764	.036	.068	.0110
$S = 8.13\times10^{-3}$	$U_* = 0.141$ fps	.324	.725	.186	.257	1.320	.163	.118	.0061
$W = 0.656$ ft	$\tau = 0.0389$ lb/ft^2	.471	.975	.177	.181	1.253	.170	.165	.0073
$Q = 0.0848$ cfs	$\nu = 0.967\times10^{-5}$ ft^2/sec	.618	1.190	.161	.135	1.140	.144	.171	.0094
$T = 24.9$ °C	$R = 10{,}220$	.765	1.330	.149	.112	1.056	.111	.148	.0107
$D = 0.100$ ft	$F = 0.719$	.961	1.490	.123	.083	.873	.149	.222	.0132
$\bar{V} = 1.290$ fps	$C/\sqrt{g} = 9.13$								
	2cm Rt ℄	.961	1.470	.139	.094	.986	.149	.219	.0119
	4cm Rt ℄	.961	1.520	.123	.081	.873	.090	.136	.0128
	6cm Rt ℄	.961	1.480	.138	.093	.978	--	--	.0125
	8cm Rt ℄	.961	1.140	.127	.111	.902	--	--	.0103
$S = 2.53\times10^{-3}$	$U_* = 0.079$ fps	0.125	0.280	.096	.343	1.216	--	--	0.0045
$W = 0.656$ ft	$\tau = 0.0121$ lb/ft^2	.312	.510	.099	.194	1.253	--	--	.0070
$Q = 0.0351$ cfs	$\nu = 0.967\times10^{-5}$ ft^2/sec	.500	.650	.080	.123	1.012	.130	.085	.0089
$T = 24.9$ °C	$R = 4{,}250$	.688	.710	.075	.106	.948	--	--	.0091
$D = 0.100$	$F = 0.298$	.950	.785	.066	.084	.836	--	--	.0098
$\bar{V} = 0.535$ fps	$C/\sqrt{g} = 6.76$								
	2cm Rt ℄	.950	.775	.064	.083	.812	.172	.133	.0106
	4cm Rt ℄	.950	.790	.058	.074	.735	.152	.120	.0114
	6cm Rt ℄	.950	.770	.056	.073	.708	--	--	.0106
	8cm Rt ℄	.950	.595	.070	.118	.886	.085	.051	.0097
$S = 2.42\times10^{-3}$	$U_* = 0.065$ fps	.139	.130	.043	.330	.660	.120	.016	.0032
$W = 0.656$ ft	$\tau = 0.0084$ lb/ft^2	.372	.300	.048	.160	.740	.116	.035	.0064
$Q = 0.0215$ dfs	$\nu = 0.967\times10^{-5}$ ft^2/sec	.605	.408	.065	.159	1.000	--	--	.0062
$T = 24.9$ °C	$R = 2{,}820$	.837	.455	.058	.127	.893	--	--	.0084
$D = 0.066$ ft	$F = 0.342$	.954	.468	.060	.128	.922	--	--	.0106
$\bar{V} = 0.499$ fps	$C/\sqrt{g} = 7.64$								
	2cm Rt ℄	.954	.438	.045	.103	.694	--	--	.0088
	4cm Rt ℄	.954	.495	.042	.085	.648	.172	.085	.0073
	6cm Rt ℄	.954	.460	.042	.091	.648	.152	.070	.0098
	8cm Rt ℄	.954	.418	.031	.074	.477	--	--	.0086
$S = 8.14\times10^{-3}$	$U_* = 0.119$ fps	.270	.662	.175	.265	1.472	.085	.056	.0082
$W = 0.656$ ft	$\tau = 0.0278$ lb/ft^2	.461	.820	.143	.174	1.201	.120	.098	.0074
$Q = 0.0351$ cfs	$\nu = 0.967\times10^{-5}$ ft^2/sec	.654	.940	.121	.129	1.018	.116	.109	.0102
$T = 24.9$ °C	$R = 4{,}600$	.846	1.020	.118	.116	.992	--	--	.0116
$D = 0.066$ ft	$F = 0.559$	.943	1.030	.118	.115	.992	.120	.124	.0108
$\bar{V} = 0.814$ fps	$C/\sqrt{g} = 6.81$								
	2cm Rt ℄	.943	.960	.095	.099	.798	.116	.111	.0101
	4cm Rt ℄	.943	1.060	.097	.092	.815	.071	.075	.0099
	6cm Rt ℄	.943	1.020	.103	.101	.868	--	--	.0109
	8cm Rt ℄	.943	.970	.099	.102	.832	--	--	.0137
$S = 18.5\times10^{-3}$	$U_* = 0.181$ fps	.283	1.070	.253	.236	1.398	.072	.077	.0072
$W = 0.656$ ft	$\tau = 0.0635$ lb/ft^2	.472	1.320	.248	.188	1.370	.022	.028	.0074
$Q = 0.0438$ cps	$\nu = 0.967\times10^{-5}$ ft^2/sec	.660	1.500	.212	.141	1.171	.036	.054	.0086
$T = 24.9$ °C	$R = 5{,}760$	.850	1.620	.188	.116	1.039	.021	.034	.0093
$D = 0.066$ ft	$F = 0.691$	.925	1.650	.185	.112	1.022	.036	.059	.0103
$\bar{V} = 1.010$ fps	$C/\sqrt{g} = 5.56$								
	2cm Rt ℄	.925	1.500	.167	.111	.924	.021	.032	.0099
	4cm Rt ℄	.925	1.600	.168	.105	.938	.022	.035	.0098
	6cm Rt ℄	.925	1.620	.188	.116	1.039	--	--	.0167
	8cm Rt ℄	.925	1.570	.140	.090	.776	.022	.035	.0090

TABLE 2. — *20-centimeter-wide flume, alluvial boundary, yawed-film results*

Mean flow parameters and variables	Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	$\sqrt{\overline{v^2}}$ (fps)	$\sqrt{\overline{v^2}}/\overline{U}$	$\sqrt{\overline{v^2}}/U_*$	Measured $\rho\,\overline{uv}$ (lbs/ft^2)	Calculated $\rho\,\overline{uv}$ (lbs/ft^2)	$\overline{uv}/\overline{U}^2$	$\overline{uv}/U_*^2$	T_E (sec)	L_x (ft)	λ_x (ft)
Flume Centerline, Incipient Motion															
$S = 0.471\times10^{-3}$ $U_* = 0.0377$ fps $W = 0.632$ ft $\tau = 0.00349$ lb/ft^2 $Q = 0.057$ cfs $\nu = 0.942\times10^{-5}$ ft^2/sec $T = 22.2$ °C $\mathsf{R} = 10{,}700$ $\underline{D} = 0.133$ ft $\underline{\mathsf{F}} = 0.43$ $\overline{V} = 0.68$ fps $C/\sqrt{g} = 18.04$ $D_{50} = 0.196$ mm	0.910	0.790	0.0477	0.061	1.265	------	------	------	-------	0.00035	-------	------	-----	-----	------
	.770	.750	.0483	.065	1.280	------	------	------	-------	.00090	-------	------	0.295	0.221	0.0209
	.670	.730	.0496	.068	1.316	0.0355	0.0486	0.9416	0.00113	.00129	0.00109	0.4098	-----	-----	------
	.630	.720	.0524	.073	1.391	------	------	------	-------	.00145	-------	------	-----	-----	------
	.500	.700	.0583	.084	1.545	------	------	------	-------	.00195	-------	------	.315	.220	.0204
	.480	.690	.0588	.085	1.560	.0396	.0574	1.0500	.00166	.00203	.00180	.6020	-----	-----	------
	.390	.660	.0630	.096	1.673	------	------	------	-------	.00238	-------	------	-----	-----	------
	.350	.640	.0672	.105	1.775	.0440	.0688	1.1670	.00219	.00254	.00276	.7943	-----	-----	------
	.220	.610	.0759	.124	2.013	------	------	------	-------	.00305	-------	------	.335	.205	.0174
	.170	.580	.0781	.135	2.074	.0454	.0783	1.2040	.00274	.00324	.00420	.9937			
	.100	.520	.0870	.167	2.308	------	------	------	-------	.00352	-------	------	-----	-----	------
	.080	.490	.0860	.175	2.281	.0442	.0902	1.1720	.00306	.00360	.00657	1.1098	-----	-----	------
	.030	.400	.0899	.224	2.381	------	------	------	-------	.00379	-------	------	-----	-----	------
Flume Centerline, Natural Flatbed															
$S = 4.33\times10^{-3}$ $U_* = 0.117$ fps $W = 0.632$ ft $\tau = 0.038$ lb/ft^2 $Q = 0.212$ cfs $\nu = 1.026\times10^{-5}$ ft^2/sec $T = 22.2$ °C $\mathsf{R} = 29{,}300$ $\underline{D} = 0.141$ ft $\underline{\mathsf{F}} = 1.00$ $\overline{V} = 2.38$ fps $C\sqrt{g} = 20.34$ $D_{50} = 0.196$ mm	0.810	2.570	0.1240	0.048	1.060	------	------	------	-------	0.00724	-------	------	-----	-----	------
	.700	2.520	.1390	.056	1.188	0.1080	0.0429	0.9230	0.01080	.01140	0.00088	0.4067	0.145	0.365	0.0076
	.580	2.440	.1480	.061	1.265	------	------	------	-------	.01600	-------	------	-----	-----	------
	.460	2.340	.1700	.073	1.453	.1150	.0491	.9829	.01610	.02060	.00152	.6063	-----	-----	------
	.340	2.220	.1830	.084	1.581	.1240	.0559	1.0598	.01850	.02510	.00194	.6966	.140	.311	.0066
	.230	2.040	.1960	.097	1.675	------	------	------	-------	.02930	-------	------	-----	-----	------
	.170	1.920	.2070	.108	1.769	.1480	.0771	1.2650	.02790	.03160	.00390	1.0506	-----	-----	------
	.110	1.730	.2230	.129	1.906	------	------	------	-------	.03390	-------	------	.205	.355	.0038
	.050	1.400	.1920	.138	1.641	------	------	------	-------	.03620	-------	------	-----	-----	------
Flume Centerline, Incipient Motion															
$S = 0.57\times10^{-3}$ $U_* = 0.041$ fps $W = 0.632$ ft $\tau = 0.0004$ lb/ft^2 $Q = 0.062$ cfs $\nu = 0.868\times10^{-5}$ ft^2/sec $T = 30.0$ °C $\mathsf{R} = 9{,}600$ $\underline{D} = 0.142$ ft $\underline{\mathsf{F}} = 0.37$ $\overline{V} = 0.720$ ft $C\sqrt{g} = 17.56$ $D_{50} = 0.38$ mm	0.941	0.800	0.0453	0.057	1.102	------	------	------	-------	0.00030	-------	------	-----	-----	------
	.795	.803	.0491	.061	1.197	0.0327	0.0410	0.8020	0.00890	.00104	0.00071	0.2700	0.261	0.210	0.0170
	.653	.782	.0536	.068	1.306	------	------	------	-------	.00175	-------	------	-----	-----	------
	.508	.752	.0561	.074	1.369	.0379	.0510	.9260	.01920	.00248	.00175	.5870	.283	.213	.0210
	.392	.723	.0588	.081	1.435	.0417	.0580	1.0170	.02140	.00307	.00213	.6560	.280	.202	.0230
	.293	.701	.0685	.098	1.667	.0457	.0650	1.1140	.02660	.00357	.00279	.8170	.247	.173	.0180
	.220	.666	.0766	.115	1.868	.0490	.0730	1.1930	.03020	.00394	.00350	.9250	.301	.200	.0200
	.161	.624	.0824	.132	2.011	------	------	------	-------	.00424	-------	------	-----	-----	------
	.119	.580	.0895	.154	2.178	.0544	.0940	1.3230	.03650	.00445	.00560	1.1120	.268	.156	.0190
	.075	.548	.0929	.169	2.267	.0595	.1086	1.4500	.03450	.00467	.00593	1.0560	.254	.139	.0160
	.046	.482	.0999	.207	2.440	------	------	------	-------	.00482	-------	------	-----	-----	------
Flume Centerline, Natural Flatbed															
$S = 9.10\times10^{-3}$ $U_* = 0.171$ fps $W = 0.632$ ft $\tau = 0.0823$ lb/ft^2 $Q = 0.243$ cfs $\nu = 0.868\times10^{-5}$ ft^2/sec $T = 30.0$ °C $\mathsf{R} = 46{,}300$ $\underline{D} = 0.145$ cfs $\underline{\mathsf{F}} = 1.28$ $\overline{V} = 2.66$ fps $C\sqrt{g} = 15.56$ $D_{50} = 0.38$ mm	0.762	3.310	0.1880	0.056	1.101	0.1360	0.0410	0.7950	0.01950	0.01960	0.00092	0.3437	0.075	0.093	0.0081
	.643	3.220	.2340	.072	1.370	------	------	------	-------	.02940	-------	------	-----	-----	------
	.524	3.160	.2570	.081	1.501	.1870	.0592	1.0920	.03350	.03920	.00173	.5905	.085	.116	.0073
	.405	3.030	.2880	.095	1.682	------	------	------	-------	.04900	-------	------	-----	-----	------
	.310	2.910	.3220	.111	1.884	.2700	.0926	1.5761	.04540	.05680	.00276	.8003	.105	.104	.0088
	.226	2.680	.3490	.130	2.042	------	------	------	-------	.06370	-------	------	-----	-----	------
	.167	2.490	.3600	.144	2.109	.2820	.1130	1.6480	.05700	.06860	.00474	1.0048	.130	.107	.0077
	.119	2.150	.3740	.173	2.186	------	------	------	-------	.07250	-------	------	-----	-----	------
	.083	1.960	.4080	.208	2.385	.2970	.1514	1.7380	.06500	.07550	.00872	1.1460	.080	.087	.0065
Flume Centerline, Artificial Flatbed With Sediment Motion															
$S = 4.86\times10^{-3}$ $U_* = 0.122$ fps $W = 0.632$ ft $\tau = 0.0415$ lb/ft^2 $Q = 0.209$ cfs $\nu = 0.942\times10^{-5}$ ft^2/sec $T = 26.1$ °C $\mathsf{R} = 30{,}000$ $\underline{D} = 0.137$ ft $\underline{\mathsf{F}} = 0.98$ $\overline{V} = 2.39$ fps $C\sqrt{g} = 19.59$ $D_{50} = 0.196$ mm	0.950	2.580	0.1020	0.040	0.835	------	------	------	-------	0.00208	-------	------	-----	-----	------
	.830	2.530	.1100	.043	.904	------	------	------	-------	.00706	-------	------	-----	-----	------
	.710	2.470	.1300	.053	1.066	0.0980	0.0400	0.8040	0.01030	.01200	0.00087	0.3567	0.127	0.314	0.0073
	.590	2.400	.1380	.057	1.130	------	------	------	-------	.01700	-------	------	-----	-----	------
	.470	2.310	.1430	.062	1.172	.1020	.0440	.8350	.01480	.02200	.00143	.5125	.143	.330	.0077
	.350	2.200	.1540	.070	1.263	------	------	------	-------	.02700	-------	------	-----	-----	------
	.230	2.050	.1770	.086	1.449	.1220	.0590	1.0000	.02020	.03200	.00248	.6996	.138	.283	.0081
	.170	1.930	.1980	.103	1.622	------	------	------	-------	.03450	-------	------	-----	-----	------
	.120	1.770	.2060	.116	1.689	.1420	.0800	1.1630	.02430	.03660	.00400	.8416	.146	.258	.0067
	.080	1.650	.2220	.135	1.820	------	------	------	-------	.03820	-------	------	-----	-----	------
	.060	1.440	.2310	.160	1.890	.1600	.1111	1.3110	.03160	.03910	.00786	1.0940	.113	.163	.0051
	.040	1.340	.2570	.192	2.108	------	------	------	-------	.03990	-------	------	-----	-----	------
Flume Centerline, Artificial Flatbed Without Sediment Motion															
$S = 4.86\times10^{-3}$ $U_* = 0.121$ fps $W = 0.632$ ft $\tau = 0.0403$ lb/ft^2 $Q = 0.181$ cfs $\nu = 0.942\times10^{-5}$ ft^2/sec $T = 26.1$ °C $\mathsf{R} = 27{,}400$ $\underline{D} = 0.133$ ft $\underline{\mathsf{F}} = 0.94$ $\overline{V} = 2.15$ fps $C/\sqrt{g} = 17.76$ $D_{50} = 0.196$ mm	0.910	2.440	0.0940	0.0390	0.776	------	------	------	-------	0.00363	-------	------	-----	-----	------
	.790	2.380	.1090	.0460	.900	0.0890	0.0370	0.7350	0.00980	.00847	0.00089	0.3450	0.123	0.293	0.0083
	.670	2.280	.1160	.0510	.958	------	------	------	-------	.01330	-------	------	-----	-----	------
	.540	2.120	.1290	.0610	1.066	.0960	.0450	.7940	.01720	.01860	.00197	.6056	.147	.312	.0086
	.420	2.020	.1520	.0750	1.256	------	------	------	-------	.02340	-------	------	-----	-----	------
	.300	1.890	.1790	.0950	1.477	.1370	.0730	1.1350	.02400	.02820	.00346	.8450	.136	.257	.0079
	.170	1.780	.2020	.1130	1.672	------	------	------	-------	.03350	-------	------	-----	-----	------
	.110	1.670	.2040	.1220	1.690	.1440	.0860	1.1900	.02810	.03590	.00519	.9893	.122	.204	.0065
	.080	1.470	.2290	.1560	1.894	------	------	------	-------	.03710	-------	------	-----	-----	------
	.040	1.320	.2590	.1970	2.140	------	------	------	-------	.03870	-------	------	-----	-----	------
Flume Centerline, Artificial Flatbed With Sediment Motion															
$S = 8.97\times10^{-3}$ $U_* = 0.167$ fps $W = 0.632$ ft $\tau = 0.0772$ lb/ft^2 $Q = 0.255$ cfs $\nu = 0.942\times10^{-5}$ ft^2/sec $T = 26.1$ °C $\mathsf{R} = 37{,}200$ $\underline{D} = 0.138$ ft $\underline{\mathsf{F}} = 1.20$ $\overline{V} = 2.92$ fps $C/\sqrt{g} = 17.48$ $D_{50} = 0.38$ mm	0.767	3.190	0.2330	0.0730	1.170	0.1230	0.0390	0.7350	0.01760	0.01800	0.00089	0.3253	0.130	0.415	0.0083
	.588	3.070	.2700	.0880	1.350	------	------	------	-------	.03180	-------	------	-----	-----	------
	.492	2.960	.2840	.0960	1.420	.1260	.0410	.7540	.02930	.03920	.00172	.5414	-----	-----	------
	.396	2.860	.2920	.1020	1.460	------	------	------	-------	.04670	-------	------	.145	.415	.0077
	.277	2.670	.3060	.1140	1.530	.1620	.0600	.9680	.03860	.05580	.00279	.7134	-----	-----	------
	.158	2.380	.3120	.1310	1.560	.1860	.0780	1.1120	.05020	.06500	.00457	.9278	.140	.333	.0069
	.098	2.140	.3250	.1520	1.947	------	------	------	-------	.06970	-------	------	-----	-----	------
	.067	1.940	.3470	.1790	2.081	.1950	.1005	1.1680	.06100	.07210	.00835	1.1270	-----	-----	------
	.038	1.650	.3690	.2240	2.202	------	------	------	-------	.07430	-------	------	.105	.173	.0037

TABLE 2. — *20-centimeter-wide flume, alluvial boundary, yawed-film results* — Continued

Mean flow parameters and variables	Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	$\sqrt{\overline{v^2}}$ (fps)	$\sqrt{\overline{v^2}}/\overline{U}$	$\sqrt{\overline{v^2}}/U_*$	Measured $\rho\,\overline{uv}$ (lbs/ft^2)	Calculated $\rho\,\overline{uv}$ (lbs/ft^2)	$\overline{uv}/\overline{U}^2$	$\overline{uv}/U_*^2$	T_E (sec)	L_x (ft)	λ_x (ft)
Flume Centerline, Artificial Flatbed Without Sediment Motion															
	0.741	3.200	0.1460	0.0460	0.868	0.1060	0.0330	0.0632	0.01890	0.02030	0.00095	0.3452	0.130	0.416	0.0081
$S = 8.97\times10^{-3}$ $U_* = 0.168$ fps	.565	3.040	.1680	.0550	1.000	.1210	.0400	.7200	.03120	.03410	.00174	.5698	-----	-----	------
$W = 0.632$ ft $\tau = 0.0783$ lb/ft^2	.389	2.820	.1850	.0660	1.100	------	------	------	-------	.04790	-------	------	.125	.353	.0078
$Q = 0.253$ cfs $\nu = 0.942\times10^{-5}$ ft^3/sec	.272	2.610	.2120	.0810	1.261	.1600	.0610	.9530	.05000	.05700	.00378	.9132	-----	-----	------
$T = 26.1$ °C R = 35,400	.155	2.280	.2500	.1100	1.487	.1780	.0780	1.0600	.06050	.06620	.00600	1.1049	-----	-----	------
$D = 0.140$ ft F = 1.12	.096	1.980	.2910	.1470	1.735	.1900	.0960	1.1320	.06600	.07080	.00868	1.2050	.165	.327	.0061
$\overline{V} = 2.86$ fps $C/\sqrt{g} = 17.02$	.054	1.650	.3200	.1940	1.905	------	------	------	-------	.07410	-------	------	-----	-----	------
$D_{50} = 0.38$ mm	.038	1.440	.3670	.2550	2.186	------	------	------	-------	.07540	-------	------	.180	.259	.0042
Flume Centerline, Dune Trough															
$S = 1.75\times10^{-3}$ $U_* = 0.077$ fps	0.863	0.920	0.0984	0.1070	0.937	0.0635	0.0690	0.8247	0.01800	0.00293	0.01100	0.1570	0.115	0.106	0.0076
$W = 0.632$ ft $\tau = 0.0214$ lb/ft^2	.728	.870	.1110	.1280	1.057	.0792	.0910	1.0290	.03500	.00582	.02390	.3050	-----	-----	------
$Q = 0.072$ cfs $\nu = 1.026\times10^{-5}$ ft^2/sec	.552	.780	.1370	.1760	1.305	.0983	.1260	1.2770	.04500	.00959	.03810	.3910	.145	.113	.0081
$T = 22.2$ °C R = 13,100	.381	.580	.2160	.3720	2.057	.1180	.2034	1.5320	.05600	.01320	.08580	.4870	.170	.099	.0072
$D = 0.196$ ft F = 0.27	.289	.350	.1000	.2870	.952	.0684	.1954	.8883	.06700	.01520	.28190	.5830	-----	-----	------
$\overline{V} = 0.728$ fps $C/\sqrt{g} = 9.45$	.223	.140	.0330	.2360	.314	.0200	.1429	.2597	.07900	.01660	.20780	.6870	.115	.016	.0051
$D_{50} = 0.38$ mm $\overline{D} = 0.157$ ft															
Flume Centerline, Dune Crest															
$S = 1.75\times10^{-3}$ $U_* = 0.077$ fps	0.817	1.000	0.1180	0.1180	1.436	------	------	------	-------	0.00240	-------	------	.095	.095	.0091
$W = 0.632$ ft $\tau = 0.0131$ lb/ft^2	.680	.960	.1210	.1260	1.472	------	------	------	-------	.00419	-------	------	-----	-----	------
$Q = 0.072$ cfs $\nu = 1.026\times10^{-5}$ ft^2/sec	.542	.940	.1260	.1340	1.533	------	------	------	-------	.00600	-------	------	-----	-----	------
$T = 22.2$ °C R = 8,000	.405	.890	.1310	.1470	1.594	------	------	------	-------	.00780	-------	------	.135	.120	.0088
$D = 0.120$ ft F = 0.35	.268	.870	.1380	.1590	1.679	------	------	------	-------	.00959	-------	------	-----	-----	------
$\overline{V} = 0.728$ fps $C/\sqrt{g} = 9.45$	.131	.840	.1460	.1740	1.776	------	------	------	-------	.01140	-------	------	.145	.122	.0064
$D_{50} = 0.38$ mm $\overline{D} = 0.157$ ft															

TABLE 3a. — *2-foot-wide flume, rigid boundary*

Mean Flow Parameters and Variables	Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)
1/8-Inch Block Roughness, Channel Centerline								
	0.900	1.170	0.106	0.091	1.072	0.660	0.770	0.0160
$S = 1.04\times10^{-3}$ $U_* = 0.0989$ fps	.800	1.170	.136	.106	1.378	.720	.840	.0153
$W = 1.96$ ft $\tau = 0.0189$ lb/ft^2	.700	1.120	.142	.126	1.436	.800	.890	.0144
$Q = 0.815$ cfs $\nu = 0.930\times10^{-5}$ ft^2/sec	.600	1.100	.151	.137	1.529	.780	.860	.0131
$T = 26.5$ °C R = 44,600	.500	1.020	.150	.147	1.518	.760	.770	.0126
$D = 0.415$ ft F = 0.274	.400	.970	.156	.161	1.580	.800	.770	.0097
$\overline{V} = 1.00$ fps $C/\sqrt{g} = 10.14$	.300	.900	.161	.178	1.630	.750	.680	.0103
	.200	.880	.169	.192	1.711	.610	.540	.0083
	.100	.710	.178	.251	1.806	.840	.600	------
1/8-Inch Block Roughness, Channel Centerline								
	0.900	2.200	0.171	0.078	0.982	0.380	0.840	0.0196
$S = 3.10\times10^{-3}$ $U_* = 0.174$ fps	.800	2.100	.173	.082	.996	.530	1.110	.0183
$W = 1.96$ ft $\tau = 0.0562$ lb/ft^2	.700	2.030	.186	.091	1.071	.640	1.300	.0161
$Q = 1.42$ cfs $\nu = 0.930\times10^{-5}$ ft^2/sec	.600	1.970	.207	.105	1.189	.260	.510	.0165
$T = 26.5$ °C R = 77,900	.500	1.890	.205	.108	1.178	.280	.530	.0143
$D = 0.415$ ft F = 0.449	.400	1.730	.217	.125	1.246	.400	.690	.0147
$\overline{V} = 1.75$ fps $C/\sqrt{g} = 10.23$	.300	1.680	.231	.137	1.324	.330	.550	.0128
	.200	1.520	.245	.161	1.410	.500	.760	.0122
	.100	1.340	.289	.216	1.662	.540	.720	.0101
1/8-Inch Block Roughness, Channel Centerline								
	0.800	3.210	0.257	0.080	0.996	0.095	0.310	0.0226
$S = 7.20\times10^{-3}$ $U_* = 0.258$ fps	.700	3.110	.264	.085	1.023	.410	1.270	.0213
$W = 1.96$ ft $\tau = 0.128$ lb/ft^2	.600	3.000	.288	.096	1.117	.390	1.170	.0209
$Q = 2.14$ cfs $\nu = 0.930\times10^{-5}$ ft^2/sec	.500	2.860	.287	.095	1.112	.330	.940	.0216
$T = 26.5$ °C R = 117,700	.400	2.700	.324	.120	1.258	.440	1.180	.0193
$D = 0.410$ ft F = 0.734	.300	2.610	.360	.138	1.396	.420	1.100	.0185
$\overline{V} = 2.67$ fps $C/\sqrt{g} = 10.21$	.200	2.410	.395	.164	1.534	.380	.910	.0169
	.100	2.030	.380	.187	1.471	.360	.730	.0122
1/2-Inch Block Roughness, Channel Centerline								
	0.900	1.160	0.174	0.149	0.979	0.510	0.580	-----
$S = 3.40\times10^{-3}$ $U_* = 0.1775$ fps	.800	1.140	.188	.165	1.101	.540	.610	-----
$W = 1.96$ ft $\tau = 0.0611$ lb/ft^2	.700	1.110	.202	.183	1.138	.470	.520	-----
$Q = 0.815$ cfs $\nu = 0.930\times10^{-5}$ ft^2/sec	.600	1.060	.204	.193	1.150	.680	.720	-----
$T = 26.5$ °C R = 44,800	.500	1.090	.230	.211	1.296	.290	.320	-----
$D = 0.409$ ft F = 0.282	.400	1.020	.248	.243	1.396	.510	.520	-----
$\overline{V} = 1.02$ fps $C/\sqrt{g} = 6.17$	.300	1.000	.240	.240	1.354	.480	.480	-----
	.200	.800	.248	.310	1.396	.370	.300	-----

TABLE 3a. — *2-foot-wide flume, rigid boundary* — Continued

Mean Flow Parameters and Variables	Y/D	$\bar{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\bar{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)
1/2-Inch Block Roughness, Channel Centerline								
	0.900	2.420	0.256	0.106	0.958	0.470	1.140	-----
	.800	2.420	.262	.109	.983	.510	1.230	-----
$S = 7.63\times10^{-3}$ $U_* = 0.267$ fps	.700	2.330	.264	.113	.990	.760	1.770	-----
$W = 1.96$ ft $\tau = 0.138$ lb/ft^2	.600	2.260	.281	.125	1.052	.600	1.380	-----
$Q = 1.42$ cfs $\nu = 0.930\times10^{-5}$ ft^2/sec	.500	2.090	.285	.136	1.067	.620	1.290	-----
$T = 26.5$ °C $R = 77{,}900$	.400	1.940	.296	.153	1.110	.450	.870	-----
$D = 0.414$ ft $F = 0.481$	.300	1.830	.308	.168	1.152	.540	.990	-----
$\bar{V} = 1.75$ fps $C/\sqrt{g} = 6.65$	.200	1.600	.342	.214	1.281	.380	.610	-----
	.100	.730	.313	.428	1.176	.470	.340	-----
1/2-Inch Block Roughness, Channel Centerline								
	0.900	3.110	0.303	0.097	0.834	0.330	1.030	-----
$S = 14.00\times10^{-3}$ $U_* = 0.364$ fps	.800	3.030	.318	.105	.875	.500	1.510	-----
$W = 1.96$ ft $\tau = 0.256$ lb/ft^2	.700	2.920	.318	.109	.875	.530	1.550	-----
$Q = 2.14$ cfs $\nu = 0.930\times10^{-5}$ ft^2/sec	.600	2.780	.355	.128	.975	.550	1.530	-----
$T = 26.5$ °C $R = 117{,}200$	.500	2.600	.381	.147	1.050	.630	1.640	-----
$D = 0.433$ ft $F = 0.676$	.400	2.350	.386	.164	1.060	.370	.870	-----
$\bar{V} = 2.52$ fps $C/\sqrt{g} = 6.94$	.300	2.050	.399	.194	1.095	.200	.410	-----
	.200	1.670	.352	.217	.969	.380	.630	-----
	.100	1.080	.372	.344	1.020	.240	.260	-----
1 1/8-Inch Block Roughness, Channel Centerline								
$S = 4.89\times10^{-3}$ $U_* = 0.212$ fps	0.900	1.410	0.220	0.156	1.043	0.460	0.650	-----
$W = 1.96$ ft $\tau = 0.087$ lb/ft^2	.800	1.330	.222	.168	1.062	.520	.680	-----
$Q = 0.815$ cfs $\nu = 0.930\times10^{-5}$ ft^2/sec	.700	1.220	.227	.186	1.070	.500	.610	-----
$T = 26.5$ °C $R = 46{,}000$	.600	1.150	.228	.198	1.086	.450	.520	-----
$D = 0.417$ ft $F = 0.279$	.500	1.040	.228	.219	1.086	.440	.460	-----
$\bar{V} = 1.03$ fps $C/\sqrt{g} = 4.83$	.400	.920	.228	.249	1.086	.470	.430	-----
	.300	.890	.213	.250	1.006	.370	.330	-----
1 1/8-Inch Block Roughness, Channel Centerline								
$S = 15.00\times10^{-3}$ $U_* = 0.380$ fps	0.900	2.640	0.390	0.148	1.025	0.260	0.690	-----
$W = 1.96$ ft $\tau = 0.271$ lb/ft^2	.800	2.400	.389	.163	1.020	.150	.360	-----
$Q = 1.42$ cfs $\nu = 0.930\times10^{-5}$ ft^2/sec	.700	2.150	.414	.193	1.090	.460	.980	-----
$T = 26.5$ °C $R = 77{,}900$	.600	1.990	.432	.217	1.138	.310	.620	-----
$D = 0.414$ ft $F = 0.479$	.500	1.870	.422	.226	1.110	.360	.670	-----
$\bar{V} = 1.75$ fps $C/\sqrt{g} = 4.66$	.400	1.660	.410	.247	1.078	.270	.450	-----
	.300	1.420	.395	.278	1.040	.310	.440	-----
1 1/8-Inch Block Roughness, Channel Centerline								
$S = 29.6\times10^{-3}$ $U_* = 0.535$ fps	.800	3.880	0.623	0.161	1.165	0.220	0.850	-----
$W = 1.96$ ft $\tau = 0.552$ lb/ft^2	.700	3.780	.640	.170	1.195	.240	.910	-----
$Q = 2.14$ cfs $\nu = 0.930\times10^{-5}$ ft^2/sec	.600	3.520	.675	.192	1.260	.370	1.310	-----
$T = 26.5$ °C $R = 117{,}300$	.500	3.330	.678	.204	1.260	.440	1.460	-----
$D = 0.430$ ft $F = 0.683$	.400	3.010	.719	.239	1.345	.370	1.110	-----
$\bar{V} = 2.54$ fps $C/\sqrt{g} = 4.76$	.300	2.670	.705	.265	1.320	.180	.480	-----

TABLE 3b. — *2-foot-wide flume, rigid boundary, developing flow*

Mean Flow Parameters and Variables	Y/D	$\bar{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\bar{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)
1 1/8-Inch Block Roughness, Channel Centerline, Station 5								
$S = 5.04\times10^{-3}$ $U_* = 0.216$ fps	0.898	1.445	0.174	0.120	0.806	0.124	0.179	0.0086
$W = 1.96$ ft $\tau = 0.128$ lb/ft^2	.796	1.445	.175	.121	.810	.126	.182	.0092
$Q = 0.78$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.694	1.415	.181	.128	.838	.140	.198	.0083
$T = 21$ °C $R = 37{,}247$	.592	1.400	.177	.126	.819	.128	.179	.0081
$D = 0.408$ ft $F = 0.269$	.490	1.340	.197	.147	.912	.142	.190	.0085
$\bar{V} = 0.975$ fps $C/\sqrt{g} = 4.514$	.388	1.170	.217	.185	1.005	.135	.158	.0079
	.286	.960	.199	.207	.921	.160	.153	.0063
1 1/8-Inch Block Roughness, 6 Inches From wall, Station 5								
$S = 5.04\times10^{-3}$ $U_* = 0.216$ fps	0.898	1.500	0.167	0.111	0.773	0.131	0.196	0.0074
$W = 1.96$ ft $\tau = 0.128$ lb/ft^2	.796	1.485	.165	.111	.764	.135	.200	.0076
$Q = 0.78$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.694	1.390	.163	.117	.755	.132	.184	.0071
$T = 21$ °C $R = 37{,}247$	.592	1.330	.178	.134	.824	.142	.189	.0072
$D = 0.408$ ft $F = 0.269$	.490	1.285	.242	.188	1.120	.125	.161	.0087
$\bar{V} = 0.975$ fps $C/\sqrt{g} = 4.514$	.388	1.195	.223	.187	1.032	.132	.158	.0081
	.286	.990	.232	.234	1.074	.138	.137	.0075
1 1/8-Inch Block Roughness, Channel Centerline, Station 10								
$S = 5.04\times10^{-3}$ $U_* = 0.217$ fps	0.898	1.195	0.120	0.100	0.553	0.126	0.151	0.0102
$W = 1.96$ ft $\tau = 0.130$ lb/ft^2	.796	1.195	.136	.114	.627	.117	.140	.0109
$Q = 0.78$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.694	1.125	.142	.126	.654	.142	.160	.0094
$T = 21.1$ °C $R = 37{,}278$	.592	1.090	.171	.157	.788	.154	.168	.0112
$D = 0.413$ ft $F = 0.264$	.490	1.070	.167	.156	.770	.137	.147	.0094
$\bar{V} = 0.964$ fps $C/\sqrt{g} = 4.442$	.388	.940	.175	.186	.806	.119	.112	.0081
	.286	.900	.212	.236	.977	.130	.117	.0067

