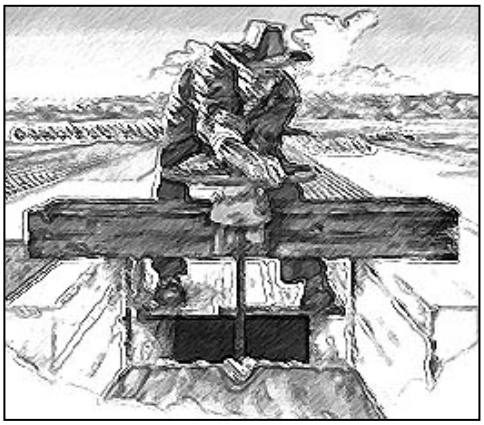
Utah
Water Measurement Pocket Reference



Irrigation Water Measurement for Agriculture

Produced by the Utah Association of Conservation Districts

Funding grant provided by the
U.S. Department of the Interior, Bureau of Reclamation

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Introduction

Irrigated agriculture is vital to our society, using less than 20 percent of our total cropland to provide about half of our national food and fiber production. As competition increases for limited water resources, the management and conservation of our agricultural water supply becomes more important than ever. The farming and ranching segment of water users must strive to use their share of this precious resource to its greatest benefit for the production of food and fiber, and accurate water measurement is the first and most important step for achieving effective water management.

This booklet was prepared to help water managers with their day-to-day duties of delivering water in the proper amounts. Because of competition for water use, it is important that managers deliver only the amounts authorized. Mismanagement and use of more water than authorized will reflect poorly on agriculture, while good record-keeping and accurate delivery of authorized amounts of water will be beneficial in the future competition for water resources.

This handbook is not intended to be a complete flow measurement reference. To make the handbook easy to use, only the most commonly used measuring devices are described. Graphics that illustrate important concepts are simplified in some cases. More detailed information, methods and other measuring devices are described in the *Water Measurement Manual* produced by the U.S. Department of the Interior, Bureau of Reclamation. An online version and an electronic copy for downloading are available at **http://www.usbr.gov/pmts/hydraulics_lab/pubs/wmm/**. Additional online references and resources are listed in the Appendix of this handbook.

Basic Concepts

Irrigation water delivery systems in Utah make use of both open canals and pipe sections, with open canals being the most common within most main delivery systems. Measurement of flow in open canals is the primary focus of this handbook.

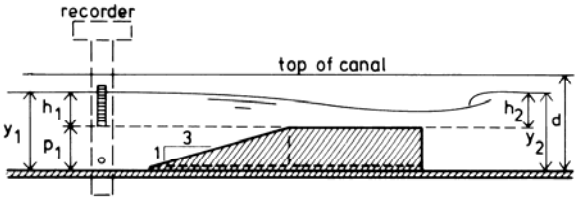
The most important measure of the flow of water is the volume of water passing a given point in a given amount of time. This *flow rate*, or *discharge*, is commonly expressed in units of cubic feet per second within the U.S., often abbreviated as "cfs". The term "second-foot" or just "foot" is also commonly spoken to indicate cfs. Other less commonly used flow rate units are gallons per minute (GPM), million gallons per day (MGD) and the miner's inch (definition varies by state; in Utah, 50 miner's inches is equivalent to 1 cfs). Conversion factors for many common measurement units are given in the Appendix.

Most practical flow measurement methods and devices can be classified into two categories. The first methods measure flow velocity and compute the flow rate using the velocity and the size of the channel or pipe. The basic equation used is:

$$Q = V \times A$$

Where Q is the flow rate, V is the average velocity, and A is the cross-sectional area of the channel or pipe. If the velocity is expressed in feet per second and the area is expressed in square feet, then the flow rate will be computed in cfs. Note that the "average" velocity is used in the equation; the basic nature of flowing water is for the velocity to vary across any section of a pipe or canal, usually being a maximum at the center and a minimum near the edge of the channel. Devices that measure flow velocity attempt to measure the average velocity for the entire channel. This handbook will not address velocity-based devices further, but this information is provided so that water managers can estimate flow by measuring velocity and channel area, when necessary.

The second category of common devices consists of structures that create a local constriction of the channel and measure the energy required for the flow to pass through the constriction. In pipe flow, common examples are venturi meters and orifice plates. In open canals, common structures of this type include weirs, flumes, and submerged orifices. The energy required for flow to pass through the constriction is usually indicated by the pressure in a pipeline or the *head* created upstream from an open channel structure. Head is the flow depth relative to a reference elevation on the structure, usually the invert of the constricted section, designated h_1 in the figure below showing a profile section through a long-throated flume. Flow is determined by measuring the pressure or head and computing the flow rate from a rating equation. To simplify the use of these structures in the field, a rating table is often provided that lists the flow rate, *Q*, for given values of the measured head. Rating tables and equations for many common measuring structures are given in the Appendix.



Other less common methods of measuring flow rate include volumetric methods and dye dilution. These techniques are usually not practical for irrigation applications, but the reader interested in them can find more detail in Reclamation's *Water Measurement Manual*.

Critical Depth Devices — Weirs and Flumes

Weirs and flumes are the most common type of open channel flow measurement device and share many similarities. Both structures use constrictions of the channel to provide flow measurement. In fact, the constriction is severe enough to produce a special flow condition called *critical depth* within the constricted section. The term *weir* is usually used when the channel constriction consists of

a section in which the floor of the channel is raised (the crest or sill). Weirs can be either sharp-crested or broad-crested, depending on the length of the constricted section in the flow direction. Sharp-crested weirs are also sometimes called thin-plate weirs. Examples include the contracted rectangular weir, suppressed rectangular weir, Cipoletti weir, and V-notch weir. The term *flume* usually describes a structure in which the constriction is formed by narrowing the channel and the constricted section (the throat) often has significant length in the flow direction. Structures having both a raised crest and a narrowed throat can be described as either flumes or weirs.

Users of flow measurement structures should have a physical understanding of the flow condition called *critical depth*. Flow in most canals is *subcritical*, or slow and deep. In very steep channels, flow may be *supercritical*, or fast and shallow. The terms slow and fast are in comparison to the speed at which waves move in a canal, which increases as the depth of flow increases. If the flow is slower than the wave speed, then it is subcritical. In this condition, waves can move both upstream and downstream. If the flow velocity is higher than the wave speed, then the flow is supercritical and waves cannot move upstream because they are being swept downstream by the rapid flow. Critical depth is the unique flow condition at which the flow velocity exactly matches the wave speed. Since waves cannot move upstream, the flow upstream from a critical section cannot be affected by anything that happens downstream from the critical section. At any critical section there is a unique relationship between the flow rate and the upstream head, and this relationship is not changed by variation of the downstream depth. Thus, by measuring the upstream head we can compute the flow rate.

For most critical-depth structures, the relationship between upstream head and flow rate has been determined through laboratory testing. The measurement uncertainty associated with these ratings is about ±3 percent in most cases. Long-throated flumes and streamlined broad-crested weirs can be calibrated by computer analysis, with a rating table uncertainty that is generally ±2 percent or better.

Submergence

Critical depth occurs at locations where there is sufficient drop in the water surface elevation to allow the flow to accelerate up to and through the velocity associated with critical depth. This condition is often called *free flow* because the flow is free to accelerate up to critical velocity under the influence of gravity. The drop in the water surface elevation might occur because of a drop in the canal profile, or it might occur because of a constriction in the channel that raises the upstream water level. If the drop is smaller than that needed for the flow to accelerate up to critical velocity, then critical depth does not occur and the flow remains subcritical throughout the device. This is the condition known as *excess submergence*, or *submerged flow*.

The photos below show two flumes operating in free flow and submerged flow, respectively. Flow through the long-throated flume on the left passes through critical depth and then goes through a hydraulic jump to return to a subcritical condition in the downstream channel. The flow through the flume on the right never passes through critical depth, and thus no hydraulic jump occurs. The presence of the hydraulic jump is a positive indication that a structure is in a free flow condition. Flumes operating near their submergence limit may exhibit a very weak, undular jump.

Submergence can be defined mathematically as the ratio of the downstream head to the upstream head, (h_2/h_1 in Fig. 1), usually expressed as a percentage. The upstream and downstream heads are always measured relative to the same zero elevation, the crest of the structure.

When submergence exceeds a certain level for each particular type of structure, the critical-depth flow condition through the structure is lost. The relationship between upstream head and flow rate becomes affected by a second parameter, the downstream depth. This invalidates the free flow rating equation and rating table for the structure.

Structures that have excess submergence deliver less water than that indicated by their standard free flow rating tables, so water users are being hurt by a structure that is submerged. Submergence limits for each type and size of structure will be given later in this handbook. For some devices, a correction procedure can be used to estimate the flow under submerged conditions, but the accuracy of the measurement is always reduced in comparison to a free flow measurement.

The most common causes of excess submergence are:

- Improper construction and/or design: The wrong type of measuring device may have been selected, or during construction the device was set too low in the channel. To correct the problem the structure must be raised or otherwise modified or replaced with one designed to work properly.

- Sedimentation: Over time a measuring device may become submerged because the downstream channel has risen due to sediment deposition. This problem can sometimes be fixed by cleaning the downstream channel.

- Downstream restriction in the channel: A measuring device may function properly at the beginning of the irrigation season but will become submerged later in the year. As vegetation grows during the season it may cause a restriction in the flow of the downstream canal, raising the tailwater on the device. Clearing the growth or other downstream restriction may restore the device to proper function.

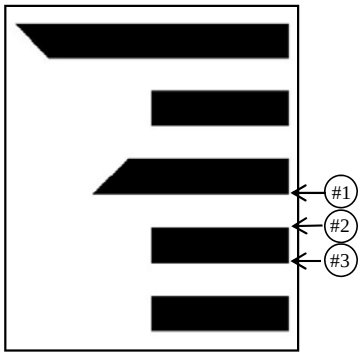
Measuring Water Depth

All devices described in this handbook measure flow indirectly. Water levels are measured and used to determine flow rate through the use of a rating table, rating curve, or mathematical equation. Almost all devices will be equipped with staff gages for measuring the necessary water levels. Even when structures are equipped with electronic sensors that automatically measure water levels, staff gages will still be used to occasionally verify proper operation of the sensors.

A staff gage is a linear measuring tool like a tape measure. Most staff gages are marked in feet, tenths, and hundredths of a foot instead of inches. The layout of the gage makes it easy to quickly know what the water level is. The major full foot increments have large labels, such as 1.0, 2.0, 3.0 in the example shown below. The top of the black bar (with the pointed indicator) is the measurement point for each full foot reading.

The smaller numbers between the full foot marks are the indicators for tenths of feet. Notice that there are nine numbers between each full foot mark separating each foot into tenths.

The black bars between each one-tenth foot mark are used to determine the depth to the nearest 1/100th of a foot. The width of each black bar and the spaces between the bars are each 1/100th of a foot. The bottom edge (the point) of the longer bar between each



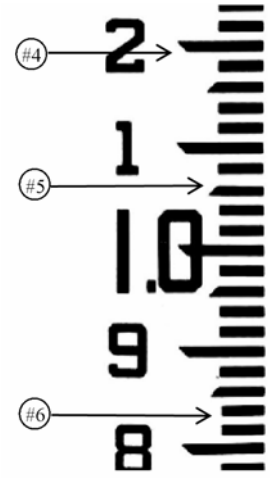
one-tenth foot mark is the 0.05 foot mark. In the figure below, the distance from #1 to #2 and from #2 to #3 is the same. Both spans are 1/100th of a foot. With practice, reading this style of staff gage becomes second nature. The ability to read a staff gage is greatly enhanced if the gage is kept clean and can be viewed in good light. In very good conditions, water levels can be measured with an accuracy of about ±0.005 ft (half the width of one mark).

Examples:

#4 The arrow is pointing to the bottom of the black bar near the 1.2 foot mark. It would therefore indicate a water level of 1.190 feet.

#5 This position would indicate that the level is between 1.0 and 1.1 feet. The arrow is at the top of the black bar with a point at the bottom of the bar where .05 would be. The arrow is therefore at a level of 1.06 feet.

#6 This level is between 0.8 and 0.9 feet. Counting up from the point of the top of the bar at 0.8 the bottom of the first bar would be .01, the top would be .02 and the bottom of the next bar would be .03. Therefore the level reading at the arrow would be 0.83 feet.



Sharp-Crested Weirs

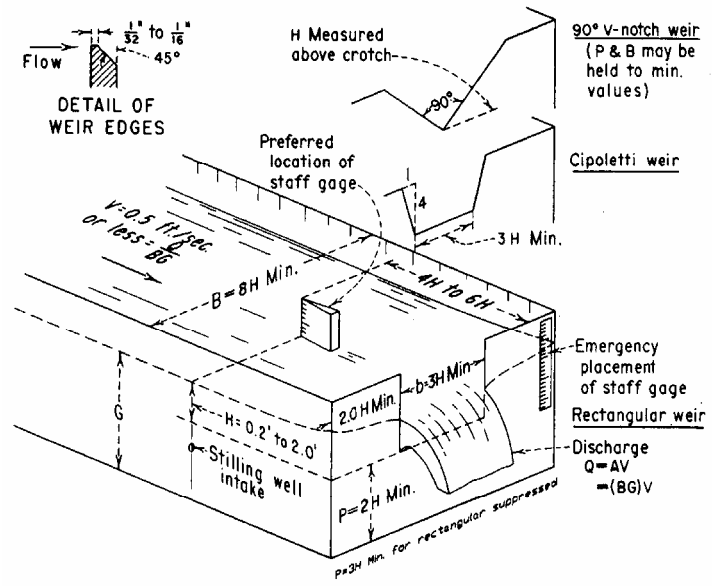
The most common sharp-crested weirs are the contracted rectangular, suppressed rectangular, Cipoletti, and 90° V-notch. Despite their differences, all of these weirs have a few things in common.

First, the weir blade should be installed on the upstream face of the structural wall that supports it. The blade should be sharp, constructed either from thin metal or thicker plate sharpened down to about 1/16 inch. A knife edge should not be used, as it tends to be prone to damage and deterioration which affects measurement accuracy.

Second, sharp-crested weirs should have no submergence for the best accuracy, and in fact the downstream water level should be at least 0.2 ft below the crest of the weir. Correction charts and graphs do exist for the purpose of correcting for sharp-crested weir submergence, but they are unreliable. Even with correction, results can easily be off by 15 to 20% or more.

Third, there should be a pool of water upstream from the weir that meets minimum depth and width requirements shown in the figure on the following page. This ensures that the approaching flow is slow and that the shape of the streamlines passing through the weir opening is unaffected by the presence of the upstream floor or sidewalls, a condition called *fully contracted flow*. The rating tables provided in this handbook require that the flow be fully contracted. The pool upstream from a weir should be kept clean of sediment to maintain fully contracted flow.

When the upstream pool is too shallow or too narrow, the shape of the flow streamlines passing through the weir is changed by the close proximity of the pool floor or sidewalls and the flow becomes *partially contracted*. In this condition, the standard rating tables are inaccurate. The flow rate will be higher than that indicated by the standard rating tables. If calibration of partially-contracted weirs is needed, a technique called the Kindsvater-Carter method can be used. This method is described in the Bureau of Reclamation's *Water Measurement Manual*. A



WEIR PROPORTIONS
RECTANGULAR, CIPOLETTI AND 90° V-NOTCH

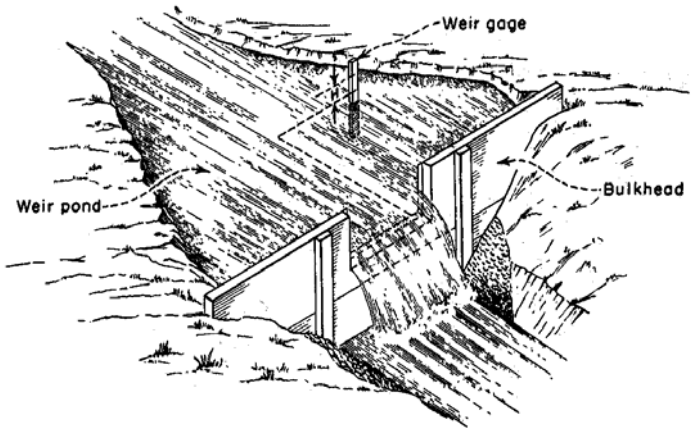
spreadsheet (USBRWeir.xls) to carry out these calculations is available from the Bureau of Reclamation's hydraulic laboratory web site (see Reference list).

The proper placement of the staff gage is upstream from the weir blade, a distance at least 4 times the head corresponding to maximum flow. An alternative gage location in the corner of the upstream pool is shown in the figure. Using this location can help to avoid debris accumulation on the gage. A 'weir stick' is preferred by some users, but these devices are less accurate and their use should not discourage the installation of a permanently mounted staff gage as well.

The thin jet of water passing through the weir opening is called the nappe. There should always be air under the nappe of a sharp-crested weir. This is usually not a problem, but on a suppressed rectangular weir this may require the installation of an air vent

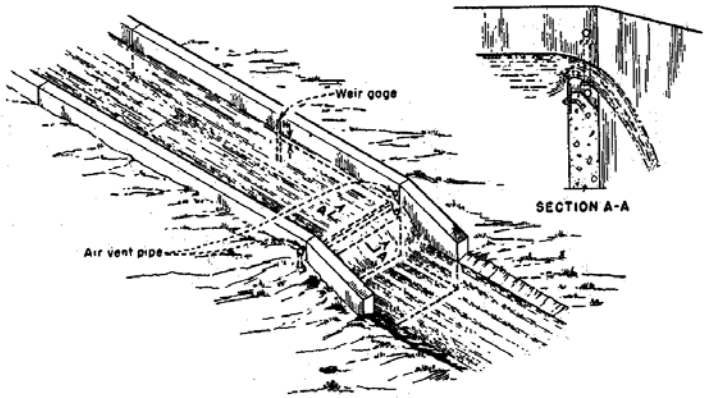
pipe through the sidewall of the channel to provide air under the nappe. If the nappe is not aerated, the weir will deliver more flow than that indicated by standard rating tables.

A contracted rectangular weir is one of the easiest weirs to construct. It has a horizontal bottom plate and straight sides. Its name is derived from the fact that flow contraction of the nappe occurs from the bottom and both sides of the weir opening. When the flow is fully contracted, the discharge equation for this weir is $Q = 3.33h_1^{1.5}(L - 0.2h_1)$. Q is the flow rate in cfs, h_1 is the upstream head in feet, and L is the length of the weir crest in feet.



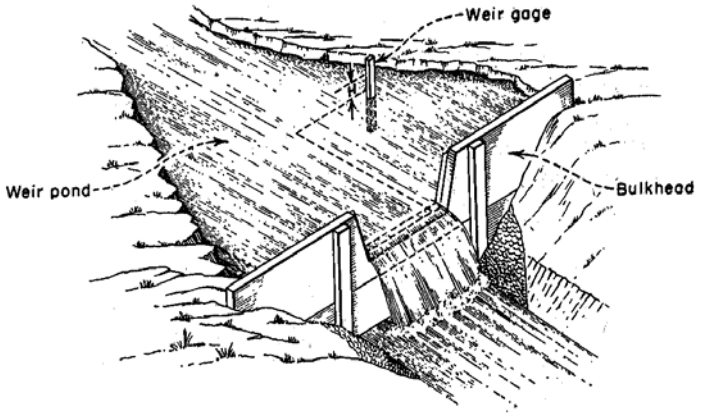
RECTANGULAR WEIR

The suppressed rectangular weir consists of a simple weir blade that spans the full width of a rectangular channel. This weir experiences flow contraction from the bottom of the weir opening, but the uninterrupted smooth profile of the side walls causes all side contractions to be suppressed. Ensuring adequate aeration of the nappe is important for this weir. The fully contracted discharge equation is $Q = 3.33Lh_1^{1.5}$.



RECTANGULAR SUPPRESSED WEIR

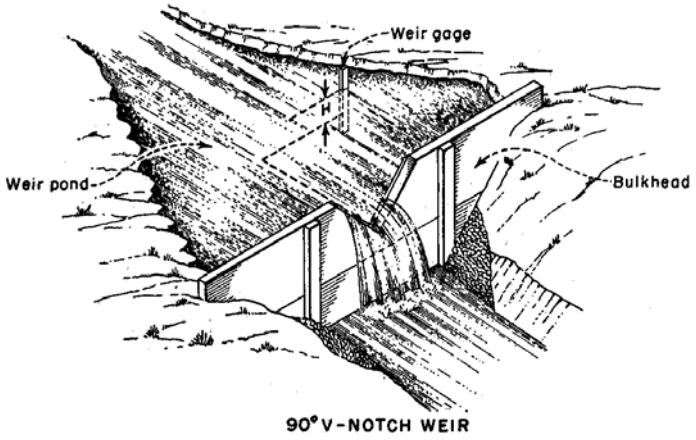
The Cipoletti Weir has a horizontal weir crest with inclined sides that have a ¼:1(horizontal:vertical) side slope. The widening of the weir as flow depth increases effectively offsets the effect of the side contractions, causing this weir to have a simpler discharge equation than the contracted rectangular weir: $Q = 3.367Lh_1^{1.5}$



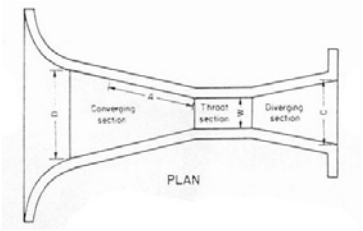
CIPOLETTI WEIR

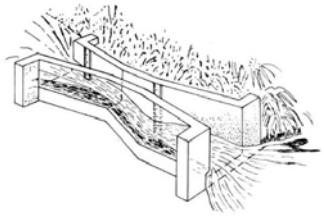
The 90° V-notch weir is most useful for measuring smaller flows of about 4.25 cfs or less. If the flow rate is often more than 2.5 cfs, then a 2-ft wide contracted rectangular weir should be considered, as it will measure the flow with similar precision, but with a much smaller amount of head needed. The discharge equation for the fully contracted 90° V-notch weir is $Q = 2.49h_1^{2.48}$

V-notch weirs with included angles other than 90° are also possible. For details, consult the *Water Measurement Manual.*



90° V-NOTCH WEIR





Parshall Flume

The Parshall flume was invented by Ralph L. Parshall while he worked for the USDA in 1922. The Parshall flume is probably the most widely used open channel measuring device in use today. For decades it was the preferred measuring device used by government and private individuals. Some states mandated its use as one of the only legally accepted flumes for official measurements. Today, long-throated flumes are recommended for most new construction, but Parshall flumes are still widespread and pre-fabricated devices are commercially available.

When properly constructed and placed, the Parshall Flume will transport sediment easily and function over a wide range of flows. Discharge tables and construction drawings have been produced for flumes with throat widths ranging from 1 inch to 50 feet, with a corresponding range of flows from 1.5 gallons per minute up to 3365 cfs. Drawings and detailed dimensions which can be used to verify proper construction of existing flumes are available in the *Water Measurement Manual*.

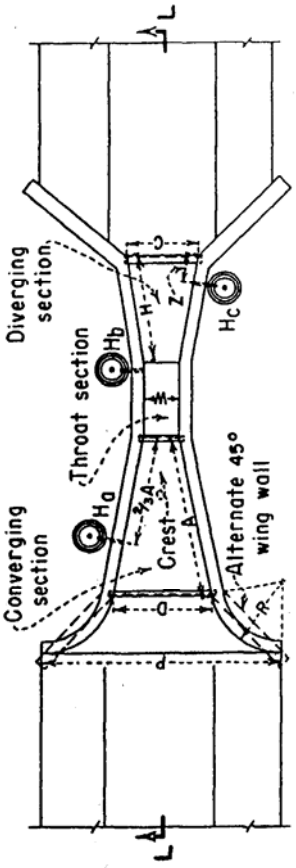
Common sources of error with Parshall flumes are non-uniform or excessively turbulent approach flow, tilted installations, non-standard dimensions associated with poor initial construction or physical damage, and misplaced staff gages. The rating of a Parshall flume assumes proper placement of the gage at the location indicated by dimension A. If the gage is placed upstream or downstream from this location, a systematic error will result, since the flow depth changes throughout the converging section of the flume.

The Parshall flume is intended to operate in free flow, with critical depth occurring in the throat section. The submergence limits for Parshall flumes vary with flume size:

- 50 percent for flumes 1, 2, and 3 in wide
- 60 percent for flumes 6 and 9 in wide
- 70 percent for flumes 1 to 8 ft wide
- 80 percent for flumes 10 to 50 ft wide

In the Parshall flume, the submergence ratio is the downstream head, h_b, divided by the upstream head, h_a, with both heads measured relative to the floor of the converging section of the flume. Many flumes are not equipped with an h_b stilling well or staff gage. Since the floor of the flume in the throat section is not level, it may be best to determine h_a and h_b by measuring down from the level top surface of the flume walls so that both measurements are referenced to the same datum. For example, assume the water level, h_a, at the upstream measuring point is 1.0 ft and the flume walls are 3 ft high in the converging section, so the distance from the top of the flume down to the water surface at the upstream staff gage is 2.0 ft. If the distance from the top of the flume down to the water surface at the "b" location is 2.2 ft, then h_b=3-2.2=0.8 ft. The flume would be operating at 80% submergence.

When submergence limits are exceeded, *flumes deliver less water than that indicated in the free-flow rating tables*. A correction must be applied to reduce the measured flow rate. The procedures vary for different sizes of flumes. The necessary charts can be found in the *Water Measurement Manual*. The accuracy of the measurement is always reduced in comparison to a free flow measurement. If submergence exceeds 95 percent, the accuracy of the measurement becomes very poor and the result should be considered only an estimate of the flow rate. Parshall flumes that are chronically submerged should be considered for rehabilitation (resetting at a higher elevation) or replacement.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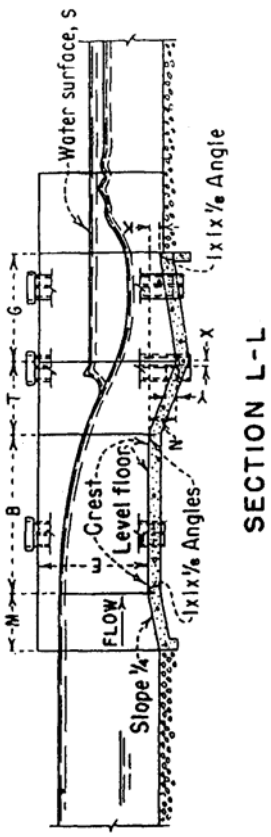
L
Diverging section
Throat section
Converging section
Hb
Ha
Hc
Crest
Alternate 45° wing wall
PLAN


Water surface, S
1x1x⅛ Angle
Crest
Level floor
1x1x⅛ Angles
FLOW
Slope ¼
SECTION L-L

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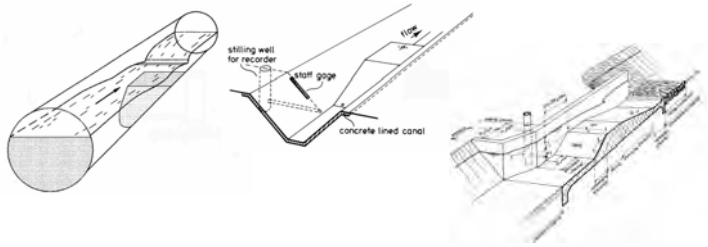
	2	0	5	0	3	4	4	$10\frac{7}{8}$	3	0	3	$11\frac{1}{2}$	3	0	2	0	3	0	-			3	1	3		9	6	1	1	8		2		3	-		.42	33.1
	3	0	5	6	3	8	5	$4\frac{3}{4}$	4	0	5	$1\frac{7}{8}$	3	0	2	0	3	0	-			3	1	3		9	7	$3\frac{1}{2}$	1	8		2		3	-		.61	50.4
	4	0	6	0	4	0	5	$10\frac{5}{8}$	5	0	6	$4\frac{1}{4}$	3	0	2	0	3	0	-			3	1	6		9	8	$10\frac{3}{4}$	2	0		2		3	-		1.3	67.9
	5	0	6	6	4	4	6	$4\frac{1}{2}$	6	0	7	$6\frac{3}{8}$	3	0	2	0	3	0	-			3	1	6		9	10	$1\frac{1}{4}$	2	0		2		3	-		1.6	85.6
	6	0	7	0	4	8	6	$10\frac{3}{8}$	7	0	8	9	3	0	2	0	3	0	-			3	1	6		9	11	$3\frac{1}{2}$	2	0		2		3	-		2.6	103.5
	7	0	7	6	5	0	7	$4\frac{1}{4}$	8	0	9	$11\frac{3}{8}$	3	0	2	0	3	0	-			3	1	6		9	12	6	2	0		2		3	-		3.0	121.4
	8	0	8	0	5	4	7	$10\frac{1}{8}$	9	0	11	$1\frac{3}{4}$	3	0	2	0	3	0	-			3	1	6		9	13	$8\frac{1}{4}$	2	0		2		3	-		3.5	139.5
[4]	10	0	-		6	0	14	0	12	0	15	$7\frac{1}{4}$	4	0	3	0	6	0	-		0	6	-		1	$1\frac{1}{2}$	-		-		0	9	1	0	-		6	200
	12	0	-		6	8	16	0	14	8	18	$4\frac{3}{4}$	5	0	3	0	8	0	-			6	-		1	$1\frac{1}{2}$	-		-			9	1	0	-		8	350
	15	0	-		7	8	25	0	18	4	25	0	6	0	4	0	10	0	-			9	-		1	6	-		-			9	1	0	-		8	600
	20	0	-		9	4	25	0	24	0	30	0	7	0	6	0	12	0	-		-	0	-		2	3	-		-			9	1	0	-		10	1000
	25	0	-		11	0	25	0	29	4	35	0	7	0	6	0	13	0	-		-	0	-		2	3	-		-			9	1	0	-		15	1200
	30	0	-		12	8	26	0	34	8	40	$4\frac{3}{4}$	7	0	6	0	14	0	-		-	0	-		2	3	-		-			9	1	0	-		15	1500
	40	0	-		16	0	27	0	45	4	50	$9\frac{1}{2}$	7	0	6	0	16	0	-		-	0	-		2	3	-		-			9	1	0	-		20	2000
	50	0	-		19	4	27	0	56	8	60	$9\frac{1}{2}$	7	0	6	0	20	0	-		-	0	-		2	3	-		-			9	1	0	-		25	3000

[1] Tolerance on throat width (w) ± 1/64 inch; tolerance on other dimensions ± 1/32 inch. Sidewalls of throat must be parallel and vertical.

[2] From Colorado State University Technical Bulletin No. 61.

[3] From U.S. Department of Agriculture Soil Conservation Circular No. 843.

[4] From Colorado State University Bulletin No. 426-A



Long-Throated Flume

The long-throated flume is a modern device that has become very popular and is now preferred by many designers over other traditional flumes and sharp-crested weirs. Several alternative names are often applied to these structures, including **ramp flume**, **broad-crested weir** and **Replogle flume**. Ease of construction, simplicity of use, adaptability to existing canals, accuracy (±2% or better in most cases), and a high submergence limit are all advantages of these flumes. Long-throated flumes require less head loss than any other critical-flow measurement device.

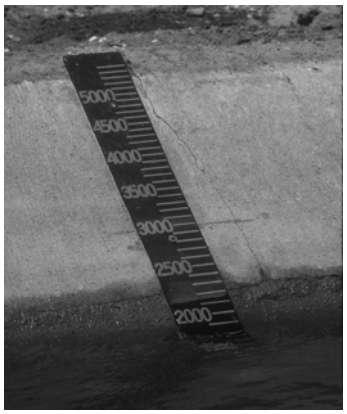
Long-throated flumes have a streamlined converging section and a long throat that produces a flow with straight, parallel streamlines in the critical-depth section. As a result, long-throated flumes can be calibrated by computer analysis, making it possible to customize flumes for special applications and develop rating tables for as-built structures. All other flumes and weirs described in this handbook must be calibrated through laboratory testing because streamlines are curved as the flow passes through the critical-depth section.

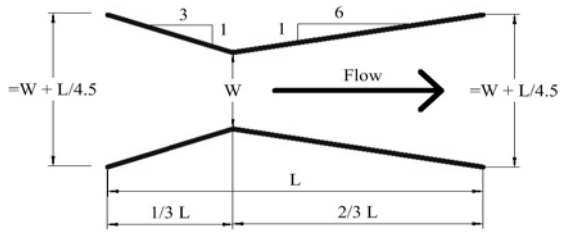
Flumes in many different configurations can be classified as long-throated, and all can be designed and calibrated using the WinFlume computer program. The throat may have a cross section of any shape, as long as it is level in the flow direction. The simplest configuration consists of a ramp and horizontal sill installed in a trapezoidal concrete-lined canal. The most crucial task during construction is to be sure that the throat section is level in the flow direction. The size, shape, and levelness of the throat determine the rating of the structure, and other aspects of the construction (slope of approach ramp, shape of transitions, etc.) do

not need to be tightly controlled. This is in contrast to a Parshall flume or cutthroat flume in which the angles and slopes of the flow surfaces affect the calibration. This translates into easier, faster, more economical construction.

Each long-throated flume is a custom structure calibrated with the computer program WinFlume, so standard discharge tables are not published in this handbook. However, the *Water Measurement Manual* and other references do provide rating equation parameters for weirs in an array of common sizes used in typical irrigation canals. Another book, *Water Measurement with Flumes and Weirs*, serves as the user manual for the WinFlume software and provides much more detailed information about these structures, including practical construction methods. The WinFlume software is a complete tool used to design new flumes, calibrate existing flumes, and determine the submergence limit for individual structures. The submergence limit is usually 90 percent or higher, better than any other critical-flow device.

Use of a long-throated flume consists of measuring an upstream water level and determining the flow rate from a rating table or equation provided by the computer program. To simplify their use, many flumes are provided with a custom-fabricated staff gage that shows the flow rate directly.





Cutthroat Flume

The cutthroat flume has been studied extensively at Utah State University by Skogerboe and others since 1967, and thus these devices are common in the state of Utah. The cutthroat flume looks like a Parshall flume with the throat cut out. The cutthroat flume is easier to build than a Parshall flume because it has a flat bottom and no throat section, but the lack of standardized entrance transitions and other factors makes the rating tables for these flumes less predictable than other types. The installation of new cutthroat flumes is discouraged by many experts.

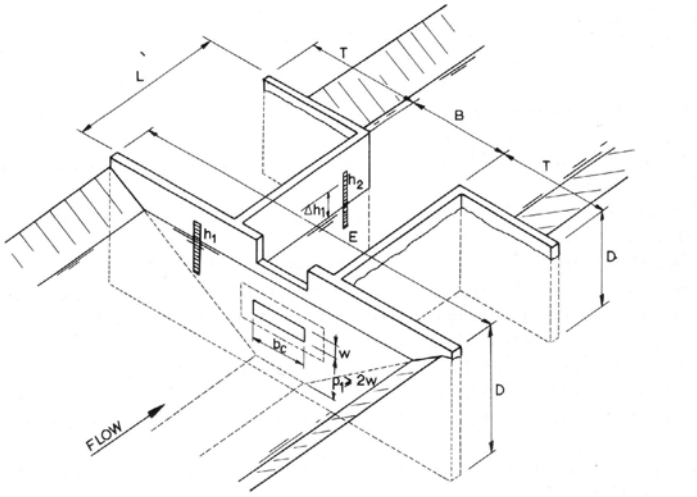
Many sizes of cutthroat flumes are in existence. Rating tables for the 2- and 3-ft wide sizes are provided in this handbook, as they are the most commonly encountered. The general free-flow rating equation for the cutthroat flume is $Q = (3.50)W^{1.025}h_a^{1.56}$ where Q is the flow rate in cfs, W is the throat width in feet, and h_a is the upstream head in feet.

The 2- and 3-ft wide cutthroat flumes whose rating tables are provided in this handbook are reported to tolerate 83 and 85 percent submergence, respectively. The tables in this handbook are only valid for free flow.

For further information on cutthroat flumes, contact the Utah State University Department of Biological and Irrigation Engineering. Professor Gary Merkley has written a computer program called ACA that can provide rating tables for many sizes of cutthroat flumes.

Submerged Orifice

A submerged orifice measurement is fundamentally different from the use of a flume or weir. The water being measured passes through an opening that has water over the top of the opening on both the upstream and downstream sides. Measurements must be taken at two locations, one upstream from the orifice and one downstream. The difference between these two measurements is the net head on the orifice and is used to find the discharge in the rating table. If the downstream water level is not above the top of the orifice opening, then the orifice is in a free flow condition and the head is instead measured from the centerline of the orifice opening to the upstream water level; the downstream water level is not used in this case.



A submerged orifice measuring device can operate with very little head loss where other measurement devices would not work, although to maintain accuracy the head differential should be at least 0.20 ft. Care must be taken to be sure that silt does not build up in front of the orifice which could cause errors in measurement. Also, debris caught in the orifice opening will reduce the flow rate. These problems are difficult to detect while in operation, since the device is entirely submerged.

Two different sets of rating tables are given in this handbook. One is for the standard case of an orifice opening that is located above the floor of the upstream canal, and thus experiences full flow contraction from all sides of the orifice opening. The discharge coefficient is assumed to be 0.61 in this case. The second table is used for orifices whose bottom and side contractions are suppressed, due to the orifice opening being at the floor of the channel and the side contractions suppressed either by close proximity of the approach channel sidewalls or sediment deposition around the orifice entrance that streamlines the opening. The coefficient is 0.70 in this case. Such a configuration (orifice at the bottom of the channel) is often used to sluice sediment through the orifice opening, keeping the floor of the channel swept clean in the area upstream from the orifice.

Other combinations of contraction or suppressed contractions for the bottom and sides of submerged orifices are possible. To determine the most accurate discharge coefficient in special situations, one should refer to the *Water Measurement Manual*.

Glossary

acre-foot: A measurement of volume. The amount of water required to cover one acre one foot deep.
crest: Top of a dam, dike, spillway, or weir sill.
cubic foot per second: A measurement of flow. Volume divided by time. Shortened to cfs, second-foot, or foot as in "they had a 5 foot stream."
delivery box (irrigation): Structure diverting water from a canal to a farm unit often including measuring devices. Also called ''turnout''.
flashboard: Wood plank, generally held horizontally in vertical slots on the crest of a dam or check structure to control the upstream water level. Sometimes called ''crestboard''.
flood irrigation, wild flooding: A surface irrigation system where water is applied to the soil surface without such flow controls as furrows, borders (including dikes), or corrugations.
flume: A specially calibrated structure for measuring open channel flows.
freeboard: Vertical distance between the maximum water surface elevation anticipated in design and the top of retaining banks, pipeline vents, or other structures, provided to prevent overtopping because of unforeseen conditions.
gage height: Elevation of a water surface measured by a gage.
head: The energy in the liquid system expressed as the equivalent height of a water column above a given point.
head gate: Water control device at the entrance to a pipe or canal.
invert: Lowest point in the internal cross section of a canal or pipe.
nappe: Sheet or curtain of water flowing from a structure, such as a weir or dam.
staff gage: Graduated scale fixed in place, generally vertical, from which the water surface elevation may be read.
weirs: Any of a group of flow measuring devices for open-channel flow. Weirs can be either sharp-crested or broad-crested. Flow opening may have a variety of shapes.
weir stick: A vertical rule placed on the crest of a weir so that water runs up against the face of the rule to approximately the same height as the water level in the upstream weir pool.

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WinFlume computer software: Design and calibration of long-throated flumes and broad-crested weirs
www.usbr.gov/pmts/hydraulics_lab/winflume/

USBRWeir spreadsheet for sharp-crested weirs
www.usbr.gov/pmts/hydraulics_lab/usbrweir/

ACA software: Rating tables for broad-crested weirs, cutthroat, Parshall, and long-throated flumes
http://www.engineering.usu.edu/bie/software/aca.php

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Rating Equations for Standard Devices

Sharp-crested weirs	Contracted rectangular	$Q = 3.33(L - 0.2h_1)h_1^{1.5}$
	Suppressed rectangular	$Q = 3.33Lh_1^{1.5}$
	Cipoletti	$Q = 3.367Lh_1^{1.5}$
	90° V-notch	$Q = 2.49h_1^{2.48}$
Parshall flumes	6-inch	$Q = 2.06h_a^{1.58}$
	9-inch	$Q = 3.07h_a^{1.53}$
	1-foot	$Q = 3.95h_a^{1.55}$
	2-foot	$Q = 8.00h_a^{1.55}$
	3-foot	$Q = 12.00h_a^{1.57}$
	4-foot	$Q = 16.00h_a^{1.58}$
	5-foot	$Q = 20.00h_a^{1.59}$
	6-foot	$Q = 24.00h_a^{1.59}$
	7-foot	$Q = 28.00h_a^{1.60}$
	8-foot	$Q = 32.00h_a^{1.61}$
	10-foot	$Q = 39.38h_a^{1.60}$
	12-foot	$Q = 46.75h_a^{1.60}$
	15-foot	$Q = 57.81h_a^{1.60}$
Cutthroat flumes	2 ft wide by 6 ft long	$Q = 7.12h_a^{1.56}$
	3 ft wide by 9 ft long	$Q = 10.79h_a^{1.56}$
Submerged orifices	Fully contracted (above floor of canal)	$Q = 0.61A\sqrt{2gh}$
	Bottom contraction suppressed (orifice on floor of canal)	$Q = 0.70A\sqrt{2gh}$

Notes:

Q = discharge, cfs — L=weir crest length, ft

h_a, h_1, h = head, ft — A=orifice cross sectional area, sq. ft.