TABLE 3b. — *2-foot-wide flume, rigid boundary, developing flow* — Continued

Mean Flow Parameters and Variables	Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)
1 1/8-Inch Block Roughness, 6 Inches From Wall, Station 10								
$S = 5.04\times10^{-3}$, $U_* = 0.217$ fps	0.898	1.620	0.205	0.127	0.945	0.147	0.238	0.0098
$W = 1.96$ ft, $\tau = 0.130$ lb/ft^2	.796	1.620	.239	.148	1.101	.148	.240	.0105
$Q = 0.78$ cfs, $\nu = 1.068\times10^{-5}$ ft^3/sec	.694	1.580	.259	.164	1.194	.120	.190	.0097
$T = 21.1$ °C, $\mathsf{R} = 37,278$	.592	1.420	.235	.165	1.083	.130	.184	.0094
$\underline{D} = 0.413$ ft, $\mathsf{F} = 0.264$	.490	1.340	.253	.189	1.166	.134	.180	.0087
$\overline{V} = 0.964$ fps, $C/\sqrt{g} = 4.442$	.388	1.140	.262	.230	1.207	.133	.152	.0079
	.286	.900	.212	.236	.977	.137	.123	.0066
1 1/8-Inch Block Roughness, Channel Centerline, Station 15								
$S = 5.04\times10^{-3}$, $U_* = 0.217$ fps	0.898	1.240	0.126	0.102	0.581	0.242	0.300	0.0101
$W = 1.96$ ft, $\tau = 0.130$ lb/ft^2	.796	1.235	.157	.127	.724	.205	.253	.0097
$Q = 0.78$ cfs, $\nu = 1.068\times10^{-5}$ ft^2/sec	.694	1.190	.169	.142	.779	.362	.430	.0098
$T = 21.1$ °C, $\mathsf{R} = 37,265$	.592	1.190	.192	.161	.885	.317	.377	.0106
$\underline{D} = 0.412$ ft, $\mathsf{F} = 0.265$	.490	1.100	.188	.171	.866	.361	.398	.0096
$\overline{V} = 0.966$ fps, $C/\sqrt{g} = 4.452$	.388	.990	.211	.213	.972	.265	.262	.0084
	.286	.880	.181	.206	.834	.299	.263	.0075
1 1/8-Inch Block Roughness, 6 Inches From Wall, Station 15								
$S = 5.04\times10^{-3}$, $U_* = 0.217$ fps	0.898	1.570	0.199	0.127	0.917	0.398	0.625	0.0135
$W = 1.96$ ft, $\tau = 0.130$ lb/ft^2	.796	1.570	.208	.132	.959	.378	.594	.0119
$Q = 0.78$ cfs, $\nu = 1.068\times10^{-5}$ ft^2/sec	.694	1.560	.232	.149	1.069	.347	.542	.0120
$T = 21.1$ °C, $\mathsf{R} = 37,265$	.592	1.500	.213	.142	.982	.264	.396	.0119
$\underline{D} = 0.412$ ft, $\mathsf{F} = 0.265$	.490	1.400	.242	.173	1.115	.329	.461	.0131
$\overline{V} = 0.966$ fps, $C/\sqrt{g} = 4.452$	.388	1.205	.214	.178	.986	.516	.622	.0092
	.286	1.010	.197	.195	.908	.403	.407	.0081
1 1/8-Inch Block Roughness, ChInnel Centerline, Station 20								
$S = 5.40\times10^{-3}$, $U_* = 0.216$ fps	0.898	1.300	0.157	0.121	0.727	0.383	0.498	0.0101
$W = 1.96$ ft, $\tau = 0.128$ lb/ft^2	.796	1.270	.178	.140	.824	.417	.530	.0122
$Q = 0.78$ cfs, $\nu = 1.068\times10^{-5}$ ft^2/sec	.694	1.230	.175	.142	.810	.537	.660	.0102
$T = 21.1$ °C, $\mathsf{R} = 37,270$	.592	1.230	.198	.161	.917	.412	.506	.0104
$\underline{D} = 0.407$ ft, $\mathsf{F} = 0.270$	.490	1.140	.205	.180	.949	.214	.244	.0088
$\overline{V} = 0.978$ fps, $C/\sqrt{g} = 4.528$	.388	1.010	.203	.201	.940	.492	.497	.0088
	.286	.770	.161	.209	.745	.751	.578	.0072
1 1/8-Inch Block Roughness, 6 Inches From Wall, Station 20								
$S = 5.04\times10^{-3}$, $U_* = 0.216$ fps	0.898	1.600	0.209	0.131	0.968	0.437	0.701	0.0123
$W = 1.96$ ft, $\tau = 0.128$ lb/ft^2	.796	1.595	.234	.147	1.083	.304	.486	.0133
$Q = 0.78$ cfs, $\nu = 1.068\times10^{-5}$ ft^2/sec	.694	1.590	.253	.159	1.171	.411	.652	.0153
$T = 21.1$ °C, $\mathsf{R} = 37,270$	.592	1.540	.275	.178	1.273	.726	1.117	.0138
$\underline{D} = 0.407$ ft, $\mathsf{F} = 0.270$	.490	1.400	.256	.183	1.185	.390	.545	.0117
$\overline{V} = 0.978$ fps, $C/\sqrt{g} = 4.528$	.388	1.270	.242	.191	1.120	.271	.344	.0100
	.286	1.100	.238	.216	1.102	.340	.374	.0091
1 1/8-Inch Block Roughness, Channel Centerline, Station 25								
$S = 5.04\times10^{-3}$, $U_* = 0.214$ fps	0.898	1.380	0.195	0.141	0.911	0.392	0.541	0.0115
$W = 1.96$ ft, $\tau = 0.125$ lb/ft^2	.796	1.350	.220	.163	1.028	.355	.480	.0101
$Q = 0.78$ cfs, $\nu = 1.068\times10^{-5}$ ft^2/sec	.694	1.310	.212	.162	.991	.486	.636	.0122
$T = 21.1$ °C, $\mathsf{R} = 37,266$	.592	1.250	.236	.189	1.103	.395	.493	.0104
$\underline{D} = 0.398$ ft, $\mathsf{F} = 0.279$	.490	1.180	.235	.199	1.098	.413	.488	.0087
$\overline{V} = 1.000$ fps, $C/\sqrt{g} = 4.673$	.388	1.120	.253	.226	1.182	.512	.572	.0084
	.286	.930	.239	.257	1.117	.404	.376	.0074
1 1/8-Inch Block Roughness, 6 Inches From Wall, Station 25								
$S = 5.04\times10^{-3}$, $U_* = 0.214$ fps	0.898	1.640	0.192	0.117	0.897	0.224	0.368	0.0133
$W = 1.96$ ft, $\tau = 0.125$ lb/ft^2	.796	1.690	.219	.130	1.023	.655	1.107	.0139
$Q = 0.78$ cfs, $\nu = 1.068\times10^{-5}$ ft^2/sec	.694	1.695	.221	.130	1.033	.367	.623	.0142
$T = 21.1$ °C, $\mathsf{R} = 37,266$	.592	1.600	.268	.168	1.252	.695	1.111	.0126
$\underline{D} = 0.398$ ft, $\mathsf{F} = 0.279$	.490	1.520	.275	.181	1.285	.327	.496	.0116
$\overline{V} = 1.000$ fps, $C/\sqrt{g} = 4.673$	.388	1.345	.272	.202	1.271	.410	.552	.0104
	.286	1.000	.239	.239	1.117	.158	.158	.0098
1 1/8-Inch Block Roughness, Channel Centerline, Station 30								
$S = 5.04\times10^{-3}$, $U_* = 0.215$ fps	0.898	1.380	0.207	0.150	0.963	0.429	0.592	0.0126
$W = 1.96$ ft, $\tau = 0.126$ lb/ft^2	.796	1.330	.229	.172	1.065	.684	.911	.0117
$Q = 0.78$ cfs, $\nu = 1.068\times10^{-5}$ ft^2/sec	.694	1.300	.238	.183	1.107	.676	.880	.0123
$T = 21.1$ °C, $\mathsf{R} = 37,264$	.592	1.270	.276	.217	1.284	.306	.388	.0109
$\underline{D} = 0.402$ ft, $\mathsf{F} = 0.275$	.490	1.130	.238	.211	1.107	.218	.246	.0096
$\overline{V} = 0.990$ fps, $C/\sqrt{g} = 4.605$	.388	1.050	.253	.241	1.177	.658	.692	.0085
	.286	.770	-----	-----	-----	.348	.268	.0079
1 1/8-Inch Block Roughness, 6 Inches From Wall, Station 30								
$S = 5.04\times10^{-3}$, $U_* = 0.215$ fps	0.898	1.630	0.188	0.115	0.874	0.468	0.764	0.0127
$W = 1.96$ ft, $\tau = 0.126$ lb/ft^2	.796	1.650	.214	.130	.995	.388	.640	.0134
$Q = 0.78$ cfs, $\nu = 1.068\times10^{-5}$ ft^2/sec	.694	1.635	.225	.138	1.047	.501	.819	.0143
$T = 21.1$ °C, $\mathsf{R} = 37,264$	.592	1.540	.230	.149	1.070	.382	.589	.0124
$\underline{D} = 0.402$ ft, $\mathsf{F} = 0.275$	.490	1.395	.226	.162	1.051	.355	.496	.0117
$\overline{V} = 0.990$ fps, $C/\sqrt{g} = 4.605$	.388	1.240	.238	.192	1.107	.416	.516	.0108
	.286	1.010	-----	-----	-----	.393	.396	.0101
1 1/8-Inch Block Roughness, Channel Centerline, Station 35								
$S = 5.04\times10^{-3}$, $U_* = 0.216$ fps	0.898	1.380	0.217	0.157	1.005	0.492	0.678	0.0132
$W = 1.96$ ft, $\tau = 0.128$ lb/ft^2	.796	1.330	.249	.187	1.153	.344	.458	.0109
$Q = 0.78$ cfs, $\nu = 1.068\times10^{-5}$ ft^2/sec	.894	1.335	.245	.184	1.134	.374	.448	.0125
$T = 21.1$ °C, $\mathsf{R} = 37,270$	.592	1.170	.227	.194	1.051	.601	.703	.0121
$\underline{D} = 0.407$ ft, $\mathsf{F} = 0.270$	.490	1.110	.235	.212	1.088	.321	.356	.0096
$\overline{V} = 0.978$ fps, $C/\sqrt{g} = 4.528$	.388	1.000	.239	.239	1.106	.538	.538	.0092
	.286	.700	.170	.243	.787	.457	.326	.0084

TABLE 3b. — *2-foot-wide flume, rigid boundary, developing flow* — Continued

Mean Flow Parameters and Variables		Y/D	$\bar{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\bar{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)
1 1/8-Inch Block Roughness, 6 Inches From Wall, Station 35									
$S = 5.04\times10^{-3}$	$U_* = 0.216$ fps	0.898	1.550	0.178	0.115	0.824	0.267	0.414	0.0142
$W = 1.96$ ft	$\tau = 0.128$ lb/ft^2	.796	1.610	.190	.118	.880	.333	.536	.0127
$Q = 0.78$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	1.620	.217	.134	1.005	.646	1.043	.0163
$T = 21.1$ °C	R = 37,270	.592	1.580	.229	.145	1.060	.255	.403	.0123
$\underline{D} = 0.407$ ft	F = 0.270	.490	1.480	.230	.155	1.065	.567	.837	.0132
$\bar{V} = 0.978$ fps	$C/\sqrt{g} = 4.528$	.388	1.280	.251	.196	1.162	.579	.741	.0121
		.286	1.030	.228	.221	1.056	.304	.313	.0107
1 1/8-Inch Block Roughness, Channel Centerline, Station 40									
$S = 5.04\times10^{-3}$	$U_* = 0.216$ fps	0.898	1.350	0.204	0.151	0.944	0.504	0.680	0.0125
$W = 1.96$ ft	$\tau = 0.128$ lb/ft^2	.796	1.260	.204	.162	.944	.343	.432	.0108
$Q = 0.78$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	1.205	.221	.183	1.023	.356	.429	.0123
$T = 21.1$ °C	R = 37,247	.592	1.060	.215	.203	.995	.342	.363	.0111
$\underline{D} = 0.408$ ft	F = 0.269	.490	1.030	.214	.208	.991	.494	.508	.0124
$\bar{V} = 0.975$ fps	$C/\sqrt{g} = 4.514$	.388	.900	.200	.222	.926	.283	.254	.0086
		.286	.770	.192	.249	.889	.243	.187	.0077
1 1/8-Inch Block Roughness, 6 Inches From Wall, Station 40									
$S = 5.04\times10^{-3}$	$U_* = 0.216$ fps	0.898	1.560	0.192	0.123	0.889	0.253	0.394	0.0125
$W = 1.96$ ft	$\tau = 0.128$ lb/ft^2	.796	1.580	.204	.129	.944	.268	.423	.0121
$Q = 0.78$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	1.580	.218	.138	1 009	.311	.491	.0117
$T = 21.1$ °C	R = 37,247	.592	1.540	.220	.143	1.019	.347	.534	.0113
$\underline{D} = 0.408$ ft	F = 0.269	.490	1.460	.237	.162	1.097	.337	.492	.0108
$\bar{V} = 0.975$ fps	$C/\sqrt{g} = 4.514$	.388	1.280	.252	.197	1.167	.618	.791	.0097
		.286	1.050	.206	.196	.954	.516	.542	.0089
1 1/8-Inch Block Roughness, Channel Centerline, Station 45									
$S = 5.04\times10^{-3}$	$U_* = 0.217$ fps	0.898	1.295	0.198	0.153	0.912	0.233	0.320	0.0119
$W = 1.96$ ft	$\tau = 0.130$ lb/ft^2	.796	1.280	.215	.168	.991	.375	.480	.0123
$Q = 0.78$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	1.160	.217	.187	1.000	.270	.313	.0121
$T = 21.1$ °C	R = 37,265	.592	1.030	.189	.183	.871	.367	.378	.0116
$\underline{D} = 0.412$ ft	F = 0.265	.490	.990	.183	.185	.843	.474	.468	.0108
$\bar{V} = 0.966$ fps	$C/\sqrt{g} = 4.452$	.388	.960	.220	.229	1.014	.289	.277	.0093
		.286	.790	.192	.243	.885	.541	.427	.0081
1 1/8-Inch Block Roughness, 6 Inches From Wall, Station 45									
$S = 5.04\times10^{-3}$	$U_* = 0.217$ fps	0.898	1.520	0.175	0.115	0.806	0.463	0.705	0.0137
$W = 1.96$ ft	$\tau = 0.130$ lb/ft^2	.796	1.550	.199	.128	.917	.289	.447	.0136
$Q = 0.78$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	1.560	.195	.125	.899	.495	.772	.0138
$T = 21.1$ °C	R = 37,265	.592	1.550	.217	.140	1.000	.300	.465	.0131
$\underline{D} = 0.412$ ft	F = 0.265	.490	1.475	.233	.158	1.074	.269	.397	.0126
$\bar{V} = 0.966$ fps	$C/\sqrt{g} = 4.452$	.388	1.270	.255	.201	1.175	.431	.547	.0114
		.286	.930	.209	.225	.963	.384	.357	.0105
1 1/8-Inch Block Roughness, Channel Centerline, Station 5									
$S = 13.25\times10^{-3}$	$U_* = 0.350$ fps	0.898	2.360	0.258	0.109	0.737	0.157	0.371	0.0133
$W = 1.96$ ft	$\tau = 0.335$ lb/ft^2	.796	2.300	0.267	0.116	0.763	.136	.313	.0127
$Q = 1.21$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	2.200	0.245	0.113	0.700	.147	.323	.0136
$T = 21.1$ °C	R = 57,792	.592	2.100	0.247	0.118	0.706	.126	.264	.0129
$\underline{D} = 0.405$ ft	F = 0.422	.490	1.870	0.238	0.127	0.680	.299	.559	.0102
$\bar{V} = 1.524$ fps	$C/\sqrt{g} = 4.354$	.388	1.590	.247	.155	.706	.151	.240	.0092
		.286	1.300	.223	.172	.637	.160	.208	.0084
1 1/8-Inch Block Roughness, 6 Inches From Wall, Station 5									
$S = 13.25\times10^{-3}$	$U_* = 0.350$ fps	0.898	2.330	0.263	0.113	0.751	0.204	0.475	0.0133
$W = 1.96$ ft	$\tau = 0.335$ lb/ft^2	.796	2.380	.310	.130	.886	.169	.402	.0136
$Q = 1.21$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	2.400	.350	.146	1.000	.152	.365	.0131
$T = 21.1$ °C	R = 57,792	.592	2.400	.446	.186	1.274	.146	.351	.0142
$\underline{D} = 0.405$ ft	F = 0.422	.490	2.310	.500	.216	1.429	.185	.427	.0131
$\bar{V} = 1.524$ fps	$C/\sqrt{g} = 4.354$	.388	2.100	.509	.242	1.454	.171	.359	.0126
		.286	1.680	.382	.227	1.091	.217	.365	.0113
1 1/8-Inch Block Roughness, Channel Centerline, Station 10									
$S = 13.25\times10^{-3}$	$U_* = 0.351$ fps	0.898	2.200	0.287	0.130	0.818	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.339$ lb/ft^2	.796	2.030	.212	.104	.604	-----	-----	-----
$Q = 1.21$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	1.960	.271	.138	.772	-----	-----	-----
$T = 21.1$ °C	R = 57,815	.592	1.805	.241	.134	.686	-----	-----	-----
$\underline{D} = 0.410$ ft	F = 0.414	.490	1.650	.260	.158	.741	-----	-----	-----
$\bar{V} = 1.506$ fps	$C/\sqrt{g} = 4.291$	.388	1.500	.269	.179	.766	-----	-----	-----
		.286	1.300	.313	.241	.892	-----	-----	-----
1 1/8-Inch Block Roughness, 6 Inches From Wall, Station 10									
$S = 13.25\times10^{-3}$	$U_* = 0.351$ fps	0.898	2.280	0.224	0.098	0.638	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.339$ lb/ft^2	.796	2.310	.300	.130	.855	-----	-----	-----
$Q = 1.21$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	2.320	.412	.178	1.174	-----	-----	-----
$T = 21.1$ °C	R = 57,815	.592	2.320	.440	.190	1.254	-----	-----	-----
$\underline{D} = 0.410$ ft	F = 0.414	.490	2.205	.415	.188	1.182	-----	-----	-----
$\bar{V} = 1.506$ fps	$C/\sqrt{g} = 4.291$	.388	1.905	.462	.243	1.316	-----	-----	-----
		.286	1.470	.411	.280	1.171	-----	-----	-----
1 1/8-Inch Block Roughness, Channel Centerline, Station 15									
$S = 13.25\times10^{-3}$	$U_* = 0.353$ fps	0.898	2.200	0.295	0.134	0.836	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.343$ lb/ft^2	.796	2.080	.309	.149	.875	-----	-----	-----
$Q = 1.21$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	2.030	.325	.160	.921	-----	-----	-----
$T = 21.1$ °C	R = 57,820	.592	1.950	.313	.161	.887	-----	-----	-----
$\underline{D} = 0.415$ ft	F = 0.407	.490	1.770	.299	.169	.847	-----	-----	-----
$\bar{V} = 1.488$ fps	$C/\sqrt{g} = 4.215$	.388	1.500	.285	.190	.807	-----	-----	-----
		.286	1.305	.293	.225	.830	-----	-----	-----

TABLE 3b. — *2-foot-wide flume, rigid boundary, developing flow* — Continued

Mean Flow Parameters and Variables		Y/D	$\bar{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\bar{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)
1 1/8-Inch Block Roughness, 6 Inches From Wall, Station 15									
$S = 13.25\times10^{-3}$	$U_* = 0.353$ fps	0.898	2.360	0.269	0.114	0.762	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.343$ lb/ft^2	.796	2.380	.265	.111	.751	-----	-----	-----
$Q = 1.21$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	2.400	.350	.146	.992	-----	-----	-----
$T = 21.1$ °C	R = 57,820	.592	2.380	.384	.161	1.088	-----	-----	-----
$\underline{D} = 0.415$ ft	$\underline{F} = 0.407$	.490	2.240	.444	.198	1.258	-----	-----	-----
$\bar{V} = 1.488$ fps	$C/\sqrt{g} = 4.215$	.388	1.900	.420	.188	1.190	-----	-----	-----
		.286	1.560	.415	.266	1.176	-----	-----	-----
1 1/8-Inch Block Roughness, Channel Centerline, Station 20									
$S = 13.25\times10^{-3}$	$U_* = 0.352$ fps	0.898	1.920	0.245	0.128	0.696	0.319	0.613	0.0131
$W = 1.96$ ft	$\tau = 0.341$ lb/ft^2	.796	1.810	.236	.130	.670	.296	.536	.0137
$Q = 1.21$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	1.680	.259	.154	.736	.505	.848	.0135
$T = 21.1$ °C	R = 57,788	.592	1.580	.255	.161	.724	.281	.444	.0123
$\underline{D} = 0.412$ ft	F = 0.411	.490	1.510	.271	.179	.770	.198	.299	.0127
$\bar{V} = 1.498$ fps	$C/\ g = 4.256$	.388	1.360	.288	.212	.818	.203	.276	.0106
		.286	1.030	.220	.214	.625	.427	.439	.0109
1 1/8-Inch Block Roughness, 6 Inches From Wall, Station 20									
$S = 13.25\times10^{-3}$	$U_* = 0.352$ fps	0.898	2.500	0.289	0.116	0.821	0.218	0.545	0.0176
$W = 1.96$ ft	$\tau = 0.341$ lb/ft^2	.796	2.530	.337	.133	.957	.209	.529	.0168
$Q = 1.21$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	2.540	.376	.148	1.068	.249	.633	.0153
$T = 21.1$ °C	R = 57,788	.592	2.500	.431	.172	1.224	.293	.733	.0144
$\underline{D} = 0.412$ ft	$\underline{F} = 0.411$	.490	2.405	.469	.195	1.332	.343	.826	.0137
$\bar{V} = 1.498$ fps	$C/\sqrt{g} = 4.256$	.388	2.170	.493	.227	1.401	.433	.940	.0119
		.286	1.735	.417	.240	1.185	.185	.321	.0123
1 1/8-Inch Block Roughness, Channel Centerline, Station 25									
$S = 13.25\times10^{-3}$	$U_* = 0.348$ fps	0.898	2.100	0.318	0.151	0.914	0.256	0.538	0.0151
$W = 1.96$ ft	$\tau = 0.329$ lb/ft^2	.796	1.995	.316	.158	.908	.245	.489	.0141
$Q = 1.21$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	1.905	.308	.162	.885	.237	.451	.0145
$T = 21.1$ °C	R = 57,799	.592	1.820	.323	.177	.928	.395	.718	.0126
$\underline{D} = 0.398$ ft	$\underline{F} = 0.433$	.490	1.750	.358	.205	1.029	.313	.548	.0131
$\bar{V} = 1.551$ fps	$C/\sqrt{g} = 4.457$	.388	1.580	.368	.233	1.057	.264	.417	.0109
		.286	1.400	-----	-----	-----	.418	.586	.0122
1 1/8-Inch Block Roughness, 6 Inches From Wall, Station 25									
$S = 13.25\times10^{-3}$	$U_* = 0.348$ fps	0.898	2.600	0.288	0.111	0.828	0.214	0.556	0.0178
$W = 1.96$ ft	$\tau = 0.329$ lb/ft^2	.796	2.660	.370	.139	1.063	.409	1.088	.0181
$Q = 1.21$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	2.680	.425	.159	1.221	.264	.708	.0166
$T = 21.1$ °C	R = 57,799	.592	2.600	.447	.172	1.284	.243	.632	.0153
$\underline{D} = 0.398$ cfs	$\underline{F} = 0.433$	.490	2.430	.489	.201	1.405	.187	.455	.0148
$\bar{V} = 1.551$ fps	$C/\sqrt{g} = 4.457$	.388	2.120	.506	.239	1.454	.261	.553	.0134
		.286	1.610	-----	-----	-----	.322	.518	.0126
1 1/8-Inch Block Roughness, Channel Centerline, Station 30									
$S = 13.25\times10^{-3}$	$U_* = 0.351$ fps	0.898	2.110	0.302	0.143	0.860	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.338$ lb/ft^2	.796	2.060	.330	.160	.940	-----	-----	-----
$Q = 1.21$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	1.940	.332	.171	.946	-----	-----	-----
$T = 21.1$ °C	R = 57,788	.592	1.840	.308	.167	.877	-----	-----	-----
$\underline{D} = 0.409$ ft	$\underline{F} = 0.416$	.490	1.720	.365	.212	1.040	-----	-----	-----
$\bar{V} = 1.509$ fps	$C/\sqrt{g} = 4.299$	.388	1.560	.392	.251	1.117	-----	-----	-----
		.286	1.200	-----	-----	-----	-----	-----	-----
1 1/8-Inch Block Roughness, 6 Inches From Wall, Station 30									
$S = 13.25\times10^{-3}$	$U_* = 0.351$ fps	0.898	2.570	0.308	0.120	0.877	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.338$ lb/ft^2	.796	2.640	.353	.134	1.006	-----	-----	-----
$Q = 1.21$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	2.620	.409	.156	1.165	-----	-----	-----
$T = 21.1$ °C	R = 57,788	.592	2.500	.424	.170	1.208	-----	-----	-----
$\underline{D} = 0.409$ ft	$\underline{F} = 0.416$	.490	2.310	.531	.230	1.513	-----	-----	-----
$\bar{V} = 1.509$ fps	$C/\sqrt{g} = 4.299$	.388	2.000	.536	.268	1.527	-----	-----	-----
		.286	1.720	-----	-----	-----	-----	-----	-----
1 1/8=Inch Block Roughness, Channel Centerline, Station 35									
$S = 13.25\times10^{-3}$	$U_* = 0.350$ fps	0.898	2.110	0.318	0.151	0.909	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.337$ lb/ft^2	.796	2.030	.337	.166	.963	-----	-----	-----
$Q = 1.21$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	1.940	.362	.187	1.034	-----	-----	-----
$T = 21.1$ °C	R = 57,811	.592	1.790	.373	.208	1.066	-----	-----	-----
$\underline{D} = 0.407$ ft	$\underline{F} = 0.416$	.490	1.630	.360	.221	1.029	-----	-----	-----
$\bar{V} = 1.517$ fps	$C/\sqrt{g} = 4.334$	.388	1.520	.405	.266	1.157	-----	-----	-----
		.286	1.205	.327	.271	.934	-----	-----	-----
1 1/8-Inch Block Roughness, 6 Inches From Wall, Station 35									
$S = 13.25\times10^{-3}$	$U_* = 0.350$ fps	0.898	2.520	0.303	0.120	0.866	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.337$ lb/ft^2	.796	2.580	.369	.143	1.054	-----	-----	-----
$Q = 1.21$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	2.600	.395	.152	1.129	-----	-----	-----
$T = 21.1$ °C	R = 57,811	.592	2.560	.448	.175	1.280	-----	-----	-----
$\underline{D} = 0.407$ ft	$\underline{F} = 0.416$	.490	2.400	.484	.202	1.383	-----	-----	-----
$\bar{V} = 1.517$ fps	$C/\sqrt{g} = 4.334$	.388	2.100	.533	.254	1.523	-----	-----	-----
		.286	1.660	.500	.301	1.429	-----	-----	-----
1 1/8-Inch Block Roughness, Channel Centerline, Station 40									
$S = 13.25\times10^{-3}$	$U_* = 0.351$ fps	0.898	2.060	0.315	0.153	0.897	0.403	0.830	0.0150
$W = 1.96$ ft	$\tau = 0.337$ lb/ft^2	.796	2.030	.360	.177	1.026	.243	.494	.0147
$Q = 1.21$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	1.930	.386	.200	1.100	.300	.579	.0142
$T = 21.1$ °C	R = 57,800	.592	1.790	.397	.222	1.131	.370	.663	.0138
$\underline{D} = 0.408$ ft	F = 0.417	.490	1.680	.421	.251	1.199	.571	.960	.0144
$\bar{V} = 1.513$ fps	$C/\sqrt{g} = 4.311$	.388	1.500	.407	.271	1.160	.568	.853	.0132
		.286	1.230	.356	.289	1.014	.262	.322	.0127

TABLE 3b. — *2-foot-wide flume, rigid boundary, developing flow* — Continued

Mean Flow Parameters and Variables		Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)
1 1/8-Inch Block Roughness, 6 Inches From Wall, Station 40									
$S = 13.25\times10^{-3}$	$U_* = 0.351$ fps	0.898	2.450	0.333	0.136	0.949	0.329	0.806	0.0181
$W = 1.96$ ft	$\tau = 0.337$ lb/ft^2	.796	2.500	.344	.138	.980	.411	1.028	.0184
$Q = 1.21$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	2.500	.394	.158	1.123	.337	.843	.0182
$T = 21.1$ °C	R = 57,800	.592	2.440	.417	.171	1.188	.320	.781	.0176
$D = 0.408$ ft	F = 0.417	.490	2.305	.474	.206	1.350	.534	1.234	.0152
$\overline{V} = 1.513$ fps	$C/\sqrt{g} = 4.311$	.388	2.030	.516	.254	1.470	.469	.960	.0121
		.286	1.660	.480	.289	1.368	.369	.613	.0108
1 1/8-Inch Block Roughness, Channel Centerline, Station 45									
$S = 13.25\times10^{-3}$	$U_* = 0.350$ fps	0.898	2.040	0.328	0.161	0.937	0.468	0.955	0.0142
$W = 1.96$ ft	$\tau = 0.336$ lb/ft^2	.796	2.000	.367	.184	1.049	.282	.564	.0139
$Q = 1.21$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	1.940	.395	.204	1.129	.406	.786	.0136
$T = 21.1$ °C	R = 57,783	.592	1.820	.396	.218	1.131	.270	.491	.0124
$D = 0.406$ ft	F = 0.420	.490	1.690	.400	.237	1.143	.398	.672	.0115
$\overline{V} = 1.520$ fps	$C/\sqrt{g} = 4.343$	.388	1.560	.415	.266	1.186	.408	.637	.0102
		.286	1.270	.352	.277	1.006	.421	.535	.0096
1 1/8-Inch Block Roughness, 6 Inches From Wall, Station 45									
$S = 13.25\times10^{-3}$	$U_* = 0.350$ fps	0.898	2.330	0.304	0.130	0.869	0.315	0.734	0.0164
$W = 1.96$ ft	$\tau = 0.336$ lb/ft^2	.796	2.420	.353	.146	1.009	.212	.513	.0166
$Q = 1.21$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	2.450	.374	.153	1.069	.249	.610	.0157
$T = 21.1$ °C	R = 57,783	.592	2.430	.404	.166	1.154	.377	.916	.0153
$D = 0.406$ ft	F = 0.420	.492	2.305	.465	.202	1.329	.312	.720	.0127
$\overline{V} = 1.520$ fps	$C/\sqrt{g} = 4.343$	.388	2.030	.464	.229	1.326	.251	.509	.0109
		.286	1.470	.400	.272	1.143	.247	.363	.0085
1 1/8-Inch Block Roughness, Channel Centerline, Station 5									
$S = 20.54\times10^{-3}$	$U_* = 0.438$ fps	0.898	3.180	0.349	0.110	0.797	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.529$ lb/ft^2	.796	3.270	.400	.122	.913	-----	-----	-----
$Q = 1.56$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	3.205	.436	.136	.995	-----	-----	-----
$T = 21.1$ °C	R = 74,518	.592	3.030	.518	.171	1.183	-----	-----	-----
$D = 0.413$ ft	F = 0.528	.490	2.800	.657	.235	1.500	-----	-----	-----
$\overline{V} = 1.927$ fps	$C/\sqrt{g} = 4.400$	.388	2.450	.718	.293	1.639	-----	-----	-----
		.286	1.960	.593	.303	1.354	-----	-----	-----
1 1/8-Inch Block Roughness, 6 Inches From Wall, Station 5									
$S = 20.54\times10^{-3}$	$U_* = 0.438$ fps	0.898	3.140	0.333	0.106	0.760	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.529$ lb/ft^2	.796	3.350	.351	.105	.801	-----	-----	-----
$Q = 1.56$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	3.405	.370	.109	.845	-----	-----	-----
$T = 21.1$ °C	R = 74,518	.592	3.340	.451	.135	1.030	-----	-----	-----
$D = 0.413$ ft	F = 0.528	.490	3.130	.475	.152	1.084	-----	-----	-----
$\overline{V} = 1.927$ fps	$C/\sqrt{g} = 4.400$	.388	2.700	.527	.195	1.203	-----	-----	-----
		.286	2.200	.511	.232	1.167	-----	-----	-----
1 1/8-Inch Block Roughness, Channel Centerline, Station 10									
$S = 20.54\times10^{-3}$	$U_* = 0.436$ fps	0.898	3.300	0.581	0.176	1.333	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.522$ lb/ft^2	.796	3.160	.640	.202	1.468	-----	-----	-----
$Q = 1.56$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	2.890	.677	.234	1.553	-----	-----	-----
$T = 21.1$ °C	R = 74,540	.592	2.740	.717	.262	1.644	-----	-----	-----
$D = 0.407$ ft	F = 0.540	.490	2.510	.755	.301	1.732	-----	-----	-----
$\overline{V} = 1.956$ fps	$C/\sqrt{g} = 4.486$	.388	2.200	.739	.336	1.695	-----	-----	-----
		.286	1.880	.690	.367	1.583	-----	-----	-----
1 1/8-Inch Block Roughness, 6 Inches From Wall, Station 10									
$S = 20.54\times10^{-3}$	$U_* = 0.436$ fps	0.898	3.370	0.454	0.135	1.041	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.522$ lb/ft^2	.796	3.380	.422	.125	.968	-----	-----	-----
$Q = 1.56$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	3.350	.417	.124	.956	-----	-----	-----
$T = 21.1$ °C	R = 74,540	.592	3.260	.435	.133	.998	-----	-----	-----
$D = 0.407$ ft	F = 0.540	.490	3.110	.492	.158	1.128	-----	-----	-----
$\overline{V} = 1.956$ fps	$C/\sqrt{g} = 4.486$	.388	2.840	.610	.215	1.399	-----	-----	-----
		.286	2.220	.485	.218	1.112	-----	-----	-----
1 1/8-Inch Block Roughness, Channel Centerline, Station 15									
$S = 20.54\times10^{-3}$	$U_* = 0.438$ fps	0.898	2.930	0.590	0.201	1.347	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.529$ lb/ft^2	.796	2.800	.624	.223	1.425	-----	-----	-----
$Q = 1.56$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	2.605	.682	.262	1.557	-----	-----	-----
$T = 21.1$ °C	R = 74,518	.592	2.310	.656	.284	1.498	-----	-----	-----
$D = 0.413$ ft	F = 0.528	.490	2.080	.614	.295	1.402	-----	-----	-----
$\overline{V} = 1.927$ fps	$C/\sqrt{g} = 4.400$	.388	1.840	.491	.267	1.121	-----	-----	-----
		.286	1.500	-----	-----	-----	-----	-----	-----
1 1/8-Inch Block Roughness, 6 Inches From Wall, Station 15									
$S = 20.54\times10^{-3}$	$U_* = 0.438$ fps	0.898	3.270	0.400	0.122	0.913	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.529$ lb/ft^2	.796	3.285	.341	.104	.779	-----	-----	-----
$Q = 1.56$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	3.290	.387	.118	.884	-----	-----	-----
$T = 21.1$ °C	R = 74,518	.592	3.240	.429	.132	.979	-----	-----	-----
$D = 0.413$ ft	F = 0.528	.490	3.100	.483	.156	1.103	-----	-----	-----
$\overline{V} = 1.927$ fps	$C/\sqrt{g} = 4.400$	.388	2.860	.614	.215	1.402	-----	-----	-----
		.286	2.250	.626	.278	1.429	-----	-----	-----
1 1/8-Inch Block Roughness, Channel Centerline, Station 20									
$S = 20.54\times10^{-3}$	$U_* = 0.438$ fps	0.898	2.700	0.489	0.181	1.116	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.528$ lb/ft^2	.796	2.610	.573	.220	1.308	-----	-----	-----
$Q = 1.56$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	2.450	.615	.251	1.404	-----	-----	-----
$T = 21.1$ °C	R = 74,530	.592	2.250	.585	.260	1.336	-----	-----	-----
$D = 0.412$ ft	F = 0.530	.490	2.000	.550	.275	1.256	-----	-----	-----
$\overline{V} = 1.932$ fps	$C/\sqrt{g} = 4.411$	.388	1.780	.624	.351	1.425	-----	-----	-----
		.286	1.400	-----	-----	-----	-----	-----	-----