90° V-Notch Weir

Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)
0.20	0.046	0.50	0.446	0.80	1.43
.21	.052	.51	.469	.81	1.48
.22	.058	.52	.492	.82	1.52
.23	.065	.53	.516	.83	1.57
.24	.072	.54	.540	.84	1.62
.25	.080	.55	.565	.85	1.66
.26	.088	.56	.591	.86	1.71
.27	.097	.57	.618	.87	1.76
.28	.106	.58	.645	.88	1.81
.29	.116	.59	.673	.89	1.87
.30	.126	.60	.701	.90	1.92
.31	.136	.61	.731	.91	1.97
.32	.148	.62	.761	.92	2.02
.33	.159	.63	.792	.93	2.08
.34	.172	.64	.823	.94	2.14
.35	.184	.65	.856	.95	2.19
.36	.198	.66	.889	.96	2.25
.37	.212	.67	.922	.97	2.31
.38	.226	.68	.957	.98	2.37
.39	.241	.69	.992	.99	2.43
.40	.257	.70	1.03	1.00	2.49
.41	.273	.71	1.06	1.01	2.55
.42	.290	.72	1.10	1.02	2.62
.43	.307	.73	1.14	1.03	2.68
.44	.325	.74	1.18	1.04	2.74
.45	.344	.75	1.22	1.05	2.81
.46	.363	.76	1.26	1.06	2.88
.47	.383	.77	1.30	1.07	2.94
.48	.403	.78	1.34	1.08	3.01
.49	.425	.79	1.39	1.09	3.08

90° V-Notch Weir (continued)

Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)
1.10	3.15	1.50	6.81	1.90	12.2
1.11	3.23	1.51	6.92	1.91	12.4
1.12	3.30	1.52	7.03	1.92	12.6
1.13	3.37	1.53	7.15	1.93	12.7
1.14	3.45	1.54	7.27	1.94	12.9
1.15	3.52	1.55	7.38	1.95	13.0
1.16	3.60	1.56	7.50	1.96	13.2
1.17	3.68	1.57	7.62	1.97	13.4
1.18	3.75	1.58	7.74	1.98	13.5
1.19	3.83	1.59	7.86	1.99	13.7
1.20	3.91	1.60	7.99	2.00	13.9
1.21	3.99	1.61	8.11		
1.22	4.08	1.62	8.24		
1.23	4.16	1.63	8.36		
1.24	4.25	1.64	8.49		
1.25	4.33	1.65	8.62		
1.26	4.42	1.66	8.75		
1.27	4.50	1.67	8.88		
1.28	4.59	1.68	9.02		
1.29	4.68	1.69	9.15		
1.30	4.77	1.70	9.28		
1.31	4.86	1.71	9.42		
1.32	4.96	1.72	9.56		
1.33	5.05	1.73	9.70		
1.34	5.15	1.74	9.83		
1.35	5.24	1.75	9.98		
1.36	5.34	1.76	10.1		
1.37	5.44	1.77	10.3		
1.38	5.53	1.78	10.4		
1.39	5.63	1.79	10.6		
1.40	5.74	1.80	10.7		
1.41	5.84	1.81	10.8		
1.42	5.94	1.82	11.0		
1.43	6.05	1.83	11.1		
1.44	6.15	1.84	11.3		
1.45	6.26	1.85	11.4		
1.46	6.36	1.86	11.6		
1.47	6.47	1.87	11.8		
1.48	6.58	1.88	11.9		
1.49	6.69	1.89	12.1		

Discharge of Standard Cipoletti Weirs in CFS

(Shaded values determined experimentally)

Head at staff gage (feet)	Weir Width (feet) 0.5	1	1.5	2	3	4	5
-----	-----	-----	-----	-----	-----	-----	-----
-----	-----	-----	-----	-----	-----	-----	-----
.18	.129	-----	-----	-----	-----	-----	-----
.19	.139	-----	-----	-----	-----	-----	-----
.20	.151	.301	.452	.602	.903	1.20	1.51
.21	.162	.324	.486	.648	.972	1.30	1.62
.22	.174	.347	.521	.695	1.04	1.39	1.74
.23	.186	.371	.557	.743	1.11	1.49	1.86
.24	.200	.396	.594	.792	1.19	1.58	1.98
.25	.214	.421	.631	.842	1.26	1.68	2.10
.26	-----	.446	.670	.893	1.34	1.79	2.23
.27	-----	.472	.709	.945	1.42	1.89	2.36
.28	-----	.499	.748	.998	1.50	2.00	2.49
.29	-----	.526	.789	1.05	1.58	2.10	2.63
.30	-----	.553	.830	1.11	1.66	2.21	2.77
.31	-----	.581	.872	1.16	1.74	2.32	2.91
.32	-----	.609	.914	1.22	1.83	2.44	3.05
.33	-----	.638	.957	1.28	1.91	2.55	3.19
.34	-----	.668	1.00	1.34	2.00	2.67	3.34
.35	-----	.697	1.05	1.39	2.09	2.79	3.49
.36	-----	.727	1.09	1.45	2.18	2.91	3.64
.37	-----	.758	1.14	1.52	2.27	3.03	3.79
.38	-----	.789	1.18	1.58	2.37	3.15	3.94
.39	-----	.820	1.23	1.64	2.46	3.28	4.10
.40	-----	.852	1.28	1.70	2.56	3.41	4.26
.41	-----	.884	1.33	1.77	2.65	3.54	4.42
.42	-----	.916	1.37	1.83	2.75	3.67	4.58
.43	-----	.949	1.42	1.90	2.85	3.80	4.75
.44	-----	.983	1.47	1.97	2.95	3.93	4.91
.45	-----	1.02	1.52	2.03	3.05	4.07	5.08
.46	-----	1.05	1.58	2.10	3.15	4.20	5.25
.47	-----	1.08	1.63	2.17	3.25	4.34	5.42
.48	-----	1.12	1.68	2.24	3.36	4.48	5.60
.49	-----	1.16	1.73	2.31	3.46	4.62	5.77
.50	-----	1.20	1.79	2.38	3.57	4.76	5.95
.51	-----	-----	-----	2.45	3.68	4.91	6.13
.52	-----	-----	-----	2.53	3.79	5.05	6.31
.53	-----	-----	-----	2.60	3.90	5.20	6.50
.54	-----	-----	-----	2.67	4.01	5.34	6.68
.55	-----	-----	-----	2.75	4.12	5.49	6.87
.56	-----	-----	-----	2.82	4.23	5.64	7.05
.57	-----	-----	-----	2.90	4.35	5.80	7.24
.58	-----	-----	-----	2.97	4.46	5.95	7.44
.59	-----	-----	-----	3.05	4.58	6.10	7.63
.60	-----	-----	-----	3.13	4.69	6.26	7.82

Discharge of Standard Cipoletti Weirs in CFS (continued)

(Shaded values determined experimentally)

Head at staff gage (feet)	Weir Width (feet) 2	3	4	5
0.61	3.21	4.81	6.42	8.02
.62	3.29	4.93	6.57	8.22
.63	3.37	5.05	6.73	8.42
.64	3.45	5.17	6.90	8.62
.65	3.53	5.29	7.06	8.82
.66	3.61	5.42	7.22	9.03
.67	3.69	5.54	7.39	9.23
.68	3.81	5.66	7.55	9.44
.69	3.90	5.79	7.72	9.65
.70	3.98	5.92	7.89	9.86
.71	4.06	6.04	8.06	10.1
.72	4.15	6.17	8.23	10.3
.73	4.24	6.30	8.40	10.5
.74	4.33	6.43	8.57	10.7
.75	4.42	6.56	8.75	10.9
.76	4.51	6.69	8.92	11.2
.77	4.60	6.82	9.10	11.4
.78	4.69	6.96	9.28	11.6
.79	4.78	7.09	9.46	11.8
.80	4.87	7.23	9.64	12.0
.81	4.96	7.36	9.82	12.3
.82	5.05	7.50	10.0	12.5
.83	5.14	7.64	10.2	12.7
.84	5.24	7.78	10.4	13.0
.85	5.34	7.92	10.6	13.2
.86	5.44	8.06	10.7	13.4
.87	5.54	8.20	10.9	13.7
.88	5.64	8.34	11.1	13.9
.89	5.74	8.48	11.3	14.1
.90	5.84	8.62	11.5	14.4
.91	5.94	8.77	11.7	14.6
.92	6.04	8.91	11.9	14.9
.93	6.14	9.06	12.1	15.1
.94	6.25	9.21	12.3	15.3
.95	6.36	9.35	12.5	15.6
.96	6.47	9.50	12.7	15.8
.97	6.58	9.65	12.9	16.1
.98	6.69	9.80	13.1	16.3
.99	6.80	9.95	13.3	16.6
1.00	6.91	10.1	13.5	16.8
1.01	-----	10.5	13.7	17.1
1.02	-----	10.6	13.9	17.3
1.03	-----	10.8	14.1	17.6
1.04	-----	10.9	14.3	17.9
1.05	-----	11.1	14.5	18.1

Head at staff gage (feet)	Weir Width (feet) 3	4	5
1.06	11.3	14.7	18.4
1.07	11.4	14.9	18.6
1.08	11.6	15.1	18.9
1.09	11.7	15.3	19.2
1.10	11.9	15.5	19.4
1.11	12.1	15.8	19.7
1.12	12.2	16.0	20.0
1.13	12.4	16.2	20.2
1.14	12.5	16.4	20.5
1.15	12.7	16.6	20.8
1.16	12.9	16.8	21.0
1.17	13.0	17.0	21.3
1.18	13.2	17.3	21.6
1.19	13.4	17.5	21.9
1.20	13.6	17.7	22.1
1.21	13.7	17.9	22.4
1.22	13.9	18.1	22.7
1.23	14.1	18.4	23.0
1.24	14.3	18.6	23.2
1.25	14.4	18.8	23.5
1.26	14.6	19.0	23.8
1.27	14.8	19.3	24.1
1.28	15.0	19.5	24.4
1.29	15.2	19.7	24.7
1.30	15.4	20.0	25.0
1.31	15.5	20.2	25.2
1.32	15.7	20.4	25.5
1.33	15.9	20.7	25.8
1.34	16.1	-----	26.1
1.35	16.2	-----	26.4
1.36	16.4	-----	26.7
1.37	16.6	-----	27.0
1.38	16.8	-----	27.3
1.39	17.0	-----	27.6
1.40	17.2	-----	27.9
1.41	17.4	-----	28.2
1.42	17.6	-----	28.5
1.43	17.8	-----	28.8
1.44	18.0	-----	29.1
1.45	18.2	-----	29.4
1.46	18.3	-----	29.7
1.47	18.5	-----	30.0
1.48	18.7	-----	30.3
1.49	18.9	-----	30.6
1.50	19.1	-----	30.9

Head at staff gage (feet)	Width 5
1.51	31.2
1.52	31.5
1.53	31.9
1.54	32.2
1.55	32.5
1.56	32.8
1.57	33.1
1.58	33.4
1.59	33.8
1.60	34.1
1.61	34.4
1.62	34.7
1.63	35.0
1.64	35.4
1.65	35.7
1.66	36.0
1.67	36.3

Discharge of Standard Cipoletti Weirs in CFS (continued)

Head at staff gage (feet)	Weir Width (feet) 6	7	8	9
0.20	1.81	2.11	2.41	2.71
.21	1.94	2.27	2.59	2.92
.22	2.08	2.43	2.78	3.13
.23	2.23	2.60	2.97	3.34
.24	2.38	2.77	3.17	3.56
.25	2.53	2.95	3.37	3.79
.26	2.68	3.12	3.57	4.02
.27	2.83	3.31	3.78	4.25
.28	2.99	3.49	3.99	4.49
.29	3.15	3.68	4.21	4.73
.30	3.32	3.87	4.43	4.98
.31	3.49	4.07	4.65	5.23
.32	3.66	4.27	4.88	5.49
.33	3.83	4.47	5.11	5.74
.34	4.01	4.67	5.34	6.01
.35	4.18	4.88	5.58	6.27
.36	4.36	5.09	5.82	6.55
.37	4.55	5.30	6.06	6.82
.38	4.73	5.52	6.31	7.10
.39	4.92	5.74	6.56	7.38
.40	5.11	5.96	6.81	7.67
.41	5.30	6.19	7.07	7.96
.42	5.50	6.42	7.33	8.25
.43	5.70	6.65	7.60	8.54
.44	5.90	6.88	7.86	8.84
.45	6.10	7.11	8.13	9.15
.46	6.30	7.35	8.40	9.45
.47	6.51	7.59	8.68	9.76
.48	6.72	7.84	8.96	10.1
.49	6.93	8.08	9.24	10.4
.50	7.14	8.33	9.52	10.7
.51	7.36	8.58	9.81	11.0
.52	7.58	8.84	10.1	11.4
.53	7.79	9.09	10.4	11.7
.54	8.02	9.35	10.7	12.0
.55	8.24	9.61	11.0	12.4
.56	8.47	9.88	11.3	12.7
.57	8.69	10.1	11.6	13.0
.58	8.92	10.4	11.9	13.4
.59	9.16	10.7	12.2	13.7
.60	9.39	11.0	12.5	14.1
.61	9.62	11.2	12.8	14.4
.62	9.86	11.5	13.1	14.8
.63	10.1	11.8	13.5	15.2
.64	10.3	12.1	13.8	15.5

Head at staff gage (feet)	Weir Width (feet) 6	7	8	9
0.65	10.6	12.4	14.1	15.9
.66	10.8	12.6	14.4	16.2
.67	11.1	12.9	14.8	16.6
.68	11.3	13.2	15.1	17.0
.69	11.6	13.5	15.4	17.4
.70	11.8	13.8	15.8	17.7
.71	12.1	14.1	16.1	18.1
.72	12.3	14.4	16.5	18.5
.73	12.6	14.7	16.8	18.9
.74	12.9	15.0	17.1	19.3
.75	13.1	15.3	17.5	19.7
.76	13.4	15.6	17.8	20.1
.77	13.6	15.9	18.2	20.5
.78	13.9	16.2	18.6	20.9
.79	14.2	16.5	18.9	21.3
.80	14.5	16.9	19.3	21.7
.81	14.7	17.2	19.6	22.1
.82	15.0	17.5	20.0	22.5
.83	15.3	17.8	20.4	22.9
.84	15.6	18.1	20.7	23.3
.85	15.8	18.5	21.1	23.7
.86	16.1	18.8	21.5	24.2
.87	16.4	19.1	21.9	24.6
.88	16.7	19.5	22.2	25.0
.89	17.0	19.8	22.6	25.4
.90	17.2	20.1	23.0	25.9
.91	17.5	20.5	23.4	26.3
.92	17.8	20.8	23.8	26.7
.93	18.1	21.1	24.2	27.2
.94	18.4	21.5	24.5	27.6
.95	18.7	21.8	24.9	28.1
.96	19.0	22.2	25.3	28.5
.97	19.3	22.5	25.7	28.9
.98	19.6	22.9	26.1	29.4
.99	19.9	23.2	26.5	29.8
1.00	20.2	23.6	26.9	30.3
1.01	20.5	23.9	27.3	30.8
1.02	20.8	24.3	27.7	31.2
1.03	21.1	24.6	28.2	31.7
1.04	21.4	25.0	28.6	32.1
1.05	21.7	25.4	29.0	32.6
1.06	22.0	25.7	29.4	33.1
1.07	22.4	26.1	29.8	33.5
1.08	22.7	26.5	30.2	34.0
1.09	23.0	26.8	30.7	34.5

Discharge of Standard Cipoletti Weirs in CFS (continued)

Head at staff gage (feet)	Weir Width (feet) 6	7	8	9
1.10	23.3	27.2	31.1	35.0
1.11	23.6	27.6	31.5	35.4
1.12	23.9	27.9	31.9	35.9
1.13	24.3	28.3	32.4	36.4
1.14	24.6	28.7	32.8	36.9
1.15	24.9	29.1	33.2	37.4
1.16	25.2	29.4	33.7	37.9
1.17	25.6	29.8	34.1	38.3
1.18	25.9	30.2	34.5	38.8
1.19	26.2	30.6	35.0	39.3
1.20	26.6	31.0	35.4	39.8
1.21	26.9	31.4	35.9	40.3
1.22	27.2	31.8	36.3	40.8
1.23	27.6	32.2	36.7	41.3
1.24	27.9	32.5	37.2	41.8
1.25	28.2	32.9	37.6	42.3
1.26	28.6	33.3	38.1	42.9
1.27	28.9	33.7	38.6	43.4
1.28	29.3	34.1	39.0	43.9
1.29	29.6	34.5	39.5	44.4
1.30	29.9	34.9	39.9	44.9
1.31	30.3	35.3	40.4	45.4
1.32	30.6	35.7	40.9	46.0
1.33	31.0	36.2	41.3	46.5
1.34	31.3	36.6	41.8	47.0
1.35	31.7	37.0	42.3	47.5
1.36	32.0	37.4	42.7	48.1
1.37	32.4	37.8	43.2	48.6
1.38	32.8	38.2	43.7	49.1
1.39	33.1	38.6	44.1	49.7
1.40	33.5	39.0	44.6	50.2
1.41	33.8	39.5	45.1	50.7
1.42	34.2	39.9	45.6	51.3
1.43	34.5	40.3	46.1	51.8
1.44	34.9	40.7	46.5	52.4
1.45	35.3	41.2	47.0	52.9
1.46	35.6	41.6	47.5	53.5
1.47	36.0	42.0	48.0	54.0
1.48	36.4	42.4	48.5	54.6
1.49	36.7	42.9	49.0	55.1
1.50	37.1	43.3	49.5	55.7
1.51	37.5	43.7	50.0	56.2
1.52	37.9	44.2	50.5	56.8
1.53	38.2	44.6	51.0	57.3
1.54	38.6	45.0	51.5	57.9

Head at staff gage (feet)	Weir Width (feet) 6	7	8	9
1.55	39.0	45.5	52.0	58.5
1.56	39.4	45.9	52.5	59.0
1.57	39.7	46.4	53.0	59.6
1.58	40.1	46.8	53.5	60.2
1.59	40.5	47.3	54.0	60.8
1.60	40.9	47.7	54.5	61.3
1.61	41.3	48.1	55.0	61.9
1.62	41.7	48.6	55.5	62.5
1.63	42.0	49.0	56.1	63.1
1.64	42.4	49.5	56.6	63.6
1.65	42.8	50.0	57.1	64.2
1.66	43.2	50.4	57.6	64.8
1.67	43.6	50.9	58.1	65.4
1.68	44.0	51.3	58.7	66.0
1.69	44.4	51.8	59.2	66.6
1.70	44.8	52.2	59.7	67.2
1.71	45.2	52.7	60.2	67.8
1.72	45.6	53.2	60.8	68.4
1.73	46.0	53.6	61.3	69.0
1.74	46.4	54.1	61.8	69.6
1.75	46.8	54.6	62.4	70.2
1.76	47.2	55.0	62.9	70.8
1.77	47.6	55.5	63.4	71.4
1.78	48.0	56.0	64.0	72.0
1.79	48.4	56.4	64.5	72.6
1.80	48.8	56.9	65.0	73.2
1.81	49.2	57.4	65.6	73.8
1.82	49.6	57.9	66.1	74.4
1.83	50.0	58.3	66.7	75.0
1.84	50.4	58.8	67.2	75.6
1.85	50.8	59.3	67.8	76.3
1.86	51.2	59.8	68.3	76.9
1.87	51.7	60.3	68.9	77.5
1.88	52.1	60.8	69.4	78.1
1.89	52.5	61.2	70.0	78.7
1.90	52.9	61.7	70.5	79.4
1.91	53.3	62.2	71.1	80.0
1.92	53.7	62.7	71.7	80.6
1.93	54.2	63.2	72.2	81.2
1.94	54.6	63.7	72.8	81.9
1.95	55.0	64.2	73.3	82.5
1.96	55.4	64.7	73.9	83.2
1.97	55.9	65.2	74.5	83.8
1.98	56.3	65.7	75.0	84.4
1.99	56.7	66.2	75.6	85.1

Discharge of Standard Cipoletti Weirs in CFS (continued)

Head at staff gage (feet)	Weir Width (feet) 6	7	8	9
2.00	57.1	66.7	76.2	85.7
2.01	-----	67.2	76.8	86.4
2.02	-----	67.7	77.3	87.0
2.03	-----	68.2	77.9	87.6
2.04	-----	68.7	78.5	88.3
2.05	-----	69.2	79.1	88.9
2.06	-----	69.7	79.6	89.6
2.07	-----	70.2	80.2	90.2
2.08	-----	70.7	80.8	90.9
2.09	-----	71.2	81.4	91.6
2.10	-----	71.7	82.0	92.2
2.11	-----	72.2	82.6	92.9
2.12	-----	72.8	83.1	93.5
2.13	-----	73.3	83.7	94.2
2.14	-----	73.8	84.3	94.9
2.15	-----	74.3	84.9	95.5
2.16	-----	74.8	85.5	96.2
2.17	-----	75.3	86.1	96.9
2.18	-----	75.9	86.7	97.5
2.19	-----	76.4	87.3	98.2
2.20	-----	76.9	87.9	98.9
2.21	-----	77.4	88.5	100.
2.22	-----	78.0	89.1	100.
2.23	-----	78.5	89.7	101.
2.24	-----	79.0	90.3	102.
2.25	-----	79.5	90.9	102.
2.26	-----	80.1	91.5	103.
2.27	-----	80.6	92.1	104.
2.28	-----	81.1	92.7	104.
2.29	-----	81.7	93.3	105.
2.30	-----	82.2	94.0	106.
2.31	-----	82.7	94.6	106.
2.32	-----	83.3	95.2	107.
2.33	-----	83.8	95.8	108.
2.34	-----	-----	96.4	108.
2.35	-----	-----	97.0	109.
2.36	-----	-----	97.7	110.
2.37	-----	-----	98.3	111.
2.38	-----	-----	98.9	111.
2.39	-----	-----	100.	112.
2.40	-----	-----	100.	113.
2.41	-----	-----	101.	113.
2.42	-----	-----	101.	114.
2.43	-----	-----	102.	115.
2.44	-----	-----	103.	115.

Head at staff gage (feet)	Width (feet) 8	9
2.45	103.	116.
2.46	104.	117.
2.47	105.	118.
2.48	105.	118.
2.49	106.	119.
2.50	106.	120.
2.51	107.	121.
2.52	108.	121.
2.53	108.	122.
2.54	109.	123.
2.55	110.	123.
2.56	110.	124.
2.57	111.	125.
2.58	112.	126.
2.59	112.	126.
2.60	113.	127.
2.61	114.	128.
2.62	114.	129.
2.63	115.	129.
2.64	116.	130.
2.65	116.	131.
2.66	117.	131.
2.67	118.	132.
2.68	-----	133.
2.69	-----	134.
2.70	-----	134.
2.71	-----	135.
2.72	-----	136.
2.73	-----	137.
2.74	-----	137.
2.75	-----	138.
2.76	-----	139.
2.77	-----	140.
2.78	-----	140.
2.79	-----	141.
2.80	-----	142.
2.81	-----	143.
2.82	-----	144.
2.83	-----	144.
2.84	-----	145.
2.85	-----	146.
2.86	-----	147.
2.87	-----	147.
2.88	-----	148.
2.89	-----	149.

Head at staff gage (feet)	Width 9
2.90	150.
2.91	150.
2.92	151.
2.93	152.
2.94	153.
2.95	154.
2.96	154.
2.97	155.
2.98	156.
2.99	157.
3.00	157.