TABLE 3b. — *2-foot-wide flume, rigid boundary, developing flow* — Continued

Mean Flow Parameters and Variables		Y/D	$\bar{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\bar{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)
1 1/8-Inch Block Roughness, 6 Inches From Wall, Station 20									
$S = 20.54\times10^{-3}$	$U_* = 0.438$ fps	0.898	3.280	0.378	0.115	0.863	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.528$ lb/ft^2	.796	3.255	.376	.116	.858	-----	-----	-----
$Q = 1.56$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	3.230	.365	.113	.833	-----	-----	-----
$T = 21.1$ °C	R = 74,530	.592	3.200	.410	.128	.936	-----	-----	-----
$\underline{D} = 0.412$ ft	F = 0.530	.490	3.130	.505	.161	1.153	-----	-----	-----
$\bar{V} = 1.932$ fps	$C/\sqrt{g} = 4.411$	.388	2.830	.617	.218	1.409	-----	-----	-----
		.286	2.400	.592	.247	1.352	-----	-----	-----
1 1/8-Inch Block Roughness, Channel Centerline, Station 25									
$S = 20.54\times10^{-3}$	$U_* = 0.433$ fps	0.898	2.800	0.536	0.191	1.238	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.510$ lb/ft^2	.796	2.600	.480	.185	1.109	-----	-----	-----
$Q = 1.56$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	2.430	.494	.203	1.141	-----	-----	-----
$T = 21.1$ °C	R = 74,532	.592	2.280	.540	.237	1.247	-----	-----	-----
$\underline{D} = 0.398$ ft	F = 0.559	.490	2.070	.508	.245	1.173	-----	-----	-----
$\bar{V} = 2.000$ fps	$C/\sqrt{g} = 4.619$	.388	1.860	.537	.289	1.240	-----	-----	-----
		.286	1.600	.458	.286	1.058	-----	-----	-----
1 1/8-Inch Block Roughness, 6 Inches From Wall, Station 25									
$S = 20.54\times10^{-3}$	$U_* = 0.433$ fps	0.898	3.430	0.374	0.109	0.864	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.510$ lb/ft^2	.796	3.430	.386	.113	.891	-----	-----	-----
$Q = 1.56$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	3.420	.389	.114	.898	-----	-----	-----
$T = 21.1$ °C	R = 74,532	.592	3.360	.432	.129	.998	-----	-----	-----
$\underline{D} = 0.398$ ft	F = 0.559	.490	3.200	.557	.174	1.286	-----	-----	-----
$\bar{V} = 2.000$ fps	$C/\sqrt{g} = 4.619$	.388	2.895	.338	.117	.781	-----	-----	-----
		.286	2.320	-----	-----	-----	-----	----	-----
1 1/8-Inch Block Roughness, Channel Centerline, Station 30									
$S = 20.54\times10^{-3}$	$U_* = 0.432$ fps	0.898	2.770	0.543	0.196	1.257	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.515$ lb/ft^2	.796	2.540	.532	.209	1.231	-----	-----	-----
$Q = 1.56$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	2.320	.520	.224	1.204	-----	-----	-----
$T = 21.1$ °C	R = 74,528	.592	2.140	.510	.238	1.181	-----	-----	-----
$\underline{D} = 0.402$ ft	F = 0.550	.490	1.920	.443	.231	1.025	-----	-----	-----
$\bar{V} = 1.980$ fps	$C/\sqrt{g} = 4.583$	.388	1.640	.405	.247	.938	-----	-----	-----
		.286	1.270	-----	-----	-----	-----	-----	-----
1 1/8-Inch Block Roughness, 6 Inches From Wall, Station 30									
$S = 20.54\times10^{-3}$	$U_* = 0.432$ fps	0.898	3.500	0.357	0.102	0.826	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.515$ lb/ft^2	.796	3.510	.403	.115	.933	-----	-----	-----
$Q = 1.56$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	3.480	.419	.120	.970	-----	-----	-----
$T = 21.1$ °C	R = 74,528	.592	3.360	.495	.147	1.146	-----	-----	-----
$\underline{D} = 0.402$ ft	F = 0.550	.490	3.100	.620	.200	1.435	-----	-----	-----
$\bar{V} = 1.980$ fps	$C/\sqrt{g} = 4.583$	.388	2.710	.663	.245	1.535	-----	-----	-----
		.286	2.220	-----	-----	-----	-----	-----	-----
1 1/8-Inch Block Roughness, Channel Centerline, Station 35									
$S = 20.54\times10^{-3}$	$U_* = 0.438$ fps	0.898	2.740	0.518	0.189	1.183	0.328	0.865	0.0168
$W = 1.96$ ft	$\tau = 0.527$ lb/ft^2	.796	2.560	.515	.201	1.176	.325	.832	-----
$Q = 1.56$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	2.350	.558	.237	1.274	.233	.548	-----
$T = 21.1$ °C	R = 74,542	.592	2.180	.516	.237	1.178	.201	.438	-----
$\underline{D} = 0.411$ ft	F = 0.532	.490	1.980	.557	.281	1.272	.285	.564	-----
$\bar{V} = 1.937$ fps	$C/\sqrt{g} = 4.422$	.388	1.700	.594	.349	1.356	.493	.840	.0113
		.286	1.350	-----	-----	-----	-----	-----	-----
1 1/8-Inch Block Roughness, 6 Inches From Wall, Station 35									
$S = 20.54\times10^{-3}$	$U_* = 0.438$ fps	0.898	3.400	0.384	0.113	0.877	0.161	0.547	0.0190
$W = 1.96$ ft	$\tau = 0.527$ lb/ft^2	.796	3.410	.400	.117	.913	.158	.538	-----
$Q = 1.56$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	3.380	.403	.119	.920	.185	.625	-----
$T = 21.1$ °C	R = 74,542	.592	3.300	.471	.143	1.075	.157	.518	-----
$\underline{D} = 0.411$ ft	F = 0.532	.490	3.120	.563	.180	1.285	.167	.522	-----
$\bar{V} = 1.937$ fps	$C/\sqrt{g} = 4.422$	.388	2.750	.693	.252	1.582	.192	.528	-----
		.286	2.200	.668	.304	1.525	.343	.755	.0134
1 1/8-Inch Block Roughness, Channel Centerline, Station 40									
$S = 20.54\times10^{-3}$	$U_* = 0.437$ fps	0.898	2.730	0.480	0.176	1.098	0.241	0.658	0.0167
$W = 1.96$ ft	$\tau = 0.525$ lb/ft^2	.796	2.630	.553	.210	1.265	.190	.500	.0161
$Q = 1.56$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	2.410	.541	.224	1.238	.259	.629	.0153
$T = 21.1$ °C	R = 74,514	.592	2.220	.519	.234	1.188	.181	.403	.0128
$\underline{D} = 0.410$ ft	F = 0.534	.490	2.000	.592	.296	1.355	.178	.356	.0136
$\bar{V} = 1.941$ fps	$C/\sqrt{g} = 4.442$	.388	1.680	.525	.313	1.201	.322	.541	.0117
		.286	1.540	.484	.314	1.108	.150	.231	.0102
1 1/8-Inch Block Roughness, 6 Inches From Wall, Station 40									
$S = 20.54\times10^{-3}$	$U_* = 0.437$ fps	0.898	3.310	0.424	0.128	0.970	0.150	0.496	0.0195
$W = 1.96$ ft	$\tau = 0.525$ lb/ft^2	.796	3.330	.408	.123	.934	.138	.460	.0186
$Q = 1.56$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	3.310	.427	.129	.977	.177	.585	.0189
$T = 21.1$ °C	R = 74,514	.592	3.230	.485	.150	1.110	.159	.514	.0171
$\underline{D} = 0.410$ ft	F = 0.534	.490	3.090	.555	.180	1.270	.201	.620	.0158
$\bar{V} = 1.941$ fps	$C/\sqrt{g} = 4.442$	.388	2.780	.648	.233	1.483	.174	.484	.0138
		.286	2.195	.778	.354	1.780	.236	.517	.0160
1 1/8-Inch Block Roughness, Channel Centerline, Station 45									
$S = 20.54\times10^{-3}$	$U_* = 0.437$ fps	0.898	2.810	0.520	0.185	1.190	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.524$ lb/ft^2	.796	2.600	.544	.209	1.245	-----	-----	-----
$Q = 1.56$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.694	2.450	.596	.243	1.364	-----	-----	-----
$T = 21.1$ °C	R = 74,524	.592	2.230	.555	.249	1.270	-----	-----	-----
$\underline{D} = 0.409$ ft	F = 0.536	.490	2.040	.595	.292	1.362	-----	-----	-----
$\bar{V} = 1.946$ fps	$C/\sqrt{g} = 4.453$	.388	1.880	.572	.304	1.309	-----	-----	-----
		.286	1.640	.665	.405	1.522	-----	-----	-----

TABLE 3b. — *2-foot-wide flume, rigid boundary, developing flow* — Continued

Mean Flow Parameters and Variables	Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)
1 1/8-Inch Block Roughness, 6 Inches From Wall, Station 45								
$S = 20.54\times10^{-3}$; $U_* = 0.437$ fps	0.898	3.200	0.389	0.122	0.890	-----	-----	-----
$W = 1.96$ ft; $\tau = 0.524$ lb/ft^2	.796	3.240	.395	.122	.904	-----	-----	-----
$Q = 1.56$ cfs; $\nu = 1.068\times10^{-5}$ ft^2/sec	.694	3.260	.413	.127	.945	-----	-----	-----
$T = 21.1$ °C; $R = 74.524$	.592	3.200	.455	.142	1.041	-----	-----	-----
$D = 0.409$ ft; $F = 0.536$	.490	3.030	.555	.183	1.270	-----	-----	-----
$V = 1.946$ fps; $C/\sqrt{g} = 4.453$	.388	2.640	.666	.252	1.524	-----	-----	-----
	.286	2.050	.519	.253	1.188	-----	-----	-----
1/2-Inch Block Roughness, Channel Centerline, Station 5								
	0.899	1.260	0.118	0.094	0.707	-----	-----	-----
$S = 2.95\times10^{-3}$; $U_* = 0.167$ fps	.798	1.185	.118	.100	.707	-----	-----	-----
$W = 1.96$ ft; $\tau = 0.077$ lb/ft	.697	1.090	.107	.098	.641	-----	-----	-----
$Q = 0.88$ cfs; $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	1.020	.092	.090	.551	-----	-----	-----
$T = 21.1$ °C; $R = 42,028$	.495	.938	.086	.092	.515	-----	-----	-----
$D = 0.416$ ft; $F = 0.295$	.394	.878	.084	.096	.503	-----	-----	-----
$V = 1.079$ fps; $C/\sqrt{g} = 6.461$	.293	.823	.084	.102	.503	-----	-----	-----
	.192	.760	.112	.147	.671	-----	-----	-----
1/2-Inch Block Roughness, 6 Inches From Wall, Station 5								
	0.899	1.370	0.163	0.119	0.976	-----	-----	-----
$S = 2.95\times10^{-3}$; $U_* = 0.167$ fps	.798	1.420	.179	.126	1.072	-----	-----	-----
$W = 1.96$ ft; $\tau = 0.077$ lb/ft^2	.697	1.440	.200	.139	1.198	-----	-----	-----
$Q = 0.88$ cfs; $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	1.450	.216	.149	1.293	-----	-----	-----
$T = 21.1$ °C; $R = 42,028$	.495	1.400	.224	.160	1.341	-----	-----	-----
$D = 0.416$ ft; $F = 0.295$	.394	1.300	.192	.148	1.150	-----	-----	-----
$V = 1.079$ fps; $C/\sqrt{g} = 6.461$	.293	1.150	.183	.159	1.096	-----	-----	-----
	.192	.980	.152	.155	.910	-----	-----	-----
1/2-Inch Block Roughness, Channel Centerline, Station 10								
	0.899	1.130	0.062	0.055	0.371	-----	-----	-----
$S = 2.95\times10^{-3}$; $U_* = 0.167$ fps	.798	1.070	.056	.052	.335	-----	-----	-----
$W = 1.96$ ft; $\tau = 0.077$ lb/ft^2	.697	.995	.054	.054	.323	-----	-----	-----
$Q = 0.88$ cfs; $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	.950	.058	.061	.347	-----	-----	-----
$T = 21.1$ °C; $R = 42,057$	.495	.900	.062	.069	.371	-----	-----	-----
$D = 0.419$ ft; $F = 0.292$	.394	.800	.078	.098	.467	-----	-----	-----
$V = 1.072$ fps; $C/\sqrt{g} = 6.419$	.293	.743	.091	.122	.545	-----	-----	-----
	.192	.690	.112	.162	.671	-----	-----	-----
1/2-Inch Block Roughness, 6 Inches From Wall, Station 10								
	0.899	1.440	0.124	0.086	0.743	-----	-----	-----
$S = 2.95\times10^{-3}$; $U_* = 0.167$ fps	.798	1.465	.149	.102	.892	-----	-----	-----
$W = 1.96$ ft; $\tau = 0.077$ lb/ft^2	.697	1.485	.178	.120	1.066	-----	-----	-----
$Q = 0.88$ cfs; $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	1.470	.209	.142	1.251	-----	-----	-----
$T = 21.1$ °C; $R = 42,057$	.495	1.420	.214	.151	1.281	-----	-----	-----
$D = 0.419$ ft; $F = 0.292$	.394	1.330	.216	.162	1.293	-----	-----	-----
$V = 1.072$ fps; $C/\sqrt{g} = 6.419$	.293	1.160	.191	.165	1.144	-----	-----	-----
	.192	.900	.171	.190	1.024	-----	-----	-----
1/2-Inch Block Roughness, Channel Centerline, Station 15								
	0.899	1.060	0.056	0.053	0.337	-----	-----	-----
$S = 2.95\times10^{-3}$; $U_* = 0.166$ fps	.798	.990	.050	.051	.301	-----	-----	-----
$W = 1.96$ ft; $\tau = 0.076$ lb/ft^2	.697	.940	.049	.052	.295	-----	-----	-----
$Q = 0.88$ cfs; $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	.900	.055	.061	.331	-----	-----	-----
$T = 21.1$ °C; $R = 42,020$	.495	.840	.057	.068	.343	-----	-----	-----
$D = 0.414$ ft; $F = 0.297$	.394	.765	.066	.086	.398	-----	-----	-----
$V = 1.084$ fps; $C/\sqrt{g} = 6.530$	.293	.710	.085	.120	.512	-----	-----	-----
	.192	.640	.087	.136	.524	-----	-----	-----
1/2-Inch Block Roughness, 6 Inches From Wall, Station 15								
	0.899	1.370	0.143	0.104	0.861	-----	-----	-----
$S = 2.95\times10^{-3}$; $U_* = 0.166$ fps	.798	1.395	.160	.115	.964	-----	-----	-----
$W = 1.96$ ft; $\tau = 0.076$ lb/ft^2	.697	1.420	.185	.130	1.114	-----	-----	-----
$Q = 0.88$ cfs; $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	1.430	.207	.145	1.247	-----	-----	-----
$T = 21.1$ °C; $R = 42,020$	.495	1.420	.227	.160	1.367	-----	-----	-----
$D = 0.414$ ft; $F = 0.297$	.394	1.380	.252	.183	1.518	-----	-----	-----
$V = 1.084$ fps; $C/\sqrt{g} = 6.530$	.293	1.230	.241	.196	1.452	-----	-----	-----
	.192	1.130	.237	.210	1.427	-----	-----	-----
1/2-Inch Block Roughness, Channel Centerline, Station 20								
	0.899	1.120	0.062	0.055	0.373	-----	-----	-----
$S = 2.95\times10^{-3}$; $U_* = 0.166$ fps	.798	1.060	.061	.058	.367	-----	-----	-----
$W = 1.96$ ft; $\tau = 0.075$ lb/ft^2	.697	1.060	.061	.058	.367	-----	-----	-----
$Q = 0.88$ cfs; $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	1.025	.065	.063	.392	-----	-----	-----
$T = 21.1$ °C; $R = 42,037$	.495	.990	.076	.077	.458	-----	-----	-----
$D = 0.410$ ft; $F = 0.301$	.394	.960	.089	.093	.536	-----	-----	-----
$V = 1.095$ fps; $C/\sqrt{g} = 6.596$	.293	.920	.118	.128	.711	-----	-----	-----
	.192	.800	.147	.184	.886	-----	-----	-----
1/2-Inch Block Roughness, 6 Inches From Wall, Station 20								
	0.899	1.350	0.109	0.081	0.657	-----	-----	-----
$S = 2.95\times10^{-3}$; $U_* = 0.164$ fps	.798	1.380	.140	.101	.843	-----	-----	-----
$W = 1.96$ ft; $\tau = 0.073$ lb/ft^2	.697	1.395	.152	.109	.916	-----	-----	-----
$Q = 0.88$ cfs; $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	1.405	.170	.121	1.024	-----	-----	-----
$T = 21.1$ °C; $R = 42,037$	.495	1.400	.196	.140	1.181	-----	-----	-----
$D = 0.399$ ft; $F = 0.314$	.394	1.335	.206	.154	1.241	-----	-----	-----
$V = 1.125$ fps; $C/\sqrt{g} = 6.860$	.293	1.220	.201	.165	1.211	-----	-----	-----
	.192	1.015	.184	.181	1.108	-----	-----	-----

TABLE 3b. — *2-foot-wide flume, rigid boundary, developing flow* — Continued

Mean Flow Parameters and Variables	Y/D	$\bar{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\bar{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)
1/2-Inch Block Roughness, Channel Centerline, Station 25								
	0.899	1.205	0.058	0.048	0.354	-----	-----	-----
$S = 2.95\times10^{-3}$ $U_* = 0.164$ fps	.798	1.180	.059	.050	.360	-----	-----	-----
$W = 1.96$ ft $\tau = 0.073$ lb/ft^2	.697	1.140	.063	.055	.384	-----	-----	-----
$Q = 0.88$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	1.100	.068	.062	.410	-----	-----	-----
$T = 21.1$ °C $\mathsf{R} = 42{,}029$	.495	1.050	.085	.081	.518	-----	-----	-----
$D = 0.399$ ft $\mathsf{F} = 0.314$	.394	1.025	.103	.100	.628	-----	-----	-----
$\bar{V} = 1.125$ fps $C/\sqrt{g} = 6.860$	.293	.970	.143	.147	.872	-----	-----	-----
	.192	.850	.157	.185	.957	-----	-----	-----
1/2-Inch Block Roughness, 6 Inches From Wall, Station 25								
	0.899	1.390	0.107	0.077	0.652	-----	-----	-----
$S = 2.95\times10^{-3}$ $U_* = 0.164$ fps	.798	1.430	.132	.092	.805	-----	-----	-----
$W = 1.96$ ft $\tau = 0.073$ lb/ft^2	.697	1.445	.170	.118	1.037	-----	-----	-----
$Q = 0.88$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	1.420	.180	.127	1.098	-----	-----	-----
$T = 2.21$ °C $\mathsf{R} = 42{,}029$	.495	1.370	.173	.126	1.055	-----	-----	-----
$D = 0.399$ ft $\mathsf{F} = 0.314$	.394	1.270	.171	.135	1.043	-----	-----	-----
$\bar{V} = 1.125$ fps $C/\sqrt{g} = 6.860$	.293	1.090	.167	.153	1.018	-----	-----	-----
	.192	.692	.124	.179	.756	-----	-----	-----
1/2-Inch Block Roughness, Channel Centerline, Station 30								
	0.899	1.215	0.055	0.045	0.333	-----	-----	-----
$S = 2.95\times10^{-3}$ $U_* = 0.165$ fps	.798	1.170	.061	.052	.370	-----	-----	-----
$W = 1.96$ ft $\tau = 0.074$ lb/ft^2	.697	1.110	.065	.059	.394	-----	-----	-----
$Q = 0.88$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	1.085	.066	.061	.400	-----	-----	-----
$T = 21.1$ °C $\mathsf{R} = 42{,}044$	.495	1.040	.085	.082	.515	-----	-----	-----
$D = 0.402$ ft $\mathsf{F} = 0.310$	.394	.960	.106	.110	.642	-----	-----	-----
$\bar{V} = 1.117$ fps $C/\sqrt{g} = 6.770$	.293	.900	.148	.164	.897	-----	-----	-----
	.192	.860	.185	.215	1.121	-----	-----	-----
1/2-Inch Block Roughness, 6 Inches From Wall, Station 30								
	0.899	1.420	0.117	0.082	0.709	-----	-----	-----
$S = 2.95\times10^{-3}$ $U_* = 0.165$ fps	.798	1.460	.124	.085	.752	-----	-----	-----
$W = 1.96$ ft $\tau = 0.074$ lb/ft^2	.697	1.480	.172	.116	1.042	-----	-----	-----
$Q = 0.88$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	1.450	.186	.128	1.127	-----	-----	-----
$T = 21.1$ °C $\mathsf{R} = 42{,}044$	.495	1.390	.189	.136	1.145	-----	-----	-----
$D = 0.402$ ft $\mathsf{F} = 0.310$	.394	1.280	.216	.169	1.309	-----	-----	-----
$\bar{V} = 1.117$ fps $C/\sqrt{g} = 6.770$	.293	1.080	.177	.164	1.073	-----	-----	-----
	.192	.720	.127	.176	.770	-----	-----	-----
1/2-Inch Block Roughness, Channel Centerline, Station 35								
	0.899	1.195	0.069	0.058	0.416	-----	-----	-----
$S = 2.95\times10^{-3}$ $U_* = 0.166$ fps	.798	1.160	.076	.066	.458	-----	-----	-----
$W = 1.96$ ft $\tau = 0.075$ lb/ft^2	.697	1.150	.078	.068	.470	-----	-----	-----
$Q = 0.88$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	1.105	.083	.075	.500	-----	-----	-----
$T = 21.1$ °C $\mathsf{R} = 42{,}037$	.495	1.030	.091	.088	.548	-----	-----	-----
$D = 0.410$ ft $\mathsf{F} = 0.301$	.394	1.005	.104	.103	.627	-----	-----	-----
$\bar{V} = 1.095$ fps $C/\sqrt{g} = 6.596$	.293	.940	.129	.137	.777	-----	-----	-----
	.192	.885	.180	.203	1.084	-----	-----	-----
1/2-Inch Block Roughness, 6 Inches From Wall, Station 35								
	0.899	1.350	0.119	0.088	0.717	-----	-----	-----
$S = 2.95\times10^{-3}$ $U_* = 0.166$ fps	.798	1.390	.135	.097	.813	-----	-----	-----
$W = 1.96$ ft $\tau = 0.075$ lb/ft^2	.697	1.410	.143	.101	.861	-----	-----	-----
$Q = 0.88$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	1.420	.168	.118	1.012	-----	-----	-----
$T = 21.1$ °C $\mathsf{R} = 42{,}037$	.495	1.400	.198	.141	1.193	-----	-----	-----
$D = 0.410$ ft $\mathsf{F} = 0.301$	.394	1.325	.196	.148	1.181	-----	-----	-----
$\bar{V} = 1.095$ fps $C/\sqrt{g} = 6.596$	.293	1.160	.190	.164	1.145	-----	-----	-----
	.192	.935	.162	.173	.976	-----	-----	-----
1/2-Inch Block Roughness, Channel Centerline, Station 40								
	0.899	1.165	0.078	0.067	0.404	-----	-----	-----
$S = 2.95\times10^{-3}$ $U_* = 0.166$ fps	.798	1.150	.081	.070	.422	-----	-----	-----
$W = 1.96$ ft $\tau = 0.076$ lb/ft^2	.697	1.140	.084	.074	.446	-----	-----	-----
$Q = 0.88$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	1.105	.094	.085	.512	-----	-----	-----
$T = 21.1$ °C $\mathsf{R} = 42{,}020$	.495	1.080	.102	.094	.566	-----	-----	-----
$D = 0.414$ ft $\mathsf{F} = 0.297$	.394	1.035	.120	.116	.699	-----	-----	-----
$\bar{V} = 1.084$ fps $C/\sqrt{g} = 6.530$	.293	1.020	.129	.126	.759	-----	-----	-----
	.192	.860	.122	.142	.855	-----	-----	-----
1/2-Inch Block Roughness, 6 Inches From Wall, Station 40								
	0.899	1.300	0.116	0.089	0.699	-----	-----	-----
$S = 2.95\times10^{-3}$ $U_* = 0.166$ fps	.798	1.335	.133	.100	.801	-----	-----	-----
$W = 1.96$ ft $\tau = 0.076$ lb/ft^2	.697	1.350	.146	.108	.880	-----	-----	-----
$Q = 0.88$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	1.340	.154	.115	.928	-----	-----	-----
$T = 21.1$ °C $\mathsf{R} = 42{,}020$	.495	1.302	.153	.118	.922	-----	-----	-----
$D = 0.414$ ft $\mathsf{F} = 0.297$	.394	1.235	.170	.138	1.024	-----	-----	-----
$\bar{V} = 1.084$ fps $C/\sqrt{g} = 6.530$	.293	1.095	.164	.150	.988	-----	-----	-----
	.192	.900	.181	.201	1.090	-----	-----	-----
1/2-Inch Block Roughness, Channel Centerline, Station 45								
	0.899	1.150	0.071	0.062	0.425	-----	-----	-----
$S = 2.95\times10^{-3}$ $U_* = 0.167$ fps	.798	1.120	.075	.067	.449	-----	-----	-----
$W = 1.96$ ft $\tau = 0.077$ lb/ft^2	.697	1.095	.075	.068	.449	-----	-----	-----
$Q = 0.88$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	1.085	.077	.071	.461	-----	-----	-----
$T = 21.1$ °C $\mathsf{R} = 42{,}035$	.495	1.100	.097	.088	.581	-----	-----	-----
$D = 0.418$ ft $\mathsf{F} = 0.293$	.394	1.090	.115	.106	.689	-----	-----	-----
$\bar{V} = 1.074$ fps $C/\sqrt{g} = 6.431$	.293	1.025	.122	.119	.731	-----	-----	-----
	.192	.900	.131	.146	.784	-----	-----	-----

TABLE 3b. — *2-foot-wide flume, rigid boundary, developing flow* — Continued

Mean Flow Parameters and Variables	Y/D	$\bar{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\bar{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)
1/2-Inch Block Roughness, 6 Inches From Wall, Station 45								
	0.899	1.290	0.107	0.083	0.641	-----	-----	-----
$S = 2.95\times10^{-3}$ $U_* = 0.167$ fps	.798	1.310	.121	.092	.725	-----	-----	-----
$W = 1.96$ ft $\tau = 0.077$ lb/ft^2	.697	1.315	.131	.100	.784	-----	-----	-----
$Q = 0.88$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	1.300	.142	.109	.850	-----	-----	-----
$T = 21.1$ °C $\mathsf{R} = 42{,}035$	.495	1.270	.152	.120	.910	-----	-----	-----
$\underline{D} = 0.418$ ft $\underline{F} = 0.293$	.394	1.220	.150	.123	.898	-----	-----	-----
$\bar{V} = 1.074$ fps $C/\sqrt{g} = 6.431$	.293	1.115	.172	.154	1.030	-----	-----	-----
	.192	.970	.176	.181	1.054	-----	-----	-----
1/2-Inch Block Roughness, Channel Centerline, Station 5								
	0.899	2.130	0.267	0.125	0.985	-----	-----	-----
$S = 7.80\times10^{-3}$ $U_* = 0.271$ fps	.798	2.145	.272	.127	1.004	-----	-----	-----
$W = 1.96$ ft $\tau = 0.202$ lb/ft^2	.697	2.170	.277	.128	1.022	-----	-----	-----
$Q = 1.53$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	2.150	.263	.122	.970	-----	-----	-----
$T = 21.1$ °C $\mathsf{R} = 73.073$	.495	2.150	.260	.121	.959	-----	-----	-----
$\underline{D} = 0.416$ ft $\underline{F} = 0.513$	.394	2.080	.280	.135	1.033	-----	-----	-----
$\bar{V} = 1.876$ fps $C/\sqrt{g} = 6.923$	.293	2.000	.341	.171	1.258	-----	-----	-----
	.192	1.630	.342	.210	1.262	-----	-----	-----
1/2-Inch Block Roughness, 6 Inches From Wall, Station 5								
	0.899	2.230	0.273	0.122	1.007	-----	-----	-----
$S = 7.80\times10^{-3}$ $U_* = 0.271$ fps	.798	2.320	.301	.130	1.111	-----	-----	-----
$W = 1.96$ ft $\tau = 0.202$ lb/ft^2	.697	2.400	.346	.144	1.277	-----	-----	-----
$Q = 1.53$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	2.470	.380	.154	1.402	-----	-----	-----
$T = 21.1$ °C $\mathsf{R} = 73{,}073$	.495	2.500	.450	.180	1.661	-----	-----	-----
$\underline{D} = 0.416$ ft $\underline{F} = 0.513$	.394	2.370	.514	.228	1.897	-----	-----	-----
$\bar{V} = 1.876$ fps $C/\sqrt{g} = 6.923$	.293	2.070	.470	.227	1.734	-----	-----	-----
	.192	1.695	.408	.241	1.506	-----	-----	-----
1/2-Inch Block Roughness, Channel Centerline, Station 10								
	0.899	2.600	0.150	0.058	0.551	-----	-----	-----
$S = 7.80\times10^{-3}$ $U_* = 0.272$ fps	.798	2.575	.167	.065	.614	-----	-----	-----
$W = 1.96$ ft $\tau = 0.204$ lb/ft^2	.697	2.480	.173	.070	.636	-----	-----	-----
$Q = 1.53$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	2.405	.211	.088	.776	-----	-----	-----
$T = 21.1$ °C $\mathsf{R} = 73{,}107$	.495	2.300	.251	.109	.923	-----	-----	-----
$\underline{D} = 0.420$ ft $\underline{F} = 0.506$	.394	2.180	.262	.120	.963	-----	-----	-----
$\bar{V} = 1.859$ fps $C/\sqrt{g} = 6.835$	.293	1.960	.300	.153	1.103	-----	-----	-----
	.192	1.780	.342	.192	1.257	-----	-----	-----
1/2-Inch Block Roughness, 6 Inches From Wall, Station 10								
	0.899	2.405	0.294	0.122	1.081	-----	-----	-----
$S = 7.80\times10^{-3}$ $U_* = 0.272$ fps	.798	2.380	.323	.136	1.188	-----	-----	-----
$W = 1.96$ ft $\tau = 0.204$ lb/ft^2	.697	2.320	.351	.151	1.290	-----	-----	-----
$Q = 1.53$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	2.230	.362	.162	1.331	-----	-----	-----
$T = 21.1$ °C $\mathsf{R} = 73{,}107$	.495	2.105	.370	.176	1.360	-----	-----	-----
$\underline{D} = 0.420$ ft $\underline{F} = 0.506$	.394	2.020	.386	.191	1.419	-----	-----	-----
$\bar{V} = 1.859$ fps $C/\sqrt{g} = 6.835$	.293	1.900	.367	.193	1.349	-----	-----	-----
	.192	1.700	.343	.202	1.261	-----	-----	-----
1/2-Inch Block Roughness, Channel Centerline, Station 15								
	0.899	2.410	0.235	0.098	0.864	-----	-----	-----
$S = 7.80\times10^{-3}$ $U_* = 0.272$ fps	.798	2.395	.277	.116	1.018	-----	-----	-----
$W = 1.96$ ft $\tau = 0.205$ lb/ft^2	.697	2.370	.307	.130	1.129	-----	-----	-----
$Q = 1.53$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	2.320	.320	.138	1.176	-----	-----	-----
$T = 21.1$ °C $\mathsf{R} = 73{,}084$	.495	2.270	.349	.154	1.283	-----	-----	-----
$\underline{D} = 0.421$ ft $\underline{F} = 0.504$	.394	2.160	.376	.174	1.382	-----	-----	-----
$\bar{V} = 1.854$ fps $C/\sqrt{g} = 6.816$	.293	2.050	.411	.200	1.511	-----	-----	-----
	.192	1.740	.474	.272	1.743	-----	-----	-----
1/2-Inch Block Roughness, 6 Inches From Wall, Station 15								
	0.899	2.510	0.289	0.115	1.063	-----	-----	-----
$S = 7.80\times10^{-3}$ $U_* = 0.272$ fps	.798	2.520	.348	.138	1.279	-----	-----	-----
$W = 1.96$ ft $\tau = 0.205$ lb/ft^2	.697	2.510	.360	.143	1.324	-----	-----	-----
$Q = 1.53$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	2.470	.377	.153	1.386	-----	-----	-----
$T = 21.1$ °C $\mathsf{R} = 73{,}084$	.495	2.410	.362	.150	1.331	-----	-----	-----
$\underline{D} = 0.421$ ft $\underline{F} = 0.504$	.394	2.350	.373	.159	1.371	-----	-----	-----
$\bar{V} = 1.854$ fps $C/\sqrt{g} = 6.816$	.293	2.250	.382	.170	1.404	-----	-----	-----
	.192	1.990	.462	.232	1.699	-----	-----	-----
1/2-Inch Block Roughness, Channel Centerline, Station 20								
	0.899	2.405	0.208	0.086	0.768	-----	-----	-----
$S = 7.80\times10^{-3}$ $U_* = 0.271$ fps	.798	2.340	.287	.123	1.059	-----	-----	-----
$W = 1.96$ ft $\tau = 0.202$ lb/ft^2	.697	2.250	.269	.120	.993	-----	-----	-----
$Q = 1.53$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	2.160	.311	.144	1.148	-----	-----	-----
$T = 21.1$ °C $\mathsf{R} = 73{,}073$	.495	2.020	.284	.141	1.048	-----	-----	-----
$\underline{D} = 0.416$ ft $\underline{F} = 0.513$	.394	1.910	.323	.169	1.192	-----	-----	-----
$\bar{V} = 1.876$ fps $C/\sqrt{g} = 6.923$	.293	1.800	.348	.193	1.284	-----	-----	-----
	.192	1.630	.395	.242	1.458	-----	-----	-----
1/2-Inch Block Roughness, 6 Inches From Wall, Station 20								
	0.899	2.415	0.170	0.070	0.627	-----	-----	-----
$S = 7.80\times10^{-3}$ $U_* = 0.271$ fps	.798	2.520	.223	.088	.823	-----	-----	-----
$W = 1.96$ ft $\tau = 0.202$ lb/ft^2	.697	2.610	.286	.110	1.055	-----	-----	-----
$Q = 1.53$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	2.645	.344	.130	1.269	-----	-----	-----
$T = 21.1$ °C $\mathsf{R} = 73{,}073$	.495	2.600	.351	.135	1.295	-----	-----	-----
$\underline{D} = 0.416$ ft $\underline{F} = 0.513$	.394	2.450	.383	.156	1.413	-----	-----	-----
$\bar{V} = 1.876$ fps $C/\sqrt{g} = 6.923$	.293	2.250	.388	.172	1.432	-----	-----	-----
	.192	1.980	.493	.249	1.819	-----	-----	-----

TABLE 3b. — *2-foot-wide flume, rigid boundary, developing flow* — Continued

Mean Flow Parameters and Variables		Y/D	$\bar{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\bar{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)
1/2-Inch Block Roughness, Channel Centerline, Station 25									
		0.899	2.495	0.207	0.083	0.772	-----	-----	-----
$S = 7.80\times10^{-3}$	$U_* = 0.268$ fps	.798	2.410	.262	.109	.978	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.196$ lb/ft^2	.697	2.280	.296	.130	1.104	-----	-----	-----
$Q = 1.53$ cfs	$\nu = 1.068\times10^{5}$ ft^2/sec	.596	2.180	.323	.148	1.205	-----	-----	-----
$T = 21.1$ °C	$\underline{R} = 73{,}098$	.495	2.030	.321	.158	1.198	-----	-----	-----
$\underline{D} = 0.402$ ft	$\underline{F} = 0.540$	.394	1.860	.317	.170	1.183	-----	-----	-----
$\bar{V} = 1.942$ fps	$C/\sqrt{g} = 7.246$	.293	1.710	.314	.184	1.172	-----	-----	-----
		.192	1.410	.263	.187	.981	-----	-----	-----
1/2-Inch Block Roughness, 6 Inches From Wall, Station 25									
		0.899	2.495	0.167	0.067	0.623	-----	-----	-----
$S = 7.80\times10^{-3}$	$U_* = 0.268$ fps	.798	2.570	.228	.089	.851	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.196$ lb/ft^2	.697	2.640	.228	.086	.851	-----	-----	-----
$Q = 1.53$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.596	2.660	.257	.097	.959	-----	-----	-----
$T = 21.1$ °C	$\underline{R} = 73{,}098$	.495	2.595	.268	.103	1.000	-----	-----	-----
$\underline{D} = 0.402$ ft	$\underline{F} = 0.540$	.394	2.390	.375	.157	1.399	-----	-----	-----
$\bar{V} = 1.942$ fps	$C/\sqrt{g} = 7.246$	.293	2.050	.389	.190	1.451	-----	-----	-----
		.192	1.530	.390	.255	1.455	-----	-----	-----
1/2-Inch Block Roughness, Channel Centerline, Station 30									
		0.899	2.310	0.290	0.126	1.082	-----	-----	-----
$S = 7.80\times10^{-3}$	$U_* = 0.268$ fps	.798	2.215	.315	.142	1.175	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.197$ lb/ft^2	.697	2.100	.330	.157	1.231	-----	-----	-----
$Q = 1.53$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.596	1.950	.328	.168	1.224	-----	-----	-----
$T = 21.1$ °C	$\underline{R} = 73{,}083$	.495	1.810	.348	.192	1.299	-----	-----	-----
$\underline{D} = 0.404$ ft	$\underline{F} = 0.536$	.394	1.690	.322	.191	1.201	-----	-----	-----
$\bar{V} = 1.932$ fps	$C/\sqrt{g} = 7.209$	.293	1.500	.305	.203	1.138	-----	-----	-----
		.192	1.390	.327	.235	1.220	-----	-----	-----
1/2-Inch Block Roughness, 6 Inches From Wall, Station 30									
		0.899	2.495	0.167	0.067	0.623	-----	-----	-----
$S = 7.80\times10^{-3}$	$U_* = 0.268$ fps	.798	2.590	.161	.062	.601	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.197$ lb/ft^2	.697	2.640	.214	.081	.799	-----	-----	-----
$Q = 1.53$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.596	2.630	.214	.081	.799	-----	-----	-----
$T = 21.1$ °C	$\underline{R} = 73{,}083$	.495	2.530	.277	.110	1.034	-----	-----	-----
$\underline{D} = 0.404$ ft	$\underline{F} = 0.536$	.394	2.330	.341	.146	1.272	-----	-----	-----
$\bar{V} = 1.932$ fps	$C/\sqrt{g} = 7.209$	.293	2.060	.398	.193	1.485	-----	-----	-----
		.192	1.615	.391	.242	1.459	-----	-----	-----
1/2-Inch Block Roughness, Channel Centerline, Station 35									
		0.899	2.250	0.271	0.120	1.007	-----	-----	-----
$S = 7.80\times10^{-3}$	$U_* = 0.269$ fps	.798	2.125	.304	.143	1.130	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.199$ lb/ft^2	.697	2.000	.313	.157	1.164	-----	-----	-----
$Q = 1.53$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.596	1.860	.270	.145	1.004	-----	-----	-----
$T = 21.1$ °C	$\underline{R} = 73{,}081$	.495	1.750	.315	.180	1.171	-----	-----	-----
$\underline{D} = 0.408$ ft	$\underline{F} = 0.528$	.394	1.600	.283	.177	1.052	-----	-----	-----
$\bar{V} = 1.913$ fps	$C/\sqrt{g} = 7.112$	.293	1.400	.255	.182	.948	-----	-----	-----
		.192	1.260	.269	.213	1.000	-----	-----	-----
1/2-Inch Block Roughness, 6 Inches From Wall, Station 35									
		0.899	2.405	0.219	0.091	0.814	-----	-----	-----
$S = 7.80\times10^{-3}$	$U_* = 0.269$ fps	.798	2.520	.222	.088	.825	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.199$ lb/ft^2	.697	2.600	.230	.088	.855	-----	-----	-----
$Q = 1.53$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.596	2.630	.235	.089	.874	-----	-----	-----
$T = 21.1$ °C	$\underline{R} = 73{,}081$	.495	2.590	.273	.105	1.015	-----	-----	-----
$\underline{D} = 0.408$ ft	$\underline{F} = 0.528$	.394	2.410	.335	.139	1.245	-----	-----	-----
$\bar{V} = 1.913$ fps	$C/\sqrt{g} = 7.112$	.293	2.220	.404	.182	1.502	-----	-----	-----
		.192	1.830	.431	.236	1.602	-----	-----	-----
1/2-Inch Block Roughness, Channel Centerline, Station 40									
		0.899	2.150	0.268	0.125	0.992	0.320	0.688	0.0154
$S = 7.80\times10^{-3}$	$U_* = 0.270$ fps	.798	2.100	.304	.145	1.126	.361	.758	.0142
$W = 1.96$ ft	$\tau = 0.201$ lb/ft^2	.697	2.020	.313	.155	1.159	.262	.529	.0132
$Q = 1.53$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.596	1.950	.335	.172	1.241	.267	.520	.0129
$T = 21.1$ °C	$\underline{R} = 73{,}087$	.495	1.870	.336	.180	1.244	.318	.595	.0121
$\underline{D} = 0.413$ ft	$\underline{F} = 0.518$	.394	1.755	.348	.198	1.289	.314	.552	.0117
$\bar{V} = 1.890$ fps	$C/\sqrt{g} = 7.000$	.293	1.660	.344	.207	1.274	.262	.435	.0106
		.192	1.500	.345	.230	1.278	.358	.537	.0085
1/2-Inch Block Roughness, 6 Inches From Wall, Station 40									
		0.899	2.405	0.274	0.114	1.015	0.209	0.503	0.0171
$S = 7.80\times10^{-3}$	$U_* = 0.270$ fps	.798	2.480	.301	.121	1.115	.254	.630	.0168
$W = 1.96$ ft	$\tau = 0.201$ lb/ft^2	.697	2.510	.311	.124	1.152	.156	.392	.0163
$Q = 1.53$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.596	2.520	.311	.124	1.152	.151	.380	.0154
$T = 21.1$ °C	$\underline{R} = 73{,}087$	.495	2.455	.366	.127	1.356	.183	.449	.0147
$\underline{D} = 0.413$ ft	$\underline{F} = 0.518$	.394	2.300	.373	.162	1.381	.297	.683	.0129
$\bar{V} = 1.890$ fps	$C/\sqrt{g} = 7.000$	.293	1.990	.390	.196	1.444	.198	.394	.0098
		.192	1.480	.383	.259	1.419	.192	.284	.0089
1/2-Inch Block Roughness, Channel Centerline, Station 45									
		0.899	2.285	0.190	0.083	0.701	0.348	0.795	0.0153
$S = 7.80\times10^{-3}$	$U_* = 0.271$ fps	.798	2.250	.216	.096	.797	.208	.468	.0141
$W = 1.96$ ft	$\tau = 0.203$ lb/ft^2	.697	2.150	.225	.105	.830	.427	.918	.0146
$Q = 1.53$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.596	2.100	.228	.109	.841	.212	.445	.0138
$T = 21.1$ °C	$\underline{R} = 73{,}092$	.495	2.000	.237	.119	.875	.348	.696	.0135
$\underline{D} = 0.417$ ft	$\underline{F} = 0.511$	.394	1.910	.252	.132	.930	.290	.554	.0127
$\bar{V} = 1.872$ fps	$C/\sqrt{g} = 6.908$	.293	1.815	.290	.160	1.070	.136	.247	.0131
		.192	1.640	.342	.209	1.262	.144	.236	.0116

TABLE 3b. — *2-foot-wide flume, rigid boundary, developing flow* — Continued

Mean Flow Parameters and Variables	Y/D	$\bar{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\bar{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)
1/2-Inch Block Roughness, 6 Inches From Wall, Station 45								
	0.899	2.300	0.256	0.111	0.945	0.175	0.403	0.0165
$S = 7.80\times10^{-3}$ $U_* = 0.271$ fps	.698	2.420	.275	.114	1.015	.173	.418	.0148
$W = 1.96$ ft $\tau = 0.203$ lb/ft^2	.697	2.480	.285	.115	1.052	.226	.560	.0152
$Q = 1.53$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	2.480	.298	.120	1.100	.198	.491	.0144
$T = 21.1$ °C **R** = 73,092	.495	2.420	.325	.134	1.199	.187	.453	.0131
$D = 0.417$ ft **F** = 0.511	.394	2.300	.342	.149	1.262	.202	.465	.0129
$V = 1.872$ fps $C/\sqrt{g} = 6.908$	.293	1.990	.353	.177	1.303	.176	.350	.0109
	.192	1.530	.417	.273	1.539	.200	.236	.0101
1/2-Inch Block Roughness, Channel Centerline, Station 5								
	0.899	3.000	0.377	0.126	1.019	0.148	0.444	0.0200
$S = 14.57\times10^{-3}$ $U_* = 0.370$ fps	.798	3.090	.408	.132	1.103	.214	.661	.0201
$W = 1.96$ ft $\tau = 0.376$ lb/ft^2	.697	3.105	.387	.125	1.046	.194	.603	.0186
$Q = 2.10$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	3.140	.405	.129	1.095	.193	.606	.0189
$T = 21.1$ °C **R** = 100,321	.495	3.050	.416	.136	1.124	.158	.492	.0166
$\underline{D} = 0.414$ ft **F** = 0.709	.394	2.840	.450	.158	1.216	.172	.488	.0154
$\bar{V} = 2.588$ fps $C/\sqrt{g} = 6.995$	.293	2.480	.464	.187	1.254	.151	.374	.0143
	.192	2.050	.528	.258	1.427	.160	.328	.0136
1/2-Inch Block Roughness, 6 Inches From Wall, Station 5								
	0.899	3.310	0.425	0.128	1.149	0.187	0.618	0.0226
$S = 14.57$ 10^{-3} $U_* = 0.370$ fps	.798	3.480	.433	.124	1.170	.160	.556	.0217
$W = 1.96$ ft $\tau = 0.376$ lb/ft^2	.697	3.530	.465	.132	1.257	.161	.568	.0229
$Q = 2.10$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	3.480	.508	.146	1.373	.205	.714	.0206
$T = 21.1$ °C **R** = 100,321	.495	3.295	.527	.160	1.424	.354	1.164	.0213
$\underline{D} = 0.414$ ft **F** = 0.709	.394	2.930	.569	.194	1.538	.273	.800	.0184
$\bar{V} = 2.588$ fps $C/\sqrt{g} = 6.995$	.293	2.580	.591	.229	1.597	.136	.352	.0169
	.192	2.140	.547	.256	1.478	.189	.405	.0146
1/2-Inch Block Roughness, Channel Centerline, Station 10								
	0.899	3.515	0.300	0.085	0.813	0.246	0.867	0.0306
$S = 14.57\times10^{-3}$ $U_* = 0.369$ fps	.798	3.320	.375	.113	1.016	.161	.535	.0273
$W = 1.96$ ft $\tau = 0.374$ lb/ft^2	.697	3.130	.422	.135	1.144	.140	.438	.0222
$Q = 2.10$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	2.810	.465	.165	1.260	.133	.374	.0197
$T = 21.1$ °C **R** = 100,326	.495	2.600	.494	.190	1.339	.153	.398	.0173
$\underline{D} = 0.411$ ft **F** = 0.717	.394	2.310	.485	.210	1.314	.167	.386	.0154
$\bar{V} = 2.607$ fps $C/\sqrt{g} = 7.065$	.293	2.000	.470	.235	1.274	.238	.476	.0133
	.192	1.605	.399	.249	1.081	.213	.342	.0119
1/2-Inch Block Roughness, 6 Inches From Wall, Station 10								
	0.899	3.200	0.189	0.059	0.512	0.185	0.592	0.0277
$S = 14.57\times10^{-3}$ $U_* = 0.369$ fps	.798	3.180	.226	.071	.721	.222	.706	.0268
$W = 1.96$ ft $\tau = 0.374$ lb/ft^2	.697	3.150	.278	.088	.753	.159	.500	.0252
$Q = 2.10$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	3.120	.304	.097	.824	.205	.640	.0261
$T = 21.1$ °C **R** = 100,326	.495	3.060	.332	.108	.900	.215	.657	.0247
$\underline{D} = 0.411$ ft **F** = 0.717	.394	2.990	.359	.120	.973	.210	.625	.0233
$\bar{V} = 2.607$ fps $C/\sqrt{g} = 7.065$	.293	2.840	.405	.143	1.098	.247	.701	.0223
	.192	2.530	.489	.193	1.325	.262	.663	.0219
1/2-Inch Block Roughness, Channel Centerline, Station 15								
	0.899	3.110	0.421	0.135	1.132	-----	-----	-----
$S = 14.57\times10^{-3}$ $U_* = 0.372$ fps	.798	3.000	.519	.173	1.395	-----	-----	-----
$W = 1.96$ ft $\tau = 0.384$ lb/ft^2	.697	2.850	.550	.193	1.478	-----	-----	-----
$Q = 2.10$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	2.640	.581	.196	1.562	-----	-----	-----
$T = 21.1$ °C **R** = 100,324	.495	2.450	.574	.234	1.543	-----	-----	-----
$\underline{D} = 0.422$ ft **F** = 0.689	.394	2.180	.568	.261	1.527	-----	-----	-----
$\bar{V} = 2.539$ fps $C/\sqrt{g} = 6.825$	.293	2.040	.563	.276	1.513	-----	-----	-----
	.192	1.415	.380	.269	1.022	-----	-----	-----
1/2-Inch Block Roughness, 6 Inches From Wall, Station 15								
	0.899	3.380	0.164	0.049	0.441	-----	-----	-----
$S = 14.57\times10^{-3}$ $U_* = 0.372$ fps	.798	3.400	.169	.050	.454	-----	-----	-----
$W = 1.96$ ft $\tau = 0.384$ lb/ft^2	.697	3.390	.194	.057	.522	-----	-----	-----
$Q = 2.10$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	3.330	.200	.060	.538	-----	-----	-----
$T = 21.1$ °C **R** = 100,324	.495	3.220	.270	.084	.726	-----	-----	-----
$\underline{D} = 0.422$ ft **F** = 0.689	.394	3.130	.337	.108	.906	-----	-----	-----
$\bar{V} = 2.539$ fps $C/\sqrt{g} = 6.825$	.293	2.935	.456	.159	1.226	-----	-----	-----
	.192	2.700	.381	.141	1.024	-----	-----	-----
1/2-Inch Block Roughness, Channel Centerline, Station 20								
	0.899	3.010	0.389	0.129	1.049	-----	-----	-----
$S = 14.57\times10^{-3}$ $U_* = 0.371$ fps	.798	2.805	.422	.150	1.137	-----	-----	-----
$W = 1.96$ ft $\tau = 0.380$ lb/ft^2	.697	2.600	.445	.171	1.199	-----	-----	-----
$Q = 2.10$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	2.360	.440	.186	1.186	-----	-----	-----
$T = 21.1$ °C **R** = 100,312	.495	2.100	.402	.191	1.084	-----	-----	-----
$\underline{D} = 0.418$ ft **F** = 0.699	.394	1.910	.388	.203	1.046	-----	-----	-----
$\bar{V} = 2.563$ fps $C/\sqrt{g} = 6.908$	.293	1.720	.337	.196	.908	-----	-----	-----
	.192	1.400	.336	.240	.906	-----	-----	-----

TABLE 3b. — *2-foot-wide flume, rigid boundary, developing flow* — Continued

Mean Flow Parameters and Variables		Y/D	$\bar{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\bar{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)
1/2-Inch Block Roughness, 6 Inches From Wall, Station 20									
		0.899	3.400	0.278	0.082	0.749	-----	-----	-----
$S = 14.57\times10^{-3}$	$U_* = 0.371$ fps	.798	3.530	.242	.068	.652	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.380$ lb/ft^2	.697	3.570	.247	.069	.666	-----	-----	-----
$Q = 2.10$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.596	3.560	.245	.069	.660	-----	-----	-----
$T = 21.1$ °C	R = 100,312	.495	3.490	.283	.081	.763	-----	-----	-----
$\bar{D} = 0.418$ ft	F = 0.699	.394	3.270	.368	.113	.992	-----	-----	-----
$\bar{V} = 2.563$ fps	$C/\sqrt{g} = 6.908$	.293	2.850	.463	.162	1.248	-----	-----	-----
		.192	2.390	.598	.250	1.612	-----	-----	-----
1/2-Inch Block Roughness, Channel Centerline, Station 25									
		0.899	2.860	0.344	0.120	0.937	-----	-----	-----
$S = 14.57\times10^{-3}$	$U_* = 0.367$ fps	.798	2.780	.390	.140	1.063	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.370$ lb/ft^2	.697	2.675	.437	.163	1.191	-----	-----	-----
$Q = 2.10$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.596	2.600	.489	.188	1.332	-----	-----	-----
$T = 21.1$ °C	R = 101,483	.495	2.470	.472	.191	1.286	-----	-----	-----
$\bar{D} = 0.407$ ft	F = 0.736	.394	2.260	.411	.182	1.120	-----	-----	-----
$\bar{V} = 2.633$ fps	$C/\sqrt{g} = 7.256$	.293	2.020	.433	.214	1.180	-----	-----	-----
		.192	1.580	.325	.206	.886	-----	-----	-----
1/2-Inch Block Roughness, 6 Inches From Wall, Station 25									
		0.899	3.390	0.194	0.057	0.529	-----	-----	-----
$S = 14.57\times10^{-3}$	$U_* = 0.367$ fps	.798	3.490	.206	.059	.561	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.370$ lb/ft^2	.697	3.520	.203	.058	.553	-----	-----	-----
$Q = 2.10$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.596	3.480	.208	.060	.567	-----	-----	-----
$T = 21.1$ °C	R = 101,483	.495	3.370	.310	.092	.845	-----	-----	-----
$\bar{D} = 0.407$ ft	F = 0.736	.394	3.090	.421	.136	1.147	-----	-----	-----
$\bar{V} = 2.633$ fps	$C/\sqrt{g} = 7.256$	.293	2.615	.513	.196	1.398	-----	-----	-----
		.192	1.680	.452	.269	1.232	-----	-----	-----
1/2-Inch Block Roughness, Channel Centerline, Station 30									
		0.899	2.910	0.390	0.134	1.057	-----	-----	-----
$S = 14.57\times10^{-3}$	$U_* = 0.369$ fps	.798	2.850	.428	.150	1.160	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.375$ lb/ft^2	.697	2.700	.462	.171	1.252	-----	-----	-----
$Q = 2.10$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.596	2.530	.455	.180	1.233	-----	-----	-----
$T = 21.1$ °C	R = 100,338	.495	2.370	.453	.191	1.228	-----	-----	-----
$\bar{D} = 0.412$ ft	F = 0.714	.394	2.220	.506	.228	1.371	-----	-----	-----
$\bar{V} = 2.601$ fps	$C/\sqrt{g} = 7.049$	.293	1.950	.476	.244	1.290	-----	-----	-----
		.192	1.680	.442	.263	1.198	-----	-----	-----
1/2-Inch Block Roughness, 6 Inches From Wall, Station 30									
		0.899	3.520	0.206	0.059	0.558	-----	-----	-----
$S = 14.57\times10^{-3}$	$U_* = 0.369$ fps	.798	3.650	.203	.056	.550	-----	-----	-----
$W = 1.96$ ft	$\tau = 0.375$ lb/ft^2	.697	3.690	.209	.057	.566	-----	-----	-----
$Q = 2.10$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.596	3.640	.244	.067	.661	-----	-----	-----
$T = 21.1$ °C	R = 100,338	.495	3.475	.366	.105	.992	-----	-----	-----
$\bar{D} = 0.412$ ft	F = 0.714	.394	3.110	.492	.158	1.333	-----	-----	-----
$\bar{V} = 2.601$ fps	$C/\sqrt{g} = 7.049$	.293	2.700	.570	.211	1.545	-----	-----	-----
		.192	1.820	.454	.249	1.230	-----	-----	-----
1/2-Inch Block Roughness, Channel Centerline, Station 35									
		0.899	3.020	0.405	0.135	1.098	0.275	0.830	0.0236
$S = 14.57\times10^{-3}$	$U_* = 0.369$ fps	.798	2.905	.447	.154	1.211	.297	.865	.0232
$W = 1.96$ ft	$\tau = 0.375$ lb/ft^2	.697	2.750	.424	.154	1.149	.320	.880	.0227
$Q = 2.10$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.596	2.610	.481	.182	1.304	.403	.836	.0209
$T = 21.1$ °C	R = 100,338	.495	2.470	.462	.187	1.252	.266	.656	.0184
$\bar{D} = 0.412$ ft	F = 0.714	.394	2.270	.476	.210	1.290	.161	.366	.0158
$\bar{V} = 2.601$ fps	$C/\sqrt{g} = 7.049$	.293	2.050	.459	.224	1.244	.258	.529	.0134
		.192	1.820	.505	.277	1.369	.276	.503	.0123
1/2-Inch Block Roughness, 6 Inches From Wall, Station 35									
		0.899	3.370	0.311	0.092	0.843	0.301	1.013	0.0294
$S = 14.57\times10^{-3}$	$U_* = 0.369$ fps	.798	3.540	.309	.087	.837	.171	.606	.0306
$W = 1.96$ ft	$\tau = 0.375$ lb/ft^2	.697	3.600	.290	.081	.786	.286	1.030	.0283
$Q = 2.10$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.596	3.600	.284	.079	.770	.190	.684	.0266
$T = 21.1$ °C	R = 100,338	.495	3.500	.341	.097	.924	.322	1.126	.0242
$\bar{D} = 0.412$ ft	F = 0.714	.394	3.250	.422	.130	1.144	.235	.764	.0209
$\bar{V} = 2.601$ fps	$C/\sqrt{g} = 7.049$	.293	2.810	.515	.183	1.396	.223	.627	.0198
		.192	2.200	.587	.267	1.591	.249	.548	.0192
1/2-Inch Block Roughness, Channel Centerline, Station 40									
		0.899	3.020	0.397	0.131	1.076	0.238	0.719	0.0230
$S = 14.57\times10^{-3}$	$U_* = 0.369$ fps	.798	2.900	.410	.141	1.111	.388	1.125	.0244
$W = 1.96$ ft	$\tau = 0.375$ lb/ft^2	.697	2.830	.428	.151	1.160	.274	.776	.0217
$Q = 2.10$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.596	2.700	.451	.167	1.222	.327	.883	.0194
$T = 21.1$ °C	R = 100,338	.495	2.610	.478	.183	1.295	.318	.830	.0168
$\bar{D} = 0.412$ ft	F = 0.714	.394	2.470	.490	.198	1.328	.316	.780	.0151
$\bar{V} = 2.601$ fps	$C/\sqrt{g} = 7.049$	.293	2.300	.487	.212	1.320	.230	.529	.0137
		.192	1.825	.457	.250	1.238	.318	.580	.0120
1/2-Inch Block Roughness, 6 Inches From Wall, Station 40									
		0.899	3.390	0.271	0.080	0.734	0.341	1.157	0.0314
$S = 14.57\times10^{-3}$	$U_* = 0.369$ fps	.798	3.500	.255	.073	.691	.254	.888	.0327
$W = 1.96$ ft	$\tau = 0.375$ lb/ft^2	.697	3.530	.259	.073	.702	.183	.646	.0294
$Q = 2.10$ cfs	$\nu = 1.068\times10^{-5}$ ft^2/sec	.596	3.500	.278	.079	.753	.314	1.099	.0285
$T = 21.1$ °C	R = 100,338	.495	3.400	.356	.105	.965	.298	1.018	.0276
$\bar{D} = 0.412$ ft	F = 0.714	.394	3.100	.445	.144	1.206	.246	.762	.0241
$\bar{V} = 2.601$ fps	$C/\sqrt{g} = 7.049$	.293	2.670	.520	.195	1.409	.294	.785	.0198
		.192	2.320	.750	.323	2.033	.388	.900	.0177

TABLE 3b. — *2-foot-wide flume, rigid boundary, developing flow* — Continued

Mean Flow Parameters and Variables	Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)
1/2-Inch Block Roughness, Channel Centerline, Station 45								
	0.899	3.030	0.342	0.113	0.924	0.369	1.118	0.0252
$S = 14.57\times10^{-3}$ $U_* = 0.370$ fps	.798	3.010	.395	.132	1.068	.451	1.356	.0255
$W = 1.96$ ft $\tau = 0.378$ lb/ft^2	.697	2.910	.400	.137	1.081	.255	.743	.0226
$Q = 2.10$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	2.800	.407	.145	1.100	.218	.610	.0241
$T = 21.1$ °C R = 100,338	.495	2.710	.442	.163	1.195	.325	.881	.0192
$D = 0.416$ ft F = 0.704	.394	2.570	.442	.172	1.195	.377	.970	.0180
$\overline{V} = 2.576$ fps $C/\sqrt{g} = 6.962$	.293	2.420	.430	.178	1.162	.301	.729	.0172
	.192	2.280	.490	.215	1.324	.372	.849	.0164
1/2-Inch Block Roughness, 6 Inches From Wall, Station 45								
	0.899	3.260	0.268	0.082	0.724	0.313	1.020	0.0302
$S = 14.57\times10^{-3}$ $U_* = 0.370$ fps	.798	3.405	.275	.081	.743	.225	.766	.0320
$W = 1.96$ ft $\tau = 0.378$ lb/ft^2	.697	3.450	.271	.079	.732	.405	1.397	.0308
$Q = 2.10$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.596	3.415	.297	.087	.803	.440	1.500	.0277
$T = 21.1$ °C R = 100,338	.495	3.300	.351	.106	.949	.467	1.584	.0233
$D = 0.416$ ft F = 0.704	.394	3.050	.400	.131	1.081	.464	1.413	.0206
$\overline{V} = 2.576$ fps $C/\sqrt{g} = 6.962$	.293	2.620	.460	.176	1.243	.501	1.311	.0183
	.192	2.020	.475	.235	1.284	.245	.495	.0148

TABLE 3c. — *2-foot-wide flume, rigid boundary, yawed-film results*

Mean flow parameters and variables	Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	$\sqrt{\overline{v^2}}$ (fps)	$\sqrt{\overline{v^2}}/\overline{U}$	$\sqrt{\overline{v^2}}/U_*$	Measured $\rho\,\overline{uv}$ (lbs/ft^2)	Calculated $\rho\,\overline{uv}$ (lbs/ft^2)	$\overline{uv}/\overline{U}^2$	$\overline{uv}/U_*^2$
Station 6 feet - 3 inches right of centerline												
$S = 5.04\times10^{-3}$ $U_* = 0.216$ fps	0.900	1.550	0.170	0.110	0.790	0.136	0.088	0.630	0.0103	.0128	0.002	0.114
$W = 1.96$ ft $\tau = 0.128$ lb/ft^2	.800	1.530	.170	.111	.790	.132	.086	.612	.0274	.0246	.006	.302
$Q = 0.78$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.700	1.520	.171	.113	.800	.139	.091	.644	.0338	.0384	.008	.373
$T = 21.1$ °C R = 37,250	.600	1.450	.178	.123	.820	.143	.099	.663	.0417	.0512	.010	.461
$D = 0.408$ ft F = 0.269	.500	1.380	.220	.160	1.020	.177	.128	.818	.0621	.0641	.017	.686
$\overline{V} = 0.975$ fps $C/\sqrt{g} = 4.51$	.400	1.260	.221	.175	1.020	.168	.133	.778	.0645	.0768	.021	.712
	.340	1.190	.219	.184	1.010	.174	.146	.806	.0672	.0842	.024	.742
	.280	1.120	.217	.193	1.008	.171	.152	.792	.0508	.0919	.021	.561
	.220	1.040	.237	.227	1.094	.181	.174	.840	.0293	.0996	.014	.324
Station 15 feet - 3 inches right of centerline												
$S = 5.04\times10^{-3}$ $U_* = 0.216$ fps	.900	1.520	.165	.108	.764	.127	.084	.590	.0335	.0128	0.007	0.370
$W = 1.96$ ft $\tau = 0.128$ lb/ft^2	.800	1.480	.182	.123	.843	.139	.094	.645	.0399	.0246	.009	.441
$Q = 0.78$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.700	1.450	.199	.137	.922	.161	.111	.746	.0477	.0384	.012	.527
$T = 21.1$ °C R = 37,250	.600	1.430	.204	.143	.945	.158	.101	.732	.0596	.0512	.015	.658
$D = 0.408$ ft F = 0.269	.500	1.400	.216	.154	1.000	.173	.124	.801	.0704	.0641	.019	.778
$\overline{V} = 0.975$ fps $C/\sqrt{g} = 4.51$	.400	1.250	.213	.170	.986	.166	.132	.768	.0761	.0768	.025	.841
	.340	1.170	.196	.167	.908	.170	.145	.788	.0734	.0842	.028	.811
	.280	1.040	.188	.181	.872	.155	.149	.718	.0762	.0919	.036	.842
	.220	.880	.193	.219	.894	.149	.170	.691	.0583	.0996	.039	.644
Station 6 feet - 3 inches right of centerline												
$S = 13.25\times10^{-3}$ $U_* = 0.350$ fps	.900	2.390	.260	.108	.744	.196	.082	.560	.0288	.0335	0.003	0.121
$W = 1.96$ ft $\tau = 0.335$ lb/ft^2	.800	2.300	.282	.123	.805	.231	.101	.659	.0470	.0670	.005	.198
$Q = 1.21$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.700	2.200	.301	.136	.860	.246	.112	.703	.0935	.1005	.010	.393
$T = 21.1$ °C R = 57,800	.600	2.030	.347	.171	.992	.268	.132	.766	.1334	.1340	.017	.561
$D = 0.405$ ft F = 0.422	.500	1.800	.370	.205	1.056	.302	.167	.863	.1440	.1675	.023	.606
$\overline{V} = 1.524$ fps $C/\sqrt{g} = 4.35$	.400	1.590	.383	.241	1.093	.297	.186	.848	.1458	.2001	.030	.614
	.340	1.430	.377	.263	1.079	.304	.212	.870	.1386	.2171	.035	.583
	.280	1.230	.319	.259	.913	.273	.222	.780	.0953	.2370	.033	.401
	.220	1.010	.307	.304	.877	.255	.253	.730	.0616	.2568	.031	.259
Station 15 feet - 3 inches right of centerline												
$S = 13.25\times10^{-3}$ $U_* = 0.350$ fps	.900	2.400	.281	.117	.803	.232	.097	.663	.0490	.0335	0.004	0.206
$W = 1.96$ ft $\tau = 0.335$ lb/ft^2	.800	2.340	.283	.121	.809	.226	.097	.645	.0622	.0670	.007	.262
$Q = 1.21$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.700	2.290	.337	.147	.964	.263	.115	.751	.0873	.1005	.009	.367
$T = 21.1$ °C R = 57,800	.600	2.210	.348	.158	.995	.278	.126	.795	.1337	.1340	.014	.562
$D = 0.405$ ft F - 0.422	.500	2.110	.421	.200	1.121	.324	.153	.925	.1408	.1675	.016	.592
$\overline{V} = 1.524$ fps $C/\sqrt{g} = 4.35$	.400	2.030	.352	.173	1.005	.298	.147	.853	.1423	.2001	.018	.599
	.340	1.950	.374	.192	1.070	.305	.156	.873	.1481	.2171	.020	.623
	.280	1.880	.339	.180	.970	.286	.153	.816	.1415	.2370	.021	.595
	.220	1.790	.326	.183	.933	.253	.141	.724	.1189	.2568	.019	.500
Station 6 feet - 3 inches right of centerline												
$S = 20.54\times10^{-3}$ $U_* = 0.438$ fps												
$W = 1.96$ ft $\tau = 0.527$ lb/ft^2	.800	2.880	.336	.116	.766	.247	.086	.564	.1025	.1054	0.006	0.275
$Q = 1.56$ cfs $\nu = 1.068\times10^{-5}$ ft^2/sec	.700	2.740	.371	.135	.848	.303	.115	.693	.1454	.1580	.010	.425
$T = 21.1$ °C R = 74,540	.600	2.600	.404	.155	.922	.331	.127	.755	.1827	.2108	.014	.491
$D = 0.411$ ft F = 0.532	.500	2.400	.483	.201	1.112	.387	.161	.883	.2364	.2637	.021	.635
$\overline{V} = 1.937$ fps $C/\sqrt{g} = 4.42$	.400	2.000	.566	.283	1.291	.472	.235	1.078	.3116	.3161	.040	.837
	.340	1.720	.613	.356	1.400	.496	.288	1.132	.2849	.3489	.050	.766
	.280	1.360	.587	.432	1.340	.458	.337	1.050	.2017	.3820	.056	.542
	.220	.980	.553	.564	1.262	.419	.427	.956	.1523	.4133	.082	.409

Note: Scales of turbulence are given in table 3b.

TABLE 3c. — *2-foot-wide flume, rigid boundary, yawed-film results* — Continued

Mean flow parameters and variables		Y/D	$\bar{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\bar{U}$	$\sqrt{\overline{u^2}}/U_*$	$\sqrt{\overline{v^2}}$ (fps)	$\sqrt{\overline{v^2}}/\bar{U}$	$\sqrt{\overline{v^2}}/U_*$	Measured $\rho\,\overline{uv}$ (lbs/ft²)	Calculated $\rho\,\overline{uv}$ (lbs/ft²)	$\overline{uv}/\bar{U}^2$	$\overline{uv}/U_*^2$
Station 15 feet - 3 inches right of centerline													
$S = 20.54\times10^{-3}$	$U_* = 0.438$ fps	.900	2.930	.545	.186	1.244	.441	.150	1.004	.0422	.0527	0.003	0.113
$W = 1.96$ ft	$\tau = 0.527$ lb/ft²	.800	2.840	.495	.175	1.130	.398	.140	.907	.0941	.1054	.006	.253
$Q = 1.56$ cfs	$\nu = 1.068\times10^{-5}$ ft²/sec	.700	2.700	.536	.198	1.222	.426	.158	.973	.1311	.1580	.009	.352
$T = 21.1$ °C	$R = 74{,}540$	.600	2.660	.539	.203	1.227	.444	.166	1.012	.1910	.2108	.014	.513
$D = 0.411$ ft	$F = 0.532$	.500	2.550	.597	.234	1.360	.473	.186	1.080	.2365	.2637	.019	.635
$\bar{V} = 1.937$ fps	$C/\sqrt{g} = 4.42$	.400	2.360	.614	.260	1.400	.502	.212	1.142	.2880	.3161	.027	.774
		.340	2.220	.609	.274	1.386	.486	.219	1.109	.2722	.3489	.028	.731
		.280	2.090	.626	.300	1.430	.477	.228	1.088	.2708	.3820	.032	.728
Station 6 feet - 6 inches right of centerline													
$S = 2.95\times10^{-3}$	$U_* = 0.164$ fps	.900	1.370	.163	.119	.994	.131	.096	.798	.0101	.0074	0.004	0.194
$W = 1.96$ ft	$\tau = 0.073$ lb/ft²	.800	1.420	.179	.126	1.091	.147	.103	.897	.0160	.0147	.004	.307
$Q = 0.88$ cfs	$\nu = 1.068\times10^{-5}$ ft²/sec	.700	1.440	.200	.139	1.220	.165	.114	1.004	.0258	.0221	.006	.495
$T = 21.1$ °C	$R = 42{,}030$	.600	1.450	.216	.149	1.316	.172	.119	1.048	.0394	.0294	.010	.755
$D = 0.399$ ft	$F = 0.314$	.500	1.400	.224	.160	1.365	.184	.131	1.121	.0478	.0368	.013	.916
$\bar{V} = 1.125$ fps	$C/\sqrt{g} = 6.86$	.400	1.300	.192	.148	1.172	.176	.136	1.073	.0403	.0431	.012	.773
		.340	1.240	.187	.151	1.141	.163	.131	.993	.0389	.0486	.013	.746
		.280	1.130	.183	.162	1.118	.144	.128	.878	.0275	.0537	.011	.527
		.220	1.002	.152	.152	.928	.118	.108	.721	.0172	.0580	.009	.330
Station 15 feet - 6 inches right of centerline													
$S = 2.95\times10^{-3}$	$U_* = 0.164$ fps	.900	1.370	.143	.104	.872	.107	.078	.654	.0088	.0074	0.002	0.169
$W = 1.96$ ft	$\tau = 0.073$ lb/ft²	.800	1.390	.160	.115	.976	.119	.086	.726	.0154	.0147	.004	.295
$Q = 0.88$ cfs	$\nu = 1.068\times10^{-5}$ ft²/sec	.700	1.420	.185	.130	1.126	.148	.104	.903	.0263	.0221	.007	.504
$T = 21.1$ °C	$R = 42{,}030$	.600	1.430	.207	.144	1.261	.173	.121	1.054	.0316	.0294	.008	.606
$D = 0.399$ ft	$F = 0.314$	.500	1.420	.226	.159	1.378	.179	.126	1.092	.0405	.0368	.010	.776
$\bar{V} = 1.125$ fps	$C/\sqrt{g} = 6.86$	.400	1.380	.252	.182	1.540	.193	.140	1.177	.0437	.0431	.012	.838
		.340	1.340	.248	.185	1.511	.196	.146	1.195	.0419	.0486	.012	.803
		.280	1.240	.241	.195	1.468	.188	.152	1.147	.0398	.0537	.013	.763
		.220	1.150	.237	.206	1.445	.175	.152	1.067	.0366	.0580	.014	.701
Station 6 feet - 6 inches right of centerline													
$S = 7.80\times10^{-3}$	$U_* = 0.272$ fps	0.900	2.230	0.273	0.122	1.003	0.194	0.087	0.713	.0196	.0380	0.002	0.137
$W = 1.96$ ft	$\tau = 0.205$ lb/ft²	.800	2.320	.301	.130	1.104	.227	.098	.835	.0383	.0760	.004	.267
$Q = 1.53$ cfs	$\nu = 1.068\times10^{-5}$ ft²/sec	.700	2.400	.346	.144	1.272	.273	.114	1.003	.0429	.1140	.004	.299
$T = 21.1$ °C	$R = 73{,}084$	.600	2.470	.380	.154	1.396	.306	.124	1.125	.0637	.1520	.005	.444
$D = 0.421$ ft	$F = 0.504$	.500	2.500	.450	.180	1.650	.344	.138	1.266	.0738	.1900	.006	.514
$\bar{V} = 1.854$ fps	$C/\sqrt{g} = 6.82$	.400	2.370	.514	.216	1.900	.398	.168	1.464	.1061	.2280	.010	.739
		.340	2.200	.497	.226	1.825	.402	.183	1.478	.1446	.2496	.015	1.007
		.280	2.010	.470	.234	1.724	.383	.191	1.409	.1145	.2731	.015	.798
		.220	1.770	.408	.230	1.503	.327	.185	1.203	.1047	.2952	.017	.729
Station 15 feet - 6 inches right of centerline													
$S = 7.80\times10^{-3}$	$U_* = 0.272$ fps	.900	2.510	.289	.115	1.062	.235	.093	.866	.0201	.0184	0.002	0.140
$W = 1.96$ ft	$\tau = 0.205$ lb/ft²	.800	2.520	.348	.138	1.278	.266	.105	.978	.0332	.0760	.003	.231
$Q = 1.53$ cfs	$\nu = 1.068\times10^{-5}$ ft²/sec	.700	2.510	.360	.143	1.323	.292	.116	1.074	.0598	.1140	.005	.417
$T = 21.1$ °C	$R = 73{,}084$	.600	2.470	.377	.153	1.386	.301	.122	1.107	.0665	.1520	.006	.463
$D = 0.421$ ft	$F = 0.504$	.500	2.410	.362	.150	1.330	.291	.121	1.071	.0862	.1900	.008	.601
$\bar{V} = 1.854$ fps	$C/\sqrt{g} = 6.82$	.400	2.350	.373	.158	1.371	.307	.131	1.128	.1121	.2280	.010	.781
		.340	2.270	.377	.166	1.386	.304	.134	1.123	.1088	.2496	.011	.758
		.280	2.180	.382	.175	1.404	.316	.145	1.161	.1454	.2731	.016	1.013
		.220	2.060	.442	.214	1.623	.363	.176	1.336	.1575	.2952	.019	1.097
Station 6 feet - 6 inches right of centerline													
$S = 14.57\times10^{-3}$	$U_* = 0.371$ fps												
$W = 1.96$ ft	$\tau = 0.380$ lb/ft²	.800	3.480	0.433	0.124	1.169	0.358	0.103	0.963	.0380	.0411	0.002	0.142
$Q = 2.10$ cfs	$\nu = 1.068\times10^{-5}$ ft²/sec	.700	3.530	.465	.132	1.253	.364	.103	.978	.0658	.0616	.003	.246
$T = 21.1$ °C	$R = 100{,}310$	.600	3.480	.508	.146	1.372	.407	.117	1.096	.0827	.0822	.004	.310
$D = 0.418$ ft	$F = 0.699$	.500	3.295	.527	.160	1.420	.413	.125	1.110	.1366	.1026	.007	.512
$\bar{V} = 2.563$fps	$C/\sqrt{g} = 6.91$	.400	2.930	.569	.194	1.532	.466	.159	1.255	.1822	.1231	.011	.682
		.340	2.710	.580	.214	1.562	.448	.165	1.204	.1829	.1332	.013	.685
		.280	2.480	.591	.238	1.591	.471	.190	1.269	.1871	.1454	.016	.701
		.220	2.190	.547	.250	1.473	.435	.198	1.170	.1543	.1575	.017	.578
Station 15 feet - 6 inches right of centerline													
$S = 14.57\times10^{-3}$	$U_* = 0.371$ fps	.900	3.380	.164	.048	.442	.153	.045	.413	.0325	.0206	0.002	0.122
$W = 1.96$ ft	$\tau = 0.380$ lb/ft²	.800	3.400	.169	.050	.456	.137	.040	.370	.0721	.0332	.003	.270
$Q = 2.10$ cfs	$\nu = 1.068\times10^{-5}$ ft²/sec	.700	3.390	.194	.057	.523	.166	.049	.448	.1163	.0598	.005	.436
$T = 21.1$ °C	$R = 100{,}310$	.600	3.330	.200	.060	.540	.174	.052	.468	.1428	.0822	.007	.535
$D = 0.418$ ft	$F = 0.699$	.500	3.220	.270	.084	.727	.233	.072	.628	.1799	.1026	.009	.674
$\bar{V} = 2.563$ fps	$C/\sqrt{g} = 6.91$	.400	3.130	.337	.107	.908	.284	.091	.766	.2064	.1231	.011	.773
		.340	2.950	.386	.131	1.041	.325	.110	.876	.2181	.1332	.013	.817
		.280	2.870	.456	.162	1.231	.372	.130	1.001	.2316	.1454	.015	.867
		.220	2.740	.381		1.026	.328	.120	.884	.1908	.1575	.013	.715

Note: Scales of turbulence are given in table 3b.