Discharge of Standard Contracted Rectangular Weirs in CFS

(Shaded values determined experimentally)

Head at staff gage (feet)	Weir Width (feet) 0.5	1	1.5	2	3	4	5	6	7
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
0.18	0.122	-----	-----	-----	-----	-----	-----	-----	-----
.19	.132	-----	-----	-----	-----	-----	-----	-----	-----
.20	.142	0.286	0.435	0.584	0.882	1.18	1.48	1.78	2.07
.21	.152	.307	.467	.627	.948	1.27	1.59	1.91	2.23
.22	.162	.329	.500	.672	1.02	1.36	1.70	2.05	2.39
.23	.173	.350	.534	.718	1.09	1.45	1.82	2.19	2.55
.24	.184	.373	.568	.764	1.16	1.55	1.94	2.33	2.72
.25	.195	.395	.604	.812	1.23	1.64	2.06	2.48	2.89
.26	-----	.419	.639	.860	1.30	1.74	2.18	2.63	3.07
.27	-----	.442	.676	.909	1.38	1.84	2.31	2.78	3.25
.28	-----	.466	.712	.959	1.45	1.95	2.44	2.93	3.43
.29	-----	.490	.750	1.01	1.53	2.05	2.57	3.09	3.61
.30	-----	.514	.788	1.06	1.61	2.16	2.70	3.25	3.80
.31	-----	.539	.827	1.11	1.69	2.26	2.84	3.41	3.99
.32	-----	.564	.866	1.17	1.77	2.37	2.98	3.58	4.18
.33	-----	.590	.905	1.22	1.85	2.48	3.11	3.75	4.38
.34	-----	.615	.945	1.28	1.94	2.60	3.26	3.92	4.58
.35	-----	.658	.986	1.33	2.02	2.71	3.40	4.09	4.78
.36	-----	.686	1.03	1.39	2.11	2.83	3.54	4.26	4.98
.37	-----	.714	1.07	1.44	2.19	2.94	3.69	4.44	5.19
.38	-----	.743	1.11	1.50	2.28	3.06	3.84	4.62	5.40
.39	-----	.772	1.15	1.56	2.37	3.18	3.99	4.80	5.61
.40	-----	.801	1.20	1.62	2.46	3.30	4.14	4.99	5.83
.41	-----	.830	1.24	1.68	2.55	3.43	4.30	5.17	6.05
.42	-----	.860	1.28	1.74	2.64	3.55	4.46	5.36	6.27
.43	-----	.890	1.33	1.80	2.74	3.68	4.61	5.55	6.49
.44	-----	.920	1.37	1.86	2.83	3.80	4.77	5.75	6.72
.45	-----	.950	1.42	1.92	2.93	3.93	4.94	5.94	6.95
.46	-----	.981	1.46	1.98	3.02	4.06	5.10	6.14	7.18
.47	-----	1.01	1.51	2.05	3.12	4.19	5.26	6.34	7.41
.48	-----	1.04	1.55	2.11	3.22	4.32	5.43	6.54	7.65
.49	-----	1.08	1.60	2.17	3.31	4.46	5.60	6.74	7.88
.50	-----	1.11	1.65	2.24	3.41	4.59	5.77	6.95	8.12
.51	-----	-----	-----	2.30	3.51	4.73	5.94	7.15	8.37
.52	-----	-----	-----	2.37	3.62	4.86	6.11	7.36	8.61
.53	-----	-----	-----	2.43	3.72	5.00	6.29	7.57	8.86
.54	-----	-----	-----	2.50	3.82	5.14	6.46	7.79	9.11
.55	-----	-----	-----	2.57	3.93	5.28	6.64	8.00	9.36
.56	-----	-----	-----	2.63	4.03	5.43	6.82	8.22	9.61
.57	-----	-----	-----	2.70	4.14	5.57	7.00	8.43	9.87
.58	-----	-----	-----	2.77	4.24	5.71	7.18	8.65	10.1
.59	-----	-----	-----	2.84	4.35	5.86	7.37	8.88	10.4
.60	-----	-----	-----	2.91	4.46	6.00	7.55	9.10	10.6

Discharge of Standard Contracted Rectangular Weirs in CFS (continued)

(Shaded values determined experimentally)

Head at staff gage (feet)	Weir Width (feet) 2	3	4	5	6	7
0.61	2.98	4.57	6.15	7.74	9.33	10.9
.62	3.05	4.68	6.30	7.93	9.55	11.2
.63	3.12	4.79	6.45	8.12	9.78	11.4
.64	3.19	4.90	6.60	8.31	10.0	11.7
.65	3.26	5.01	6.75	8.50	10.2	12.0
.66	3.34	5.12	6.91	8.69	10.5	12.3
.67	3.41	5.23	7.06	8.89	10.7	12.5
.68	3.58	5.35	7.22	9.08	10.9	12.8
.69	3.66	5.46	7.37	9.28	11.2	13.1
.70	3.74	5.58	7.53	9.48	11.4	13.4
.71	3.82	5.69	7.69	9.68	11.7	13.7
.72	3.90	5.81	7.84	9.88	11.9	13.9
.73	3.98	5.93	8.00	10.1	12.2	14.2
.74	4.06	6.05	8.17	10.3	12.4	14.5
.75	4.14	6.16	8.33	10.5	12.7	14.8
.76	4.22	6.28	8.49	10.7	12.9	15.1
.77	4.30	6.40	8.65	10.9	13.2	15.4
.78	4.38	6.52	8.82	11.1	13.4	15.7
.79	4.46	6.65	8.98	11.3	13.7	16.0
.80	4.54	6.77	9.15	11.5	13.9	16.3
.81	4.62	6.89	9.32	11.7	14.2	16.6
.82	4.70	7.01	9.49	12.0	14.4	16.9
.83	4.78	7.14	9.65	12.2	14.7	17.2
.84	4.87	7.26	9.82	12.4	15.0	17.5
.85	4.96	7.39	9.99	12.6	15.2	17.8
.86	5.05	7.51	10.2	12.8	15.5	18.1
.87	5.14	7.64	10.3	13.0	15.7	18.4
.88	5.23	7.76	10.5	13.3	16.0	18.8
.89	5.32	7.89	10.7	13.5	16.3	19.1
.90	5.41	8.02	10.9	13.7	16.5	19.4
.91	5.50	8.15	11.0	13.9	16.8	19.7
.92	5.59	8.27	11.2	14.2	17.1	20.0
.93	5.68	8.40	11.4	14.4	17.4	20.4
.94	5.77	8.53	11.6	14.6	17.6	20.7
.95	5.86	8.66	11.7	14.8	17.9	21.0
.96	5.95	8.80	11.9	15.1	18.2	21.3
.97	6.04	8.93	12.1	15.3	18.5	21.7
.98	6.13	9.06	12.3	15.5	18.8	22.0
.99	6.22	9.19	12.5	15.8	19.0	22.3
1.00	6.31	9.32	12.7	16.0	19.3	22.6
1.01	-----	-----	12.8	16.2	19.6	23.0
1.02	-----	-----	13.0	16.5	19.9	23.3
1.03	-----	-----	13.2	16.7	20.2	23.6
1.04	-----	-----	13.4	16.9	20.5	24.0
1.05	-----	-----	13.6	17.2	20.7	24.3

Discharge of Standard Contracted Rectangular Weirs in CFS (continued)

Head at staff gage (feet)	Weir Width (feet) 4	5	6	7
1.06	13.8	17.4	21.0	24.7
1.07	14.0	17.6	21.3	25.0
1.08	14.1	17.9	21.6	25.4
1.09	14.3	18.1	21.9	25.7
1.10	14.5	18.4	22.2	26.0
1.11	14.7	18.6	22.5	26.4
1.12	14.9	18.9	22.8	26.7
1.13	15.1	19.1	23.1	27.1
1.14	15.3	19.3	23.4	27.4
1.15	15.5	19.6	23.7	27.8
1.16	15.7	19.8	24.0	28.2
1.17	15.9	20.1	24.3	28.5
1.18	16.1	20.3	24.6	28.9
1.19	16.3	20.6	24.9	29.2
1.20	16.5	20.8	25.2	29.6
1.21	16.7	21.1	25.5	30.0
1.22	16.9	21.3	25.8	30.3
1.23	17.1	21.6	26.1	30.7
1.24	17.3	21.9	26.4	31.0
1.25	17.5	22.1	26.8	31.4
1.26	17.7	22.4	27.1	31.8
1.27	17.9	22.6	27.4	32.2
1.28	18.1	22.9	27.7	32.5
1.29	18.3	23.1	28.0	32.9
1.30	18.5	23.4	28.3	33.3
1.31	18.7	23.7	28.6	33.6
1.32	18.9	23.9	29.0	34.0
1.33	19.1	24.2	29.3	34.4
1.34	-----	24.4	29.6	34.8
1.35	-----	24.7	29.9	35.2
1.36	-----	25.0	30.3	35.5
1.37	-----	25.2	30.6	35.9
1.38	-----	25.5	30.9	36.3
1.39	-----	25.8	31.2	36.7
1.40	-----	26.0	31.6	37.1
1.41	-----	26.3	31.9	37.5
1.42	-----	26.6	32.2	37.8
1.43	-----	26.8	32.5	38.2
1.44	-----	27.1	32.9	38.6
1.45	-----	27.4	33.2	39.0
1.46	-----	27.7	33.5	39.4
1.47	-----	27.9	33.9	39.8
1.48	-----	28.2	34.2	40.2
1.49	-----	28.5	34.5	40.6
1.50	-----	28.8	34.9	41.0

Head at staff gage (feet)	Weir Width (feet) 5	6	7
1.51	29.0	35.2	41.4
1.52	29.3	35.5	41.8
1.53	29.6	35.9	42.2
1.54	29.9	36.2	42.6
1.55	30.1	36.6	43.0
1.56	30.4	36.9	43.4
1.57	30.7	37.2	43.8
1.58	31.0	37.6	44.2
1.59	31.3	37.9	44.6
1.60	31.5	38.3	45.0
1.61	31.8	38.6	45.4
1.62	32.1	39.0	45.8
1.63	32.4	39.3	46.3
1.64	32.7	39.7	46.7
1.65	33.0	40.0	47.1
1.66	33.2	40.4	47.5
1.67	33.5	40.7	47.9
1.68	-----	41.1	48.3
1.69	-----	41.4	48.7
1.70	-----	41.8	49.2
1.71	-----	42.1	49.6
1.72	-----	42.5	50.0
1.73	-----	42.8	50.4
1.74	-----	43.2	50.8
1.75	-----	43.6	51.3
1.76	-----	43.9	51.7
1.77	-----	44.3	52.1
1.78	-----	44.6	52.5
1.79	-----	45.0	53.0
1.80	-----	45.4	53.4
1.81	-----	45.7	53.8
1.82	-----	46.1	54.3
1.83	-----	46.4	54.7
1.84	-----	46.8	55.1
1.85	-----	47.2	55.6
1.86	-----	47.5	56.0
1.87	-----	47.9	56.4
1.88	-----	48.3	56.9
1.89	-----	48.6	57.3
1.90	-----	49.0	57.7
1.91	-----	49.4	58.2
1.92	-----	49.8	58.6
1.93	-----	50.1	59.1
1.94	-----	50.5	59.5
1.95	-----	50.9	59.9

Discharge of Standard Contracted Rectangular Weirs in CFS (continued)

Head at staff gage (feet)	Weir Width (feet) 6	7
1.96	51.2	60.4
1.97	51.6	60.8
1.98	52.0	61.3
1.99	52.4	61.7
2.00	52.7	62.2
2.01	-----	62.6
2.02	-----	63.1
2.03	-----	63.5
2.04	-----	64.0
2.05	-----	64.4
2.06	-----	64.9
2.07	-----	65.3
2.08	-----	65.8
2.09	-----	66.2
2.10	-----	66.7
2.11	-----	67.1
2.12	-----	67.6
2.13	-----	68.1
2.14	-----	68.5
2.15	-----	69.0
2.16	-----	69.4
2.17	-----	69.9
2.18	-----	70.4
2.19	-----	70.8
2.20	-----	71.3
2.21	-----	71.7
2.22	-----	72.2
2.23	-----	72.7
2.24	-----	73.1
2.25	-----	73.6
2.26	-----	74.1
2.27	-----	74.6
2.28	-----	75.0
2.29	-----	75.5
2.30	-----	76.0
2.31	-----	76.4
2.32	-----	76.9
2.33	-----	77.4

Discharge of Standard Contracted Rectangular Weirs in CFS (continued)

Head at staff gage (feet)	Weir Width (feet) 8	9	10	12	15	18	20
-----	-----	-----	-----	-----	-----	-----	-----
0.20	2.37	2.67	2.97	3.56	4.46	5.35	5.94
.30	4.34	4.89	5.44	6.53	8.17	9.82	10.91
.40	6.67	7.51	8.36	10.0	12.6	15.1	16.8
.50	9.30	10.5	11.7	14.0	17.5	21.1	23.4
.60	12.2	13.7	15.3	18.4	23.0	27.7	30.8
.70	15.3	17.3	19.2	23.1	29.0	34.8	38.7
.80	18.7	21.1	23.4	28.2	35.4	42.5	47.3
.90	22.2	25.1	27.9	33.6	42.1	50.7	56.4
1.00	26.0	29.3	32.6	39.3	49.3	59.3	65.9
1.10	29.9	33.7	37.6	45.3	56.8	68.3	76.0
1.20	34.0	38.3	42.7	51.5	64.6	77.7	86.5
1.30	38.2	43.1	48.1	57.9	72.8	87.6	97.4
1.40	42.6	48.1	53.6	64.6	81.2	97.7	109.
1.50	47.1	53.2	59.3	71.6	89.9	108.	121.
1.60	51.8	58.5	65.2	78.7	98.9	119.	133.
1.70	56.5	63.9	71.3	86.1	108.	130.	145.
1.80	61.4	69.5	77.5	93.6	118.	142.	158.
1.90	66.5	75.2	83.9	101.	128.	154.	171.
2.00	71.6	81.0	90.4	109.	138.	166.	185.
2.10	76.8	86.9	97.1	117.	148.	178.	198.
2.20	82.1	93.0	104.	126.	158.	191.	213.
2.30	87.6	99.2	111.	134.	169.	204.	227.
2.40	93.1	105.	118.	143.	180.	217.	242.
2.50	98.7	112.	125.	151.	191.	230.	257.
2.60	104.	118.	132.	160.	202.	244.	272.
2.70	110.	125.	140.	169.	214.	258.	287.
2.80	-----	132.	147.	178.	225.	272.	303.
2.90	-----	138.	155.	188.	237.	286.	319.
3.00	-----	145.	163.	197.	249.	301.	336.
3.10	-----	-----	170.	207.	261.	316.	352.
3.20	-----	-----	178.	217.	274.	331.	369.
3.30	-----	-----	186.	226.	286.	346.	386.
3.40	-----	-----	-----	236.	299.	362.	403.
3.50	-----	-----	-----	246.	312.	377.	421.
3.60	-----	-----	-----	257.	325.	393.	439.
3.70	-----	-----	-----	267.	338.	409.	456.
3.80	-----	-----	-----	277.	351.	425.	475.
3.90	-----	-----	-----	288.	365.	442.	493.
4.00	-----	-----	-----	298.	378.	458.	511.
4.10	-----	-----	-----	-----	392.	475.	530.
4.20	-----	-----	-----	-----	406.	492.	549.
4.30	-----	-----	-----	-----	420.	509.	568.
4.40	-----	-----	-----	-----	434.	526.	588.
4.50	-----	-----	-----	-----	448.	544.	607.

Discharge of Standard Suppressed Rectangular Weirs in CFS

Head at staff gage (feet)	Weir Width (feet) 1	1.5	2	3	4	5
0.20	0.298	0.447	0.596	0.894	1.19	1.49
.21	.320	.481	.641	.961	1.28	1.60
.22	.344	.515	.687	1.03	1.37	1.72
.23	.367	.551	.735	1.10	1.47	1.84
.24	.392	.587	.783	1.17	1.57	1.96
.25	.416	.624	.833	1.25	1.67	2.08
.26	.441	.662	.883	1.32	1.77	2.21
.27	.467	.701	.934	1.40	1.87	2.34
.28	.493	.740	.987	1.48	1.97	2.47
.29	.520	.780	1.04	1.56	2.08	2.60
.30	.547	.821	1.09	1.64	2.19	2.74
.31	.575	.862	1.15	1.72	2.30	2.87
.32	.603	.904	1.21	1.81	2.41	3.01
.33	.631	.947	1.26	1.89	2.53	3.16
.34	-----	.990	1.32	1.98	2.64	3.30
.35	-----	1.03	1.38	2.07	2.76	3.45
.36	-----	1.08	1.44	2.16	2.88	3.60
.37	-----	1.12	1.50	2.25	3.00	3.75
.38	-----	1.17	1.56	2.34	3.12	3.90
.39	-----	1.22	1.62	2.43	3.24	4.06
.40	-----	1.26	1.68	2.53	3.37	4.21
.41	-----	1.31	1.75	2.62	3.50	4.37
.42	-----	1.36	1.81	2.72	3.63	4.53
.43	-----	1.41	1.88	2.82	3.76	4.69
.44	-----	1.46	1.94	2.92	3.89	4.86
.45	-----	1.51	2.01	3.02	4.02	5.03
.46	-----	1.56	2.08	3.12	4.16	5.19
.47	-----	1.61	2.15	3.22	4.29	5.36
.48	-----	1.66	2.21	3.32	4.43	5.54
.49	-----	1.71	2.28	3.43	4.57	5.71
.50	-----	1.77	2.35	3.53	4.71	5.89
.51	-----	-----	2.43	3.64	4.85	6.06
.52	-----	-----	2.50	3.75	4.99	6.24
.53	-----	-----	2.57	3.85	5.14	6.42
.54	-----	-----	2.64	3.96	5.29	6.61
.55	-----	-----	2.72	4.07	5.43	6.79
.56	-----	-----	2.79	4.19	5.58	6.98
.57	-----	-----	2.87	4.30	5.73	7.17
.58	-----	-----	2.94	4.41	5.88	7.35
.59	-----	-----	3.02	4.53	6.04	7.55
.60	-----	-----	3.10	4.64	6.19	7.74
.61	-----	-----	3.17	4.76	6.35	7.93
.62	-----	-----	3.25	4.88	6.50	8.13
.63	-----	-----	3.33	5.00	6.66	8.33
.64	-----	-----	3.41	5.11	6.82	8.52
.65	-----	-----	3.49	5.24	6.98	8.73
.66	-----	-----	3.57	5.36	7.14	8.93
.67	-----	-----	3.65	5.48	7.30	9.13
.68	-----	-----	3.73	5.60	7.47	9.34
.69	-----	-----	3.82	5.73	7.63	9.54

Discharge of Standard Suppressed Rectangular Weirs in CFS (continued)

Head at staff gage (feet)	Weir Width (feet) 3	4	5
0.70	5.85	7.80	9.75
.71	5.98	7.97	9.96
.72	6.10	8.14	10.2
.73	6.23	8.31	10.4
.74	6.36	8.48	10.6
.75	6.49	8.65	10.8
.76	6.62	8.83	11.0
.77	6.75	9.00	11.2
.78	6.88	9.18	11.5
.79	7.01	9.35	11.7
.80	7.15	9.53	11.9
.81	7.28	9.71	12.1
.82	7.42	9.89	12.4
.83	7.55	10.1	12.6
.84	7.69	10.3	12.8
.85	7.83	10.4	13.0
.86	7.97	10.6	13.3
.87	8.11	10.8	13.5
.88	8.25	11.0	13.7
.89	8.39	11.2	14.0
.90	8.53	11.4	14.2
.91	8.67	11.6	14.5
.92	8.82	11.8	14.7
.93	8.96	11.9	14.9
.94	9.10	12.1	15.2
.95	9.25	12.3	15.4
.96	9.40	12.5	15.7
.97	9.54	12.7	15.9
.98	9.69	12.9	16.2
.99	9.84	13.1	16.4
1.00	9.99	13.3	16.7
1.01	-----	13.5	16.9
1.02	-----	13.7	17.2
1.03	-----	13.9	17.4
1.04	-----	14.1	17.7
1.05	-----	14.3	17.9
1.06	-----	14.5	18.2
1.07	-----	14.7	18.4
1.08	-----	14.9	18.7
1.09	-----	15.2	18.9
1.10	-----	15.4	19.2
1.11	-----	15.6	19.5
1.12	-----	15.8	19.7
1.13	-----	16.0	20.0
1.14	-----	16.2	20.3
1.15	-----	16.4	20.5
1.16	-----	16.6	20.8
1.17	-----	16.9	21.1
1.18	-----	17.1	21.3
1.19	-----	17.3	21.6

Head at staff gage (feet)	Weir Width (feet) 4	5
1.20	17.5	21.9
1.21	17.7	22.2
1.22	17.9	22.4
1.23	18.2	22.7
1.24	18.4	23.0
1.25	18.6	23.3
1.26	18.8	23.5
1.27	19.1	23.8
1.28	19.3	24.1
1.29	19.5	24.4
1.30	19.7	24.7
1.31	20.0	25.0
1.32	20.2	25.3
1.33	20.4	25.5
1.34	-----	25.8
1.35	-----	26.1
1.36	-----	26.4
1.37	-----	26.7
1.38	-----	27.0
1.39	-----	27.3
1.40	-----	27.6
1.41	-----	27.9
1.42	-----	28.2
1.43	-----	28.5
1.44	-----	28.8
1.45	-----	29.1
1.46	-----	29.4
1.47	-----	29.7
1.48	-----	30.0
1.49	-----	30.3
1.50	-----	30.6
1.51	-----	30.9
1.52	-----	31.2
1.53	-----	31.5
1.54	-----	31.8
1.55	-----	32.1
1.56	-----	32.4
1.57	-----	32.8
1.58	-----	33.1
1.59	-----	33.4
1.60	-----	33.7
1.61	-----	34.0
1.62	-----	34.3
1.63	-----	34.6
1.64	-----	35.0
1.65	-----	35.3
1.66	-----	35.6
1.67	-----	35.9