TABLE 4. — *4-foot-wide flume, rigid boundary*

Mean Flow Parameters and Variables	Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)
Smooth Boundary, Channel Centerline								
	0.963	1.096	0.027	0.025	0.613	2.342	2.566	0.022
	.908	1.090	.024	.022	.546	1.566	1.706	-----
	.854	1.091	.023	.021	.520	1.405	1.532	.018
	.799	1.102	.022	.020	.500	1.432	1.578	-----
$S = 0.0928\times10^{-3}$ $U_* = 0.044$ fps	.744	1.110	.023	.021	.520	2.043	2.267	.020
	.690	1.110	.024	.022	.546	1.373	1.920	-----
$W = 3.87$ ft $\tau = 0.0036$ lb/ft^2	.635	1.108	.026	.023	.593	1.422	1.575	.025
	.580	1.095	.029	.026	.661	1.516	1.660	-----
$Q = 3.67$ cfs $\nu = 1.62\times10^{-5}$ ft^2/sec	.526	1.077	.033	.031	.750	1.995	2.148	.034
	.471	1.055	.037	.035	.840	1.620	1.709	-----
$T = 5.2\ ^{\circ}$C **R** = 58,500	.416	1.001	.040	.040	.910	1.581	1.582	.033
	.362	.970	.044	.045	1.000	2.724	2.642	-----
$D = 0.915$ ft **F** = 0.191	.307	.938	.046	.049	1.045	1.504	1.410	.030
	.252	.907	.053	.059	1.211	2.565	2.326	-----
$\overline{V} = 1.036$ fps $C/\sqrt{g} = 22.6$	.198	.879	.057	.065	1.300	1.853	1.628	.026
	.143	.845	.061	.072	1.388	1.575	1.565	-----
	.089	.797	.069	.087	1.570	1.558	1.265	.021
	.034	.700	.088	.125	2.000	2.064	1.444	-----
	.025	.647	.099	.153	2.250	1.525	.986	.018
	.017	.615	.110	.179	2.500	1.002	.616	-----
Smooth Boundary, Between Channel Centerline and Wall								
	0.963	1.007	0.026	0.026	0.592	1.335	1.344	-----
	.908	1.012	.026	.026	.592	1.431	1.448	-----
	.854	1.042	.026	.025	.568	1.433	1.493	-----
	.799	1.077	.025	.023	.524	1.450	1.561	-----
	.744	1.105	.023	.021	.477	1.523	1.682	-----
$S = 0.0928\times10^{-3}$ $U_* = 0.044$ fps	.690	1.110	.025	.023	.524	1.355	1.504	-----
	.635	1.107	.027	.025	.568	1.333	1.475	-----
$W = 3.87$ ft $\tau = 0.0036$ lb/ft^2	.580	1.094	.029	.026	.592	1.426	1.560	-----
	.526	1.075	.032	.030	.683	1.283	1.379	-----
$Q = 3.67$ cfs $\nu = 1.62\times10^{-5}$ ft^2/sec	.471	1.046	.034	.033	.749	1.640	1.715	-----
	.416	1.001	.037	.037	.843	2.337	2.339	-----
$T = 5.2\ ^{\circ}$C **R** = 58,500	.362	.970	.039	.040	.910	1.351	1.310	-----
	.307	.938	.046	.049	1.045	1.504	1.410	-----
$D = 0.915$ ft **F** = 0.191	.252	.908	.054	.060	1.228	1.412	1.282	-----
	.198	.880	.063	.072	1.436	1.821	1.602	-----
$\overline{V} = 1.036$ fps $C/\sqrt{g} = 22.6$	.143	.846	.067	.079	1.522	1.492	1.262	-----
	.089	.797	.071	.089	1.612	2.133	1.700	-----
	.034	.700	.083	.119	1.886	1.324	.926	-----
	.025	.671	.096	.143	2.181	1.247	.836	-----
	.016	.610	.105	.172	2.386	1.201	.732	-----
	.009	.541	.123	.228	2.800	.943	.510	-----
3/4-Inch Rock Roughness, Channel Centerline								
	0.943	1.132	0.048	0.042	0.593	0.824	.932	0.018
	.890	1.123	.051	.045	.630	1.214	1.363	-----
	.836	1.120	.051	.046	.630	.747	.836	.020
$S = 0.324\times10^{-3}$ $U_* = 0.081$ fps	.782	1.124	.054	.048	.667	.690	.775	-----
	.729	1.126	.057	.051	.704	.716	.806	.020
$W = 3.87$ ft $\tau = 0.0128$ lb/ft^2	.675	1.124	.061	.054	.754	1.349	1.516	-----
	.622	1.120	.062	.055	.767	.647	.724	.021
$Q = 3.071$ cfs $\nu = 1.72\times10^{-5}$ ft^2/sec	.568	1.120	.064	.057	.781	.821	.919	-----
	.514	1.101	.067	.061	.828	.769	.846	.020
$T = 2.7\ ^{\circ}$C **R** = 46,100	.461	1.067	.072	.068	.888	.763	.814	-----
	.407	1.012	.073	.072	.903	.656	.669	.018
$D = 0.933$ ft **F** = 0.155	.354	.954	.077	.081	1.000	1.095	1.044	-----
	.300	.900	.083	.092	1.025	.654	.588	.016
$\overline{V} = 0.849$ fps $C/\sqrt{g} = 10.50$	.247	.847	.085	.100	1.050	.765	.647	-----
	.193	.785	.089	.113	1.098	.696	.546	.016
	.139	.695	.097	.140	1.198	1.061	.716	-----
	.086	.570	.119	.209	1.470	.679	.387	.014
	.032	.340	.136	.400	1.679	.445	.153	.009
3/4-Inch Rock Roughness, Between Channel Centerline and Wall								
	0.943	0.867	0.043	0.050	0.531	1.255	1.088	-----
	.890	.870	.045	.052	.554	.835	.726	-----
	.836	.879	.047	.053	.581	.629	.525	-----
$S = 0.324\times10^{-3}$ $U_* = 0.081$ fps	.782	.886	.051	.058	.630	.783	.693	-----
	.728	.889	.054	.061	.667	.665	.591	-----
$W = 3.87$ ft $\tau = 0.0128$ lb/ft^2	.675	.889	.055	.062	.679	.734	.652	-----
	.622	.880	.058	.066	.716	.755	.664	-----
$Q = 3.071$ cfs $\nu = 1.72\times10^{-5}$ ft^2/sec	.568	.865	.062	.072	.765	1.349	1.166	-----
	.514	.842	.065	.077	.803	.813	.684	-----
$T = 2.7\ ^{\circ}$C **R** = 46,100	.461	.829	.071	.086	.876	.498	.412	-----
	.407	.827	.068	.082	.840	.949	.784	-----
$D = 0.933$ ft **F** = 0.155	.354	.838	.074	.088	.913	.766	.641	-----
	.300	.842	.077	.092	.951	.913	.768	-----
$\overline{V} = 0.849$ fps $C/\sqrt{g} = 10.50$	.274	.830	.082	.099	1.012	.831	.689	-----
	.193	.719	.086	.119	1.061	.841	.585	-----
	.139	.661	.094	.142	1.160	1.042	.688	-----
	.086	.567	.111	.195	1.370	.644	.365	-----
	.032	.334	.129	.385	1.592	.473	.157	-----

TABLE 4. — *4-foot-wide flume, rigid boundary* — Continued

Mean Flow Parameters and Variables	Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)
Riverbed Roughness, Channel Centerline								
	0.934	1.219	0.089	0.073	0.851	0.833	1.015	-----
	.885	1.210	.090	.074	.862	.942	1.139	-----
	.835	1.200	.091	.076	.872	.922	1.106	-----
	.785	1.190	.093	.078	.890	.734	.873	-----
$S = 0.443\times10^{-3}$ $U_* = 0.1045$ fps	.736	1.172	.094	.080	.900	.692	.811	0.018
	.686	1.155	.096	.083	.918	.742	.857	-----
$W = 3.87$ ft $\tau = 0.0212$ lb/ft^2	.636	1.130	.099	.088	.947	.739	.835	.019
	.586	1.100	.102	.093	.976	.889	.977	-----
$Q = 3.205$ cfs $\nu = 1.73\times10^{-5}$ ft^2/sec	.537	1.066	.105	.098	1.004	.610	.650	.019
	.487	1.022	.107	.104	1.025	.689	.704	-----
$T = 2.65$ °C **R** = 47,800	.437	1.012	.110	.108	1.053	.633	.640	.020
	.388	.919	.113	.123	1.081	1.080	.992	-----
$D = 0.945$ ft **F** = 0.158	.338	.851	.118	.139	1.129	.801	.681	.018
	.288	.798	.127	.159	1.215	.676	.539	-----
$\overline{V} = 0.875$ fps $C/\sqrt{g} = 8.4$	.239	.730	.133	.182	1.273	.614	.448	.021
	.189	.649	.139	.214	1.330	.854	.554	-----
	.139	.548	.152	.277	1.456	1.016	.556	.011
	.089	.410	.173	.422	1.654	.861	.353	-----
	.040	.282	.197	.699	1.884	.420	.118	.006
Riverbed Roughness, Between Channel Centerline and Wall								
	0.947	1.049	0.089	0.084	0.851	0.861	0.903	-----
	.894	1.049	.086	.081	.823	.816	.855	-----
	.841	1.065	.087	.081	.832	.737	.784	-----
$S = 0.443\times10^{-3}$ $U_* = 0.1045$ fps	.788	1.095	.090	.082	.861	1.348	1.476	-----
	.735	1.115	.093	.083	.890	.837	.933	-----
$W = 3.87$ ft $\tau = 0.0212$ lb/ft^2	.683	1.099	.097	.088	.928	1.291	1.418	-----
	.598	1.072	.101	.094	.965	.913	.978	-----
$Q = 3.205$ cfs $\nu = 1.73\times10^{-5}$ ft^2/sec	.545	1.071	.107	.099	1.024	.763	.817	-----
	.492	1.028	.106	.103	1.013	.671	.689	-----
$T = 2.65$ °C **R** = 47,800	.439	.977	.113	.115	1.081	.693	.677	-----
	.386	.914	.116	.118	1.110	.814	.743	-----
$D = 0.945$ ft **F** = 0.158	.333	.843	.121	.143	1.158	.843	.710	-----
	.280	.788	.129	.163	1.236	.613	.483	-----
$\overline{V} = 0.875$ fps $C/\sqrt{g} = 8.4$	.228	.714	.134	.187	1.282	.734	.524	-----
	.175	.621	.141	.227	1.350	.947	.588	-----
	.122	.502	.156	.310	1.493	.614	.308	-----
	.069	.362	.181	.500	1.731	.812	.293	-----
	.016	.168	.233	1.386	2.228	.737	.123	-----
Smooth Boundary, Channel Centerline								
$S = 0.1427\times10^{-3}$ $U_* = 0.0415$ fps	0.928	0.97	0.031	0.032	0.748	1.594	1.546	-----
$W = 3.87$ ft $\tau = 0.0037$ lb/ft^2	.833	.96	.034	.035	.821	1.858	1.782	-----
$Q = 1.643$ cfs $\nu = 1.778\times10^{-5}$ ft^2/sec	.739	.95	.036	.038	.916	1.346	1.278	-----
$T = 8.3$ °C **R** = 25,300	.644	.94	.039	.041	.988	1.639	1.539	-----
$D = 0.528$ ft **F** = 0.206	.549	.92	.044	.048	1.156	1.594	1.467	-----
$\overline{V} = 0.852$ fps $C/\sqrt{g} = 20.5$	.455	.90	.049	.054	1.300	2.099	1.885	-----
	.360	.88	.051	.058	1.399	1.519	1.334	-----
Smooth Boundary, Channel Centerline								
	0.924	1.16	0.028	0.024	0.583	1.519	1.762	-----
	.816	1.17	.026	.022	.540	1.673	1.960	-----
$S = 0.162\times10^{-3}$ $U_* = 0.0482$ fps	.762	1.17	.026	.022	.540	1.998	2.331	-----
$W = 3.87$ ft $\tau = 0.0066$ lb/ft^2	.654	1.16	.029	.025	.602	1.467	1.703	-----
$Q = 3.888$ cfs $\nu = 1.778\times10^{-5}$ ft^2/sec	.545	1.15	.032	.028	.665	2.021	2.320	-----
$T = 8.3$ °C **R** = 57,100	.437	1.13	.036	.032	.748	1.462	1.648	-----
$D = 0.924$ ft **F** = 0.201	.329	1.09	.043	.040	.894	1.329	1.447	-----
$\overline{V} = 1.098$ fps $C/\sqrt{g} = 22.8$	.221	1.04	.052	.050	1.081	.865	.902	-----
	.113	.94	.068	.072	1.411	1.480	1.392	-----
	.040	.78	.093	.119	1.934	1.283	1.000	-----
1 1/2-Inch Rock Roughness, Channel Centerline								
	0.951	0.86	0.064	0.074	0.922	0.757	0.650	-----
	.898	.85	.067	.079	.965	.803	.682	-----
$S = 0.3939\times10^{-3}$ $U_* = 0.0694$ fps	.791	.83	.071	.086	1.022	.919	.763	-----
$W = 3.87$ ft $\tau = 0.0093$ lb/ft^2	.684	.81	.077	.095	1.110	.732	.582	-----
$Q = 1.302$ cfs $\nu = 1.778\times10^{-5}$ ft^2/sec	.578	.79	.082	.104	1.183	.845	.667	-----
$T = 8.3$ °C **R** = 17,200	.471	.74	.084	.113	1.210	.787	.583	-----
$D = 0.469$ ft **F** = 0.185	.365	.68	.088	.129	1.267	.781	.532	-----
$\overline{V} = 0.72$ fps $C/\sqrt{g} = 10.4$	.258	.62	.097	.156	1.398	.880	.545	-----
	.151	.51	.114	.224	1.643	.713	.366	-----
	.087	.42	.119	.284	1.716	.686	.288	-----
1 1/2-Inch Rock Roughness, Channel Centerline								
$S = 0.3667\times10^{-3}$ $U_* = 0.085$ fps	0.900	1.16	0.067	0.058	0.788	0.873	1.012	-----
$W = 3.87$ ft $\tau = 0.0141$ lb/ft^2	.676	1.09	.079	.072	.929	.944	1.029	-----
$Q = 3.450$ cfs $\nu = 1.778\times10^{-5}$ ft^2/sec	.452	.98	.084	.086	.988	.737	.723	-----
$T = 8.3$ °C **R** = 48,000	.228	.83	.103	.124	1.212	.829	.687	-----
$D = 0.892$ ft **F** = 0.178	.037	.51	.137	.268	1.613	.668	.342	-----
$\overline{V} = 0.956$ fps $C/\sqrt{g} = 11.2$								

TABLE 4. — *4-foot-wide flume, rigid boundary* — Continued

Mean Flow Parameters and Variables	Y/D	$\bar{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\bar{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)
Riverbed Roughness, Channel Centerline								
	0.960	0.94	0.098	0.104	0.984	0.981	0.921	-----
$S = 0.7439\times10^{-3}$ $U_* = 0.0996$ fps	.866	.93	.080	.086	.804	.706	.656	-----
$W = 3.87$ ft $\tau = 0.192$ lb/ft^2	.771	.91	.086	.095	.865	.817	.744	-----
$Q = 1.591$ cfs $\nu = 1.778\times10^{-5}$ ft^2/sec	.676	.89	.104	.117	1.043	.722	.642	-----
$T = 8.3\ ^\circ C$ **R** = 18,700	.581	.86	.110	.128	1.105	.697	.600	-----
$D = 0.528$ ft **F** = 0.189	.487	.83	.124	.149	1.246	.741	.615	-----
$\bar{V} = 0.780$ fps $C/\sqrt{g} = 7.8$	.392	.77	.143	.186	1.436	.811	.624	-----
	.297	.70	.162	.231	1.628	.871	.610	-----
	.203	.60	.164	.274	1.647	.711	.427	-----
Riverbed Roughness, Channel Centerline								
$S = 0.473\times10^{-3}$ $U_* = 0.0948$ fps	0.906	1.20	0.076	0.063	0.803	0.813	0.975	-----
$W = 3.87$ ft $\tau = 0.0174$ lb/ft^2	.730	1.18	.082	.069	.866	1.219	1.434	-----
$Q = 3.205$ cfs $\nu = 1.778\times10^{-5}$ ft^2/sec	.553	1.12	.094	.083	.993	.761	.853	-----
$T = 8.3\ ^\circ C$ **R** = 41,900	.377	1.01	.099	.098	1.047	.868	.876	-----
$D = 0.851$ ft **F** = 0.167	.260	.89	.117	.132	1.236	.829	.737	-----
$\bar{V} = 0.876$ fps $C/\sqrt{g} = 9.2$								

TABLE 5. — *8-foot-wide flume, rigid boundary*

Mean Flow Parameters and Variables	Y/D	$\bar{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\bar{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)
Flume Centerline, Station 5 Feet - Parabolic Sensor								
	0.900	1.220	0.037	0.030	0.2891	-----	-----	-----
	.800	1.150	.035	.030	.2734	-----	-----	-----
$S = 0.505\times10^{-3}$ $U_* = 0.128$ fps	.700	1.170	.038	.032	.2969	-----	-----	-----
$W = 8.0$ ft $\tau = 0.042$ lb/ft^2	.600	1.160	.042	.036	.3281	-----	-----	-----
$Q = 10.23$ cfs $\nu = 1.12\times10^{-5}$ ft^2/sec	.500	1.130	.050	.044	.3906	-----	-----	-----
$T = 18.9\ ^\circ C$ **R** = 123,000	.400	1.090	.067	.061	.5234	-----	-----	-----
$D = 1.335$ ft **F** = 0.146	.300	.990	.130	.131	1.0160	-----	-----	-----
$\bar{V} = 0.964$ fps $C/\sqrt{g} = 7.53$	.200	.760	.166	.218	1.2970	-----	-----	-----
	.100	.390	.157	.402	1.2270	-----	-----	-----
	.050	.190	.031	.163	.2422	-----	-----	-----
Flume Centerline, Station 10 Feet - Parabolic Sensor								
	0.900	1.270	0.029	0.023	0.2266	-----	-----	-----
	.800	1.220	.028	.023	.2188	-----	-----	-----
$S = 0.505\times10^{-3}$ $U_* = 0.128$ fps	.700	1.210	.034	.028	.2656	-----	-----	-----
$W = 8.0$ ft $\tau = 0.042$ lb/ft^2	.600	1.190	.048	.040	.3750	-----	-----	-----
$Q = 10.23$ cfs $\nu = 1.12\times10^{-5}$ ft^2/sec	.500	1.130	.081	.072	.6328	-----	-----	-----
$T = 18.9\ ^\circ C$ **R** = 123,000	.400	1.050	.108	.103	.8438	-----	-----	-----
$D = 1.335$ ft **F** = 0.146	.300	.890	.161	.181	1.2580	-----	-----	-----
$\bar{V} = 0.964$ fps $C\sqrt{g} = 7.53$	.200	.720	.183	.254	1.4300	-----	-----	-----
	.100	.350	.164	.469	1.2810	-----	-----	-----
	.050	.180	.024	.133	.1875	-----	-----	-----
Flume Centerline, Station 15 Feet - Parabolic Sensor								
	0.900	1.310	0.032	0.024	0.2500	-----	-----	-----
	.800	1.270	.034	.027	.2656	-----	-----	-----
$S = 0.505\times10^{-3}$ $U_* = 0.128$ fps	.700	1.230	.047	.038	.3672	-----	-----	-----
$W = 8.0$ ft $\tau = 0.042$ lb/ft^2	.600	1.170	.067	.055	.5234	-----	-----	-----
$Q = 10.23$ cfs $\nu = 1.12\times10^{-5}$ ft^2/sec	.500	1.100	.094	.085	.7344	-----	-----	-----
$T = 18.9\ ^\circ C$ **R** = 123,000	.400	1.040	.105	.101	.8203	-----	-----	-----
$D = 1.335$ ft **F** = 0.146	.300	.880	.118	.134	.9219	-----	-----	-----
$\bar{V} = 0.964$ fps $C/\sqrt{g} = 7.53$	.200	.690	.140	.203	1.0940	-----	-----	-----
	.100	.490	.123	.251	.9609	-----	-----	-----
	.050	.270	.062	.230	.4844	-----	-----	-----
Flume Centerline, Station 25 Feet - Parabolic Sensor								
	0.900	1.340	0.051	0.038	0.3984	-----	-----	-----
	.800	1.310	.059	.045	.4609	-----	-----	-----
$S = 0.505\times10^{-3}$ $U_* = 0.128$ fps	.700	1.240	.072	.058	.5625	-----	-----	-----
$W = 8.0$ ft $\tau = 0.042$ lb/ft^2	.600	1.160	.086	.074	.6719	-----	-----	-----
$Q = 10.23$ cfs $\nu = 1.12\times10^{-5}$ ft^2/sec	.500	1.100	.098	.089	.7656	-----	-----	-----
$T = 18.9\ ^\circ C$ **R** = 123,000	.400	1.020	.115	.113	.8984	-----	-----	-----
$D = 1.335$ ft **F** = 0.146	.300	.930	.143	.154	1.1170	-----	-----	-----
$\bar{V} = 0.964$ fps $C/\sqrt{g} = 7.53$	.200	.780	.170	.218	1.3280	-----	-----	-----
	.100	.470	.131	.279	1.0230	-----	-----	-----
	.050	.260	.072	.277	.5625	-----	-----	-----

TABLE 5. — *8-foot-wide flume, rigid boundary* — Continued

Flume Centerline, Station 35 Feet - Parabolic Sensor

Mean Flow Parameters and Variables	Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)
	0.900	1.330	0.077	0.058	.6016	-----	-----	-----
	.800	1.290	.085	.066	.6641	-----	-----	-----
S = 0.505×10^{-3} U_* = 0.128 fps	.700	1.220	.086	.070	.6719	-----	-----	-----
W = 8.0 ft τ = 0.042 lb/ft^2	.600	1.180	.089	.075	.6953	-----	-----	-----
Q = 10.23 cfs ν = 1.12×10^{-5} ft^2/sec	.500	1.170	.102	.087	.7969	-----	-----	-----
T = 18.9 °C **R** = 123,000	.400	1.080	.120	.111	.9375	-----	-----	-----
D = 1.335 ft **F** = 0.146	.300	1.000	.145	.145	1.1330	-----	-----	-----
$\overline{V}$ = 0.964 fps $C/\sqrt{g}$ = 7.53	.200	.840	.168	.200	1.3120	-----	-----	-----
	.100	.580	.169	.291	1.3200	-----	-----	-----
	.050	.330	.102	.309	.7969	-----	-----	-----

Flume Centerline, Station 50 Feet - Parabolic Sensor

Mean Flow Parameters and Variables	Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)
	0.900	1.320	0.075	0.057	.5859	-----	-----	-----
	.800	1.270	.081	.064	.6328	-----	-----	-----
S = 0.505×10^{-3} U_* = 0.128 fps	.700	1.220	.087	.071	.6797	-----	-----	-----
W = 8.0 ft τ = 0.042 lb/ft^2	.600	1.180	.097	.082	.7578	-----	-----	-----
Q = 10.23 cfs ν = 1.12×10^{-5} ft^5/sec	.500	1.180	.108	.092	.8438	-----	-----	-----
T = 18.9 °C **R** = 123,000	.400	1.140	.123	.108	.9609	-----	-----	-----
D = 1.335 ft **F** = 0.146	.300	1.020	.155	.152	1.2110	-----	-----	-----
$\overline{V}$ = 0.964 fps $C/\sqrt{g}$ = 7.53	.200	.790	.169	.214	1.3200	-----	-----	-----
	.100	.550	.161	.293	1.2580	-----	-----	-----
	.050	.320	.102	.319	.7969	-----	-----	-----

Flume Centerline, Station 75 Feet - Parabolic Sensor

Mean Flow Parameters and Variables	Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)
	0.900	1.230	0.073	0.059	.5703	-----	-----	-----
	.800	1.210	.077	.064	.6016	-----	-----	-----
S = 0.505×10^{-3} U_* = 0.128 fps	.700	1.190	.086	.072	.6719	-----	-----	-----
W = 8.0 ft τ = 0.042 lb/ft^2	.600	1.170	.092	.079	.7188	-----	-----	-----
Q = 10.23 cfs ν = 1.12×10^{-5} ft^2/sec	.500	1.150	.103	.090	.8047	-----	-----	-----
T = 18.9 °C **R** = 123,000	.400	1.120	.122	.109	.9531	-----	-----	-----
D = 1.335 ft **F** = 0.146	.300	.960	.149	.155	1.1640	-----	-----	-----
$\overline{V}$ = 0.964 fps $C/\sqrt{g}$ = 7.53	.200	.800	.177	.221	1.3830	-----	-----	-----
	.100	.500	.151	.302	1.1800	-----	-----	-----
	.050	.280	.106	.379	.8281	-----	-----	-----

Flume Centerline, Station 100 Feet - Parabolic Sensor

Mean Flow Parameters and Variables	Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)
	0.875	1.375	0.078	0.0567	0.5571	0.640	0.880	-----
	.750	1.320	.085	.0644	.6071	.740	.977	-----
S = 0.61×10^{-3} U_* = 0.140 fps	.625	1.250	.101	.0808	.7214	-----	-----	-----
W = 8.0 ft τ = 0.50 lb/ft^2	.500	1.180	.116	.0983	.8286	.840	.991	-----
Q = 11.52 cfs ν = 1.04×10^{-5} ft^2/sec	.375	1.080	.128	.1185	.9143	.730	.788	-----
T = 22.2 °C **R** = 138,500	.250	.932	.164	.1760	1.1710	.770	.718	-----
D = 1.312 ft **F** = 0.17	.125	.704	.194	.2756	1.3860	.510	.359	-----
$\overline{V}$ = 1.098 fps $C/\sqrt{g}$ = 7.83	.108	.650	.201	.3092	1.4360	.490	.319	-----
	.063	.446	.180	.4036	1.2860	-----	-----	-----
	.031	.279	.116	.4158	.8286	-----	-----	-----

Flume Centerline, Station 100 Feet - Cylindrical Sensor

Mean Flow Parameters and Variables	Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)
	0.900	1.420	0.076	0.054	0.535	-----	-----	-----
	.800	1.390	.083	.060	.586	-----	-----	-----
S = 0.473×10^{-3} U_* = 0.141 fps	.700	1.370	.088	.064	.627	-----	-----	-----
W = 8.0 ft τ = 0.039 lb/ft^2	.600	1.310	.105	.080	.746	-----	-----	-----
Q = 11.52 cfs ν = 1.04×10^{-5} ft^2/sec	.500	1.220	.116	.095	.818	-----	-----	-----
T = 22.2 °C **R** = 137,600	.400	1.160	.128	.110	.905	-----	-----	-----
D = 1.312 ft **F** = 0.17	.300	1.030	.154	.150	1.089	-----	-----	-----
$\overline{V}$ = 1.091 fps $C/\sqrt{g}$ = 7.72	.200	.900	.173	.192	1.227	-----	-----	-----
	.100	.800	.208	.260	1.475	-----	-----	-----
	.050	.630	.142	.226	1.009	-----	-----	-----

Flume Centerline, Station 5 Feet - Parabolic Sensor

Mean Flow Parameters and Variables	Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)
	0.900	2.390	0.084	0.035	.3443	-----	-----	-----
	.800	2.300	.090	.039	.3689	-----	-----	-----
S = 1.84×10^{-3} U_* = 0.244 fps	.700	2.250	.088	.039	.3607	-----	-----	-----
W = 8.0 ft τ = 0.153 lb/ft^2	.600	2.210	.090	.041	.3689	-----	-----	-----
Q = 20.15 cfs ν = 1.03×10^{-5} ft^2/sec	.500	2.160	.105	.049	.4303	-----	-----	-----
T = 22.6 °C **R** = 237,000	.400	2.060	.147	.071	.6025	-----	-----	-----
D = 1.333 ft **F** = 0.287	.300	1.820	.248	.136	1.0160	-----	-----	-----
$\overline{V}$ = 1.88 fps $C/\sqrt{g}$ = 7.72	.250	1.640	.264	.161	1.0820	-----	-----	-----
	.200	1.420	.314	.221	1.2870	-----	-----	-----
	.150	1.150	.325	.283	1.3320	-----	-----	-----
	.100	.750	.258	.344	1.0570	-----	-----	-----

Flume Centerline, Station 10 Feet - Parabolic Sensor

Mean Flow Parameters and Variables	Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)
	0.900	2.580	0.092	0.036	0.3770	-----	-----	-----
	.800	2.480	.078	.031	.3197	-----	-----	-----
	.700	2.370	.094	.040	.3852	-----	-----	-----
S = 1.84×10^{-3} U_* = 0.244 fps	.600	2.280	.126	.055	.5164	-----	-----	-----
W = 8.0 ft τ = 0.153 lb/ft^2	.500	2.130	.168	.079	.6885	-----	-----	-----
Q = 20.15 cfs ν = 1.03×10^{-5} ft^2/sec	.400	1.920	.213	.111	.8730	-----	-----	-----
T = 22.6 °C **R** = 237,000	.300	1.670	.251	.150	1.0290	-----	-----	-----
D = 1.333 ft **F** = 0.287	.250	1.500	.252	.168	1.0330	-----	-----	-----
$\overline{V}$ = 1.88 fps $C/\sqrt{g}$ = 7.72	.200	1.300	.280	.215	1.1480	-----	-----	-----
	.150	1.050	.275	.262	1.1270	-----	-----	-----
	.100	.680	.222	.326	.9098	-----	-----	-----

TABLE 5. — *8-foot-wide flume, rigid boundary* — Continued

Mean Flow Parameters and Variables	Y/D	$\bar{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\bar{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)
Flume Centerline, Station 15 Feet - Parabolic Sensor								
	0.900	2.690	0.097	0.036	0.3975	-----	-----	-----
$S = 1.84\times10^{-3}$ $U_* = 0.244$ fps	.800	2.560	.105	.041	.4303	-----	-----	-----
	.700	2.420	.140	.058	.5738	-----	-----	-----
$W = 8.0$ ft $\tau = 0.153$ lb/ft^2	.600	2.260	.169	.075	.6926	-----	-----	-----
	.500	2.080	.198	.095	.8115	-----	-----	-----
$Q = 20.15$ cfs $\nu = 1.03\times10^{-5}$ ft^2/sec	.400	1.890	.225	.119	.9221	-----	-----	-----
	.300	1.660	.256	.154	1.0490	-----	-----	-----
$T = 22.6$ °C **R** = 237,000	.250	1.510	.250	.166	1.0250	-----	-----	-----
	.200	1.340	.273	.204	1.1190	-----	-----	-----
$D = 1.333$ ft **F** = 0.287	.150	1.100	.278	.253	1.1390	-----	-----	-----
	.100	.780	.235	.301	.9631	-----	-----	-----
$\bar{V} = 1.88$ fps $C/\sqrt{g} = 7.72$	.050	.120	.123	1.025	.5041	-----	-----	-----
Flume Centerline, Station 25 Feet - Parabolic Sensor								
	0.900	2.760	0.161	0.058	0.6598	-----	-----	-----
$S = 1.84\times10^{-3}$ $U_* = 0.244$ fps	.800	2.590	.190	.073	.7787	-----	-----	-----
	.700	2.410	.218	.090	.8934	-----	-----	-----
$W = 8.0$ ft $\tau = 0.153$ lb/ft^2	.600	2.240	.229	.102	.9385	-----	-----	-----
	.500	2.070	.256	.124	1.0490	-----	-----	-----
$Q = 20.15$ cfs $\nu = 1.03\times10^{-5}$ ft^2/sec	.400	1.890	.259	.137	1.0610	-----	-----	-----
	.300	1.680	.287	.171	1.1760	-----	-----	-----
$T = 22.6$ °C **R** = 237,000	.250	1.540	.284	.184	1.1640	-----	-----	-----
	.200	1.370	.298	.218	1.2210	-----	-----	-----
$D = 1.333$ ft **F** = 0.287	.150	1.150	.308	.268	1.2620	-----	-----	-----
	.100	.840	.340	.405	1.3930	-----	-----	-----
$\bar{V} = 1.88$ fps $C/\sqrt{g} = 7.72$	.050	.310	.158	.510	.6475	-----	-----	-----
Flume Centerline, Station 45 Feet, Parabolic Sensor								
$S = 1.84\times10^{-3}$ $U_* = 0.244$ fps	0.900	2.520	0.202	0.080	.8279	-----	-----	-----
	.800	2.440	.192	.079	.7869	-----	-----	-----
$W = 8.0$ ft $\tau = 0.153$ lb/ft^2	.700	2.350	.205	.087	.8402	-----	-----	-----
	.600	2.240	.233	.104	.9549	-----	-----	-----
$Q = 20.15$ cfs $\nu = 1.03\times10^{-5}$ ft^2/sec	.500	2.110	.216	.102	.8852	-----	-----	-----
	.400	1.960	.248	.126	1.0160	-----	-----	-----
$T = 22.6$ °C **R** = 237,000	.300	1.760	.279	.158	1.1430	-----	-----	-----
	.200	1.480	.305	.206	1.2500	-----	-----	-----
$D = 1.333$ ft **F** = 0.287	.150	1.280	.370	.289	1.5160	-----	-----	-----
	.100	1.000	.398	.398	1.6310	-----	-----	-----
$\bar{V} = 1.88$ fps $C/\sqrt{g} = 7.72$	.050	.520	.260	.500	1.0660	-----	-----	-----
Flume Centerline, Station 75 Feet - Parabolic Sensor								
	0.900	2.450	0.198	0.081	0.8115	-----	-----	-----
$S = 1.84\times10^{-3}$ $U_* = 0.244$ fps	.800	2.440	.201	.082	.8238	-----	-----	-----
	.700	2.340	.205	.088	.8402	-----	-----	-----
$W = 8.0$ ft $\tau = 0.153$ lb/ft^2	.600	2.270	.234	.103	.9590	-----	-----	-----
	.500	2.130	.239	.112	.9795	-----	-----	-----
$Q = 20.15$ cfs $\nu = 1.03\times10^{-5}$ ft^2/sec	.400	1.940	.251	.129	1.0290	-----	-----	-----
	.300	1.750	.283	.162	1.1600	-----	-----	-----
$T = 22.6$ °C **R** = 237,000	.250	1.630	.298	.183	1.2210	-----	-----	-----
	.200	1.480	.316	.214	1.2950	-----	-----	-----
$D = 1.33$ ft **F** = 0.287	.150	1.260	.371	.294	1.5200	-----	-----	-----
	.100	.980	.407	.415	1.6680	-----	-----	-----
$\bar{V} = 1.88$ fps $C/\sqrt{g} = 7.72$	.050	.510	.253	.496	1.0370	-----	-----	-----
Flume Centerline, Station 100 Feet - Parabolic Sensor								
	0.900	2.590	0.164	0.0633	0.5816	0.430	1.114	-----
$S = 1.88\times10^{-3}$ $U_* = 0.282$ fps	.800	2.500	.180	.0720	.6383	-----	-----	-----
	.750	2.460	.198	.0805	.7021	.660	1.624	-----
$W = 8.0$ ft $\tau = 0.156$ lb/ft^2	.700	2.410	.212	.0880	.7518	-----	-----	-----
	.600	2.290	.229	.1000	.8121	.460	1.053	-----
$Q = 22.06$ cfs $\nu = 1.03\times10^{-5}$ ft^2/sec	.500	2.180	.233	.1069	.8262	.760	1.657	-----
	.400	2.020	.250	.1238	.8865	.460	.929	-----
$T = 22.6$ °C **R** = 267,900	.300	1.810	.286	.1581	1.0140	-----	-----	-----
	.250	1.670	.335	.2006	1.1880	.540	.902	-----
$D = 1.331$ ft **F** = 0.31	.200	1.520	.357	.2349	1.2660	-----	-----	-----
	.150	1.140	.383	.3360	1.3580	-----	-----	-----
$\bar{V} = 2.073$ fps $C/\sqrt{g} = 8.4$	.100	.840	.421	.5012	1.4930	.480	.403	-----
	.050	.530	.280	.5283	.9929	.560	.297	-----
Flume Centerline, Station 75 Feet - Parabolic Sensor								
	0.900	4.050	0.264	0.065	0.6804	-----	-----	-----
$S = 4.63\times10^{-3}$ $U_* = 0.388$ fps	.800	4.100	.270	.066	.6959	-----	-----	-----
	.700	4.010	.285	.071	.7345	-----	-----	-----
$W = 8.0$ ft $\tau = 0.380$ lb/ft^2	.600	3.770	.316	.084	.8144	-----	-----	-----
	.500	3.670	.386	.105	.9948	-----	-----	-----
$Q = 30.53$ cfs $\nu = 1.04\times10^{-5}$ ft^2/sec	.400	3.530	.436	.124	1.1240	-----	-----	-----
	.300	3.070	.480	.156	1.2370	-----	-----	-----
$T = 22.2$ °C **R** = 369,000	.250	2.840	.500	.176	1.2890	-----	-----	-----
	.200	2.480	.520	.210	1.3400	-----	-----	-----
$D = 1.316$ ft **F** = 0.446	.150	2.290	.604	.264	1.5570	-----	-----	-----
	.100	1.710	.675	.395	1.7400	-----	-----	-----
$\bar{V} = 2.903$ fps $C/\sqrt{g} = 7.50$	.050	.920	.497	.540	1.2810	-----	-----	-----

TABLE 5. — *8-foot-wide flume, rigid boundary* — Continued

Mean Flow Parameters and Variables	Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)
18 Inches Off Flume Centerline, Station 100 Feet - Parabolic Sensor								
	0.900	3.900	0.266	0.068	0.6856	-----	-----	-----
$S = 4.63\times10^{-3}$ $U_* = 0.388$ fps	.800	3.890	.250	.064	.6443	-----	-----	-----
	.700	3.770	.302	.080	.7784	-----	-----	-----
$W = 8.0$ ft $\tau = 0.380$ lb/ft^2	.600	3.770	.316	.084	.8144	-----	-----	-----
	.500	3.620	.376	.104	.9691	-----	-----	-----
$Q = 30.53$ cfs $\nu = 1.04\times10^{-5}$ ft^2/sec	.400	3.430	.438	.128	1.1290	-----	-----	-----
	.300	3.110	.479	.154	1.2350	-----	-----	-----
$T = 22.2\ ^\circ C$ **R** = 369,000	.250	2.920	.520	.178	1.3400	-----	-----	-----
	.200	2.660	.572	.215	1.4740	-----	-----	-----
$D = 1.316$ ft **F** = 0.446	.150	2.250	.608	.270	1.5670	-----	-----	-----
	.100	1.740	.636	.365	1.6390	-----	-----	-----
$\overline{V} = 2.903$ fps $C/\sqrt{g} = 7.50$	.050	.980	.556	.567	1.4330	-----	-----	-----
Flume Centerline, Station 100 Feet - Parabolic Sensor								
	0.900	3.960	0.267	0.0674	0.6881	0.530	2.099	-----
	.800	3.940	.266	.0675	.6856	-----	-----	-----
$S = 4.63\times10^{-3}$ $U_* = 0.388$ fps	.750	3.910	.282	.0721	.7268	.480	1.877	-----
	.700	3.880	.298	.0768	.7680	-----	-----	-----
$W = 8.0$ ft $\tau = 0.381$ lb/ft^2	.600	3.760	.319	.0848	.8222	.540	2.030	-----
	.500	3.600	.366	.1017	.9433	.320	1.152	-----
$Q = 30.53$ cfs $\nu = 1.04\times10^{-5}$ ft^2/sec	.400	3.390	.413	.1218	1.0640	.380	1.288	-----
	.350	3.260	.446	.1368	1.1490	-----	-----	-----
$T = 22.2\ ^\circ C$ **R** = 436,000	.300	3.110	.486	.1563	1.2530	-----	-----	-----
	.250	2.940	.522	.1776	1.3450	.330	.970	-----
$D = 1.32$ ft **F** = 0.446	.200	2.680	.546	.2037	1.4070	-----	-----	-----
	.126	2.350	.611	.2600	1.5750	-----	-----	-----
$\overline{V} = 2.903$ fps $C/\sqrt{g} = 7.50$	.100	1.750	.639	.3651	1.6470	.350	.613	-----
	.080	1.380	.561	.4065	1.4460	-----	-----	-----
Flume Centerline, Station 50 Feet - Parabolic Sensor								
	0.900	2.790	0.154	0.055	0.658	-----	-----	-----
	.800	2.840	.150	.053	.640	-----	-----	-----
$S = 1.101\times10^{-3}$ $U_* = 0.234$ fps	.700	2.810	.176	.063	.752	-----	-----	-----
$W = 8.0$ ft $\tau = 0.172$ lb/ft^2	.600	2.650	.195	.074	.833	-----	-----	-----
$Q = 46.6$ cfs $\nu = 1.12\times10^{-5}$ ft^2/sec	.500	2.470	.222	.090	.948	-----	-----	-----
$T = 18.9\ ^\circ C$ **R** = 463,000	.400	2.140	.249	.116	1.062	-----	-----	-----
$D = 2.50$ ft **F** = 0.23	.300	1.850	.276	.149	1.179	-----	-----	-----
$\overline{V} = 2.34$ fps $C/\sqrt{g} = 10.0$	.200	1.520	.306	.201	1.307	-----	-----	-----
	.100	1.140	.348	.303	1.488	-----	-----	-----
	.050	.660	.375	.568	1.602	-----	-----	-----
Flume Centerline, Station 75 Feet - Parabolic Sensor								
	0.900	2.910	0.172	0.058	0.745	-----	-----	-----
	.800	2.820	.184	.065	.781	-----	-----	-----
$S = 1.101\times10^{-3}$ $U_* = 0.234$ fps	.700	2.670	.202	.076	.863	-----	-----	-----
$W = 8.0$ ft $\tau = 0.172$ lb/ft^2	.600	2.510	.224	.089	.956	-----	-----	-----
$Q = 46.6$ cfs $\nu = 1.12\times10^{-5}$ ft^2/sec	.500	2.290	.254	.111	1.084	-----	-----	-----
$T = 18.9\ ^\circ C$ **R** = 463,000	.400	2.050	.269	.131	1.152	-----	-----	-----
$D = 2.51$ ft **F** = 0.23	.300	1.840	.287	.156	1.226	-----	-----	-----
$\overline{V} = 2.34$ fps $C/\sqrt{g} = 10.0$	.200	1.570	.316	.201	1.352	-----	-----	-----
	.100	1.130	.354	.316	1.514	-----	-----	-----
	.050	.680	.388	.562	1.661	-----	-----	-----
Flume Centerline, Station 100 Feet - Parabolic Sensor								
	0.900	2.660	0.178	0.067	0.761	-----	-----	-----
	.800	2.710	.184	.068	.786	-----	-----	-----
$S = 1.101\times10^{-3}$ $U_* = 0.234$ fps	.700	2.590	.204	.079	.872	-----	-----	-----
$W = 8.0$ ft $\tau = 0.172$ lb/ft^2	.600	2.490	.226	.091	.966	-----	-----	-----
$Q = 46.6$ cfs $\nu = 1.12\times10^{-5}$ ft^2/sec	.500	2.400	.254	.106	1.087	-----	-----	-----
$T = 18.9\ ^\circ C$ **R** = 463,000	.400	2.290	.264	.115	1.129	-----	-----	-----
$D = 2.52$ ft **F** = 0.23	.300	1.940	.285	.147	1.218	-----	-----	-----
$\overline{V} = 2.34$ fps $C/\sqrt{g} = 10.0$	.200	1.760	.312	.177	1.334	-----	-----	-----
	.100	1.330	.369	.278	1.577	-----	-----	-----
	.050	.820	.390	.475	1.668	-----	-----	-----
Flume Centerline, Station 50 Feet - Parabolic Sensor								
	0.900	3.200	0.316	0.099	0.708	-----	-----	-----
$S = 10.54\times10^{-3}$ $U_* = 0.447$ fps	.800	3.040	.362	.119	.811	-----	-----	-----
$W = 8.0$ ft $\tau = 0.452$ lb/ft^2	.700	2.890	.400	.138	.896	-----	-----	-----
$Q = 14.09$ cfs $\nu = 1.06\times10^{-5}$ ft^2/sec	.600	2.650	.441	.166	.989	-----	-----	-----
$T = 21.1\ ^\circ C$ **R** = 141,900	.500	2.420	.487	.201	1.091	-----	-----	-----
$D = 0.687$ ft **F** = 0.46	.400	2.010	.530	.264	1.188	-----	-----	-----
$\overline{V} = 2.56$ fps $C/\sqrt{g} = 5.60$	.300	1.530	.547	.358	1.224	-----	-----	-----
	.200	1.130	.517	.458	1.157	-----	-----	-----
	.100	.900	.455	.506	1.020	-----	-----	-----
Flume Centerline, Station 75 Feet - Parabolic Sensor								
	0.900	3.210	0.348	0.108	0.780	-----	-----	-----
$S = 10.54\times10^{-3}$ $U_* = 0.447$ fps	.800	3.130	.373	.119	.834	-----	-----	-----
$W = 8.0$ ft $\tau = 0.452$ lb/ft^2	.700	2.910	.392	.135	.879	-----	-----	-----
$Q = 14.09$ cfs $\nu = 1.06\times10^{-5}$ ft^2/sec	.600	2.710	.448	.165	1.005	-----	-----	-----
$T = 21.1\ ^\circ C$ **R** = 146,300	.500	2.440	.513	.210	1.148	-----	-----	-----
$D = 0.687$ ft **F** = 0.48	.400	2.090	.580	.278	1.298	-----	-----	-----
$\overline{V} = 2.56$ fps $C/\sqrt{g} = 5.60$	.300	1.640	.590	.360	1.322	-----	-----	-----
	.200	1.220	.543	.445	1.216	-----	-----	-----
	.100	.970	.463	.447	1.038	-----	-----	-----

TABLE 5. — *8-foot-wide flume, rigid boundary* — Continued

Mean Flow Parameters and Variables	Y/D	$\bar{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\bar{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)
Flume Centerline, Station 100 Feet - Parabolic Sensor								
	0.900	3.270	0.338	0.103	0.758	-----	-----	-----
$S = 10.54\times10^{-3}$ $U_* = 0.447$ fps	.800	3.140	.395	.126	.884	-----	-----	-----
$W = 8.0$ ft $\tau = 0.452$ lb/ft^2	.700	2.970	.413	.139	.924	-----	-----	-----
$Q = 14.09$ cfs $\nu = 1.06\times10^{-5}$ ft^2/sec	.600	2.740	.470	.172	1.052	-----	-----	-----
$T = 21.1$ °C **R** = 149,100	.500	2.450	.533	.218	1.195	-----	-----	-----
$D = 0.687$ ft **F** = 0.49	.400	2.140	.608	.318	1.363	-----	-----	-----
$\bar{V} = 2.56$ fps $C/\sqrt{g} = 5.60$	.300	1.690	.608	.402	1.363	-----	-----	-----
	.200	1.290	.562	.436	1.258	-----	-----	-----
	.100	1.020	.438	.429	.983	-----	-----	-----
Flume Centerline, Station 140 Feet - Parabolic Sensor								
	0.900	3.240	0.361	0.111	0.807	-----	-----	-----
$S = 10.54\times10^{-3}$ $U_* = 0.447$ fps	.800	3.110	.382	.123	.846	-----	-----	-----
$W = 8.0$ ft $\tau = 0.452$ lb/ft^2	.700	2.930	.388	.132	.870	-----	-----	-----
$Q = 14.09$ cfs $\nu = 1.06\times10^{-5}$ ft^2/sec	.600	2.700	.477	.177	1.068	-----	-----	-----
$T = 21.1$ °C **R** = 150,000	.500	2.460	.502	.204	1.122	-----	-----	-----
$D = 0.687$ ft **F** = 0.49	.400	2.150	.558	.260	1.250	-----	-----	-----
$\bar{V} = 2.56$ fps $C/\sqrt{g} = 5.6$	.300	1.790	.614	.343	1.375	-----	-----	-----
	.200	1.350	.577	.427	1.296	-----	-----	-----
	.100	1.070	.485	.453	1.086	-----	-----	-----

TABLE 6. — *8-foot-wide flume, alluvial boundary*

Mean Flow Parameters and Variables	Y/D	$\bar{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\bar{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)	C_s (gpl)	d_{50} (mm)	σ	ω (fps)
Flume Centerline, Station 120 Feet - Ripples												
	0.90	1.45	0.063	0.044	0.677	1.11	1.610	-----	--	----	----	------
$S = 0.3201\times10^{-3}$ $d_{50} = 0.121$ mm	.80	1.44	.074	.051	.796	.92	1.325	-----	8	0.11	1.36	.0361
$W = 8.0$ ft $U_* = 0.093$ fps	.70	1.41	.084	.059	.903	.97	1.368	-----	--	----	----	------
$Q = 9.94$ cfs $\tau = 0.0209$ lb/ft^2	.60	1.37	.093	.068	1.000	1.01	1.384	-----	10	.12	1.41	.0387
$T = 22.7$ °C $\nu = 1.027\times10^{-5}$ ft^2/sec	.50	1.31	.105	.080	1.129	.94	1.231	-----	12	.12	1.37	.0387
$D = 1.046$ ft **R** = 124,300	.40	1.23	.104	.084	1.118	.92	1.132	-----	--	----	----	------
$\bar{V} = 1.19$ fps **F** = 0.210	.30	1.12	.107	.095	1.151	.94	1.053	-----	21	.13	1.38	.0427
$C_t = 0.813$ gpl $C/\sqrt{g} = 12.80$	.20	.95	.110	.116	1.183	.78	.741	-----	56	.14	1.37	.0483
$\bar{D} = 1.046$ ft $D_{50} = 0.26$ mm	.10	.66	.114	.173	1.226	.65	.429	-----	81	.16	1.36	.0565
Flume Centerline, Station 120 Feet - Ripples												
	0.90	1.85	0.088	0.047	0.779	0.97	1.795	-----	--	----	----	------
$S = 0.4743\times10^{-3}$ $d_{50} = 0.141$ mm	.80	1.84	.123	.067	1.088	.80	1.472	-----	7	.12	1.42	.0387
$W = 8.0$ ft $U_* = 0.113$ fps	.70	1.80	.142	.079	1.257	.79	1.422	-----	--	----	----	------
$Q = 15.07$ cfs $\tau = 0.0311$ lb/ft^2	.60	1.75	.149	.085	1.319	.78	1.365	-----	9	.13	1.37	.0427
$T = 21.7$ °C $\nu = 1.044\times10^{-5}$ ft^2/sec	.50	1.67	.183	.110	1.619	.75	1.253	-----	--	----	----	------
$D = 1.052$ ft **R** = 160,200	.40	1.59	.195	.123	1.726	.67	1.065	-----	18	.16	1.46	.0565
$\bar{V} = 1.79$ fps **F** = 0.273	.30	1.47	.152	.137	1.345	.70	1.029	-----	--	----	----	------
$C_t = 73.0$ gpl $C/\sqrt{g} = 15.80$	.20	1.32	.162	.153	1.434	.66	.871	-----	76	.19	1.38	.0722
$\bar{D} = 1.052$ ft $D_{50} = 0.26$ mm	.10	1.07	.131	.177	1.159	.54	.578	-----	139	.20	1.37	.0791
Flume Centerline, Station 120 Feet - Dune Trough												
	0.92	2.74	0.238	0.087	1.400	----	-----	-----	--	----	----	------
	.83	2.78	.240	.086	1.412	----	-----	-----	--	----	----	------
$S = 1.107\times10^{-3}$ $d_{50} = 0.179$ mm	.75	2.68	.309	.115	1.818	----	-----	-----	--	----	----	------
$W = 8.0$ ft $U_* = 0.170$ fps	.67	2.36	.345	.145	2.029	----	-----	-----	--	----	----	------
$Q = 19.66$ cfs $\tau = 0.0905$ lb/ft^2	.59	2.17	.339	.156	1.994	----	-----	-----	--	----	----	------
$T = 20.6$ °C $\nu = 1.075\times10^{-5}$ ft^2/sec	.50	2.10	.354	.168	2.082	----	-----	-----	--	----	----	------
$D = 1.31$ ft **R** = 251,600	.42	1.96	.398	.203	2.341	----	-----	-----	--	----	----	------
$\bar{V} = 2.42$ fps **F** = 0.313	.34	1.93	.492	.245	2.894	----	-----	-----	--	----	----	------
$C_t = 996.4$ gpl $C/\sqrt{g} = 14.30$	.26	1.70	.532	.314	3.129	----	-----	-----	--	----	----	------
$\bar{D} = 1.012$ ft $D_{50} = 0.26$ mm	.19	1.46	.392	.268	2.306	----	-----	-----	--	----	----	------
	.15	1.36	.361	.266	2.124	----	-----	-----	--	----	----	------
	.08	1.13	.468	.287	2.753	----	-----	-----	--	----	----	------
Flume Centerline, Station 95 Feet - Dune Crest												
	0.88	3.56	0.185	0.0520	1 088	----	-----	-----	--	----	----	------
$S = 1.107\times10^{-3}$ $d_{50} = 0.179$ mm	.76	3.50	.199	.0569	1.171	----	-----	-----	--	----	----	------
$W = 8.0$ ft $U_* = 0.170$ fps	.64	3.43	.219	.0638	1.288	----	-----	-----	--	----	----	------
$Q = 19.66$ cfs $\tau = 0.0580$ lb/ft^2	.52	3.25	.251	.0772	1.476	----	-----	-----	--	----	----	------
$T = 20.6$ °C $\nu = 1.075\times10^{-5}$ ft^2/sec	.40	3.07	.269	.0876	1.582	----	-----	-----	--	----	----	------
$D = 0.84$ ft **R** = 214,100	.29	2.84	.283	.0996	1.665	----	-----	-----	--	----	----	------
$\bar{V} = 2.42$ fps **F** = 0.527	.25	2.29	.241	.1052	1.418	----	-----	-----	--	----	----	------
$C_t = 996.4$ gpl $C/\sqrt{g} = 14.30$	.17	1.62	.208	.1284	1.224	----	-----	-----	--	----	----	------
$\bar{D} = 1.012$ ft $D_{50} = 0.26$ mm	.09	1.07	.167	.1561	.982	----	-----	-----	--	----	----	------

TABLE 6. — *8-foot-wide flume, alluvial boundary* — Continued

Mean Flow Parameters and Variables	Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)	C_s (gpl)	d_{50} (mm)	σ	ω (fps)
Flume Centerline, Station 105 Feet - Dune Trough												
	0.93	2.57	0.139	0.054	0.818	0.51	1.311	-----	---	----	----	------
	.86	2.50	.159	.063	.935	.54	1.350	-----	---	----	----	------
	.80	2.45	.185	.076	1.088	.55	1.348	-----	241	0.14	1.36	0.0460
$S = 1.1073\times10^{-3}$ $d_{50} = 0.179$ mm	.73	2.22	.211	.095	1.241	.44	.977	-----	---	----	----	------
$W = 8.0$ ft $U_* = 0.170$ fps	.65	2.21	.256	.116	1.506	.58	1.282	-----	---	----	----	------
$Q = 19.66$ cfs $\tau = 0.0988$ lb/ft^2	.58	2.16	.246	.114	1.447	.53	1.145	-----	422	.16	1.41	.0559
$T = 20.6$ °C $\nu = 1.075\times10^{-5}$ ft^2/sec	.52	2.07	.310	.150	1.824	.57	1.180	-----	---	----	----	------
$D = 1.43$ ft R = 228,800	.45	1.94	.339	.175	1.994	.54	1.048	-----	---	----	----	------
$\overline{V} = 2.42$ fps F = 0.253	.38	1.79	.396	.221	2.329	.59	1.056	-----	583	.19	1.34	.0717
$C_t = 996.4$ gpl $C/\sqrt{g} = 14.30$	.31	.85	.208	.245	1.224	.61	.519	-----	---	----	----	------
$\overline{D} = 1.012$ ft $D_{50} = 0.26$ mm	.24	.84	.202	.241	1.188	.53	.445	-----	191	.19	1.46	.0717
	.14	.83	.200	.241	1.176	.48	.398	-----	---	----	----	------
	.08	.82	.191	.233	1.124	.47	.385	-----	101	.18	1.43	.0614
	.07	.80	.177	.216	1.041	.48	.384	-----	---	----	----	------
Flume Centerline, Station 100 Feet - Dune Crest												
	0.88	2.40	0.143	0.059	0.841	0.48	1.152	-----	---	----	----	------
$S = 1.107\times10^{-3}$ $d_{50} = 0.179$ mm	.79	2.32	.145	.063	.853	.64	1.485	-----	---	----	----	------
$W = 8.0$ ft $U_* = 0.170$ fps	.68	2.22	.147	.066	.865	.46	1.021	-----	337	.15	1.38	0.0512
$Q = 19.66$ cfs $\tau = 0.0642$ lb/ft^2	.58	2.18	.173	.079	1.018	.50	1.090	-----	---	----	----	------
$T = 20.6$ °C $\nu = 1.075\times10^{-5}$ ft^2/sec	.46	2.16	.180	.083	1.059	.53	1.145	-----	447	.16	1.42	.0559
$D = 0.93$ ft R = 177,300	.38	2.15	.204	.095	1.200	.54	1.161	-----	---	----	----	------
$\overline{V} = 2.42$ fps F = 0.375	.24	2.11	.217	.103	1.276	.48	1.013	-----	554	.16	1.37	.0559
$C_t = 996.4$ gpl $C/\sqrt{g} = 14.30$	.16	2.10	.264	.126	1.553	.50	1.050	-----	---	----	----	------
	.08	1.91	.282	.148	1.659	.48	.917	-----	1670	.18	1.40	.0614
$\overline{D} = 1.012$ ft $D_{50} = 0.26$ mm	.04	.92	.176	.191	1.035	.46	.423	-----	3030	.18	1.43	.0614
Flume Centerline, Station 120 Feet - Transition												
	0.90	2.81	0.181	0.0644	1.168	0.54	1.517	-----	---	----	----	------
$S = 0.887\times10^{-3}$ $d_{50} = 0.183$ mm	.80	2.73	.185	.0678	1.194	.46	1.256	-----	---	----	----	------
$W = 8.0$ ft $U_* = 0.155$ fps	.70	2.64	.205	.0776	1.323	.50	1.320	-----	134	0.13	1.33	0.0427
$Q = 24.72$ cfs $\tau = 0.0591$ lb/ft^2	.60	2.59	.224	.0865	1.445	.57	1.476	-----	---	----	----	------
$T = 21.3$ °C $\nu = 1.054\times10^{-5}$ ft^2/sec	.50	2.54	.229	.0902	1.477	.56	1.422	-----	256	.14	1.35	.0460
$D = 1.068$ ft R = 247,200	.40	2.39	.228	.0954	1.471	.52	1.243	-----	---	----	----	------
$\overline{V} = 2.89$ fps F = 0.416	.30	2.30	.244	.1061	1.574	.46	1.058	-----	449	.15	1.37	.0512
$C_t = 872.8$ gpl $C/\sqrt{g} = 18.68$	.20	2.20	.269	.1223	1.735	.42	.924	-----	885	.16	1.36	.0559
$\overline{D} = 1.068$ ft $D_{50} = 0.26$ mm	.10	1.90	.291	.1532	1.877	.38	.722	-----	2220	.18	1.38	.0614
Flume Centerline, Station 120 Feet - Flatbed												
	0.90	4.86	0.242	0.050	1.316	0.48	2.333	-----	---	-----	----	------
$S = 1.219\times10^{-3}$ $d_{50} = 0.205$ mm	.80	4.82	.256	.053	1.391	.57	2.747	-----	270	0.123	1.41	0.0387
$W = 8.0$ ft $U_* = 0.184$ fps	.70	4.64	.265	.058	1.441	.54	2.506	-----	---	-----	----	------
$Q = 35.98$ cfs $\tau = 0.0822$ lb/ft^2	.60	4.62	.291	.063	1.580	.69	3.188	-----	425	.128	1.46	.0417
$T = 21.8$ °C $\nu = 1.046\times10^{-5}$ ft^2/sec	.50	4.49	.314	.070	1.702	.63	2.829	-----	---	-----	----	------
$D = 1.081$ ft R = 450,600	.40	4.43	.349	.079	1.895	.65	2.880	-----	665	.131	1.44	.0429
$\overline{V} = 4.15$ fps F = 0.739	.30	4.31	.402	.093	2.180	.66	2.845	-----	918	.140	1.52	.0460
$C_t = 1719.2$ gpl $C/\sqrt{g} = 22.55$	.20	3.92	.419	.107	2.276	.61	2.391	-----	1220	.144	1.50	.0480
$\overline{D} = 1.081$ ft $D_{50} = 0.26$ mm	.10	3.18	.426	.134	2.317	.48	1.526	-----	2950	.152	1.56	.0518
Flume Centerline, Station 110 Feet - Dune Trough												
	0.93	2.35	0.177	0.076	1.060	0.41	0.964	-----	46	-----	----	------
	.85	2.24	.206	.092	1.234	.67	1.501	-----	122	0.147	1.33	0.0536
$S = 1.023\times10^{-3}$ $d_{50} = 0.206$ mm	.77	2.19	.296	.135	1.772	.52	1.139	-----	301	-----	----	------
$W = 8.0$ ft $U_* = 0.167$ fps	.68	2.20	.293	.133	1.754	.49	1.078	-----	788	-----	----	------
$Q = 17.02$ cfs $\tau = 0.0842$ lb/ft^2	.61	2.22	.300	.135	1.796	.53	1.177	-----	343	-----	----	------
$T = 20.8$ °C $\nu = 1.82\times10^{-5}$ ft^2/sec	.52	2.06	.260	.126	1.557	.44	.906	-----	225	-----	----	------
$D = 1.32$ ft R = 225,600	.45	2.13	.297	.140	1.778	.56	1.193	-----	236	.164	1.35	0.0635
$\overline{V} = 1.97$ fps F = 0.279	.38	1.95	.329	.168	1.970	.46	.897	-----	231	-----	----	------
$C_t = 350.8$ gpl $C/\sqrt{g} = 11.77$	.31	1.63	.442	.270	2.647	.54	.880	-----	305	-----	----	------
$\overline{D} = 1.079$ ft $D_{50} = 0.26$ mm	.28	1.66	.507	.306	3.036	.49	.813	-----	475	.171	1.37	.0665
	.16	1.27	.327	.257	1.958	.54	.686	-----	221	-----	----	------
	.08	1.17	.361	.309	2.162	.43	.503	-----	501	.172	1.33	.0680
Flume Centerline, Station 100 Feet - Dune Crest												
	0.89	2.23	0.161	0.072	0.964	0.57	1.271	-----	66	0.138	1.43	0.0482
$S = 1.023\times10^{-3}$ $d_{50} = 0.206$ mm	.78	2.18	.159	.073	.952	.62	1.352	-----	67	-----	----	------
$W = 8.0$ ft $U_* = 0.167$ fps	.66	2.20	.178	.081	1.066	.48	1.056	-----	130	.142	1.36	.0517
$Q = 17.02$ cfs $\tau = 0.0575$ lb/ft^2	.55	2.19	.186	.085	1.114	.53	1.161	-----	96	-----	----	------
$T = 20.8$ °C $\nu = 1.065\times10^{-5}$ ft^2/sec	.44	2.17	.202	.093	1.210	.47	1.020	-----	109	-----	----	------
$D = 0.90$ ft R = 182,500	.33	2.14	.208	.097	1.246	.61	1.305	-----	117	.148	1.25	.0551
$\overline{V} = 1.97$ fps F = 0.401	.24	2.17	.230	.106	1.377	.63	1.367	-----	175	-----	----	------
$C_t = 350.8$ gpl $C/\sqrt{g} = 11.77$	.10	2.15	.297	.138	1.778	.51	1.097	-----	290	.164	1.40	.0636
$\overline{D} = 1.079$ ft $D_{50} = 0.26$ mm	.01	2.00	.510	.255	3.054	.72	1.440	-----	9085	-----	----	------

TABLE 6. — *8-foot-wide flume, alluvial boundary* — Continued

Mean Flow Parameters and Variables	Y/D	$\bar{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\bar{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)	C_s (gpl)	d_{50} (mm)	σ	ω (fps)
Flume Centerline, Station 120 Feet - Flatbed												
	0.94	5.71	0.325	0.057	1.231	0.76	4.340	0.023	185	-----	----	------
	.89	5.62	.326	.058	1.235	.68	3.822	.022	161	-----	----	------
	.83	5.69	.341	.060	1.292	.83	4.723	.024	221	-----	----	------
	.72	5.43	.353	.065	1.337	.78	4.235	.023	351	-----	----	------
$S = 1.791\times10^{-3}$ $d_{50} = 0.200$ mm	.67	5.55	.411	.074	1.557	.75	4.163	.022	352	-----	----	------
$W = 8.0$ ft $U_* = 0.264$ fps	.61	5.43	.440	.081	1.666	.86	4.670	.023	512	0.122	1.64	0.0413
$Q = 73.33$ cfs $\tau = 0.194$ lb/ft^2	.50	5.42	.461	.085	1.746	.80	4.336	.024	697	-----	----	------
$T = 21.0$ °C $\nu = 1.057\times10^{-5}$ ft^2/sec	.45	5.38	.490	.091	1.856	.71	3.820	.023	685	-----	----	------
$D = 1.732$ ft R = 834,000	.39	5.39	.550	.102	2.083	.63	3.396	.024	940	.136	1.39	.0478
$\bar{V} = 5.30$ fps F = 0.682	.28	5.13	.533	.104	2.019	.75	3.848	.025	1399	-----	----	------
$C_t = 1796.9$ gpl $C/\sqrt{g} = 20.48$	.22	4.88	.522	.107	1.977	.68	3.318	.024	1650	-----	----	------
$\bar{D} = 1.732$ ft $D_{50} = 0.26$ mm	.17	4.67	.579	.124	2.193	.68	3.176	.023	2103	.152	1.69	.0577
	.11	4.35	.592	.136	2.242	.62	2.697	.022	2673	-----	----	------
	.07	3.92	.592	.151	2.242	.66	2.587	.020	6477	.183	1.71	.0742
	.06	3.74	.587	.157	2.223	.58	2.169	.012	6732	-----	----	------
Flume Centerline, Station 105 Feet - Dune Crest												
	0.94	3.85	0.262	0.068	1.248	0.43	1.656	0.034	118	-----	----	------
$S = 1.056\times10^{-3}$ $d_{50} = 0.183$ mm	.82	3.90	.285	.073	1.357	.57	2.223	.033	149	-----	----	------
$W = 8.0$ ft $U_* = 0.210$ fps	.69	3.93	.322	.082	1.533	.63	2.476	.036	176	0.127	1.46	0.0436
$Q = 48.65$ cfs $\tau = 0.111$ lb/ft^2	.57	3.87	.329	.085	1.566	.76	2.941	.028	197	-----	----	------
$T = 21.0$ °C $\nu = 1.054\times10^{-5}$ ft^2/sec	.45	3.80	.365	.096	1.738	.59	2.242	.028	262	-----	----	------
$D = 1.68$ ft R = 573,800	.36	3.52	.348	.099	1.657	.71	2.499	.027	256	.137	1.50	.0485
$\bar{V} = 3.16$ fps F = 0.489	.24	3.42	.338	.099	1.609	.80	2.736	.025	345	.139	1.48	.0500
$C_t = 778.1$ gpl $C/\sqrt{g} = 15.03$	.13	3.53	.431	.122	2.052	.59	2.083	.026	449	-----	----	------
$\bar{D} = 1.920$ ft $D_{50} = 0.26$ mm	.09	3.30	.469	.142	2.233	.62	2.046	.025	551	.145	1.45	.0544
	.03	2.86	.603	.211	2.871	.56	1.602	.024	---	-----	----	------
Flume Centerline, Station 95 Feet - Dune Trough												
	0.96	3.80	0.236	0.062	1.124	0.54	2.052	-----	83	-----	----	------
	.89	3.75	.244	.065	1.162	.72	2.700	-----	162	-----	----	------
	.81	3.76	.271	.072	1.290	.69	2.594	-----	229	-----	----	------
$S = 1.056\times10^{-3}$ $d_{50} = 0.183$ mm	.74	3.70	.296	.080	1.410	.58	2.146	-----	246	0.129	1.41	0.0446
$W = 8.0$ ft $U_* = 0.210$ fps	.68	3.58	.286	.080	1.362	.64	2.291	0.041	332	-----	----	------
$Q = 48.65$ cfs $\tau = 0.186$ lb/ft^2	.61	3.60	.306	.085	1.457	.61	2.196	.034	418	-----	----	------
$T = 21.0$ °C $\nu = 1.054\times10^{-5}$ ft^2/sec	.53	3.55	.330	.093	1.571	.68	2.414	.031	458	.139	1.44	.0500
$D = 2.82$ ft R = 671,600	.47	3.23	.400	.124	1.905	.62	2.003	.034	1110	-----	----	------
$\bar{V} = 3.16$ fps F = 0.263	.40	3.32	.647	.195	3.081	.58	1.926	.034	2304	.158	1.40	.0594
$C_t = 778.1$ gpl $C/\sqrt{g} = 15.03$	.33	1.27	.485	.382	2.310	.66	.838	.035	1554	.164	1.39	.0636
$\bar{D} = 1.920$ ft $D_{50} = 0.26$ mm	.26	.47	.186	.397	.886	.67	.315	.038	2022	.187	1.44	.0755
	.18	.47	.173	.368	.824	.65	.306	.028	----	-----	----	------
	.11	.34	.110	.323	.524	.68	.231	.023	----	-----	----	------
	.04	.32	.092	.287	.438	.74	.237	.012	----	-----	----	------
Flume Centerline, Station 105 Feet - Dune Back												
	0.94	3.64	0.266	0.073	1.267	0.42	1.529	-----	104	-----	----	------
$S = 1.056\times10^{-3}$ $d_{50} = 0.183$ mm	.83	3.56	.281	.079	1.338	.58	2.065	-----	389	-----	----	------
$W = 8.0$ ft $U_* = 0.210$ fps	.71	3.43	.394	.115	1.876	.60	2.058	-----	296	-----	----	------
$Q = 48.65$ cfs $\tau = 0.115$ lb/ft^2	.60	3.40	.401	.118	1.910	.53	1.802	-----	391	0.149	1.41	0.0552
$T = 21.0$ °C $\nu = 1.054\times10^{-5}$ ft^2/sec	.49	3.35	.402	.120	1.914	.54	1.809	-----	374	-----	----	------
$D = 1.75$ ft R = 564,500	.37	3.34	.431	.129	2.052	.64	2.138	-----	513	.156	1.57	.0647
$\bar{V} = 3.16$ fps F = 0.453	.26	3.31	.447	.135	2.129	.80	2.648	-----	592	-----	----	------
$C_t = 778.1$ gpl $C/\sqrt{g} = 15.03$	.14	3.27	.477	.146	2.271	.62	2.027	-----	569	.147	1.45	.0547
$\bar{D} = 1.920$ ft $D_{50} = 0.26$ mm	.03	3.22	.505	.157	2.405	.51	1.642	-----	763	.151	1.46	.0564
Flume Centerline, Station 20 Feet - Flatbed												
	0.91	2.93	0.196	0.067	1.059	0.48	1.406	-----	186	0.153	1.45	0.0584
	.82	2.92	.196	.067	1.059	.64	1.869	-----	254	-----	----	------
$S = 1.221\times10^{-3}$ $d_{50} = 0.206$ mm	.73	2.86	.212	.074	1.146	.53	1.516	-----	289	-----	----	------
$W = 8.0$ ft $U_* = 0.185$ fps	.64	2.86	.226	.079	1.222	.58	1.659	-----	349	-----	----	------
$Q = 25.81$ cfs $\tau = 0.0843$ lb/ft^2	.55	2.87	.247	.086	1.335	.56	1.607	-----	401	.178	1.42	.0702
$T = 20.7$ °C $\nu = 1.049\times10^{-5}$ ft^2/sec	.46	2.80	.263	.094	1.422	.64	1.792	-----	474	-----	----	------
$D = 1.107$ ft R = 296,500	.37	2.79	.265	.095	1.432	.68	1.897	-----	519	-----	----	------
$\bar{V} = 2.92$ fps F = 0.469	.28	2.72	.261	.096	1.411	.57	1.550	-----	571	.187	1.40	.0754
$C_t = 826.8$ gpl $C/\sqrt{g} = 15.80$	.19	2.74	.266	.097	1.438	.61	1.671	-----	714	-----	----	------
$\bar{D} = 1.107$ ft $D_{50} = 0.26$ mm	.09	2.66	.295	.111	1.595	.54	1.436	-----	1203	.192	1.39	.0780
	.04	2.63	.329	.125	1.778	.63	1.657	-----	----	-----	----	------
Flume Centerline, Station 60 Feet - Flatbed												
	0.92	3.67	0.257	0.070	1.389	0.54	1.982	-----	59	0.130	1.37	0.0456
	.83	3.58	.265	.074	1.432	.56	2.005	-----	60	-----	----	------
$S = 1.221\times10^{-3}$ $d_{50} = 0.206$ mm	.75	3.54	.297	.084	1.605	.52	1.841	-----	39	-----	----	------
$W = 8.0$ ft $U_* = 0.185$ fps	.67	3.51	.305	.087	1.649	.55	1.931	-----	81	-----	----	------
$Q = 25.81$ cfs $\tau = 0.0843$ lb/ft^2	.58	3.48	.310	.089	1.676	.54	1.879	-----	147	-----	----	------
$T = 20.7$ °C $\nu = 1.049\times10^{-5}$ ft^2/sec	.50	3.37	.347	.103	1.876	.62	2.089	-----	328	0.156	1.47	0.0581
$D = 1.107$ ft R = 350,400	.42	3.36	.380	.113	2.054	.54	1.814	-----	257	-----	----	------
$\bar{V} = 2.92$ fps F = 0.556	.33	3.22	.399	.124	2.157	.68	2.190	-----	272	-----	----	------
$C_t = 826.8$ gpl $C/\sqrt{g} = 15.80$	.25	3.17	.412	.130	2.227	.60	1.902	-----	279	.143	1.39	.0524
$\bar{D} = 1.107$ ft $D_{50} = 0.26$ mm	.17	2.96	.462	.156	2.497	.54	1.598	-----	369	-----	----	------
	.08	2.62	.524	.200	2.832	.49	1.284	-----	618	.147	1.32	.0544
Flume Centerline, Station 90 Feet - Flatbed												
	0.89	3.68	0.217	0.059	1.173	0.62	2.282	-----	25	0.117	1.39	0.0388
$S = 1.221\times10^{-3}$ $d_{50} = 0.206$ mm	.79	3.67	.235	.064	1.270	.56	2.055	-----	24	-----	----	------
$W = 8.0$ ft $U_* = 0.185$ fps	.68	3.64	.240	.065	1.297	.52	1.893	-----	39	.119	1.36	.0394
$Q = 25.81$ cfs $\tau = 0.0843$ lb/ft^2	.57	3.62	.246	.068	1.330	.58	2.100	-----	78	-----	----	------
$T = 20.7$ °C $\nu = 1.049\times10^{-5}$ ft^2/sec	.47	3.50	.290	.082	1.568	.68	2.380	-----	129	-----	----	------
$D = 1.107$ ft R = 340,900	.36	3.27	.307	.093	1.659	.65	2.126	-----	218	.134	1.33	.0472
$\bar{V} = 2.92$ fps F = 0.541	.25	3.15	.335	.106	1.811	.52	1.638	-----	434	-----	----	------
$C_t = 826.8$ gpl $C/\sqrt{g} = 15.80$	.15	2.86	.377	.131	2.038	.51	1.459	-----	974	.172	1.43	.0675
$\bar{D} = 1.107$ ft $D_{50} = 0.26$ mm	.05	2.12	.367	.173	1.984	.46	.975	-----	5383	-----	----	------