6 inch wide Parshall flume

Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)
0.10	0.05	0.50	0.69	0.90	1.74
.11	.06	.51	.71	.91	1.77
.12	.07	.52	.73	.92	1.81
.13	.08	.53	.76	.93	1.84
.14	.09	.54	.78	.94	1.87
.15	.10	.55	.80	.95	1.90
.16	.11	.56	.82	.96	1.93
.17	.13	.57	.85	.97	1.96
.18	.14	.58	.87	.98	2.00
.19	.15	.59	.89	.99	2.03
.20	.16	.60	.92	1.00	2.06
.21	.17	.61	.94	1.01	2.09
.22	.19	.62	.97	1.02	2.13
.23	.20	.63	.99	1.03	2.16
.24	.22	.64	1.02	1.04	2.19
.25	.23	.65	1.04	1.05	2.23
.26	.25	.66	1.07	1.06	2.26
.27	.26	.67	1.09	1.07	2.29
.28	.28	.68	1.12	1.08	2.33
.29	.29	.69	1.15	1.09	2.36
.30	.31	.70	1.17	1.10	2.39
.31	.32	.71	1.20	1.11	2.43
.32	.34	.72	1.23	1.12	2.46
.33	.36	.73	1.25	1.13	2.50
.34	.37	.74	1.28	1.14	2.53
.35	.39	.75	1.31	1.15	2.57
.36	.41	.76	1.34	1.16	2.60
.37	.43	.77	1.36	1.17	2.64
.38	.45	.78	1.39	1.18	2.68
.39	.47	.79	1.42	1.19	2.71
.40	.48	.80	1.45	1.20	2.75
.41	.50	.81	1.48	1.21	2.78
.42	.52	.82	1.51	1.22	2.82
.43	.54	.83	1.53	1.23	2.86
.44	.56	.84	1.56	1.24	2.89
.45	.58	.85	1.59	1.25	2.93
.46	.60	.86	1.62	1.26	2.97
.47	.62	.87	1.65	1.27	3.01
.48	.65	.88	1.68	1.28	3.04
.49	.67	.89	1.71	1.29	3.08

9 inch wide Parshall flume

Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)
0.10	0.09	0.60	1.41	1.10	3.55
.11	.10	.61	1.44	1.11	3.60
.12	.12	.62	1.48	1.12	3.65
.13	.14	.63	1.51	1.13	3.70
.14	.15	.64	1.55	1.14	3.75
.15	.17	.65	1.59	1.15	3.80
.16	.19	.66	1.63	1.16	3.85
.17	.20	.67	1.66	1.17	3.90
.18	.22	.68	1.70	1.18	3.95
.19	.24	.69	1.74	1.19	4.01
.20	.26	.70	1.78	1.20	4.06
.21	.28	.71	1.82	1.21	4.11
.22	.30	.72	1.86	1.22	4.16
.23	.32	.73	1.90	1.23	4.21
.24	.35	.74	1.94	1.24	4.27
.25	.37	.75	1.98	1.25	4.32
.26	.39	.76	2.02	1.26	4.37
.27	.41	.77	2.06	1.27	4.43
.28	.44	.78	2.10	1.28	4.48
.29	.46	.79	2.14	1.29	4.53
.30	.49	.80	2.18	1.30	4.59
.31	.51	.81	2.22	1.31	4.64
.32	.54	.82	2.27	1.32	4.69
.33	.56	.83	2.31	1.33	4.75
.34	.59	.84	2.35	1.34	4.80
.35	.62	.85	2.39	1.35	4.86
.36	.64	.86	2.44	1.36	4.91
.37	.67	.87	2.48	1.37	4.97
.38	.70	.88	2.52	1.38	5.03
.39	.73	.89	2.57	1.39	5.08
.40	.76	.90	2.61	1.40	5.14
.41	.78	.91	2.66	1.41	5.19
.42	.81	.92	2.70	1.42	5.25
.43	.84	.93	2.75	1.43	5.31
.44	.87	.94	2.79	1.44	5.36
.45	.90	.95	2.84	1.45	5.42
.46	.94	.96	2.88	1.46	5.48
.47	.97	.97	2.93	1.47	5.54
.48	1.00	.98	2.98	1.48	5.59
.49	1.03	.99	3.02	1.49	5.65
.50	1.06	1.00	3.07	1.50	5.71
.51	1.10	1.01	3.12	1.51	5.77
.52	1.13	1.02	3.16	1.52	5.83
.53	1.16	1.03	3.21	1.53	5.88
.54	1.20	1.04	3.26	1.54	5.94
.55	1.23	1.05	3.31	1.55	6.00
.56	1.26	1.06	3.36	1.56	6.06
.57	1.30	1.07	3.40	1.57	6.12
.58	1.33	1.08	3.45	1.58	6.18
.59	1.37	1.09	3.50	1.59	6.24

1 foot wide Parshall flume

Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)
0.20	0.33	0.60	1.79	1.00	3.95
.21	.35	.61	1.84	1.01	4.01
.22	.38	.62	1.88	1.02	4.07
.23	.40	.63	1.93	1.03	4.14
.24	.43	.64	1.98	1.04	4.20
.25	.46	.65	2.03	1.05	4.26
.26	.49	.66	2.07	1.06	4.32
.27	.52	.67	2.12	1.07	4.39
.28	.55	.68	2.17	1.08	4.45
.29	.58	.69	2.22	1.09	4.51
.30	.61	.70	2.27	1.10	4.58
.31	.64	.71	2.32	1.11	4.64
.32	.68	.72	2.37	1.12	4.71
.33	.71	.73	2.43	1.13	4.77
.34	.74	.74	2.48	1.14	4.84
.35	.78	.75	2.53	1.15	4.91
.36	.81	.76	2.58	1.16	4.97
.37	.85	.77	2.63	1.17	5.04
.38	.88	.78	2.69	1.18	5.11
.39	.92	.79	2.74	1.19	5.17
.40	.95	.80	2.80	1.20	5.24
.41	.99	.81	2.85	1.21	5.31
.42	1.03	.82	2.90	1.22	5.38
.43	1.07	.83	2.96	1.23	5.44
.44	1.11	.84	3.01	1.24	5.51
.45	1.15	.85	3.07	1.25	5.58
.46	1.19	.86	3.13	1.26	5.65
.47	1.23	.87	3.18	1.27	5.72
.48	1.27	.88	3.24	1.28	5.79
.49	1.31	.89	3.30	1.29	5.86
.50	1.35	.90	3.35	1.30	5.93
.51	1.39	.91	3.41	1.31	6.00
.52	1.43	.92	3.47	1.32	6.07
.53	1.48	.93	3.53	1.33	6.15
.54	1.52	.94	3.59	1.34	6.22
.55	1.56	.95	3.65	1.35	6.29
.56	1.61	.96	3.71	1.36	6.36
.57	1.65	.97	3.77	1.37	6.43
.58	1.70	.98	3.83	1.38	6.51
.59	1.74	.99	3.89	1.39	6.58

1 foot wide Parshall flume (continued)

Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)
1.40	6.65	1.80	9.82	2.20	13.4
1.41	6.73	1.81	9.91	2.21	13.5
1.42	6.80	1.82	9.99	2.22	13.6
1.43	6.88	1.83	10.1	2.23	13.7
1.44	6.95	1.84	10.2	2.24	13.8
1.45	7.03	1.85	10.2	2.25	13.9
1.46	7.10	1.86	10.3	2.26	14.0
1.47	7.18	1.87	10.4	2.27	14.1
1.48	7.25	1.88	10.5	2.28	14.2
1.49	7.33	1.89	10.6	2.29	14.3
1.50	7.41	1.90	10.7	2.30	14.4
1.51	7.48	1.91	10.8	2.31	14.5
1.52	7.56	1.92	10.9	2.32	14.6
1.53	7.64	1.93	10.9	2.33	14.7
1.54	7.71	1.94	11.0	2.34	14.8
1.55	7.79	1.95	11.1	2.35	14.9
1.56	7.87	1.96	11.2	2.36	14.9
1.57	7.95	1.97	11.3	2.37	15.0
1.58	8.03	1.98	11.4	2.38	15.1
1.59	8.11	1.99	11.5	2.39	15.2
1.60	8.18	2.00	11.6	2.40	15.3
1.61	8.26	2.01	11.7	2.41	15.4
1.62	8.34	2.02	11.7	2.42	15.5
1.63	8.42	2.03	11.8	2.43	15.6
1.64	8.50	2.04	11.9	2.44	15.7
1.65	8.58	2.05	12.0	2.45	15.8
1.66	8.66	2.06	12.1	2.46	15.9
1.67	8.75	2.07	12.2	2.47	16.0
1.68	8.83	2.08	12.3	2.48	16.1
1.69	8.91	2.09	12.4	2.49	16.2
1.70	8.99	2.10	12.5	2.50	16.3
1.71	9.07	2.11	12.6		
1.72	9.16	2.12	12.7		
1.73	9.24	2.13	12.8		
1.74	9.32	2.14	12.8		
1.75	9.40	2.15	12.9		
1.76	9.49	2.16	13.0		
1.77	9.57	2.17	13.1		
1.78	9.65	2.18	13.2		
1.79	9.74	2.19	13.3		

2 foot wide Parshall flume

Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)
0.20	0.66	0.60	3.62	1.00	8.00
.21	.71	.61	3.72	1.01	8.12
.22	.77	.62	3.81	1.02	8.25
.23	.82	.63	3.91	1.03	8.37
.24	.88	.64	4.01	1.04	8.50
.25	.93	.65	4.10	1.05	8.63
.26	.99	.66	4.20	1.06	8.76
.27	1.05	.67	4.30	1.07	8.88
.28	1.11	.68	4.40	1.08	9.01
.29	1.17	.69	4.50	1.09	9.14
.30	1.24	.70	4.60	1.10	9.27
.31	1.30	.71	4.71	1.11	9.40
.32	1.37	.72	4.81	1.12	9.54
.33	1.44	.73	4.91	1.13	9.67
.34	1.50	.74	5.02	1.14	9.80
.35	1.57	.75	5.12	1.15	9.93
.36	1.64	.76	5.23	1.16	10.1
.37	1.71	.77	5.34	1.17	10.2
.38	1.79	.78	5.44	1.18	10.3
.39	1.86	.79	5.55	1.19	10.5
.40	1.93	.80	5.66	1.20	10.6
.41	2.01	.81	5.77	1.21	10.7
.42	2.09	.82	5.88	1.22	10.9
.43	2.16	.83	5.99	1.23	11.0
.44	2.24	.84	6.11	1.24	11.2
.45	2.32	.85	6.22	1.25	11.3
.46	2.40	.86	6.33	1.26	11.4
.47	2.48	.87	6.45	1.27	11.6
.48	2.57	.88	6.56	1.28	11.7
.49	2.65	.89	6.68	1.29	11.9
.50	2.73	.90	6.79	1.30	12.0
.51	2.82	.91	6.91	1.31	12.2
.52	2.90	.92	7.03	1.32	12.3
.53	2.99	.93	7.15	1.33	12.4
.54	3.08	.94	7.27	1.34	12.6
.55	3.17	.95	7.39	1.35	12.7
.56	3.26	.96	7.51	1.36	12.9
.57	3.35	.97	7.63	1.37	13.0
.58	3.44	.98	7.75	1.38	13.2
.59	3.53	.99	7.88	1.39	13.3

2 foot wide Parshall flume (continued)

Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)
1.40	13.5	1.80	19.9	2.20	27.1
1.41	13.6	1.81	20.1	2.21	27.3
1.42	13.8	1.82	20.2	2.22	27.5
1.43	13.9	1.83	20.4	2.23	27.7
1.44	14.1	1.84	20.6	2.24	27.9
1.45	14.2	1.85	20.8	2.25	28.1
1.46	14.4	1.86	20.9	2.26	28.3
1.47	14.5	1.87	21.1	2.27	28.5
1.48	14.7	1.88	21.3	2.28	28.7
1.49	14.8	1.89	21.5	2.29	28.9
1.50	15.0	1.90	21.6	2.30	29.1
1.51	15.2	1.91	21.8	2.31	29.3
1.52	15.3	1.92	22.0	2.32	29.5
1.53	15.5	1.93	22.2	2.33	29.7
1.54	15.6	1.94	22.3	2.34	29.9
1.55	15.8	1.95	22.5	2.35	30.1
1.56	15.9	1.96	22.7	2.36	30.3
1.57	16.1	1.97	22.9	2.37	30.5
1.58	16.3	1.98	23.1	2.38	30.7
1.59	16.4	1.99	23.2	2.39	30.9
1.60	16.6	2.00	23.4	2.40	31.1
1.61	16.7	2.01	23.6	2.41	31.3
1.62	16.9	2.02	23.8	2.42	31.5
1.63	17.1	2.03	24.0	2.43	31.7
1.64	17.2	2.04	24.1	2.44	31.9
1.65	17.4	2.05	24.3	2.45	32.1
1.66	17.5	2.06	24.5	2.46	32.3
1.67	17.7	2.07	24.7	2.47	32.5
1.68	17.9	2.08	24.9	2.48	32.7
1.69	18.0	2.09	25.1	2.49	32.9
1.70	18.2	2.10	25.3	2.50	33.1
1.71	18.4	2.11	25.4		
1.72	18.5	2.12	25.6		
1.73	18.7	2.13	25.8		
1.74	18.9	2.14	26.0		
1.75	19.0	2.15	26.2		
1.76	19.2	2.16	26.4		
1.77	19.4	2.17	26.6		
1.78	19.6	2.18	26.8		
1.79	19.7	2.19	27.0		

3 foot wide Parshall flume

Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)
0.20	0.96	0.60	5.39	1.00	12.0
.21	1.04	.61	5.53	1.01	12.2
.22	1.12	.62	5.68	1.02	12.4
.23	1.20	.63	5.82	1.03	12.6
.24	1.28	.64	5.97	1.04	12.8
.25	1.37	.65	6.11	1.05	13.0
.26	1.46	.66	6.26	1.06	13.1
.27	1.54	.67	6.41	1.07	13.3
.28	1.63	.68	6.56	1.08	13.5
.29	1.73	.69	6.71	1.09	13.7
.30	1.82	.70	6.86	1.10	13.9
.31	1.92	.71	7.02	1.11	14.1
.32	2.01	.72	7.17	1.12	14.3
.33	2.11	.73	7.33	1.13	14.5
.34	2.22	.74	7.49	1.14	14.7
.35	2.32	.75	7.65	1.15	14.9
.36	2.42	.76	7.81	1.16	15.1
.37	2.53	.77	7.97	1.17	15.3
.38	2.64	.78	8.13	1.18	15.6
.39	2.75	.79	8.30	1.19	15.8
.40	2.86	.80	8.46	1.20	16.0
.41	2.97	.81	8.63	1.21	16.2
.42	3.08	.82	8.79	1.22	16.4
.43	3.20	.83	8.96	1.23	16.6
.44	3.32	.84	9.13	1.24	16.8
.45	3.44	.85	9.30	1.25	17.0
.46	3.56	.86	9.48	1.26	17.2
.47	3.68	.87	9.65	1.27	17.4
.48	3.80	.88	9.82	1.28	17.7
.49	3.93	.89	10.0	1.29	17.9
.50	4.05	.90	10.2	1.30	18.1
.51	4.18	.91	10.4	1.31	18.3
.52	4.31	.92	10.5	1.32	18.5
.53	4.44	.93	10.7	1.33	18.8
.54	4.57	.94	10.9	1.34	19.0
.55	4.71	.95	11.1	1.35	19.2
.56	4.84	.96	11.3	1.36	19.4
.57	4.98	.97	11.4	1.37	19.6
.58	5.11	.98	11.6	1.38	19.9
.59	5.25	.99	11.8	1.39	20.1

3 foot wide Parshall flume (continued)

Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)
1.40	20.3	1.80	30.1	2.20	41.3
1.41	20.6	1.81	30.4	2.21	41.5
1.42	20.8	1.82	30.7	2.22	41.8
1.43	21.0	1.83	30.9	2.23	42.1
1.44	21.2	1.84	31.2	2.24	42.4
1.45	21.5	1.85	31.4	2.25	42.7
1.46	21.7	1.86	31.7	2.26	43.0
1.47	21.9	1.87	32.0	2.27	43.3
1.48	22.2	1.88	32.3	2.28	43.6
1.49	22.4	1.89	32.5	2.29	43.9
1.50	22.6	1.90	32.8	2.30	44.2
1.51	22.9	1.91	33.1	2.31	44.5
1.52	23.1	1.92	33.3	2.32	44.8
1.53	23.4	1.93	33.6	2.33	45.1
1.54	23.6	1.94	33.9	2.34	45.4
1.55	23.8	1.95	34.2	2.35	45.7
1.56	24.1	1.96	34.4	2.36	46.0
1.57	24.3	1.97	34.7	2.37	46.4
1.58	24.6	1.98	35.0	2.38	46.7
1.59	24.8	1.99	35.3	2.39	47.0
1.60	25.1	2.00	35.5	2.40	47.3
1.61	25.3	2.01	35.8	2.41	47.6
1.62	25.5	2.02	36.1	2.42	47.9
1.63	25.8	2.03	36.4	2.43	48.2
1.64	26.0	2.04	36.7	2.44	48.5
1.65	26.3	2.05	36.9	2.45	48.8
1.66	26.5	2.06	37.2	2.46	49.1
1.67	26.8	2.07	37.5	2.47	49.5
1.68	27.0	2.08	37.8	2.48	49.8
1.69	27.3	2.09	38.1	2.49	50.1
1.70	27.5	2.10	38.4	2.50	50.4
1.71	27.8	2.11	38.6		
1.72	28.1	2.12	38.9		
1.73	28.3	2.13	39.2		
1.74	28.6	2.14	39.5		
1.75	28.8	2.15	39.8		
1.76	29.1	2.16	40.1		
1.77	29.3	2.17	40.4		
1.78	29.6	2.18	40.7		
1.79	29.9	2.19	41.0		

4 foot wide Parshall flume

Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)
0.20	1.26	0.60	7.15	1.00	16.0
.21	1.36	.61	7.34	1.01	16.3
.22	1.47	.62	7.53	1.02	16.5
.23	1.57	.63	7.72	1.03	16.8
.24	1.68	.64	7.91	1.04	17.0
.25	1.80	.65	8.11	1.05	17.3
.26	1.91	.66	8.31	1.06	17.5
.27	2.03	.67	8.51	1.07	17.8
.28	2.15	.68	8.71	1.08	18.1
.29	2.27	.69	8.91	1.09	18.3
.30	2.39	.70	9.11	1.10	18.6
.31	2.52	.71	9.32	1.11	18.9
.32	2.65	.72	9.53	1.12	19.1
.33	2.78	.73	9.74	1.13	19.4
.34	2.92	.74	9.95	1.14	19.7
.35	3.05	.75	10.2	1.15	19.9
.36	3.19	.76	10.4	1.16	20.2
.37	3.33	.77	10.6	1.17	20.5
.38	3.48	.78	10.8	1.18	20.8
.39	3.62	.79	11.0	1.19	21.1
.40	3.77	.80	11.3	1.20	21.3
.41	3.92	.81	11.5	1.21	21.6
.42	4.07	.82	11.7	1.22	21.9
.43	4.22	.83	11.9	1.23	22.2
.44	4.38	.84	12.2	1.24	22.5
.45	4.54	.85	12.4	1.25	22.8
.46	4.70	.86	12.6	1.26	23.0
.47	4.86	.87	12.8	1.27	23.3
.48	5.03	.88	13.1	1.28	23.6
.49	5.19	.89	13.3	1.29	23.9
.50	5.36	.90	13.5	1.30	24.2
.51	5.53	.91	13.8	1.31	24.5
.52	5.70	.92	14.0	1.32	24.8
.53	5.88	.93	14.3	1.33	25.1
.54	6.05	.94	14.5	1.34	25.4
.55	6.23	.95	14.8	1.35	25.7
.56	6.41	.96	15.0	1.36	26.0
.57	6.59	.97	15.2	1.37	26.3
.58	6.77	.98	15.5	1.38	26.6
.59	6.96	.99	15.7	1.39	26.9

4 foot wide Parshall flume (continued)

Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)
1.40	27.2	1.80	40.4	2.20	55.5
1.41	27.5	1.81	40.8	2.21	55.9
1.42	27.8	1.82	41.2	2.22	56.3
1.43	28.1	1.83	41.5	2.23	56.7
1.44	28.4	1.84	41.9	2.24	57.1
1.45	28.8	1.85	42.2	2.25	57.5
1.46	29.1	1.86	42.6	2.26	57.9
1.47	29.4	1.87	43.0	2.27	58.3
1.48	29.7	1.88	43.3	2.28	58.7
1.49	30.0	1.89	43.7	2.29	59.1
1.50	30.3	1.90	44.1	2.30	59.5
1.51	30.7	1.91	44.4	2.31	60.0
1.52	31.0	1.92	44.8	2.32	60.4
1.53	31.3	1.93	45.2	2.33	60.8
1.54	31.6	1.94	45.5	2.34	61.2
1.55	31.9	1.95	45.9	2.35	61.6
1.56	32.3	1.96	46.3	2.36	62.0
1.57	32.6	1.97	46.6	2.37	62.4
1.58	32.9	1.98	47.0	2.38	62.9
1.59	33.3	1.99	47.4	2.39	63.3
1.60	33.6	2.00	47.8	2.40	63.7
1.61	33.9	2.01	48.1	2.41	64.1
1.62	34.3	2.02	48.5	2.42	64.5
1.63	34.6	2.03	48.9	2.43	64.9
1.64	34.9	2.04	49.3	2.44	65.4
1.65	35.3	2.05	49.7	2.45	65.8
1.66	35.6	2.06	50.0	2.46	66.2
1.67	35.9	2.07	50.4	2.47	66.6
1.68	36.3	2.08	50.8	2.48	67.1
1.69	36.6	2.09	51.2	2.49	67.5
1.70	37.0	2.10	51.6	2.50	67.9
1.71	37.3	2.11	52.0		
1.72	37.6	2.12	52.4		
1.73	38.0	2.13	52.8		
1.74	38.3	2.14	53.1		
1.75	38.7	2.15	53.5		
1.76	39.0	2.16	53.9		
1.77	39.4	2.17	54.3		
1.78	39.7	2.18	54.7		
1.79	40.1	2.19	55.1		

5 foot wide Parshall flume

Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)
0.20	1.56	0.60	8.89	1.00	20.0
.21	1.68	.61	9.13	1.01	20.3
.22	1.81	.62	9.37	1.02	20.6
.23	1.94	.63	9.61	1.03	21.0
.24	2.08	.64	9.85	1.04	21.3
.25	2.22	.65	10.1	1.05	21.6
.26	2.36	.66	10.3	1.06	21.9
.27	2.50	.67	10.6	1.07	22.3
.28	2.65	.68	10.8	1.08	22.6
.29	2.80	.69	11.1	1.09	22.9
.30	2.96	.70	11.4	1.10	23.3
.31	3.12	.71	11.6	1.11	23.6
.32	3.28	.72	11.9	1.12	23.9
.33	3.44	.73	12.1	1.13	24.3
.34	3.61	.74	12.4	1.14	24.6
.35	3.78	.75	12.7	1.15	25.0
.36	3.95	.76	12.9	1.16	25.3
.37	4.13	.77	13.2	1.17	25.7
.38	4.31	.78	13.5	1.18	26.0
.39	4.49	.79	13.8	1.19	26.4
.40	4.67	.80	14.0	1.20	26.7
.41	4.86	.81	14.3	1.21	27.1
.42	5.05	.82	14.6	1.22	27.4
.43	5.24	.83	14.9	1.23	27.8
.44	5.43	.84	15.2	1.24	28.1
.45	5.63	.85	15.5	1.25	28.5
.46	5.83	.86	15.7	1.26	28.9
.47	6.03	.87	16.0	1.27	29.2
.48	6.24	.88	16.3	1.28	29.6
.49	6.45	.89	16.6	1.29	30.0
.50	6.66	.90	16.9	1.30	30.3
.51	6.87	.91	17.2	1.31	30.7
.52	7.08	.92	17.5	1.32	31.1
.53	7.30	.93	17.8	1.33	31.4
.54	7.52	.94	18.1	1.34	31.8
.55	7.74	.95	18.4	1.35	32.2
.56	7.97	.96	18.7	1.36	32.6
.57	8.20	.97	19.1	1.37	33.0
.58	8.43	.98	19.4	1.38	33.3
.59	8.66	.99	19.7	1.39	33.7

5 foot wide Parshall flume (continued)

Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)
1.40	34.1	1.80	50.8	2.20	69.9
1.41	34.5	1.81	51.3	2.21	70.4
1.42	34.9	1.82	51.7	2.22	70.9
1.43	35.3	1.83	52.2	2.23	71.4
1.44	35.7	1.84	52.6	2.24	71.9
1.45	36.1	1.85	53.1	2.25	72.4
1.46	36.5	1.86	53.5	2.26	72.9
1.47	36.9	1.87	54.0	2.27	73.5
1.48	37.3	1.88	54.5	2.28	74.0
1.49	37.7	1.89	54.9	2.29	74.5
1.50	38.1	1.90	55.4	2.30	75.0
1.51	38.5	1.91	55.9	2.31	75.5
1.52	38.9	1.92	56.3	2.32	76.0
1.53	39.3	1.93	56.8	2.33	76.6
1.54	39.7	1.94	57.3	2.34	77.1
1.55	40.1	1.95	57.7	2.35	77.6
1.56	40.5	1.96	58.2	2.36	78.1
1.57	40.9	1.97	58.7	2.37	78.7
1.58	41.3	1.98	59.1	2.38	79.2
1.59	41.7	1.99	59.6	2.39	79.7
1.60	42.2	2.00	60.1	2.40	80.2
1.61	42.6	2.01	60.6	2.41	80.8
1.62	43.0	2.02	61.0	2.42	81.3
1.63	43.4	2.03	61.5	2.43	81.8
1.64	43.9	2.04	62.0	2.44	82.4
1.65	44.3	2.05	62.5	2.45	82.9
1.66	44.7	2.06	63.0	2.46	83.5
1.67	45.1	2.07	63.5	2.47	84.0
1.68	45.6	2.08	63.9	2.48	84.5
1.69	46.0	2.09	64.4	2.49	85.1
1.70	46.4	2.10	64.9	2.50	85.6
1.71	46.9	2.11	65.4		
1.72	47.3	2.12	65.9		
1.73	47.7	2.13	66.4		
1.74	48.2	2.14	66.9		
1.75	48.6	2.15	67.4		
1.76	49.1	2.16	67.9		
1.77	49.5	2.17	68.4		
1.78	49.9	2.18	68.9		
1.79	50.4	2.19	69.4		

6 foot wide Parshall flume

Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)
0.20	1.84	0.60	10.6	1.00	24.0
.21	1.99	.61	10.9	1.01	24.4
.22	2.15	.62	11.2	1.02	24.8
.23	2.30	.63	11.5	1.03	25.2
.24	2.47	.64	11.8	1.04	25.5
.25	2.63	.65	12.1	1.05	25.9
.26	2.80	.66	12.4	1.06	26.3
.27	2.97	.67	12.7	1.07	26.7
.28	3.15	.68	13.0	1.08	27.1
.29	3.33	.69	13.3	1.09	27.5
.30	3.52	.70	13.6	1.10	27.9
.31	3.71	.71	13.9	1.11	28.3
.32	3.90	.72	14.2	1.12	28.8
.33	4.10	.73	14.5	1.13	29.2
.34	4.30	.74	14.8	1.14	29.6
.35	4.50	.75	15.2	1.15	30.0
.36	4.71	.76	15.5	1.16	30.4
.37	4.92	.77	15.8	1.17	30.8
.38	5.13	.78	16.1	1.18	31.2
.39	5.35	.79	16.5	1.19	31.7
.40	5.57	.80	16.8	1.20	32.1
.41	5.79	.81	17.2	1.21	32.5
.42	6.02	.82	17.5	1.22	33.0
.43	6.25	.83	17.8	1.23	33.4
.44	6.48	.84	18.2	1.24	33.8
.45	6.72	.85	18.5	1.25	34.3
.46	6.96	.86	18.9	1.26	34.7
.47	7.20	.87	19.2	1.27	35.1
.48	7.45	.88	19.6	1.28	35.6
.49	7.69	.89	19.9	1.29	36.0
.50	7.95	.90	20.3	1.30	36.5
.51	8.20	.91	20.6	1.31	36.9
.52	8.46	.92	21.0	1.32	37.4
.53	8.72	.93	21.4	1.33	37.8
.54	8.98	.94	21.7	1.34	38.3
.55	9.25	.95	22.1	1.35	38.7
.56	9.52	.96	22.5	1.36	39.2
.57	9.79	.97	22.9	1.37	39.6
.58	10.1	.98	23.2	1.38	40.1
.59	10.3	.99	23.6	1.39	40.6

6 foot wide Parshall flume (continued)

Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)
1.40	41.0	1.80	61.3	2.20	84.4
1.41	41.5	1.81	61.8	2.21	85.0
1.42	42.0	1.82	62.4	2.22	85.6
1.43	42.5	1.83	62.9	2.23	86.2
1.44	42.9	1.84	63.5	2.24	86.8
1.45	43.4	1.85	64.0	2.25	87.5
1.46	43.9	1.86	64.6	2.26	88.1
1.47	44.4	1.87	65.1	2.27	88.7
1.48	44.8	1.88	65.7	2.28	89.3
1.49	45.3	1.89	66.2	2.29	89.9
1.50	45.8	1.90	66.8	2.30	90.6
1.51	46.3	1.91	67.4	2.31	91.2
1.52	46.8	1.92	67.9	2.32	91.8
1.53	47.3	1.93	68.5	2.33	92.5
1.54	47.8	1.94	69.0	2.34	93.1
1.55	48.3	1.95	69.6	2.35	93.7
1.56	48.8	1.96	70.2	2.36	94.4
1.57	49.3	1.97	70.8	2.37	95.0
1.58	49.8	1.98	71.3	2.38	95.7
1.59	50.3	1.99	71.9	2.39	96.3
1.60	50.8	2.00	72.5	2.40	96.9
1.61	51.3	2.01	73.1	2.41	97.6
1.62	51.8	2.02	73.6	2.42	98.2
1.63	52.3	2.03	74.2	2.43	98.9
1.64	52.8	2.04	74.8	2.44	99.5
1.65	53.3	2.05	75.4	2.45	100.
1.66	53.9	2.06	76.0	2.46	101.
1.67	54.4	2.07	76.6	2.47	101.
1.68	54.9	2.08	77.2	2.48	102.
1.69	55.4	2.09	77.8	2.49	103.
1.70	55.9	2.10	78.3	2.50	103.
1.71	56.5	2.11	78.9		
1.72	57.0	2.12	79.5		
1.73	57.5	2.13	80.1		
1.74	58.0	2.14	80.7		
1.75	58.6	2.15	81.3		
1.76	59.1	2.16	81.9		
1.77	59.7	2.17	82.6		
1.78	60.2	2.18	83.2		
1.79	60.7	2.19	83.8		

7 foot wide Parshall flume

Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)
0.20	2.13	0.60	12.4	1.00	28.0
.21	2.30	.61	12.7	1.01	28.4
.22	2.48	.62	13.0	1.02	28.9
.23	2.66	.63	13.4	1.03	29.4
.24	2.85	.64	13.7	1.04	29.8
.25	3.04	.65	14.0	1.05	30.3
.26	3.24	.66	14.4	1.06	30.7
.27	3.44	.67	14.7	1.07	31.2
.28	3.65	.68	15.1	1.08	31.7
.29	3.86	.69	15.5	1.09	32.1
.30	4.07	.70	15.8	1.10	32.6
.31	4.29	.71	16.2	1.11	33.1
.32	4.52	.72	16.5	1.12	33.6
.33	4.75	.73	16.9	1.13	34.1
.34	4.98	.74	17.3	1.14	34.5
.35	5.21	.75	17.7	1.15	35.0
.36	5.46	.76	18.0	1.16	35.5
.37	5.70	.77	18.4	1.17	36.0
.38	5.95	.78	18.8	1.18	36.5
.39	6.20	.79	19.2	1.19	37.0
.40	6.46	.80	19.6	1.20	37.5
.41	6.72	.81	20.0	1.21	38.0
.42	6.98	.82	20.4	1.22	38.5
.43	7.25	.83	20.8	1.23	39.0
.44	7.52	.84	21.2	1.24	39.5
.45	7.80	.85	21.6	1.25	40.0
.46	8.08	.86	22.0	1.26	40.5
.47	8.36	.87	22.4	1.27	41.1
.48	8.65	.88	22.8	1.28	41.6
.49	8.94	.89	23.2	1.29	42.1
.50	9.23	.90	23.7	1.30	42.6
.51	9.53	.91	24.1	1.31	43.1
.52	9.83	.92	24.5	1.32	43.7
.53	10.1	.93	24.9	1.33	44.2
.54	10.4	.94	25.4	1.34	44.7
.55	10.8	.95	25.8	1.35	45.3
.56	11.1	.96	26.2	1.36	45.8
.57	11.4	.97	26.7	1.37	46.3
.58	11.7	.98	27.1	1.38	46.9
.59	12.0	.99	27.6	1.39	47.4

7 foot wide Parshall flume (continued)

Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)
1.40	48.0	1.80	71.8	2.20	98.9
1.41	48.5	1.81	72.4	2.21	99.7
1.42	49.1	1.82	73.0	2.22	100.
1.43	49.6	1.83	73.7	2.23	101.
1.44	50.2	1.84	74.3	2.24	102.
1.45	50.8	1.85	75.0	2.25	103.
1.46	51.3	1.86	75.6	2.26	103.
1.47	51.9	1.87	76.3	2.27	104.
1.48	52.4	1.88	76.9	2.28	105.
1.49	53.0	1.89	77.6	2.29	105.
1.50	53.6	1.90	78.2	2.30	106.
1.51	54.2	1.91	78.9	2.31	107.
1.52	54.7	1.92	79.6	2.32	108.
1.53	55.3	1.93	80.2	2.33	108.
1.54	55.9	1.94	80.9	2.34	109.
1.55	56.5	1.95	81.6	2.35	110.
1.56	57.1	1.96	82.2	2.36	111.
1.57	57.6	1.97	82.9	2.37	111.
1.58	58.2	1.98	83.6	2.38	112.
1.59	58.8	1.99	84.3	2.39	113.
1.60	59.4	2.00	84.9	2.40	114.
1.61	60.0	2.01	85.6	2.41	114.
1.62	60.6	2.02	86.3	2.42	115.
1.63	61.2	2.03	87.0	2.43	116.
1.64	61.8	2.04	87.7	2.44	117.
1.65	62.4	2.05	88.4	2.45	118.
1.66	63.0	2.06	89.1	2.46	118.
1.67	63.6	2.07	89.7	2.47	119.
1.68	64.3	2.08	90.4	2.48	120.
1.69	64.9	2.09	91.1	2.49	121.
1.70	65.5	2.10	91.8	2.50	121.
1.71	66.1	2.11	92.5		
1.72	66.7	2.12	93.2		
1.73	67.3	2.13	93.9		
1.74	68.0	2.14	94.7		
1.75	68.6	2.15	95.4		
1.76	69.2	2.16	96.1		
1.77	69.8	2.17	96.8		
1.78	70.5	2.18	97.5		
1.79	71.1	2.19	98.2		

8 foot wide Parshall flume

Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)
0.20	2.41	0.60	14.1	1.00	32.0
.21	2.61	.61	14.5	1.01	32.5
.22	2.81	.62	14.8	1.02	33.0
.23	3.02	.63	15.2	1.03	33.6
.24	3.23	.64	15.6	1.04	34.1
.25	3.45	.65	16.0	1.05	34.6
.26	3.68	.66	16.4	1.06	35.1
.27	3.90	.67	16.8	1.07	35.7
.28	4.14	.68	17.2	1.08	36.2
.29	4.38	.69	17.6	1.09	36.8
.30	4.63	.70	18.0	1.10	37.3
.31	4.88	.71	18.5	1.11	37.8
.32	5.13	.72	18.9	1.12	38.4
.33	5.39	.73	19.3	1.13	38.9
.34	5.66	.74	19.7	1.14	39.5
.35	5.92	.75	20.2	1.15	40.1
.36	6.20	.76	20.6	1.16	40.6
.37	6.48	.77	21.0	1.17	41.2
.38	6.76	.78	21.5	1.18	41.7
.39	7.05	.79	21.9	1.19	42.3
.40	7.34	.80	22.4	1.20	42.9
.41	7.64	.81	22.8	1.21	43.5
.42	7.94	.82	23.3	1.22	44.0
.43	8.25	.83	23.7	1.23	44.6
.44	8.56	.84	24.2	1.24	45.2
.45	8.87	.85	24.6	1.25	45.8
.46	9.19	.86	25.1	1.26	46.4
.47	9.51	.87	25.6	1.27	47.0
.48	9.84	.88	26.1	1.28	47.6
.49	10.2	.89	26.5	1.29	48.2
.50	10.5	.90	27.0	1.30	48.8
.51	10.8	.91	27.5	1.31	49.4
.52	11.2	.92	28.0	1.32	50.0
.53	11.5	.93	28.5	1.33	50.6
.54	11.9	.94	29.0	1.34	51.2
.55	12.2	.95	29.5	1.35	51.8
.56	12.6	.96	30.0	1.36	52.4
.57	13.0	.97	30.5	1.37	53.1
.58	13.3	.98	31.0	1.38	53.7
.59	13.7	.99	31.5	1.39	54.3

8 foot wide Parshall flume (continued)

Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)
1.40	54.9	1.80	82.3	2.20	114.
1.41	55.6	1.81	83.0	2.21	114.
1.42	56.2	1.82	83.7	2.22	115.
1.43	56.8	1.83	84.5	2.23	116.
1.44	57.5	1.84	85.2	2.24	117.
1.45	58.1	1.85	86.0	2.25	118.
1.46	58.8	1.86	86.7	2.26	119.
1.47	59.4	1.87	87.5	2.27	119.
1.48	60.1	1.88	88.2	2.28	120.
1.49	60.7	1.89	89.0	2.29	121.
1.50	61.4	1.90	89.7	2.30	122.
1.51	62.0	1.91	90.5	2.31	123.
1.52	62.7	1.92	91.3	2.32	124.
1.53	63.4	1.93	92.0	2.33	125.
1.54	64.0	1.94	92.8	2.34	125.
1.55	64.7	1.95	93.6	2.35	126.
1.56	65.4	1.96	94.3	2.36	127.
1.57	66.1	1.97	95.1	2.37	128.
1.58	66.7	1.98	95.9	2.38	129.
1.59	67.4	1.99	96.7	2.39	130.
1.60	68.1	2.00	97.4	2.40	131.
1.61	68.8	2.01	98.2	2.41	131.
1.62	69.5	2.02	99.0	2.42	132.
1.63	70.2	2.03	99.8	2.43	133.
1.64	70.8	2.04	101.	2.44	134.
1.65	71.5	2.05	101.	2.45	135.
1.66	72.2	2.06	102.	2.46	136.
1.67	72.9	2.07	103.	2.47	137.
1.68	73.6	2.08	104.	2.48	138.
1.69	74.3	2.09	105.	2.49	139.
1.70	75.1	2.10	105.	2.50	139.
1.71	75.8	2.11	106.		
1.72	76.5	2.12	107.		
1.73	77.2	2.13	108.		
1.74	77.9	2.14	109.		
1.75	78.6	2.15	109.		
1.76	79.4	2.16	110.		
1.77	80.1	2.17	111.		
1.78	80.8	2.18	112.		
1.79	81.5	2.19	113.		

10 foot wide Parshall flume

Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)
0.20	3.00	1.00	39.4	1.80	101.
.22	3.49	1.02	40.6	1.82	103.
.24	4.01	1.04	41.9	1.84	104.
.26	4.56	1.06	43.2	1.86	106.
.28	5.14	1.08	44.5	1.88	108.
.30	5.74	1.10	45.9	1.90	110.
.32	6.36	1.12	47.2	1.92	112.
.34	7.01	1.14	48.6	1.94	114.
.36	7.68	1.16	49.9	1.96	116.
.38	8.37	1.18	51.3	1.98	117.
.40	9.09	1.20	52.7	2.00	119.
.42	9.83	1.22	54.1	2.02	121.
.44	10.6	1.24	55.6	2.04	123.
.46	11.4	1.26	57.0	2.06	125.
.48	12.2	1.28	58.5	2.08	127.
.50	13.0	1.30	59.9	2.10	129.
.52	13.8	1.32	61.4	2.12	131.
.54	14.7	1.34	62.9	2.14	133.
.56	15.6	1.36	64.4	2.16	135.
.58	16.5	1.38	65.9	2.18	137.
.60	17.4	1.40	67.5	2.20	139.
.62	18.3	1.42	69.0	2.22	141.
.64	19.3	1.44	70.6	2.24	143.
.66	20.3	1.46	72.2	2.26	145.
.68	21.2	1.48	73.7	2.28	147.
.70	22.3	1.50	75.3	2.30	149.
.72	23.3	1.52	77.0	2.32	151.
.74	24.3	1.54	78.6	2.34	153.
.76	25.4	1.56	80.2	2.36	156.
.78	26.5	1.58	81.9	2.38	158.
.80	27.6	1.60	83.5	2.40	160.
.82	28.7	1.62	85.2	2.42	162.
.84	29.8	1.64	86.9	2.44	164.
.86	30.9	1.66	88.6	2.46	166.
.88	32.1	1.68	90.3	2.48	168.
.90	33.3	1.70	92.0	2.50	171.
.92	34.5	1.72	93.8	2.52	173.
.94	35.7	1.74	95.5	2.54	175.
.96	36.9	1.76	97.3	2.56	177.
.98	38.1	1.78	99.1	2.58	179.

10 foot wide Parshall flume (continued)

Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)
2.60	182.	3.40	279.	4.20	391.
2.62	184.	3.42	282.	4.22	394.
2.64	186.	3.44	284.	4.24	397.
2.66	188.	3.46	287.	4.26	400.
2.68	191.	3.48	290.	4.28	403.
2.70	193.	3.50	292.	4.30	406.
2.72	195.	3.52	295.	4.32	409.
2.74	198.	3.54	298.	4.34	412.
2.76	200.	3.56	300.	4.36	415.
2.78	202.	3.58	303.	4.38	418.
2.80	205.	3.60	306.	4.40	422.
2.82	207.	3.62	308.	4.42	425.
2.84	209.	3.64	311.	4.44	428.
2.86	212.	3.66	314.	4.46	431.
2.88	214.	3.68	317.	4.48	434.
2.90	216.	3.70	319.	4.50	437.
2.92	219.	3.72	322.	4.52	440.
2.94	221.	3.74	325.	4.54	443.
2.96	224.	3.76	328.	4.56	446.
2.98	226.	3.78	331.	4.58	449.
3.00	228.	3.80	333.	4.60	453.
3.02	231.	3.82	336.	4.62	456.
3.04	233.	3.84	339.	4.64	459.
3.06	236.	3.86	342.	4.66	462.
3.08	238.	3.88	345.	4.68	465.
3.10	241.	3.90	348.	4.70	468.
3.12	243.	3.92	350.	4.72	472.
3.14	246.	3.94	353.	4.74	475.
3.16	248.	3.96	356.	4.76	478.
3.18	251.	3.98	359.	4.78	481.
3.20	253.	4.00	362.	4.80	484.
3.22	256.	4.02	365.	4.82	488.
3.24	258.	4.04	368.	4.84	491.
3.26	261.	4.06	371.	4.86	494.
3.28	263.	4.08	374.	4.88	497.
3.30	266.	4.10	376.	4.90	501.
3.32	269.	4.12	379.	4.92	504.
3.34	271.	4.14	382.	4.94	507.
3.36	274.	4.16	385.	4.96	511.
3.38	276.	4.18	388.	4.98	514.
				5.00	517.