TABLE 7. — *Atrisco feeder canal*

Mean Flow Parameters and Variables		Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u'^2}}$ (fps)	$\sqrt{\overline{u'^2}}/\overline{U}$	$\sqrt{\overline{u'^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)	C_s (gpl)	d_{50} (mm)	σ	ω (fps)
44 Feet From Left Bank - Dunes													
		0.98	2.07	0.127	0.061	0.742	----	-----	----	---	----	----	------
		.86	2.06	.135	.065	.791	----	-----	----	---	----	----	------
$S = 0.57\times10^{-3}$	$U_* = 0.171$ fps	.75	2.05	.145	.071	.847	----	-----	----	---	----	----	------
$W = 56$ ft	$\tau = 0.059$ lb/ft^2	.49	2.07	.168	.081	.982	----	-----	----	---	----	----	------
$Q = 203$ cfs	$\nu = 1.36\times10^{-5}$ ft^2/sec	.37	2.05	.187	.091	1.092	----	-----	----	---	----	----	------
$T = 11.4$ °C	R = 250,200	.36	2.05	.194	.095	1.133	----	-----	----	---	----	----	------
$\underline{D} = 1.66$ ft	$\underline{F} = 0.28$	.27	2.05	.219	.107	1.280	----	-----	----	---	----	----	------
$\overline{V} = 2.13$ fps	$C/\sqrt{g} = 12.45$	.22	2.04	.228	.112	1.334	----	-----	----	---	----	----	------
$\overline{D} = 1.70$ ft	$D_{50} = 0.235$ mm	.17	2.04	.240	.118	1.403	----	-----	----	---	----	----	------
		.13	2.03	.268	.132	1.567	----	-----	----	---	----	----	------
44 Feet From Left Bank - Dunes													
		0.92	1.67	0.126	0.075	0.737	----	-----	----	---	----	----	------
$S = 0.57\times10^{-3}$	$U_* = 0.171$ fps	.81	1.64	.138	.083	.808	----	-----	----	---	----	----	------
$W = 56$ ft	$\tau = 0.063$ lb/ft^2	.70	1.64	.148	.090	.865	----	-----	----	---	----	----	------
$Q = 203$ cfs	$\nu = 1.33\times10^{-5}$ ft^2/sec	.60	1.62	.157	.097	.918	----	-----	----	---	----	----	------
$T = 12.2$ °C	R = 212,900	.49	1.58	.171	.108	1.000	----	-----	----	---	----	----	------
$\underline{D} = 1.77$ ft	$\underline{F} = 0.13$	.36	1.57	.191	.121	1.117	----	-----	----	---	----	----	------
$\overline{V} = 2.13$ fps	$C/\sqrt{g} = 12.45$	.22	1.56	.217	.138	1.269	----	-----	----	---	----	----	------
$\overline{D} = 1.70$ ft	$D_{50} = 0.235$ mm	.11	1.41	.251	.178	1.469	----	-----	----	---	----	----	------
44 Feet From Left Bank - Dunes													
		0.97	2.39	0.124	0.052	0.725	0.69	0.550	----	60	0.12	1.42	0.0364
$S = 0.57\times10^{-3}$	$U_* = 0.171$ fps	.86	2.36	.142	.060	.830	.80	.448	----	73	.12	1.46	.0364
$W = 56$ ft	$\tau = 0.066$ lb/ft^2	.76	2.33	.224	.096	1.310	.78	.466	----	90	.12	1.43	.0364
$Q = 203$ cfs	$\nu = 1.22\times10^{-5}$ ft^2/sec	.65	2.31	.229	.099	1.339	.72	.554	----	116	.13	1.47	.0412
$T = 14.7$ °C	R = 326,500	.45	2.29	.247	.108	1.444	.88	.412	----	294	.14	1.44	.0457
$\underline{D} = 1.87$ ft	$\underline{F} = 0.27$	.29	2.14	.280	.130	1.637	.88	.599	----	320	.14	1.42	.0457
$\overline{V} = 2.13$ fps	$C/\sqrt{g} = 12.45$	.19	1.91	.302	.158	1.766	.80	.573	----	409	.15	1.39	.0513
$\overline{D} = 1.70$ ft	$D_{50} = 0.235$ mm	.08	1.35	.305	.226	1.784	.76	.351	----	816	.16	1.46	.0565
44 Feet From Left Bank - Dunes													
		0.95	2.78	0.145	0.052	0.848	----	-----	----	---	----	----	------
		.85	2.76	.164	.059	.959	----	-----	----	---	----	----	------
$S = 0.57\times10^{-3}$	$U_* = 0.171$ fps	.73	2.66	.177	.067	1.035	----	-----	----	---	----	----	------
$W = 56$ ft	$\tau = 0.0679$ lb/ft^2	.64	2.55	.188	.074	1.099	----	-----	----	---	----	----	------
$Q = 203$ cfs	$\nu = 1.41\times10^{-5}$ ft^2/sec	.52	2.59	.196	.076	1.146	----	-----	----	---	----	----	------
$T = 10.0$ °C	R = 270,900	.41	2.06	.186	.090	1.088	----	-----	----	---	----	----	------
$\underline{D} = 1.91$ ft	$\underline{F} = 0.306$	.31	2.12	.200	.095	1.170	----	-----	----	---	----	----	------
$\overline{V} = 2.13$ fps	$C/\sqrt{g} = 12.45$	.23	2.10	.232	.110	1.357	----	-----	----	---	----	----	------
$\overline{D} = 1.70$ ft	$D_{50} = 0.235$ mm	.13	2.00	.270	.135	1.579	----	-----	----	---	----	----	------
28 Feet From Left Bank - Dunes													
		0.95	2.54	0.151	0.060	0.883	0.65	1.651	----	69	0.11	1.33	0.0325
$S = 0.570\times10^{-3}$	$U_* = 0.171$ fps	.84	2.43	.189	.078	1.105	.85	2.066	----	76	.12	1.36	.0364
$W = 56$ ft	$\tau = 0.0662$ lb/ft^2	.74	2.35	.194	.084	1.134	.77	1.810	----	94	.12	1.42	.0364
$Q = 203$ cfs	$\nu = 1.38\times10^{-5}$ ft^2/sec	.64	2.30	.207	.090	1.211	.85	1.955	----	127	.13	1.32	.0412
$T = 10.8$ °C	R = 281,700	.54	2.02	.202	.100	1.181	.82	1.656	----	249	.14	1.41	.0457
$\underline{D} = 1.86$ ft	$\underline{F} = 0.270$	.43	2.06	.227	.110	1.327	.89	1.833	----	339	.14	1.38	.0457
$\overline{V} = 2.13$ fps	$C/\sqrt{g} = 12.45$	.35	1.86	.234	.126	1.368	.79	1.469	----	428	.15	1.34	.0513
$\overline{D} = 1.70$ ft	$D_{50} = 0.235$ mm	.28	1.75	.268	.153	1.567	.87	1.523	----	644	.16	1.47	.0565
		.16	1.55	.318	.205	1.860	.77	1.194	----	876	.17	1.43	.0614
12 Feet From Left Bank - Dunes													
$S = 0.570\times10^{-3}$	$U_* = 0.171$ fps	0.90	2.30	0.146	0.064	0.854	----	-----	----	---	----	----	------
$W = 56$ ft	$\tau = 0.0494$ lb/ft^2	.77	2.27	.158	.070	.924	----	-----	----	---	----	----	------
$Q = 203$ cfs	$\nu = 1.29\times10^{-5}$ ft^2/sec	.58	2.27	.180	.080	1.053	----	-----	----	---	----	----	------
$T = 13.3$ °C	R = 227,400	.48	2.12	.198	.094	1.158	----	-----	----	---	----	----	------
$\underline{D} = 1.39$ ft	$\underline{F} = 0.315$	.34	2.01	.217	.108	1.269	----	-----	----	---	----	----	------
$\overline{V} = 2.13$ fps	$C/\sqrt{g} = 12.45$	.19	1.70	.248	.146	1.452	----	-----	----	---	----	----	------
$\overline{D} = 1.70$ ft	$D_{50} = 0.235$ mm												

TABLE 8.—*Rio Grande conveyance channel*

Mean Flow Parameters and Variables	Y/D	$\bar{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\bar{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)	C_s (gpl)	d_{50} (mm)	σ	ω (fps)
52 Feet From Left Bank - Dunes												
	0.96	1.53	0.139	0.091	0.650	----	-----	-----	---	-----	----	------
	.86	1.78	.185	.104	.864	----	-----	-----	---	-----	----	------
$S = 0.55\times10^{-3}$; $U_* = 0.214$ fps	.78	1.94	.322	.166	1.505	----	-----	-----	---	-----	----	------
$W = 68$ ft; $\tau = 0.109$ lb/ft^2	.68	1.81	.348	.192	1.626	----	-----	-----	---	-----	----	------
$Q = 510$ cfs; $\nu = 1.217\times10^{-5}$ ft^2/sec	.58	2.16	.488	.266	2.280	----	-----	-----	---	-----	----	------
$T = 15.6$ °C; R = 444,200	.49	1.82	.480	.264	2.243	----	-----	-----	---	-----	----	------
$\underline{D} = 3.18$ ft; F = 0.168	.40	1.58	.426	.270	1.991	----	-----	-----	---	-----	----	------
$\bar{V} = 2.68$ fps; $C/\sqrt{g} = 12.53$	.30	1.50	.474	.316	2.215	----	-----	-----	---	-----	----	------
$\bar{D} = 2.80$ ft; $D_{50} = 0.240$ mm	.18	1.53	.496	.324	2.318	----	-----	-----	---	-----	----	------
	.09	1.53	.468	.306	2.187	----	-----	-----	---	-----	----	------
	.08	1.46	.153	.105	.715	----	-----	-----	---	-----	----	------
34 Feet From Left Bank - Dunes												
	0.96	2.83	0.125	0.044	0.584	1.08	3.056	-----	283	0.132	1.32	0.0432
	.86	2.86	.154	.054	.720	.82	2.345	-----	346	.135	1.37	.0444
$S = 0.55\times10^{-3}$; $U_* = 0.214$ fps	.76	2.85	.191	.067	.893	1.28	3.648	-----	483	.137	1.43	.0458
$W = 68$ ft; $\tau = 0.105$ lb/ft^2	.66	2.73	.202	.074	.944	1.03	2.812	-----	530	.138	1.51	.0463
$Q = 510$ cfs; $\nu = 1.16\times10^{-5}$ ft^2/sec	.57	2.70	.232	.086	1.084	1.06	2.862	-----	594	.141	1.42	.0479
$T = 17.2$ °C; R = 674,900	.47	2.62	.259	.099	1.210	1.31	3.432	-----	673	.145	1.46	.0494
$\underline{D} = 3.07$ ft; F = 0.256	.36	2.52	.242	.096	1.131	1.19	2.999	-----	612	.148	1.41	.0519
$\bar{V} = 2.68$ fps; $C/\sqrt{g} = 12.53$	.25	2.21	.256	.116	1.196	1.01	2.232	-----	882	.163	1.51	.0584
$\bar{D} = 2.80$ ft; $D_{50} = 0.240$ mm	.18	2.11	.279	.132	1.304	1.03	2.173	-----	1039	.171	1.44	.0623
	.12	2.02	.323	.160	1.509	.89	1.798	-----	1221	.183	1.46	.0692
16 Feet From Left Bank - Dunes												
	0.94	2.59	0.140	0.054	0.654	----	-----	-----	---	-----	----	------
	.84	2.47	.158	.064	.738	----	-----	-----	---	-----	----	------
$S = 0.55\times10^{-3}$; $U_* = 0.214$ fps	.76	2.44	.151	.061	.706	----	-----	-----	---	-----	----	------
$W = 68$ ft; $\tau = 0.114$ lb/ft^2	.66	2.66	.173	.065	.808	----	-----	-----	---	-----	----	------
$Q = 510$ cfs; $\nu = 1..45\times10^{-5}$ ft^2/sec	.58	2.75	.215	.078	1.005	----	-----	-----	---	-----	----	------
$T = 17.8$ °C; R = 685,100	.47	2.64	.241	.091	1.126	----	-----	-----	---	-----	----	------
$\underline{D} = 3.31$ ft; F = 0.230	.37	2.50	.260	.104	1.215	----	-----	-----	---	-----	----	------
$\bar{V} = 2.68$ fps; $C/\sqrt{g} = 12.53$	.28	2.36	.277	.117	1.294	----	-----	-----	---	-----	----	------
$\bar{D} = 2.80$ ft; $D_{50} = 0.240$ mm	.18	2.17	.306	.141	1.430	----	-----	-----	---	-----	----	------
	.11	1.86	.293	.157	1.369	----	-----	-----	---	-----	----	------
	.09	1.67	.284	.170	1.327	----	-----	-----	---	-----	----	------
34 Feet From Left Bank - Dunes												
	0.95	3.09	0.167	0.055	0.780	----	-----	-----	---	-----	----	------
	.86	3.05	.235	.077	1.098	----	-----	-----	---	-----	----	------
$S = 0.550\times10^{-3}$; $U_* = 0.214$ fps	.77	3.16	.275	.087	1.285	----	-----	-----	---	-----	----	------
$W = 68$ ft; $\tau = 0.111$ lb/ft^2	.67	3.08	.342	.111	1.598	----	-----	-----	---	-----	----	------
$Q = 550$ cfs; $\nu = 1.29\times10^{-5}$ ft^2/sec	.58	2.97	.404	.136	1.888	----	-----	-----	---	-----	----	------
$T = 13.3$ °C; R = 691,100	.49	2.83	.416	.147	1.944	----	-----	-----	---	-----	----	------
$\underline{D} = 3.23$ ft; F = 0.271	.41	2.67	.433	.162	2.023	----	-----	-----	---	-----	----	------
$\bar{V} = 2.88$ fps; $C/\sqrt{g} = 13.42$	.30	2.48	.439	.177	2.051	----	-----	-----	---	-----	----	------
$\bar{D} = 2.80$ ft; $D_{50} = 0.240$ mm	.22	2.28	.431	.189	2.014	----	-----	-----	---	-----	----	------
	.15	2.30	.361	.157	1.687	----	-----	-----	---	-----	----	------
	.09	2.40	.415	.173	1.939	----	-----	-----	---	-----	----	------
34 Feet From Left Bank - Dunes												
	0.96	2.54	0.107	0.042	0.500	----	-----	-----	---	-----	----	------
	.86	2.59	.111	.043	.519	----	-----	-----	---	-----	----	------
	.77	2.64	.166	.063	.766	----	-----	-----	---	-----	----	------
$S = 0.550\times10^{-3}$; $U_* = 0.214$ fps	.69	2.72	.245	.090	1.145	----	-----	-----	---	-----	----	------
$W = 68$ ft; $\tau = 0.114$ lb/ft^2	.58	2.70	.351	.130	1.640	----	-----	-----	---	-----	----	------
$Q = 550$ cfs; $\nu = 1.29\times10^{-5}$ ft^2/sec	.50	2.62	.443	.169	2.070	----	-----	-----	---	-----	----	------
$T = 13.3$ °C; R = 614,400	.42	2.50	.455	.182	2.126	----	-----	-----	---	-----	----	------
$\underline{D} = 3.33$ ft; F = 0.230	.32	2.29	.472	.206	2.206	----	-----	-----	---	-----	----	------
$\bar{V} = 2.88$ fps; $C/\sqrt{g} = 13.42$	.24	2.00	.490	.245	2.290	----	-----	-----	---	-----	----	------
$\bar{D} = 2.80$ ft; $D_{50} = 0.240$ mm	.16	1.88	.451	.240	2.107	----	-----	-----	---	-----	----	------
	.09	1.73	.303	.175	1.416	----	-----	-----	---	-----	----	------
34 Feet From Left Bank - Dunes												
	0.98	2.86	0.123	0.043	0.575	----	-----	-----	---	-----	----	------
	.92	2.94	.138	.047	.645	----	-----	-----	---	-----	----	------
	.86	2.98	.176	.059	.822	----	-----	-----	---	-----	----	------
$S = 0.550\times10^{-3}$; $U_* = 0.214$ fps	.72	2.94	.223	.076	1.042	----	-----	-----	---	-----	----	------
$W = 68$ ft; $\tau = 0.119$ lb/ft^2	.63	2.82	.288	.102	1.346	----	-----	-----	---	-----	----	------
$Q = 545$ cfs; $\nu = 1.28\times10^{-5}$ ft^2/sec	.55	2.48	.407	.164	1.902	----	-----	-----	---	-----	----	------
$T = 13.6$ °C; R = 574,700	.46	2.12	.409	.193	1.911	----	-----	-----	---	-----	----	------
$\underline{D} = 3.47$ ft; F = 0.201	.37	1.71	.393	.230	1.836	----	-----	-----	---	-----	----	------
$\bar{V} = 2.86$ fps; $C/\sqrt{g} = 13.35$	.31	1.40	.294	.210	1.374	----	-----	-----	---	-----	----	------
$\bar{D} = 2.80$ ft; $D_{50} = 0.240$ mm	.22	1.09	.251	.230	1.173	----	-----	-----	---	-----	----	------
	.15	1.07	.209	.195	.977	----	-----	-----	---	-----	----	------
	.09	1.10	.248	.225	1.159	----	-----	-----	---	-----	----	------
34 Feet From Left Bank - Dunes												
	0.95	2.78	0.170	0.061	0.794	----	-----	-----	---	-----	----	------
	.86	2.70	.181	.067	.846	----	-----	-----	---	-----	----	------
	.77	2.75	.179	.065	.836	----	-----	-----	---	-----	----	------
$S = 0.550\times10^{-3}$; $U_* = 0.214$ fps	.68	2.90	.203	.070	.949	----	-----	-----	---	-----	----	------
$W = 68.0$ ft; $\tau = 0.115$ lb/ft^2	.60	2.66	.210	.079	.981	----	-----	-----	---	-----	----	------
$Q = 540$ cfs; $\nu = 1.28\times10^{-5}$ ft^2/sec	.51	2.23	.256	.115	1.196	----	-----	-----	---	-----	----	------
$T = 13.6$ °C; R = 493,200	.42	1.77	.381	.215	1.780	----	-----	-----	---	-----	----	------
$\underline{D} = 3.34$ ft; F = 0.182	.34	1.22	.373	.306	1.743	----	-----	-----	---	-----	----	------
$\bar{V} = 2.84$ fps; $C/\sqrt{g} = 13.25$	.23	1.06	.264	.249	1.234	----	-----	-----	---	-----	----	------
$\bar{D} = 2.80$ ft; $D_{50} = 0.240$ mm	.16	.90	.178	.198	.836	----	-----	-----	---	-----	----	------
	.12	.90	.169	.188	.790	----	-----	-----	---	-----	----	------
	.08	.80	.137	.171	.640	----	-----	-----	---	-----	----	------

TABLE 8. — *Rio Grande conveyance channel* — Continued

34 Feet From Left Bank - Dunes

Mean Flow Parameters and Variables	Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)	C_s (gpl)	d_{50} (mm)	σ	ω (fps)
	0.95	2.42	0.165	0.068	0.771	----	-----	-----	---	-----	----	------
	.86	2.49	.184	.074	.860	----	-----	-----	---	-----	----	------
S = 0.550×10^{-3}; U_* = 0.214 fps	.77	2.65	.191	.072	.893	----	-----	-----	---	-----	----	------
W = 68.0 ft; τ = 0.101 lb/ft^2	.67	2.75	.198	.072	.925	----	-----	-----	---	-----	----	------
Q = 540 cfs; ν = 1.27×10^{-5} ft^2/sec	.56	2.89	.280	.097	1.308	----	-----	-----	---	-----	----	------
T = 13.9 °C; R = 578,700	.45	2.83	.293	.104	1.369	----	-----	-----	---	-----	----	------
$\underline{D}$ = 2.94 ft; $\underline{F}$ = 0.257	.33	2.83	.351	.124	1.640	----	-----	-----	---	-----	----	------
$\overline{V}$ = 2.84 fps; $C/\sqrt{g}$ = 13.25	.20	2.78	.487	.175	2.276	----	-----	-----	---	-----	----	------
$\overline{D}$ = 2.80 ft; D_{50} = 0.240 mm	.08	0.86	.170	.198	.794	----	-----	-----	---	-----	----	------

34 Feet From Left Bank - Dunes

Mean Flow Parameters and Variables	Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)	C_s (gpl)	d_{50} (mm)	σ	ω (fps)
	0.94	2.69	0.202	0.075	0.944	----	-----	-----	---	-----	----	------
	.85	2.86	.260	.091	1.215	----	-----	-----	---	-----	----	------
	.77	2.96	.299	.101	1.397	----	-----	-----	---	-----	----	------
S = 0.550×10^{-3}; U_* = 0.214 fps	.69	2.86	.332	.116	1.551	----	-----	-----	---	-----	----	------
W = 68.0 ft; τ = 0.0824 lb/ft^2	.60	2.79	.379	.136	1.771	----	-----	-----	---	-----	----	------
Q = 530 cfs; ν = 1.25×10^{-5} ft^2/sec	.52	2.86	.332	.116	1.551	----	-----	-----	---	-----	----	------
T = 14.4 °C; R = 562,600	.44	2.96	.326	.110	1.523	----	-----	-----	---	-----	----	------
$\underline{D}$ = 2.40 ft; $\underline{F}$ = 0.333	.36	3.06	.397	.130	1.855	----	-----	-----	---	-----	----	------
$\overline{V}$ = 2.78 fps; $C/\sqrt{g}$ = 12.98	.28	3.13	.385	.123	1.799	----	-----	-----	---	-----	----	------
$\overline{D}$ = 2.80 ft; D_{50} = 0.250 mm	.19	3.03	.373	.123	1.743	----	-----	-----	---	-----	----	------
	.12	2.98	.374	.126	1.748	----	-----	-----	---	-----	----	------

34 Feet From Left Bank - Dunes

Mean Flow Parameters and Variables	Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)	C_s (gpl)	d_{50} (mm)	σ	ω (fps)
	0.94	2.86	0.223	0.078	1.042	----	-----	-----	---	-----	----	------
	.85	2.96	.243	.082	1.136	----	-----	-----	---	-----	----	------
	.76	3.03	.294	.097	1.374	----	-----	-----	---	-----	----	------
S = 0.550×10^{-3}; U_* = 0.214 fps	.67	2.96	.302	.102	1.411	----	-----	-----	---	-----	----	------
W = 68.0 ft; τ = 0.0844 lb/ft^2	.59	2.86	.323	.113	1.509	----	-----	-----	---	-----	----	------
Q = 530 cfs; ν = 1.25×10^{-5} ft^2/sec	.51	2.82	.327	.116	1.528	----	-----	-----	---	-----	----	------
T = 14.4 °C; R = 558,900	.42	2.76	.351	.127	1.640	----	-----	-----	---	-----	----	------
$\underline{D}$ = 2.46 ft; $\underline{F}$ = 0.319	.39	2.76	.364	.132	1.701	----	-----	-----	---	-----	----	------
$\overline{V}$ = 2.78 fps; $C/\sqrt{g}$ = 12.98	.31	2.82	.361	.128	1.687	----	-----	-----	---	-----	----	------
$\overline{D}$ = 2.80 ft; D_{50} = 0.240 mm	.23	2.96	.429	.145	2.005	----	-----	-----	---	-----	----	------
	.15	2.98	.401	.135	1.874	----	-----	-----	---	-----	----	------
	.12	2.86	.486	.170	2.271	----	-----	-----	---	-----	----	------

34 Feet From Left Bank - Dunes

Mean Flow Parameters and Variables	Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)	C_s (gpl)	d_{50} (mm)	σ	ω (fps)
	0.94	2.50	0.215	0.086	1.005	----	-----	-----	---	-----	----	------
S = 0.550×10^{-3}; U_* = 0.214 fps	.83	2.41	.251	.104	1.173	----	-----	-----	---	-----	----	------
W = 68.0 ft; τ = 0.0916 lb/ft^2	.72	2.30	.269	.117	1.257	----	-----	-----	---	-----	----	------
Q = 520 cfs; ν = 1.24×10^{-5} ft^2/sec	.60	2.12	.267	.126	1.248	----	-----	-----	---	-----	----	------
T = 14.7 °C; R = 480,200	.50	2.06	.280	.136	1.308	----	-----	-----	---	-----	----	------
$\underline{D}$ = 2.67 ft; $\underline{F}$ = 0.241	.39	2.02	.295	.146	1.379	----	-----	-----	---	-----	----	------
$\overline{V}$ = 2.74 fps; $C/\sqrt{g}$ = 12.80	.28	2.11	.312	.148	1.458	----	-----	-----	---	-----	----	------
$\overline{D}$ = 2.80 ft; D_{50} = 0.240 mm	.16	2.30	.313	.136	1.463	----	-----	-----	---	-----	----	------
	.11	2.26	.389	.172	1.818	----	-----	-----	---	-----	----	------

34 Feet From Left Bank - Dunes

Mean Flow Parameters and Variables	Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)	C_s (gpl)	d_{50} (mm)	σ	ω (fps)
	0.94	2.58	0.196	0.076	0.916	0.26	0.671	0.028	426	0.126	1.46	0.0394
S = 0.550×10^{-3}; U_* = 0.214 fps	.83	2.68	.263	.098	1.229	.22	.590	.031	497	.125	1.42	.0388
W = 68.0 ft; τ = 0.0916 lb/ft^2	.71	2.55	.293	.115	1.369	.17	.434	.033	545	.127	1.47	.0408
Q = 520 cfs; ν = 1.23×10^{-5} ft^2/sec	.61	2.40	.338	.141	1.579	.21	.504	.029	489	.127	1.38	.0408
T = 15.0 °C; R = 494,900	.50	2.28	.415	.182	1.939	.23	.524	.027	526	.128	1.40	.0418
$\underline{D}$ = 2.67 ft; $\underline{F}$ = 0.246	.38	2.10	.372	.177	1.738	.24	.504	.030	525	.131	1.46	.0440
$\overline{V}$ = 2.74 fps; $C/\sqrt{g}$ = 12.80	.28	2.00	.366	.183	1.710	.19	.380	.028	998	.145	1.54	.0498
$\overline{D}$ = 2.80 ft; D_{50} = 0.240 mm	.17	1.95	.343	.176	1.603	.20	.390	.026	1112	.159	1.50	.0564
	.13	1.97	.299	.152	1.397	.18	.355	.027	1311	.169	1.48	.0623

34 Feet From Left Bank - Dunes

Mean Flow Parameters and Variables	Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)	C_s (gpl)	d_{50} (mm)	σ	ω (fps)
	0.94	3.08	0.129	0.042	0.603	----	-----	-----	---	-----	----	------
	.83	2.92	.178	.061	.832	----	-----	-----	---	-----	----	------
S = 0.550×10^{-3}; U_* = 0.214 fps	.71	2.77	.255	.092	1.192	----	-----	-----	---	-----	----	------
W = 68.0 ft; τ = 0.0903 lb/ft^2	.60	2.54	.272	.107	1.271	----	-----	-----	---	-----	----	------
Q = 510 cfs; ν = 1.23×10^{-5} ft^2/sec	.48	2.37	.313	.132	1.463	----	-----	-----	---	-----	----	------
T = 15.0 °C; R = 472,500	.38	2.07	.277	.134	1.294	----	-----	-----	---	-----	----	------
$\underline{D}$ = 2.63 ft; $\underline{F}$ = 0.240	.27	1.83	.258	.141	1.206	----	-----	-----	---	-----	----	------
$\overline{V}$ = 2.68 fps; $C/\sqrt{g}$ = 12.53	.16	1.64	.246	.150	1.150	----	-----	-----	---	-----	----	------
$\overline{D}$ = 2.80 ft; D_{50} = 0.240 mm	.11	1.65	.261	.158	1.220	----	-----	-----	---	-----	----	------

34 Feet From Left Bank - Dunes

Mean Flow Parameters and Variables	Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)	C_s (gpl)	d_{50} (mm)	σ	ω (fps)
	0.95	2.74	0.156	0.057	0.729	----	-----	-----	---	-----	----	------
	.84	2.77	.249	.090	1.164	----	-----	-----	---	-----	----	------
S = 0.550×10^{-3}; U_* = 0.214 fps	.75	2.60	.341	.131	1.593	----	-----	-----	---	-----	----	------
W = 68.0 ft; τ = 0.0913 lb/ft^2	.64	2.42	.351	.145	1.640	----	-----	-----	---	-----	----	------
Q = 510 cfs; ν = 1.217×10^{-5} ft^2/sec	.52	2.15	.357	.166	1.668	----	-----	-----	---	-----	----	------
T = 15.6 °C; R = 478,700	.39	2.03	.309	.152	1.444	----	-----	-----	---	-----	----	------
$\underline{D}$ = 2.66 ft; $\underline{F}$ = 0.237	.30	1.82	.348	.191	1.626	----	-----	-----	---	-----	----	------
$\overline{V}$ = 2.68 fps; $C/\sqrt{g}$ = 12.53	.19	1.66	.400	.241	1.869	----	-----	-----	---	-----	----	------
$\overline{D}$ = 2.80 ft; D_{50} = 0.240 mm	.11	1.55	.375	.242	1.752	----	-----	-----	---	-----	----	------