12 foot wide Parshall flume

Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)
0.20	3.56	1.00	46.8	1.80	120.
.22	4.15	1.02	48.3	1.82	122.
.24	4.77	1.04	49.8	1.84	124.
.26	5.42	1.06	51.3	1.86	126.
.28	6.10	1.08	52.9	1.88	128.
.30	6.81	1.10	54.5	1.90	131.
.32	7.55	1.12	56.0	1.92	133.
.34	8.32	1.14	57.7	1.94	135.
.36	9.12	1.16	59.3	1.96	137.
.38	9.94	1.18	60.9	1.98	139.
.40	10.8	1.20	62.6	2.00	142.
.42	11.7	1.22	64.3	2.02	144.
.44	12.6	1.24	66.0	2.04	146.
.46	13.5	1.26	67.7	2.06	149.
.48	14.4	1.28	69.4	2.08	151.
.50	15.4	1.30	71.1	2.10	153.
.52	16.4	1.32	72.9	2.12	156.
.54	17.4	1.34	74.7	2.14	158.
.56	18.5	1.36	76.5	2.16	160.
.58	19.6	1.38	78.3	2.18	163.
.60	20.6	1.40	80.1	2.20	165.
.62	21.8	1.42	81.9	2.22	167.
.64	22.9	1.44	83.8	2.24	170.
.66	24.0	1.46	85.7	2.26	172.
.68	25.2	1.48	87.5	2.28	175.
.70	26.4	1.50	89.4	2.30	177.
.72	27.6	1.52	91.4	2.32	180.
.74	28.9	1.54	93.3	2.34	182.
.76	30.1	1.56	95.2	2.36	185.
.78	31.4	1.58	97.2	2.38	187.
.80	32.7	1.60	99.2	2.40	190.
.82	34.0	1.62	101.	2.42	192.
.84	35.4	1.64	103.	2.44	195.
.86	36.7	1.66	105.	2.46	197.
.88	38.1	1.68	107.	2.48	200.
.90	39.5	1.70	109.	2.50	203.
.92	40.9	1.72	111.	2.52	205.
.94	42.3	1.74	113.	2.54	208.
.96	43.8	1.76	116.	2.56	210.
.98	45.3	1.78	118.	2.58	213.

12 foot wide Parshall flume (continued)

Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)
2.60	216.	3.40	331.	4.20	464.
2.62	218.	3.42	334.	4.22	468.
2.64	221.	3.44	338.	4.24	472.
2.66	224.	3.46	341.	4.26	475.
2.68	226.	3.48	344.	4.28	479.
2.70	229.	3.50	347.	4.30	482.
2.72	232.	3.52	350.	4.32	486.
2.74	235.	3.54	353.	4.34	490.
2.76	237.	3.56	357.	4.36	493.
2.78	240.	3.58	360.	4.38	497.
2.80	243.	3.60	363.	4.40	500.
2.82	246.	3.62	366.	4.42	504.
2.84	248.	3.64	369.	4.44	508.
2.86	251.	3.66	373.	4.46	511.
2.88	254.	3.68	376.	4.48	515.
2.90	257.	3.70	379.	4.50	519.
2.92	260.	3.72	383.	4.52	522.
2.94	263.	3.74	386.	4.54	526.
2.96	265.	3.76	389.	4.56	530.
2.98	268.	3.78	392.	4.58	534.
3.00	271.	3.80	396.	4.60	537.
3.02	274.	3.82	399.	4.62	541.
3.04	277.	3.84	402.	4.64	545.
3.06	280.	3.86	406.	4.66	549.
3.08	283.	3.88	409.	4.68	552.
3.10	286.	3.90	413.	4.70	556.
3.12	289.	3.92	416.	4.72	560.
3.14	292.	3.94	419.	4.74	564.
3.16	295.	3.96	423.	4.76	567.
3.18	298.	3.98	426.	4.78	571.
3.20	301.	4.00	430.	4.80	575.
3.22	304.	4.02	433.	4.82	579.
3.24	307.	4.04	437.	4.84	583.
3.26	310.	4.06	440.	4.86	587.
3.28	313.	4.08	443.	4.88	591.
3.30	316.	4.10	447.	4.90	594.
3.32	319.	4.12	450.	4.92	598.
3.34	322.	4.14	454.	4.94	602.
3.36	325.	4.16	457.	4.96	606.
3.38	328.	4.18	461.	4.98	610.
				5.00	614.

15 foot wide Parshall flume

Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)
0.20	4.40	1.20	77.4	2.20	204.
.22	5.13	1.22	79.5	2.22	207.
.24	5.89	1.24	81.6	2.24	210.
.26	6.70	1.26	83.7	2.26	213.
.28	7.54	1.28	85.8	2.28	216.
.30	8.42	1.30	88.0	2.30	219.
.32	9.34	1.32	90.1	2.32	222.
.34	10.3	1.34	92.3	2.34	225.
.36	11.3	1.36	94.6	2.36	228.
.38	12.3	1.38	96.8	2.38	231.
.40	13.3	1.40	99.0	2.40	235.
.42	14.4	1.42	101.	2.42	238.
.44	15.5	1.44	104.	2.44	241.
.46	16.7	1.46	106.	2.46	244.
.48	17.9	1.48	108.	2.48	247.
.50	19.1	1.50	111.	2.50	250.
.52	20.3	1.52	113.	2.52	254.
.54	21.6	1.54	115.	2.54	257.
.56	22.9	1.56	118.	2.56	260.
.58	24.2	1.58	120.	2.58	263.
.60	25.5	1.60	123.	2.60	267.
.62	26.9	1.62	125.	2.62	270.
.64	28.3	1.64	128.	2.64	273.
.66	29.7	1.66	130.	2.66	277.
.68	31.2	1.68	133.	2.68	280.
.70	32.7	1.70	135.	2.70	283.
.72	34.2	1.72	138.	2.72	287.
.74	35.7	1.74	140.	2.74	290.
.76	37.3	1.76	143.	2.76	293.
.78	38.8	1.78	145.	2.78	297.
.80	40.5	1.80	148.	2.80	300.
.82	42.1	1.82	151.	2.82	304.
.84	43.7	1.84	153.	2.84	307.
.86	45.4	1.86	156.	2.86	311.
.88	47.1	1.88	159.	2.88	314.
.90	48.8	1.90	161.	2.90	318.
.92	50.6	1.92	164.	2.92	321.
.94	52.4	1.94	167.	2.94	325.
.96	54.2	1.96	170.	2.96	328.
.98	56.0	1.98	172.	2.98	332.
1.00	57.8	2.00	175.	3.00	335.
1.02	59.7	2.02	178.	3.02	339.
1.04	61.6	2.04	181.	3.04	342.
1.06	63.5	2.06	184.	3.06	346.
1.08	65.4	2.08	187.	3.08	350.
1.10	67.3	2.10	189.	3.10	353.
1.12	69.3	2.12	192.	3.12	357.
1.14	71.3	2.14	195.	3.14	361.
1.16	73.3	2.16	198.	3.16	364.
1.18	75.3	2.18	201.	3.18	368.

15 foot wide Parshall flume (continued)

Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)
3.20	372.	4.20	574.	5.20	808.
3.22	375.	4.22	579.	5.22	813.
3.24	379.	4.24	583.	5.24	818.
3.26	383.	4.26	588.	5.26	823.
3.28	387.	4.28	592.	5.28	828.
3.30	391.	4.30	596.	5.30	833.
3.32	394.	4.32	601.	5.32	838.
3.34	398.	4.34	605.	5.34	843.
3.36	402.	4.36	610.	5.36	849.
3.38	406.	4.38	614.	5.38	854.
3.40	410.	4.40	619.	5.40	859.
3.42	413.	4.42	623.	5.42	864.
3.44	417.	4.44	628.	5.44	869.
3.46	421.	4.46	632.	5.46	874.
3.48	425.	4.48	637.	5.48	879.
3.50	429.	4.50	641.	5.50	884.
3.52	433.	4.52	646.	5.52	889.
3.54	437.	4.54	651.	5.54	895.
3.56	441.	4.56	655.	5.56	900.
3.58	445.	4.58	660.	5.58	905.
3.60	449.	4.60	664.	5.60	910.
3.62	453.	4.62	669.	5.62	915.
3.64	457.	4.64	674.	5.64	921.
3.66	461.	4.66	678.	5.66	926.
3.68	465.	4.68	683.	5.68	931.
3.70	469.	4.70	688.	5.70	936.
3.72	473.	4.72	692.	5.72	942.
3.74	477.	4.74	697.	5.74	947.
3.76	481.	4.76	702.	5.76	952.
3.78	485.	4.78	706.	5.78	957.
3.80	489.	4.80	711.	5.80	963.
3.82	494.	4.82	716.	5.82	968.
3.84	498.	4.84	721.	5.84	973.
3.86	502.	4.86	725.	5.86	979.
3.88	506.	4.88	730.	5.88	984.
3.90	510.	4.90	735.	5.90	989.
3.92	514.	4.92	740.	5.92	995.
3.94	519.	4.94	745.	5.94	1000.
3.96	523.	4.96	750.	5.96	1006.
3.98	527.	4.98	754.	5.98	1011.
4.00	531.	5.00	759.	6.00	1016.
4.02	536.	5.02	764.		
4.04	540.	5.04	769.		
4.06	544.	5.06	774.		
4.08	548.	5.08	779.		
4.10	553.	5.10	784.		
4.12	557.	5.12	789.		
4.14	561.	5.14	793.		
4.16	566.	5.16	798.		
4.18	570.	5.18	803.		

2 ft wide x 6 ft long cutthroat flume

Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)
0.20	0.58	0.70	4.08	1.20	9.46
.21	.62	.71	4.17	1.21	9.59
.22	.67	.72	4.26	1.22	9.71
.23	.72	.73	4.36	1.23	9.83
.24	.77	.74	4.45	1.24	9.96
.25	.82	.75	4.55	1.25	10.1
.26	.87	.76	4.64	1.26	10.2
.27	.92	.77	4.74	1.27	10.3
.28	.98	.78	4.83	1.28	10.5
.29	1.03	.79	4.93	1.29	10.6
.30	1.09	.80	5.03	1.30	10.7
.31	1.15	.81	5.13	1.31	10.8
.32	1.20	.82	5.22	1.32	11.0
.33	1.26	.83	5.32	1.33	11.1
.34	1.32	.84	5.42	1.34	11.2
.35	1.38	.85	5.53	1.35	11.4
.36	1.45	.86	5.63	1.36	11.5
.37	1.51	.87	5.73	1.37	11.6
.38	1.57	.88	5.83	1.38	11.8
.39	1.64	.89	5.94	1.39	11.9
.40	1.70	.90	6.04	1.40	12.0
.41	1.77	.91	6.15	1.41	12.2
.42	1.84	.92	6.25	1.42	12.3
.43	1.91	.93	6.36	1.43	12.4
.44	1.98	.94	6.46	1.44	12.6
.45	2.05	.95	6.57	1.45	12.7
.46	2.12	.96	6.68	1.46	12.8
.47	2.19	.97	6.79	1.47	13.0
.48	2.27	.98	6.90	1.48	13.1
.49	2.34	.99	7.01	1.49	13.3
.50	2.41	1.00	7.12	1.50	13.4
.51	2.49	1.01	7.23	1.51	13.5
.52	2.57	1.02	7.34	1.52	13.7
.53	2.64	1.03	7.46	1.53	13.8
.54	2.72	1.04	7.57	1.54	14.0
.55	2.80	1.05	7.68	1.55	14.1
.56	2.88	1.06	7.80	1.56	14.2
.57	2.96	1.07	7.91	1.57	14.4
.58	3.04	1.08	8.03	1.58	14.5
.59	3.13	1.09	8.14	1.59	14.7
.60	3.21	1.10	8.26	1.60	14.8
.61	3.29	1.11	8.38	1.61	15.0
.62	3.38	1.12	8.50	1.62	15.1
.63	3.46	1.13	8.62	1.63	15.3
.64	3.55	1.14	8.73	1.64	15.4
.65	3.64	1.15	8.85	1.65	15.6
.66	3.72	1.16	8.97	1.66	15.7
.67	3.81	1.17	9.10	1.67	15.8
.68	3.90	1.18	9.22	1.68	16.0
.69	3.99	1.19	9.34	1.69	16.1

2 ft wide x 6 ft long cutthroat flume (continued)

Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)
1.70	16.3	2.20	24.4	2.70	33.5
1.71	16.4	2.21	24.5	2.71	33.7
1.72	16.6	2.22	24.7	2.72	33.9
1.73	16.7	2.23	24.9	2.73	34.1
1.74	16.9	2.24	25.1	2.74	34.3
1.75	17.0	2.25	25.2	2.75	34.5
1.76	17.2	2.26	25.4	2.76	34.7
1.77	17.4	2.27	25.6	2.77	34.9
1.78	17.5	2.28	25.8	2.78	35.1
1.79	17.7	2.29	25.9	2.79	35.3
1.80	17.8	2.30	26.1	2.80	35.5
1.81	18.0	2.31	26.3	2.81	35.7
1.82	18.1	2.32	26.5	2.82	35.9
1.83	18.3	2.33	26.6	2.83	36.1
1.84	18.4	2.34	26.8	2.84	36.3
1.85	18.6	2.35	27.0	2.85	36.5
1.86	18.7	2.36	27.2	2.86	36.7
1.87	18.9	2.37	27.4	2.87	36.9
1.88	19.1	2.38	27.5	2.88	37.1
1.89	19.2	2.39	27.7	2.89	37.3
1.90	19.4	2.40	27.9	2.90	37.5
1.91	19.5	2.41	28.1	2.91	37.7
1.92	19.7	2.42	28.3	2.92	37.9
1.93	19.9	2.43	28.4	2.93	38.1
1.94	20.0	2.44	28.6	2.94	38.3
1.95	20.2	2.45	28.8	2.95	38.5
1.96	20.3	2.46	29.0	2.96	38.7
1.97	20.5	2.47	29.2	2.97	38.9
1.98	20.7	2.48	29.4	2.98	39.1
1.99	20.8	2.49	29.5	2.99	39.3
2.00	21.0	2.50	29.7	3.00	39.5
2.01	21.2	2.51	29.9		
2.02	21.3	2.52	30.1		
2.03	21.5	2.53	30.3		
2.04	21.7	2.54	30.5		
2.05	21.8	2.55	30.7		
2.06	22.0	2.56	30.9		
2.07	22.2	2.57	31.0		
2.08	22.3	2.58	31.2		
2.09	22.5	2.59	31.4		
2.10	22.7	2.60	31.6		
2.11	22.8	2.61	31.8		
2.12	23.0	2.62	32.0		
2.13	23.2	2.63	32.2		
2.14	23.3	2.64	32.4		
2.15	23.5	2.65	32.6		
2.16	23.7	2.66	32.8		
2.17	23.8	2.67	32.9		
2.18	24.0	2.68	33.1		
2.19	24.2	2.69	33.3		

3 ft wide x 9 ft long cutthroat flume

Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)
0.20	0.88	0.70	6.19	1.20	14.3
.21	.95	.71	6.32	1.21	14.5
.22	1.02	.72	6.46	1.22	14.7
.23	1.09	.73	6.60	1.23	14.9
.24	1.16	.74	6.75	1.24	15.1
.25	1.24	.75	6.89	1.25	15.3
.26	1.32	.76	7.03	1.26	15.5
.27	1.40	.77	7.18	1.27	15.7
.28	1.48	.78	7.32	1.28	15.9
.29	1.56	.79	7.47	1.29	16.1
.30	1.65	.80	7.62	1.30	16.2
.31	1.74	.81	7.77	1.31	16.4
.32	1.82	.82	7.92	1.32	16.6
.33	1.91	.83	8.07	1.33	16.8
.34	2.01	.84	8.22	1.34	17.0
.35	2.10	.85	8.37	1.35	17.2
.36	2.19	.86	8.53	1.36	17.4
.37	2.29	.87	8.68	1.37	17.6
.38	2.38	.88	8.84	1.38	17.8
.39	2.48	.89	9.00	1.39	18.0
.40	2.58	.90	9.15	1.40	18.2
.41	2.69	.91	9.31	1.41	18.4
.42	2.79	.92	9.47	1.42	18.6
.43	2.89	.93	9.64	1.43	18.9
.44	3.00	.94	9.80	1.44	19.1
.45	3.10	.95	9.96	1.45	19.3
.46	3.21	.96	10.1	1.46	19.5
.47	3.32	.97	10.3	1.47	19.7
.48	3.43	.98	10.5	1.48	19.9
.49	3.55	.99	10.6	1.49	20.1
.50	3.66	1.00	10.8	1.50	20.3
.51	3.77	1.01	11.0	1.51	20.5
.52	3.89	1.02	11.1	1.52	20.7
.53	4.01	1.03	11.3	1.53	20.9
.54	4.13	1.04	11.5	1.54	21.2
.55	4.25	1.05	11.6	1.55	21.4
.56	4.37	1.06	11.8	1.56	21.6
.57	4.49	1.07	12.0	1.57	21.8
.58	4.61	1.08	12.2	1.58	22.0
.59	4.74	1.09	12.3	1.59	22.2
.60	4.86	1.10	12.5	1.60	22.5
.61	4.99	1.11	12.7	1.61	22.7
.62	5.12	1.12	12.9	1.62	22.9
.63	5.25	1.13	13.1	1.63	23.1
.64	5.38	1.14	13.2	1.64	23.3
.65	5.51	1.15	13.4	1.65	23.6
.66	5.64	1.16	13.6	1.66	23.8
.67	5.78	1.17	13.8	1.67	24.0
.68	5.91	1.18	14.0	1.68	24.2
.69	6.05	1.19	14.2	1.69	24.5

3 ft wide x 9 ft long cutthroat flume (continued)

Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)	Head at staff gage (feet)	Discharge (CFS)
1.70	24.7	2.20	36.9	2.70	50.8
1.71	24.9	2.21	37.2	2.71	51.1
1.72	25.1	2.22	37.4	2.72	51.4
1.73	25.4	2.23	37.7	2.73	51.7
1.74	25.6	2.24	38.0	2.74	52.0
1.75	25.8	2.25	38.2	2.75	52.3
1.76	26.1	2.26	38.5	2.76	52.6
1.77	26.3	2.27	38.8	2.77	52.9
1.78	26.5	2.28	39.0	2.78	53.2
1.79	26.8	2.29	39.3	2.79	53.5
1.80	27.0	2.30	39.6	2.80	53.8
1.81	27.2	2.31	39.8	2.81	54.1
1.82	27.5	2.32	40.1	2.82	54.4
1.83	27.7	2.33	40.4	2.83	54.7
1.84	27.9	2.34	40.6	2.84	55.0
1.85	28.2	2.35	40.9	2.85	55.3
1.86	28.4	2.36	41.2	2.86	55.6
1.87	28.6	2.37	41.5	2.87	55.9
1.88	28.9	2.38	41.7	2.88	56.2
1.89	29.1	2.39	42.0	2.89	56.5
1.90	29.4	2.40	42.3	2.90	56.8
1.91	29.6	2.41	42.6	2.91	57.1
1.92	29.9	2.42	42.8	2.92	57.4
1.93	30.1	2.43	43.1	2.93	57.7
1.94	30.3	2.44	43.4	2.94	58.0
1.95	30.6	2.45	43.7	2.95	58.3
1.96	30.8	2.46	43.9	2.96	58.6
1.97	31.1	2.47	44.2	2.97	59.0
1.98	31.3	2.48	44.5	2.98	59.3
1.99	31.6	2.49	44.8	2.99	59.6
2.00	31.8	2.50	45.1	3.00	59.9
2.01	32.1	2.51	45.3		
2.02	32.3	2.52	45.6		
2.03	32.6	2.53	45.9		
2.04	32.8	2.54	46.2		
2.05	33.1	2.55	46.5		
2.06	33.3	2.56	46.8		
2.07	33.6	2.57	47.0		
2.08	33.8	2.58	47.3		
2.09	34.1	2.59	47.6		
2.10	34.3	2.60	47.9		
2.11	34.6	2.61	48.2		
2.12	34.8	2.62	48.5		
2.13	35.1	2.63	48.8		
2.14	35.4	2.64	49.1		
2.15	35.6	2.65	49.3		
2.16	35.9	2.66	49.6		
2.17	36.1	2.67	49.9		
2.18	36.4	2.68	50.2		
2.19	36.7	2.69	50.5		

Fully-contracted standard submerged rectangular orifice

head Δh in feet	Cross-sectional area of orifice, square feet							
	0.25	**0.50**	**0.75**	**1.00**	**1.25**	**1.50**	**1.75**	**2.00**
0.01	0.122	0.245	0.367	0.490	0.612	0.734	0.857	0.979
.02	.173	.346	.519	.692	.865	1.04	1.21	1.38
.03	.212	.424	.636	.848	1.06	1.27	1.48	1.70
.04	.245	.490	.734	.979	1.22	1.47	1.71	1.96
.05	.274	.547	.821	1.09	1.37	1.64	1.92	2.19
.06	.300	.600	.899	1.20	1.50	1.80	2.10	2.40
.07	.324	.648	.971	1.30	1.62	1.94	2.27	2.59
.08	.346	.692	1.04	1.38	1.73	2.08	2.42	2.77
.09	.367	.734	1.10	1.47	1.84	2.20	2.57	2.94
.10	.387	.774	1.16	1.55	1.94	2.32	2.71	3.10
.11	.406	.812	1.22	1.62	2.03	2.44	2.84	3.25
.12	.424	.848	1.27	1.70	2.12	2.54	2.97	3.39
.13	.441	.882	1.32	1.76	2.21	2.65	3.09	3.53
.14	.458	.916	1.37	1.83	2.29	2.75	3.21	3.66
.15	.474	.948	1.42	1.90	2.37	2.84	3.32	3.79
.16	.490	.979	1.47	1.96	2.45	2.94	3.43	3.92
.17	.505	1.01	1.51	2.02	2.52	3.03	3.53	4.04
.18	.519	1.04	1.56	2.08	2.60	3.12	3.63	4.15
.19	.533	1.07	1.60	2.13	2.67	3.20	3.73	4.27
.20	.547	1.09	1.64	2.19	2.74	3.28	3.83	4.38
.21	.561	1.12	1.68	2.24	2.80	3.36	3.93	4.49
.22	.574	1.15	1.72	2.30	2.87	3.44	4.02	4.59
.23	.587	1.17	1.76	2.35	2.93	3.52	4.11	4.70
.24	.600	1.20	1.80	2.40	3.00	3.60	4.20	4.80
.25	.612	1.22	1.84	2.45	3.06	3.67	4.28	4.90
.26	.624	1.25	1.87	2.50	3.12	3.74	4.37	4.99
.27	.636	1.27	1.91	2.54	3.18	3.82	4.45	5.09
.28	.648	1.30	1.94	2.59	3.24	3.89	4.53	5.18
.29	.659	1.32	1.98	2.64	3.30	3.95	4.61	5.27
.30	.670	1.34	2.01	2.68	3.35	4.02	4.69	5.36
.31	.681	1.36	2.04	2.73	3.41	4.09	4.77	5.45
.32	.692	1.38	2.08	2.77	3.46	4.15	4.85	5.54
.33	.703	1.41	2.11	2.81	3.52	4.22	4.92	5.62
.34	.714	1.43	2.14	2.85	3.57	4.28	5.00	5.71
.35	.724	1.45	2.17	2.90	3.62	4.34	5.07	5.79
.36	.734	1.47	2.20	2.94	3.67	4.41	5.14	5.87
.37	.744	1.49	2.23	2.98	3.72	4.47	5.21	5.96
.38	.754	1.51	2.26	3.02	3.77	4.53	5.28	6.04
.39	.764	1.53	2.29	3.06	3.82	4.59	5.35	6.11
.40	.774	1.55	2.32	3.10	3.87	4.64	5.42	6.19

Fully-contracted standard submerged rectangular orifice (continued)

head Δh in feet	Cross-sectional area of orifice, square feet							
	0.25	**0.50**	**0.75**	**1.00**	**1.25**	**1.50**	**1.75**	**2.00**
0.41	0.784	1.57	2.35	3.13	3.92	4.70	5.49	6.27
.42	.793	1.59	2.38	3.17	3.97	4.76	5.55	6.34
.43	.803	1.61	2.41	3.21	4.01	4.82	5.62	6.42
.44	.812	1.62	2.44	3.25	4.06	4.87	5.68	6.49
.45	.821	1.64	2.46	3.28	4.10	4.93	5.75	6.57
.46	.830	1.66	2.49	3.32	4.15	4.98	5.81	6.64
.47	.839	1.68	2.52	3.36	4.19	5.03	5.87	6.71
.48	.848	1.70	2.54	3.39	4.24	5.09	5.94	6.78
.49	.857	1.71	2.57	3.43	4.28	5.14	6.00	6.85
.50	.865	1.73	2.60	3.46	4.33	5.19	6.06	6.92
.51	.874	1.75	2.62	3.50	4.37	5.24	6.12	6.99
.52	.882	1.76	2.65	3.53	4.41	5.29	6.18	7.06
.53	.891	1.78	2.67	3.56	4.45	5.35	6.24	7.13
.54	.899	1.80	2.70	3.60	4.50	5.40	6.30	7.19
.55	.908	1.82	2.72	3.63	4.54	5.45	6.35	7.26
.56	.916	1.83	2.75	3.66	4.58	5.49	6.41	7.33
.57	.924	1.85	2.77	3.70	4.62	5.54	6.47	7.39
.58	.932	1.86	2.80	3.73	4.66	5.59	6.52	7.46
.59	.940	1.88	2.82	3.76	4.70	5.64	6.58	7.52
.60	.948	1.90	2.84	3.79	4.74	5.69	6.64	7.58
.61	.956	1.91	2.87	3.82	4.78	5.73	6.69	7.65
.62	.964	1.93	2.89	3.85	4.82	5.78	6.75	7.71
.63	.971	1.94	2.91	3.89	4.86	5.83	6.80	7.77
.64	.979	1.96	2.94	3.92	4.90	5.87	6.85	7.83
.65	.987	1.97	2.96	3.95	4.93	5.92	6.91	7.89
.66	.994	1.99	2.98	3.98	4.97	5.97	6.96	7.95
.67	1.00	2.00	3.01	4.01	5.01	6.01	7.01	8.01
.68	1.01	2.02	3.03	4.04	5.05	6.06	7.06	8.07
.69	1.02	2.03	3.05	4.07	5.08	6.10	7.12	8.13
.70	1.02	2.05	3.07	4.10	5.12	6.14	7.17	8.19
.71	1.03	2.06	3.09	4.12	5.16	6.19	7.22	8.25
.72	1.04	2.08	3.12	4.15	5.19	6.23	7.27	8.31
.73	1.05	2.09	3.14	4.18	5.23	6.27	7.32	8.36
.74	1.05	2.11	3.16	4.21	5.26	6.32	7.37	8.42
.75	1.06	2.12	3.18	4.24	5.30	6.36	7.42	8.48
.76	1.07	2.13	3.20	4.27	5.33	6.40	7.47	8.54
.77	1.07	2.15	3.22	4.30	5.37	6.44	7.52	8.59
.78	1.08	2.16	3.24	4.32	5.40	6.49	7.57	8.65
.79	1.09	2.18	3.26	4.35	5.44	6.53	7.61	8.70
.80	1.09	2.19	3.28	4.38	5.47	6.57	7.66	8.76

Submerged rectangular orifice with bottom and side contractions suppressed

head Δh in feet	Cross-sectional area of orifice, square feet							
	0.25	**0.50**	**0.75**	**1.00**	**1.25**	**1.50**	**1.75**	**2.00**
0.01	0.140	0.281	0.421	0.562	0.702	0.843	0.983	1.12
.02	.199	.397	.596	.794	.993	1.19	1.39	1.59
.03	.243	.486	.730	.973	1.22	1.46	1.70	1.95
.04	.281	.562	.843	1.12	1.40	1.69	1.97	2.25
.05	.314	.628	.942	1.26	1.57	1.88	2.20	2.51
.06	.344	.688	1.03	1.38	1.72	2.06	2.41	2.75
.07	.372	.743	1.11	1.49	1.86	2.23	2.60	2.97
.08	.397	.794	1.19	1.59	1.99	2.38	2.78	3.18
.09	.421	.843	1.26	1.69	2.11	2.53	2.95	3.37
.10	.444	.888	1.33	1.78	2.22	2.66	3.11	3.55
.11	.466	.932	1.40	1.86	2.33	2.79	3.26	3.73
.12	.486	.973	1.46	1.95	2.43	2.92	3.41	3.89
.13	.506	1.01	1.52	2.03	2.53	3.04	3.54	4.05
.14	.525	1.05	1.58	2.10	2.63	3.15	3.68	4.20
.15	.544	1.09	1.63	2.18	2.72	3.26	3.81	4.35
.16	.562	1.12	1.69	2.25	2.81	3.37	3.93	4.49
.17	.579	1.16	1.74	2.32	2.90	3.47	4.05	4.63
.18	.596	1.19	1.79	2.38	2.98	3.57	4.17	4.77
.19	.612	1.22	1.84	2.45	3.06	3.67	4.29	4.90
.20	.628	1.26	1.88	2.51	3.14	3.77	4.40	5.02
.21	.644	1.29	1.93	2.57	3.22	3.86	4.50	5.15
.22	.659	1.32	1.98	2.63	3.29	3.95	4.61	5.27
.23	.674	1.35	2.02	2.69	3.37	4.04	4.71	5.39
.24	.688	1.38	2.06	2.75	3.44	4.13	4.82	5.50
.25	.702	1.40	2.11	2.81	3.51	4.21	4.92	5.62
.26	.716	1.43	2.15	2.86	3.58	4.30	5.01	5.73
.27	.730	1.46	2.19	2.92	3.65	4.38	5.11	5.84
.28	.743	1.49	2.23	2.97	3.72	4.46	5.20	5.94
.29	.756	1.51	2.27	3.03	3.78	4.54	5.29	6.05
.30	.769	1.54	2.31	3.08	3.85	4.62	5.38	6.15
.31	.782	1.56	2.35	3.13	3.91	4.69	5.47	6.26
.32	.794	1.59	2.38	3.18	3.97	4.77	5.56	6.36
.33	.807	1.61	2.42	3.23	4.03	4.84	5.65	6.45
.34	.819	1.64	2.46	3.28	4.09	4.91	5.73	6.55
.35	.831	1.66	2.49	3.32	4.15	4.99	5.82	6.65
.36	.843	1.69	2.53	3.37	4.21	5.06	5.90	6.74
.37	.854	1.71	2.56	3.42	4.27	5.13	5.98	6.83
.38	.866	1.73	2.60	3.46	4.33	5.19	6.06	6.93
.39	.877	1.75	2.63	3.51	4.39	5.26	6.14	7.02
.40	.888	1.78	2.66	3.55	4.44	5.33	6.22	7.11

Submerged rectangular orifice with bottom and side contractions suppressed (continued)

head Δh in feet	Cross-sectional area of orifice, square feet							
	0.25	**0.50**	**0.75**	**1.00**	**1.25**	**1.50**	**1.75**	**2.00**
0.41	0.899	1.80	2.70	3.60	4.50	5.40	6.29	7.19
.42	.910	1.82	2.73	3.64	4.55	5.46	6.37	7.28
.43	.921	1.84	2.76	3.68	4.60	5.53	6.45	7.37
.44	.932	1.86	2.79	3.73	4.66	5.59	6.52	7.45
.45	.942	1.88	2.83	3.77	4.71	5.65	6.59	7.54
.46	.952	1.90	2.86	3.81	4.76	5.71	6.67	7.62
.47	.963	1.93	2.89	3.85	4.81	5.78	6.74	7.70
.48	.973	1.95	2.92	3.89	4.86	5.84	6.81	7.78
.49	.983	1.97	2.95	3.93	4.92	5.90	6.88	7.86
.50	.993	1.99	2.98	3.97	4.97	5.96	6.95	7.94
.51	1.00	2.01	3.01	4.01	5.01	6.02	7.02	8.02
.52	1.01	2.03	3.04	4.05	5.06	6.08	7.09	8.10
.53	1.02	2.04	3.07	4.09	5.11	6.13	7.16	8.18
.54	1.03	2.06	3.10	4.13	5.16	6.19	7.22	8.26
.55	1.04	2.08	3.12	4.17	5.21	6.25	7.29	8.33
.56	1.05	2.10	3.15	4.20	5.25	6.31	7.36	8.41
.57	1.06	2.12	3.18	4.24	5.30	6.36	7.42	8.48
.58	1.07	2.14	3.21	4.28	5.35	6.42	7.49	8.56
.59	1.08	2.16	3.24	4.31	5.39	6.47	7.55	8.63
.60	1.09	2.18	3.26	4.35	5.44	6.53	7.61	8.70
.61	1.10	2.19	3.29	4.39	5.48	6.58	7.68	8.77
.62	1.11	2.21	3.32	4.42	5.53	6.63	7.74	8.85
.63	1.11	2.23	3.34	4.46	5.57	6.69	7.80	8.92
.64	1.12	2.25	3.37	4.49	5.62	6.74	7.86	8.99
.65	1.13	2.26	3.40	4.53	5.66	6.79	7.93	9.06
.66	1.14	2.28	3.42	4.56	5.70	6.85	7.99	9.13
.67	1.15	2.30	3.45	4.60	5.75	6.90	8.05	9.20
.68	1.16	2.32	3.47	4.63	5.79	6.95	8.11	9.26
.69	1.17	2.33	3.50	4.67	5.83	7.00	8.17	9.33
.70	1.17	2.35	3.52	4.70	5.87	7.05	8.22	9.40
.71	1.18	2.37	3.55	4.73	5.92	7.10	8.28	9.47
.72	1.19	2.38	3.57	4.77	5.96	7.15	8.34	9.53
.73	1.20	2.40	3.60	4.80	6.00	7.20	8.40	9.60
.74	1.21	2.42	3.62	4.83	6.04	7.25	8.46	9.66
.75	1.22	2.43	3.65	4.86	6.08	7.30	8.51	9.73
.76	1.22	2.45	3.67	4.90	6.12	7.35	8.57	9.79
.77	1.23	2.46	3.70	4.93	6.16	7.39	8.63	9.86
.78	1.24	2.48	3.72	4.96	6.20	7.44	8.68	9.92
.79	1.25	2.50	3.74	4.99	6.24	7.49	8.74	9.99
.80	1.26	2.51	3.77	5.02	6.28	7.54	8.79	10.05

Discharge from Sprinkler Nozzles

These tables provide the flow rate from pressurized sprinkler nozzles in gallons per minute (GPM). Read across the row corresponding to your pipeline pressure until you reach the column matching your sprinkler nozzle size.

Example: If the pipeline pressure is 45 psi and the sprinkler nozzle size is 9/64 inch, the flow rate is 3.99 GPM.

Pressure	Nozzle size (inches)					
(psi)	3/32	7/64	1/8	9/64	5/32	11/64
20	1.17	1.59	2.08	2.64	3.25	3.94
25	1.31	1.78	2.33	2.95	3.64	4.40
30	1.43	1.95	2.55	3.23	3.99	4.82
35	1.55	2.11	2.76	3.49	4.31	5.21
40	1.66	2.26	2.95	3.73	4.60	5.57
45	1.76	2.39	3.12	3.95	4.88	5.91
50	1.85	2.52	3.29	4.17	5.15	6.23
55	1.94	2.64	3.45	4.37	5.40	6.53
60	2.03	2.76	3.61	4.57	5.64	6.82
65	2.11	2.87	3.76	4.75	5.87	7.10
70	2.19	2.98	3.90	4.93	6.09	7.37
75	2.27	3.09	4.03	5.10	6.30	7.63
80	2.34	3.19	4.17	5.27	6.51	7.88
85	2.42	3.29	4.29	5.43	6.71	8.12
90	2.49	3.38	4.42	5.59	6.90	8.35
100	2.62	3.57	4.66	5.89	7.28	8.81
110	2.75	3.74	4.88	6.18	7.63	9.24
120	2.87	3.91	5.10	6.46	7.97	9.65
130	2.99	4.07	5.31	6.72	8.30	10.04

Pressure	Nozzle size (inches)				
(psi)	3/16	13/64	7/32	15/64	1/4
20	4.69	5.50	6.38	7.32	8.33
25	5.24	6.15	7.13	8.19	9.32
30	5.74	6.74	7.81	8.97	10.20
35	6.20	7.28	8.44	9.69	11.02
40	6.63	7.78	9.02	10.36	11.78
45	7.03	8.25	9.57	10.98	12.50
50	7.41	8.70	10.09	11.58	13.17
55	7.77	9.12	10.58	12.14	13.82
60	8.12	9.53	11.05	12.68	14.43
65	8.45	9.92	11.50	13.20	15.02
70	8.77	10.29	11.93	13.70	15.59
75	9.08	10.65	12.35	14.18	16.13
80	9.37	11.00	12.76	14.65	16.66
85	9.66	11.34	13.15	15.10	17.18
90	9.94	11.67	13.53	15.53	17.67
100	10.48	12.30	14.26	16.37	18.63
110	10.99	12.90	14.96	17.17	19.54
120	11.48	13.47	15.63	17.94	20.41
130	11.95	14.02	16.26	18.67	21.24

Application Rates for Wheel-Move Sprinkler Systems

At the intersection of the sprinkler flow rate and the sprinkler spacing, the table below shows the gross application rate in inches per hour.

Example: If sprinkler heads are located in a 30×40 foot grid and each sprinkler provides 5 GPM, then the gross application rate is 0.40 inches per hour.

Average gross application rate (inches/hour)										
Spacing (feet)	Flow rate from each sprinkler (gallons per minute)									
	1	2	3	4	5	6	7	8	9	10
20x20	0.24	0.48	0.72	0.96	1.20	1.44	1.68	1.93	2.17	2.41
20x30	0.16	0.32	0.48	0.64	0.80	0.96	1.12	1.28	1.44	1.60
20x40	0.12	0.24	0.36	0.48	0.60	0.72	0.84	0.96	1.08	1.20
30x30	0.11	0.21	0.32	0.43	0.53	0.64	0.75	0.86	0.96	1.07
30x40	0.08	0.16	0.24	0.32	0.40	0.48	0.56	0.64	0.72	0.80
30x50	0.06	0.13	0.19	0.26	0.32	0.39	0.45	0.51	0.58	0.64
40x40	0.06	0.12	0.18	0.24	0.30	0.36	0.42	0.48	0.54	0.60
40x50	0.05	0.10	0.14	0.19	0.24	0.29	0.34	0.39	0.43	0.48
40x60	0.04	0.08	0.12	0.16	0.20	0.24	0.28	0.32	0.36	0.40

Amount of Water Applied to a Field

At the intersection of the hours and flow rate you will find the total acre-feet applied. Divide the total acre-feet by the number of acres in the field to obtain the depth of water applied in feet. Multiply by 12 to obtain the number of inches applied. This is an average for the entire field; parts of the field will receive more or less depending on the uniformity of your irrigation methods.

Example: A 30 acre field receives 3 cfs for 5 hours. The total water applied is 1.2 acre-feet. The depth of water applied is 1.2/30=0.04 ft, or 0.04×12=0.48 inches.

Acre-Feet Discharged

	Flow Rate, CFS									
Hours	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.7	0.8
2	.2	.3	.5	.7	.8	1.0	1.2	1.3	1.5	1.7
3	.2	.5	.7	1.0	1.2	1.5	1.7	2.0	2.2	2.5
4	.3	.7	1.0	1.3	1.7	2.0	2.3	2.6	3.0	3.3
5	.4	.8	1.2	1.7	2.1	2.5	2.9	3.3	3.7	4.1
6	.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
7	.6	1.2	1.7	2.3	2.9	3.5	4.0	4.6	5.2	5.8
8	.7	1.3	2.0	2.6	3.3	4.0	4.6	5.3	6.0	6.6
9	.7	1.5	2.2	3.0	3.7	4.5	5.2	6.0	6.7	7.4
10	.8	1.7	2.5	3.3	4.1	5.0	5.8	6.6	7.4	8.3
11	.9	1.8	2.7	3.6	4.5	5.5	6.4	7.3	8.2	9.1
12	1.0	2.0	3.0	4.0	5.0	6.0	6.9	7.9	8.9	9.9
13	1.1	2.1	3.2	4.3	5.4	6.4	7.5	8.6	9.7	10.7
14	1.2	2.3	3.5	4.6	5.8	6.9	8.1	9.3	10.4	11.6
15	1.2	2.5	3.7	5.0	6.2	7.4	8.7	9.9	11.2	12.4
16	1.3	2.6	4.0	5.3	6.6	7.9	9.3	10.6	11.9	13.2
17	1.4	2.8	4.2	5.6	7.0	8.4	9.8	11.2	12.6	14.0
18	1.5	3.0	4.5	6.0	7.4	8.9	10.4	11.9	13.4	14.9
19	1.6	3.1	4.7	6.3	7.9	9.4	11.0	12.6	14.1	15.7
20	1.7	3.3	5.0	6.6	8.3	9.9	11.6	13.2	14.9	16.5
21	1.7	3.5	5.2	6.9	8.7	10.4	12.1	13.9	15.6	17.4
22	1.8	3.6	5.5	7.3	9.1	10.9	12.7	14.5	16.4	18.2
23	1.9	3.8	5.7	7.6	9.5	11.4	13.3	15.2	17.1	19.0
24	2.0	4.0	6.0	7.9	9.9	11.9	13.9	15.9	17.9	19.8

Conversions and Rules of Thumb

Conversions	
1 mile	5280 feet
1 foot	12 inches
	0.3048 meters
1 meter	3.2808 feet
1 acre	43560 ft^2
1 square mile	640 acres
1 cubic foot	7.48 gallons
1 ft of water head	0.433 psi
1 psi	2.31 ft of water head
1 cfs (cubic foot per second)	448.8 GPM (gallons per minute)
	0.646 MGD (million gallons per day)
1 MGD	1.548 cfs

Rules of Thumb (Approximate Conversions)	
1 cfs flowing for 24 hours	2 acre-feet
1 ft of pressure head	approx. 0.5 psi
1 psi	approx. 2 ft of head
1 cfs	450 gpm
1 cubic foot	7.5 gallons
15 gallons	2 cubic feet

Utah Bridging-the-Headgate Partnership

This handbook was prepared by the Utah Association of Conservation Districts in coordination with the Utah Bridging-the-Headgate Partnership. Partners include:

Utah Association of Conservation Districts

Utah Water Users Association

U.S. Dept. of the Interior, Bureau of Reclamation

Utah Department of Agriculture & Food

Utah Division of Water Resources

Utah State University Extension

USDA Natural Resources Conservation Service

The Irrigation Association

The Utah Bridging-the-Headgate Partnership was formed in 2000 to coordinate opportunities for members to facilitate and promote agricultural water use efficiency and conservation through planning, training and information dissemination. The partners are committed to working together for sustainable and efficient use of Western agricultural water supplies.


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