TABLE 8. — *Rio Grande conveyance channel* — Continued

Mean Flow Parameters and Variables		Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)	C_s (gpl)	d_{50} (mm)	σ	ω (fps)
34 Feet From Left Bank - Dunes													
		0.94	2.95	0.156	0.053	0.729	0.73	2.15	0.026	368	0.134	1.43	0.0434
$S = 0.550\times10^{-3}$	$U_* = 0.214$ fps	.83	3.00	.183	.061	.855	.68	2.04	.031	414	.136	1.41	.0442
$W = 68.0$ ft	$\tau = 0.0793$ lb/ft^2	.71	3.00	.204	.068	.953	.81	2.43	.028	487	.139	1.35	.0454
$Q = 510$ cfs	$\nu = 1.217\times10^{-5}$ ft^2/sec	.58	2.97	.223	.075	1.042	1.33	3.95	.025	544	.142	1.38	.0471
$T = 15.6$ °C	R = 525,800	.45	3.05	.262	.086	1.224	.84	2.56	.029	527	.147	1.45	.0497
$D = 2.31$ ft	F = 0.321	.27	2.70	.338	.125	1.579	.92	2.48	.027	987	.167	1.42	.0585
$\overline{V} = 2.68$ fps	$C/\sqrt{g} = 12.53$	.13	1.70	.380	.223	1.776	.89	1.51	.024	1518	.182	1.51	.0676
$\overline{D} = 2.31$ ft	$D_{50} = 0.240$ mm												
34 Feet From Left Bank - Dunes													
		0.94	3.32	0.173	0.052	0.808	----	-----	-----	---	-----	----	------
$S = 0.550\times10^{-3}$	$U_* = 0.214$ fps	.86	3.34	.200	.060	.935	----	-----	-----	---	-----	----	------
$W = 68.0$ ft	$\tau = 0.0872$ lb/ft^2	.74	3.31	.225	.068	1.051	----	-----	-----	---	-----	----	------
$Q = 510$ cfs	$\nu = 1.217\times10^{-5}$ ft^2/sec	.63	3.29	.273	.088	1.276	----	-----	-----	---	-----	----	------
$T = 15.6$ °C	R = 690,800	.42	3.28	.302	.092	1.411	----	-----	-----	---	-----	----	------
$D = 2.54$ ft	F = 0.366	.31	3.26	.346	.106	1.617	----	-----	-----	---	-----	----	------
$\overline{V} = 2.68$ fps	$C/\sqrt{g} = 12.53$	.20	3.27	.405	.124	1.893	----	-----	-----	---	-----	----	------
$\overline{D} = 2.80$ ft	$D_{50} = 0.240$ mm	.10	3.40	.517	.152	2.416	----	-----	-----	---	-----	----	------
36 Feet From Left Bank - Flatbed													
		0.90	5.43	0.261	0.048	1.155	1.54	8.36	0.037	413	0.163	1.32	0.0574
		.79	5.32	.289	.054	1.279	1.53	8.14	.038	476	.167	1.33	.0590
		.79	5.30	.314	.059	1.388	1.51	8.00	.041	476	-----	----	------
$S = 0.57\times10^{-3}$	$U_* = 0.226$ fps	.69	5.23	.341	.066	1.510	1.24	6.48	.039	544	.174	1.35	.0612
$W = 73.0$ ft	$\tau = 0.103$ lb/ft^2	.59	5.12	.384	.075	1.700	1.03	5.27	.043	661	.179	1.36	.0638
$Q = 930.0$ cfs	$\nu = 1.34\times10^{-5}$ ft^2/sec	.48	5.01	.391	.078	1.726	1.32	6.61	.038	777	.185	1.36	.0662
$T = 12.0$ °C	R = 1,021,500	.48	4.97	.398	.080	1.761	1.43	7.11	.036	777	-----	----	------
$D = 3.00$ ft	F = 0.488	.38	4.82	.442	.092	1.951	1.08	5.21	.040	1162	.189	1.41	.0683
$\overline{V} = 4.60$ fps	$C/\sqrt{g} = 20.40$	.28	4.56	.452	.099	1.993	1.26	5.75	.039	1479	.196	1.43	.0722
$\overline{D} = 3.00$ ft	$D_{50} = 0.200$ mm	.28	4.61	.456	.101	2.020	1.17	5.39	.042	1479	-----	----	------
		.17	4.19	.518	.124	2.282	1.44	6.03	.038	2423	.217	1.44	.0813
		.07	3.58	.548	.153	2.430	1.51	5.41	.034	6084	.237	1.45	.0893
		.04	3.29	.624	.190	2.763	.94	3.09	.031	15800	.263	1.51	.1032
36 Feet From Left Bank - Flatbed													
$S = 0.57\times10^{-3}$	$U_* = 0.224$ fps	0.87	4.14	0.228	0.055	1.018	1.04	4.31	0.042	397	0.156	1.36	0.0522
$W = 73.0$ ft	$\tau = 0.107$ lb/ft^2	.73	4.13	.248	.060	1.107	1.16	4.79	.037	526	.164	1.38	.0566
$Q = 815.0$ cfs	$\nu = 1.34\times10^{-5}$ ft^2/sec	.60	4.11	.279	.068	1.246	1.57	6.45	.039	764	.172	1.37	.0598
$T = 12.0$ °C	R = 866,400	.47	4.07	.334	.082	1.491	1.56	6.35	.041	916	.185	1.41	.0658
$D = 2.90$ ft	F = 0.394	.33	3.93	.424	.108	1.893	1.34	5.27	.036	1031	.192	1.43	.0690
$\overline{V} = 3.85$ fps	$C/\sqrt{g} = 17.2$	.20	3.69	.435	.118	1.942	1.29	4.76	.032	1426	.209	1.44	.0787
$\overline{D} = 2.90$ ft	D_{50} - 0.202 mm	.07	3.12	.543	.174	2.424	1.23	3.84	.035	4116	.252	1.47	.1015

TABLE 9. — *Columbia River estuary*

Mean Flow Parameters and Variables		T	Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	C_s (gpl)
		19.2	0.98	4.73	-----	-----	-----	2.34	11:070	-----
		18.0	.83	4.03	0.387	0.196	-----	1.78	7.173	-----
		15.8	.68	4.34	1.128	.260	-----	2.28	9.895	100
$\overline{V} = 1.88$ fps	R = 93,271	12.4	.51	.61	.171	.280	-----	.74	.451	180
		11.2	.36	.37	.119	.321	-----	1.53	.566	173
$\nu = 1.29\times10^{-5}$ ft^2/sec	F = 0.041	10.7	.20	.27	.104	.386	-----	3.32	.896	116
		10.5	.04	.37	-----	-----	-----	2.07	.766	260
		10.3	.01	.35	.152	.435	-----	1.49	.522	321

TABLE 10. — *Missouri River*

Mean Flow Parameters and Variables		Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u'^2}}$ (fps)	$\sqrt{\overline{u'^2}}/\overline{U}$	$\sqrt{\overline{u'^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)	C_s (gpl)	d_{50} (mm)	σ	ω (fps)
						580 Feet From Left Bank at River Mile 612.51 - Dunes							
$S = 0.150\times10^{-3}$	$U_* = 0.263$ fps	0.81	4.70	0.235	0.050	0.890	2.93	13.77	-----	37	0.097	1.34	0.0285
W = 697.6 ft	τ = 0.135 lb/ft^2	.55	4.33	.282	.065	1.071	3.32	14.38	-----	109	.102	1.35	.0311
Q = 31,400 cfs	$\nu = 1.091\times10^{-5}$ ft^2/sec	.34	3.98	.295	.074	1.120	4.06	15.91	-----	132	.104	1.36	.0322
T = 20.0 °C	R = 5,675,500	.23	3.92	.343	.088	1.303	4.12	16.15	-----	215	.107	1.40	.0334
D = 14.4 ft	F = 0.200	.17	3.90	.378	.097	1.438	2.98	11.62	-----	256	.109	1.42	.0341
$\overline{V}$ = 4.44 fps	$C/\sqrt{g}$ = 19.20	.12	3.82	.393	.104	1.501	2.61	9.97	-----	286	.112	1.44	.0360
$\overline{D}$ = 10.15 ft	D_{50} = 0.203 mm												
						497 Feet From Left Bank at River Mile 612.51 - Dunes							
$S = 0.150\times10^{-3}$	$U_* = 0.274$ fps	0.80	6.49	0.305	0.047	1.112	3.42	22.20	0.061	117	0.110	1.26	0.0358
W = 697.6 ft	τ = 0.146 lb/ft^2	.54	6.16	.357	.058	1.302	5.88	36.22	.062	285	.121	1.28	.0410
Q = 31,400 cfs	$\nu = 1.091\times10^{-5}$ ft^2/sec	.33	5.44	.359	.066	1.311	4.16	22.63	.056	409	.125	1.27	.0426
T = 20.0 °C	R = 8,420,000	.21	5.18	.378	.073	1.380	3.81	16.47	.057	238	.119	1.29	.0394
D = 15.6 ft	F = 0.263	.15	5.05	.408	.081	1.493	3.24	16.36	.058	341	.127	1.31	.0437
$\overline{V}$ = 4.44 fps	$C/\sqrt{g}$ = 19.20	.11	4.96	.500	.102	1.828	2.90	14.38	.048	826	.129	1.33	.0450
$\overline{D}$ = 10.15 ft	D_{50} = 0.237 mm												
						440 Feet From Left Bank at River Mile 612.51 - Dunes							
$S = 0.150\times10^{-3}$	$U_* = 0.256$ fps	0.81	6.81	0.318	0.047	1.243	2.94	20.02	-----	151	0.125	1.28	0.0426
W = 697.6 ft	τ = 0.0849 lb/	.55	6.61	.349	.053	1.366	3.87	25.58	-----	295	.133	1.30	.0466
Q = 31,400 cfs	$\nu = 1.091\times10^{-5}$ ft^2/sec	.35	6.42	.371	.058	1.450	4.04	25.94	-----	510	.137	1.34	.0479
T = 20.0 °C	R = 8,102,700	.24	6.13	.406	.067	1.591	3.08	18.88	-----	656	.139	1.33	.0497
D = 13.6 ft	F = 0.311	.17	5.82	.441	.076	1.724	3.84	22.35	-----	1190	.141	1.39	.0512
$\overline{V}$ = 4.44 fps	$C/\sqrt{g}$ = 19.20	.13	5.52	.486	.089	1.902	2.75	15.18	-----	1989	.145	1.41	.0531
$\overline{D}$ = 10.15 ft	D_{50} = 0.252 mm												
						373 Feet From Left Bank at River Mile 612.51 - Dunes							
$S = 0.150\times10^{-3}$	$U_* = 0.234$ fps	0.82	6.59	0.309	0.047	1.320	3.68	24.25	0.067	238	0.136	1.35	0.0476
W = 697.6 ft	τ = 0.0705 lb/ft^2	.55	6.26	.346	.056	1.476	3.23	20.22	.062	161	.138	1.32	.0488
Q = 31,400 cfs	$\nu = 1.091\times10^{-5}$ ft^2/sec	.34	5.90	.384	.066	1.643	4.04	23.84	.057	391	.143	1.36	.0521
T = 20.0 °C	R = 6,183,400	.22	5.61	.413	.074	1.764	3.26	18.29	.063	666	.147	1.34	.0541
D = 11.3 ft	F = 0.266	.16	5.36	.474	.089	2.023	2.82	15.12	.052	802	.151	1.37	.0561
$\overline{V}$ = 4.44 fps	$C/\sqrt{g}$ = 19.20												
$\overline{D}$ = 10.15 ft	D_{50} = 0.283 mm												
						226 Feet From Left Bank at River Mile 612.51 - Dunes							
$S = 0.150\times10^{-3}$	$U_* = 0.187$ fps	0.91	5.38	0.228	0.043	1.222	2.76	14.85	-----	162	0.154	1.31	0.0578
W = 697.6 ft	τ = 0.0399 lb/ft^2	.66	5.30	.281	.050	1.396	3.49	18.50	-----	262	.162	1.33	.0616
Q = 31,400 cfs	$\nu = 1.091\times10^{-5}$ ft^2/sec	.45	5.13	.297	.058	1.589	3.16	16.21	-----	292	.166	1.37	.0640
T = 20.0 °C	R = 2,974,200	.34	4.99	.324	.065	1.781	3.03	15.12	-----	588	.175	1.41	.0694
D = 6.4 ft	F = 0.353	.28	4.88	.374	.071	2.004	2.45	11.96	-----	1062	.188	1.43	.0748
$\overline{V}$ = 4.44 fps	$C/\sqrt{g}$ = 19.20												
$\overline{D}$ = 10.15 ft	D_{50} = 0.302 mm												
						540 Feet From Left Bank at River Mile 612.51 - Flat Bed							
$S = 0.155\times10^{-3}$	$U_* = 0.285$ fps	0.77	6.82	0.294	0.044	1.032	4.08	27.83	0.060	199	0.117	1.29	0.0272
W = 645.4 ft	τ = 0.119 lb/ft^2	.51	6.36	.308	.049	1.081	5.19	33.01	.055	322	.125	1.33	.0308
Q = 32,500 cfs	$\nu = 1.764\times10^{-5}$ ft^2/sec	.30	5.63	.369	.066	1.296	3.18	17.87	.047	607	.128	1.34	.0314
T = 2.8 °C	R = 5,645,900	.18	5.45	.444	.082	1.555	3.74	20.38	.053	980	.138	1.36	.0361
D = 16.3 ft	F = 0.266	.12	4.62	.466	.101	1.637	2.66	12.29	.036	1280	.146	1.39	.0390
$\overline{V}$ = 5.21 fps	$C/\sqrt{g}$ = 23.01	.10	4.64	.472	.102	1.660	2.95	13.69	.032	2518	.181	1.40	.0546
$\overline{D}$ = 9.67 ft	D_{50} = 0.217 mm												
						481 Feet From Left Bank at River Mile 612.51 - Flat Bed							
$S = 0.155\times10^{-3}$	$U_* = 0.267$ fps	0.77	7.46	0.322	0.044	1.205	3.22	24.02	-----	220	0.135	1.31	0.0345
W = 645.4 ft	τ = 0.104 lb/ft^2	.50	7.04	.362	.052	1.356	3.92	27.60	-----	459	.137	1.33	.0357
Q = 32,500 cfs	$\nu = 1.764\times10^{-5}$ ft^2/sec	.22	6.46	.441	.068	1.650	4.17	26.94	-----	821	.135	1.35	.0345
T = 2.8 °C	R = 5,431,400	.17	6.09	.463	.076	1.734	4.06	24.74	-----	1250	.139	1.37	.0371
D = 14.3 ft	F = 0.312	.10	5.36	.472	.088	1.766	3.07	16.46	-----	1807	.140	1.38	.0377
$\overline{V}$ = 5.21 fps	$C/\sqrt{g}$ = 23.01	.06	5.36	.488	.092	1.832	2.84	15.22	-----	3603	.188	1.40	.0588
$\overline{D}$ = 9.67 ft	D_{50} = 0.232 mm												
						340 Feet From Left Bank at River Mile 612.51 - Flat Bed							
$S = 0.155\times10^{-3}$	$U_* = 0.232$ fps	0.77	6.86	0.305	0.045	1.310	3.23	22.16	-----	182	0.135	1.30	0.0345
W = 645.4 ft	τ = 0.0788 lb/ft^2	.50	6.46	.372	.058	1.595	3.78	24.42	-----	382	.141	1.32	.0377
Q = 32,500 cfs	$\nu = 1.764\times10^{-5}$ ft^2/sec	.29	5.81	.433	.075	1.860	4.06	23.59	-----	672	.160	1.35	.0459
T = 2.8 °C	R = 3,673,400	.17	5.27	.448	.085	1.925	3.26	17.18	-----	1159	.155	1.38	.0434
D = 10.8 ft	F = 0.322	.10	5.08	.491	.097	2.108	2.73	13.87	-----	1756	.160	1.41	.0459
$\overline{V}$ = 5.21 fps	$C/\sqrt{g}$ = 23.01												
$\overline{D}$ = 9.67 ft	D_{50} = 0.135 mm												

TABLE 11. — *Mississippi River*

Mean Flow Parameters and Variables		Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)	C_s (gpl)	d_{50} (mm)	σ	ω (fps)
550 Feet From Left Bank at River Mile 444.0 - Dunes													
$S = 0.0236\times10^{-3}$	$U_* = 0.139$ fps	0.86	2.51	0.138	0.055	0.994	5.02	12.57	-----	24	0.143	1.54	0.0492
$W = 2910$ ft	$\tau = 0.0375$ lb/ft^2	.66	2.37	.152	.064	1.093	4.89	11.80	-----	18	.148	2.26	.0541
$Q = 325{,}000$ cfs	$\nu = 1.13\times10^{-5}$ ft^2/sec	.46	2.24	.181	.081	1.302	6.95	15.55	-----	18	.103	2.72	.0308
$T = 18.3$ °C	R = 4,896,900	.26	2.06	.208	.101	1.495	6.10	12.53	-----	32	.116	1.71	.0377
$\underline{D} = 25.5$ ft	F = 0.0757	.06	1.66	.251	.153	1.804	5.51	9.14	-----	34	.112	1.70	.0361
$\overline{V} = 2.52$ fps	$C/\sqrt{g} = 13.72$												
$\overline{D} = 44.4$ ft	$D_{50} = 0.38$ mm												
1150 Feet From Left Bank at River Mile 444.0 - Dunes													
$S = 0.0236\times10^{-3}$	$U_* = 0.208$ fps	0.88	4.65	0.244	0.052	1.172	7.34	34.13	0.103	35	0.130	1.77	0.0446
$W = 2910$ ft	$\tau = 0.0810$ lb/ft^2	.68	4.28	.268	.063	1.288	8.53	36.51	.114	60	.148	1.56	.0541
$Q = 325{,}000$ cfs	$\nu = 1.13\times10^{-5}$ ft^2/sec	.48	3.42	.294	.086	1.413	4.97	17.00	.097	74	.141	1.58	.0499
$T = 18.3$ °C	R = 18,349,600	.28	3.67	.391	.107	1.880	6.49	23.82	.095	76	.146	1.64	.0525
$\underline{D} = 55.0$ ft	F = 0.0896	.08	2.84	.412	.145	1.982	6.23	17.70	.086	115	.157	1.53	.0581
$\overline{V} = 2.52$ fps	$C/\sqrt{g} = 13.72$												
$\overline{D} = 44.4$ ft	$D_{50} = 0.38$ mm												
1600 Feet From Left Bank at River Mile 444.0 - Dunes													
$S = 0.0236\times10^{-3}$	$U_* = 0.289$ fps	0.89	4.30	0.284	0.066	0.984	8.78	37.75	-----	23	0.124	1.69	0.0413
$W = 2910$ ft	$\tau = 0.1620$ lb/ft^2	.69	3.94	.324	.082	1.121	6.45	25.41	-----	25	.121	1.54	.0394
$Q = 325{,}000$ cfs	$\nu = 1.13\times10^{-5}$ ft^2/sec	.49	3.30	.365	.110	1.263	11.38	37.55	-----	39	.140	1.76	.0492
$T = 18.3$ °C	R = 33,876,100	.29	3.52	.426	.121	1.475	8.23	28.97	-----	23	.135	2.10	.0472
$\underline{D} = 110.0$ ft	F = 0.0585	.09	2.36	.486	.206	1.683	6.09	14.37	-----	17	.116	1.70	.0377
$\overline{V} = 2.52$ fps	$C/\sqrt{g} = 13.72$												
$\overline{D} = 44.4$ ft	$D_{50} = 0.38$ mm												
650 Feet From Left Bank at River Mile 443.2 - Dunes													
$S = 0.0181\times10^{-3}$	$U_* = 0.115$ fps	0.86	2.14	0.132	0.061	1.147	5.18	11.08	-----	23	0.207	1.87	0.0820
$W = 1880$ ft	$\tau = 0.0254$ lb/ft^2	.64	2.05	.167	.081	1.453	6.53	13.38	-----	17	-----	----	-------
$Q = 325{,}000$ cfs	$\nu = 1.18\times10^{-5}$ ft^2/sec	.46	2.00	.176	.088	1.530	8.06	16.12	-----	10	.127	2.04	.0413
$T = 17.7$ °C	R = 3,489,400	.25	1.79	.187	.105	1.626	5.98	10.70	-----	--	.149	2.16	.0525
$\underline{D} = 22.5$ ft	F = 0.068	.06	1.15	.202	.175	1.756	4.75	5.46	-----	123	.108	1.58	.0322
$\overline{V} = 3.23$ fps	$C/\sqrt{g} = 18.30$												
$\overline{D} = 53.5$ ft	$D_{50} = 0.37$ mm												
1050 Feet From Left Bank at River Mile 443.2 - Dunes													
$S = 0.0181\times10^{-3}$	$U_* = 0.206$ fps	0.88	3.00	0.202	0.067	0.983	8.09	24.27	-----	41	0.120	1.59	0.0731
$W = 1880$ ft	$\tau = 0.0818$ lb/ft^2	.68	3.06	.242	.079	1.176	11.50	35.19	-----	67	.123	1.67	.0384
$Q = 325{,}000$ cfs	$\nu = 1.18\times10^{-5}$ ft^2/sec	.48	3.56	.278	.078	1.347	9.23	32.86	-----	62	.160	1.74	.0577
$T = 17.7$ °C	R = 19,108,100	.28	3.07	.365	.119	1.772	8.58	26.34	-----	126	.154	1.40	.0545
$\underline{D} = 72.5$ ft	F = 0.0644	.08	2.88	.429	.149	2.081	6.93	19.96	-----	293	.214	2.10	.0843
$\overline{V} = 3.23$ fps	$C/\sqrt{g} = 18.30$												
$\overline{D} = 53.5$ ft	$D_{50} = 0.37$ mm												
1650 Feet From Left Bank at River Mile 443.2 - Dunes													
$S = 0.0181\times10^{-3}$	$U_* = 0.246$ fps	0.89	4.28	0.265	0.062	1.077	7.15	30.60	-----	33	0.134	2.56	0.0440
$W = 1880$ ft	$\tau = 0.1173$ lb/ft^2	.69	3.96	.301	.076	1.223	10.16	40.24	-----	45	.098	2.33	.0269
$Q = 325{,}000$ cfs	$\nu = 1.18\times10^{-5}$ ft^2/sec	.49	4.14	.352	.085	1.431	10.73	44.42	-----	105	.122	1.68	.0384
$T = 16.7$ °C	R = 35,871,200	.29	4.35	.470	.108	1.910	6.93	30.15	-----	32	.117	1.95	.0355
$\underline{D} = 104.0$ ft	F = 0.0703	.09	3.55	.482	.136	1.956	5.18	18.40	-----	115	.154	2.08	.0551
$\overline{V} = 3.23$ fps	$C/\sqrt{g} = 18.30$												
$\overline{D} = 53.5$ ft	$D_{50} = 0.37$ mm												
1155 Feet From Left Bank at River Mile 441.6 - Dunes													
$S = 0.0241\times10^{-3}$	$U_* = 0.216$ fps	0.88	4.43	0.221	0.050	1.023	8.50	37.66	0.118	14	0.121	1.71	0.0387
$W = 2000$ ft	$\tau = 0.0901$ lb/ft^2	.68	4.87	.336	.069	1.554	4.94	24.06	.119	--	-----	----	-------
$Q = 325{,}000$ cfs	$\nu = 1.16\times10^{-5}$ ft^2/sec	.48	4.74	.393	.083	1.817	7.31	34.65	.094	226	.203	1.58	.0804
$T = 17.2$ °C	R = 21,982,800	.28	4.15	.486	.117	2.250	8.53	35.40	.073	73	.137	1.41	.0469
$\underline{D} = 60.0$ ft	F = 0.0967	.08	3.58	.523	.146	2.418	5.74	20.55	.052	504	.188	1.37	.0728
$\overline{V} = 3.20$ fps	$C/\sqrt{g} = 16.11$												
$\overline{D} = 50.9$ ft	$D_{50} = 0.43$ mm												
1755 Feet From Left Bank at River Mile 441.6 - Dunes													
$S = 0.0241\times10^{-3}$	$U_* = 0.225$ fps	0.88	4.08	0.236	0.058	1.049	6.28	25.62	-----	14	0.117	2.23	0.0374
$W = 2000$ ft	$\tau = 0.0976$ lb/ft^2	.68	4.18	.297	.071	1.318	8.40	35.11	-----	12	.102	1.85	.0295
$Q = 325{,}000$ cfs	$\nu = 1.16\times10^{-5}$ ft^2/sec	.48	3.71	.319	.086	1.416	10.03	37.21	-----	15	.103	1.93	.0299
$T = 17.2$ °C	R = 20,172,400	.28	3.52	.384	.109	1.705	7.14	25.14	-----	14	.110	1.33	.0335
$\underline{D} = 65.0$ ft	F = 0.0787	.08	2.51	.364	.145	1.619	4.34	10.90	-----	464	.182	1.25	.0692
$\overline{V} = 3.20$ fps	$C/\sqrt{g} = 16.11$												
$\overline{D} = 50.9$ ft	$D_{50} = 0.43$ mm												

TABLE 11. — *Mississippi River* — Continued

Mean Flow Parameters and Variables		Y/D	$\overline{U}$ (fps)	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}/U_*$	T_E (sec)	L_x (ft)	λ_x (ft)	C_s (gpl)	d_{50} (mm)	σ	ω (fps)
770 Feet From Left Bank at River Mile 440.0 - Dunes													
$S = 0.0486\times10^{-3}$	$U_* = 0.195$ fps	0.88	4.82	0.323	0.067	1.146	6.00	28.92	0.096	28	0.117	1.63	0.0377
$W = 2690$ ft	$\tau = 0.0736$ lb/ft^2	.68	4.54	.368	.081	1.374	6.36	28.87	.090	30	.130	1.60	.0427
$Q = 280{,}000$ cfs	$\nu = 1.16\times10^{-5}$ ft^2/sec	.48	3.95	.356	.090	1.671	5.27	20.82	.091	86	.184	1.74	.0709
$T = 17.2$ °C	R = 13,862,100	.28	3.87	.406	.105	1.980	4.64	17.96	.094	144	.192	1.66	.0738
$D = 24.3$ ft	F = 0.112	.08	2.93	.419	.143	2.143	3.24	9.50	.093	118	.166	1.44	.0620
$\overline{V} = 4.27$ fps	$C/\sqrt{g} = 21.90$												
$\overline{D} = 24.3$ ft	$D_{50} = 0.41$ mm												
1370 Feet From Left Bank at River Mile 440.0 - Dunes													
$S = 0.0486\times10^{-3}$	$U_* = 0.234$ fps	0.87	4.70	0.254	0.054	1.087	4.90	23.03	0.093	22	0.121	1.47	0.0387
$W = 2690$ ft	$\tau = 0.1062$ lb/ft^2	.67	4.48	.296	.066	1.263	5.70	25.54	.087	77	.171	2.25	.0971
$Q = 280{,}000$ cfs	$\nu = 1.16\times10^{-5}$ ft^2/sec	.47	4.06	.349	.086	1.490	5.14	20.87	.077	8	.263	4.05	.1106
$T = 17.2$ °C	R = 12,129,300	.27	3.79	.379	.100	1.620	6.46	24.48	.083	143	.182	2.68	.0696
$D = 35.0$ ft	F = 0.120	.07	3.08	.456	.148	1.948	3.72	11.46	.065	95	.263	2.73	.1106
$\overline{V} = 4.27$ fps	$C/\sqrt{g} = 21.90$												
$\overline{D} = 24.3$ ft	$D_{50} = 0.41$ mm												
1970 Feet From Left Bank at River Mile 440.0 - Dunes													
$S = 0.0486\times10^{-3}$	$U_* = 0.181$ fps	0.84	4.63	0.239	0.052	1.320	5.14	23.80	0.088	11	0.248	2.37	0.1043
$W = 2690$ ft	$\tau = 0.0637$ lb/ft^2	.60	4.48	.327	.073	1.804	7.40	33.15	.089	293	.108	1.59	.0328
$Q = 280{,}000$ cfs	$\nu = 1.16\times10^{-5}$ ft^2/sec	.36	4.42	.385	.087	2.119	4.92	21.74	.084	405	.272	1.74	.1158
$T = 17.2$ °C	R = 7,856,900	.12	3.83	.486	.127	2.690	3.48	13.36	.076	524	.228	1.64	.0945
$D = 21.0$ ft	F = 0.167												
$\overline{V} = 4.27$ fps	$C/\sqrt{g} = 21.90$												
$\overline{D} = 24.3$ ft	$D_{50} = 0.41$ mm												

TABLE 12a. — *Current meter results, Atrisco feeder canal*

Mean flow parameter and variables		Y/D	$\overline{U}$ (fps)	Hot-Film		Current Meter	
				$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$	$\sqrt{\overline{u^2}}$ (fps)	$\sqrt{\overline{u^2}}/\overline{U}$
Atrisco Feeder Canal, 44 Feet From Left Bank - Dunes							
		0.92	1.67	0.126	0.073	0.057	0.034
$S = 0.57\times10^{-3}$	$U_* = 0.180$ fps	.81	1.64	.138	.083	.049	.030
$W = 56.0$ ft	$\tau = 0.063$ lb/ft^2	.70	1.64	.148	.090	.065	.043
$Q = 203$ cfs	$\nu = 1.700\times10^{-5}$ ft^2/sec	.60	1.62	.157	.097	.059	.036
$T = 12.2$ °C	R = 212,900	.49	1.58	.171	.108	.065	.043
$D = 1.77$ ft	F = 0.132	.36	1.57	.191	.121	.098	.060
$\overline{V} = 1.60$ fps	$C/\sqrt{g} = 8.89$	.22	1.56	.217	.138	.090	.058
		.11	1.41	.251	.178	.065	.039
Atrisco Feeder Canal, 28 Feet From Left Bank - Dunes							
		0.95	2.54	0.151	0.060	0.009	0.004
$S = 0.57\times10^{-3}$	$U_* = 0.185$ fps	.84	2.43	.189	.078	.009	.004
$W = 56.0$ ft	$\tau = 0.066$ lb/ft^2	.74	2.35	.194	.084	.010	.004
$Q = 203$ cfs	$\nu = 1.714\times10^{-5}$ ft^2/sec	.64	2.30	.207	.090	.014	.006
$T = 10.8$ °C	R = 281,700	.54	2.02	.202	.100	.043	.020
$D = 1.86$ ft	F = 0.207	.43	2.06	.227	.110	.069	.032
$\overline{V} = 2.09$ fps	$C/\sqrt{g} = 11.30$	.35	1.86	.234	.126	.139	.078
		.28	1.75	.268	.153	.117	.067
		.16	1.55	.318	.205	.137	.098
Atrisco Feeder Canal, 12 Feet From Left Bank - Dunes							
		0.91	2.31	0.126	0.054	0.061	0.026
$S = 0.57\times10^{-3}$	$U_* = 0.160$ fps	.80	2.25	.135	.060	.046	.020
$W = 56.0$ ft	$\tau = 0.049$ lb/ft^2	.71	2.28	.143	.063	.036	.016
$Q = 203$ cfs	$\nu = 1.682\times10^{-5}$ ft^2/sec	.59	2.28	.161	.070	.045	.020
$T = 13.3$ °C	R = 227,400	.48	2.11	.168	.079	.059	.028
$D = 1.39$ ft	F = 0.315	.41	2.12	.174	.082	.065	.031
$\overline{V} = 2.11$ fps	$C/\sqrt{g} = 13.19$	.30	1.96	.179	.091	.084	.043
		.21	1.72	.198	.114	.087	.051
		.10	1.37	.214	.156	.087	.064

TABLE 12b. — *Current meter results, Rio Grande conveyance channel*

Mean flow parameter and variables		Y/D	$\overline{U}$ (fps)	Hot-Film $\sqrt{\overline{u^2}}$ (fps)	Hot-Film $\sqrt{\overline{u^2}}/\overline{U}$	Current Meter $\sqrt{\overline{v^2}}$ (fps)	Current Meter $\sqrt{\overline{v^2}}/\overline{U}$
Rio Grande Conveyance Channel, 34 Feet From Left Bank - Dunes							
		0.96	2.83	0.125	0.044	0.017	0.006
		.86	2.86	.154	.054	.028	.010
$S = 0.55\times10^{-3}$	$U_* = 0.214$ fps	.76	2.85	.191	.067	.048	.017
$W = 68.0$ ft	$\tau = 0.105$ lb/ft^2	.66	2.73	.202	.074	.127	.046
$Q = 510$ cfs	$\nu = 1.635\times10^{-5}$ ft^2/sec	.57	2.70	.232	.086	.143	.053
$T = 17.2$ °C	R = 674,900	.47	2.62	.259	.099	.120	.044
$\underline{D} = 3.07$ ft	$\underline{F} = 0.256$	.36	2.52	.242	.096	.141	.056
$\overline{V} = 2.68$ fps	$C/\sqrt{g} = 12.53$	.25	2.21	.256	.116	.159	.072
		.18	2.11	.279	.132	.136	.066
		.12	2.02	.323	.160	.158	.086
Rio Grande Conveyance Channel, 16 Feet From Left Bank - Dunes							
		0.94	2.59	0.140	0.054	0.051	0.020
		.84	2.47	.158	.064	.059	.024
$S = 0.55\times10^{-3}$	$U_* = 0.214$ fps	.76	2.44	.151	.062	.107	.042
$W = 68.0$ ft	$\tau = 0.114$ lb/ft^2	.66	2.66	.173	.065	.171	.062
$Q = 510$ cfs	$\nu = 1.664\times10^{-5}$ ft^2/sec	.58	2.75	.215	.078	-----	-----
$T = 17.8$ °C	R = 685,100	.47	2.64	.201	.076	.194	.073
$\underline{D} = 3.31$ ft	$\underline{F} = 0.230$	.37	2.50	.200	.080	.121	.048
$\overline{V} = 2.68$ fps	$C/\sqrt{g} = 12.53$	.28	2.36	.217	.092	.100	.043
		.18	2.17	.206	.095	.106	.048
		.11	1.86	.193	.104	-----	-----
		.09	1.67	.184	.110	.211	.129
Rio Grande Conveyance Channel, 52 Feet From Left Bank - Dunes							
		0.96	1.53	0.139	0.091	0.435	0.271
		.86	1.78	.185	.104	-----	-----
$S = 0.55\times10^{-3}$	$U_* = 0.214$ fps	.78	1.94	.322	.166	.392	.202
$W = 68.0$ ft	$\tau = 0.109$ lb/ft^2	.68	1.81	.348	.192	.375	.206
$Q = 510$ cfs	$\nu = 1.65\times10^{-5}$ ft^2/sec	.58	2.16	.488	.226	.679	.314
$T = 15.6$ °C	R = 444,200	.49	1.82	.480	.264	.469	.261
$\underline{D} = 3.18$ ft	$\underline{F} = 0.168$	.40	1.58	.426	.270	-----	-----
$\overline{V} = 2.68$ fps	$C/\sqrt{g} = 12.53$	.30	1.50	.474	.316	.292	.194
		.18	1.53	.496	.324	-----	-----
		.09	1.53	.468	.306	.312	.202
		.08	1.46	.153	.105	-----	-----

TABLE 12c. — *Current meter results, Mississippi River*

Mean flow parameter and variables		Y/D	$\overline{U}$ (fps)	Hot-Film $\sqrt{\overline{u^2}}$ (fps)	Hot-Film $\sqrt{\overline{u^2}}/\overline{U}$	Current Meter $\sqrt{\overline{u^2}}$ (fps)	Current Meter $\sqrt{\overline{u^2}}/\overline{U}$
Mississippi River, 770 Feet From Left Bank, River Mile 440.0 - Dunes							
$S = 0.0486\times10^{-3}$	$U_* = 0.195$ fps	0.88	4.82	0.223	0.047	0.512	0.103
$W = 2690$ ft	$\tau = 0.0736$ lb/ft^2	.68	4.54	.268	.059	.342	.073
$Q = 280,000$ cfs	$\nu = 1.635\times10^{-5}$ ft^2/sec	.48	3.95	.326	.083	.576	.132
$T = 17.2$ °C	R = 13,862,100	.28	3.87	.386	.100	.441	.111
$\underline{D} = 40.0$ ft	$\underline{F} = 0,112$	.08	2.93	.419	.143	.541	.180
$\overline{V} = 4.27$ fps	$C/\sqrt{g} = 21.90$						
Mississippi River, 1370 Feet From Left Bank, River Mile 440.0 - Dunes							
$S = 0.0486\times10^{-3}$	$U_* = 0.234$ fps	0.87	4.70	0.254	0.054	0.383	0.078
$W = 2690$ ft	$\tau = 0.1062$ lb/ft^2	.67	4.48	.296	.066	.575	.131
$Q = 280,000$ cfs	$\nu = 1.635\times10^{-5}$ ft^2/sec	.47	4.06	.349	.086	.514	.117
$T = 17.2$ °C	R = 12,129,300	.27	3.79	.379	.100	.757	.192
$\underline{D} = 35.0$ ft	$\underline{F} = 0.120$	.07	3.08	.456	.148	.545	.168
$\overline{V} = 4.27$ fps	$C/\sqrt{g} = 21.90$						
Mississippi River, 1970 Feet From Left Bank, River Mile 440.0 - Dunes							
$S = 0.0486\times10^{-3}$	$U_* = 0.181$ fps	0.84	4.63	0.199	0.043	0.518	0.109
$W = 2690$ ft	$\tau = 0.0637$ lb/ft^2	.60	4.48	.327	.073	.637	.135
$Q = 280,000$ cfs	$\nu = 1.635\times10^{-5}$ ft^2/sec	.36	4.42	.385	.087	.830	.188
$T = 17.2$ °C	R = 7,556,900	.12	3.83	.486	.127	.888	.243
$\underline{D} = 21.0$ ft	$\underline{F} = 0.167$						
$\overline{V} = 4.27$ fps	$C/\sqrt{g} = 21.90$						
Mississippi River, 1055 Feet From Left Bank, River Miles 441.6 - Dunes							
$S = 0.0241\times10^{-3}$	$U_* = 0.216$ fps	0.88	4.43	0.221	0.050	0.293	0.066
$W = 2000$ ft	$\tau = 0.0901$ lb/ft^2	.68	4.87	.336	.069	.813	.168
$Q = 325,000$ cfs	$\nu = 1.63\times10^{-5}$ ft^2/sec	.48	4.73	.393	.083	.494	.114
$T = 17.2$ °C	R = 21,982,800	.28	4.15	.486	.117	1.156	.277
$\underline{D} = 50.9$ ft	$\underline{F} = 0.097$	.08	3.58	.523	.146	.734	.209
$\overline{V} = 3.20$ fps	$C/\sqrt{g} = 11.61$						
Mississippi River, 1755 Feet From Left Bank, River Mile 441.6 - Dunes							
$S = 0.0241\times10^{-3}$	$U_* = 0.225$ fps	0.88	4.08	0.216	0.058	0.647	0.140
$W = 2000$ ft	$\tau = 0.0976$ lb/ft^2	.68	4.18	.297	.071	.701	.163
$Q = 325,000$ cfs	$\nu = 1.635\times10^{-5}$ ft^2/sec	.48	3.71	.319	.086	.634	.149
$T = 17.2$ °C	R = 20,172,400	.28	3.52	.384	.109	.427	.110
$\underline{D} = 65.0$ ft	$\underline{F} = 0.079$	.08	2.51	.344	.137	.571	.181
$\overline{V} = 3.20$ fps	$C/\sqrt{g} = 16.11$						

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