Accurate water measurement is essential to maintaining equity of water delivery within an irrigation company or water districts. Good management of our scarce water resource is dependent upon quantifying supplies and uses with accurate measurement techniques. State water rights adjudication and management procedures often require installation of water measurement devices and keeping records of flows. Open channel (canals, rivers or streams, and ditches) devices are the most common form of water measurement in the western U.S., although often flows in closed conduits (pipelines) must be measured. Regular maintenance is an essential and often critical need to ensure continued accurate measurement.

**OPEN CHANNEL**

The most common open channel irrigation water measurement devices are sharp crested weirs and Parshall flumes. Submerged orifices and ramp flumes are also used.

**WEIRS**

Weirs include rectangular (fully contracted, or suppressed), 90° V. Notch, and trapezoidal (or Cipolletti) all of which have a sharp crest at the top edge of a vertical plate set perpendicular to the water flow direction. When weirs are correctly installed with a deep, still pool upstream and properly maintained (i.e., silt and debris cleaned out) accurate measurements are obtained from a single upstream depth reading and the use of standard tables.

**Figure 1. Field installation of rectangular weir.**
Common problems in actual weir installations are insufficient pool upstream (often from sediment accumulation), non-level crest, and the use of 2-inch boards instead of sharp edges for the crest.

**FLUMES**

Parshall (Fig. 2) and other types of flumes have advantages of lower head loss and of passing the sediment on through but are more costly to fabricate and install. Non-level flumes and improper installation (insufficient crest height) are the most common problems. Cutthroat flumes (developed at USU) are simpler to construct than Parshalls and can operate as free flow conditions at a higher degree of submergence. The long-throated ramp flume (also known as a broad-crested-weir) has strong advantages in flat ditches or canals as free flow conditions can be maintained at 90% submergence and above.

![Figure 2. Illustration of fre flow and submerged flow in a Parshall flume. Figure a,b-freeflow; c-transition; and d-submerged.](image1)

![Figure 3. Ramp flume measurement structure for earthen channel with a rectangular control section.](image2)
CLOSED CONDUIT - PIPELINE

In-line propeller or turbine meters and impeller (small paddle wheel) transducer velocity meters are most commonly used to measure pipeline flow rates. Proper installation is critical for each, as is a rigorous maintenance program. Usually, most of the problems can be traced to partially full pipes, debris or chemical deposits and lack of preventative maintenance. While some still have mechanical readout of flow rate and accumulated volume, many are electronically operated.

WATER LEVEL RECORDING DEVICES

Three types of currently available water level recording devices are: mechanical chart recorder with a float; digital (electronic) recorder with mechanical float, and digital recorder with an electronic water level sensor. Electronic recording devices are being used instead of the usual strip chart to provide accurate stage height records with much less manual effort and time in many areas of the Western U.S. Electronic recorders have the advantage of allowing digital data transfer directly to a computer. This greatly simplifies data entry and analysis and allows the use of spreadsheet software for preparing water use reports.

Mechanical chart recorders, with float and pulley, produce a continuous paper graph of water level (or stage) and time. Some can be interfaced to digital recorders in addition to the chart.

Electronic data logging equipment can be interfaced to various types of water level detecting devices and are available from several companies. The most economical is a single input datalogger which connects to a mechanical float and pulley assembly. Water level is sampled at a user specified interval and recorded on a solid state storage module. The data can be retrieved manually in the field with a laptop portable PC or the storage module can be removed and connected to a desktop computer for data transfer.

Electronic water level sensors include pressure transducers and ultrasonic depth sensors. The ultrasonic depth sensors are an accurate non-contact sensor that can be mounted above any liquid surface.

WHERE TO FIND HELP

A list of possible sources of water measurement instrumentation and devices is on page 4 herein. Many suppliers provide on-site assistance with installation and operation. The local NRCS (formerly SCS) office can also be a source of technical assistance. For more information and/or technical assistance with your water measurement needs, contact your county Cooperative Extension Agent or the University Extension Irrigation Specialist.

County Extension offices can obtain pocket booklets (i.e. Wyoming. 583R) with standard tables of stage and discharge for weirs and flumes.

TYPICAL PRICES FOR VARIOUS INSTRUMENTATION AND DEVICES

Prices shown are approximate list prices from recent vendor literature for single unit purchases. Optional accessory configurations may account for considerable price variations.

Current Meters, Flow Meters, and Velocity Meters

* Current Meter with Rod, Price AA type $1300
  Mini (pygmy) $1150
  (add about $1,000 for digital readout)
* Propeller Type Hand held Velocity Meter $700 - $800  
  (Global Flow Probe)

* Magnetic Field Portable Velocity Meter $3500  
  (no moving parts)

* Ultrasonic Flow Meters (portable)  
  Doppler $2000 - $3000 or more  
  Transit Time $4000 - $13,000

**Pipeline**  
* Impeller Transducer Flow Meters with Electronic Readout $600 plus  
  (Grain land, Flow Research, Data Industrial, etc.)

* Venturi shunt meter (10" dia) $650

* In-line propeller or turbine with mechanical readout  
  8" dia flange tube $700 - $1300  
  12" dia flange tube $800 - $1900  
  8" dia saddle $650  
  12" dia saddle $720

**Flumes**  
Parshall, Cutthroat, Trapezoidal, Ramp  
Cost varies considerable depending on whether unit was purchased prefabricated ready to install, preformed (needs assembly prior to installation), or fabricated locally (by self or metal shop, etc.)

* Preformed Galvanized 2' Parshall (needs assembly) $1200

* Prefabricated Fiberglass 4' ramp flume $1600 - $2400 or more  
  (make your own out of concrete or steel for $800 - $1200)

**Water Level Recorders**  
* Mechanical Chart $1300 - $2600 (adds $1400 + for digital output)

*Electronic Sensors:  
  Float and Pulley Assembly $350 - $400  
  Pressure Transducer $500 - $1500+  
  Interface equipment $500 - $1200  
  Accessories

* Dataloggers:  
  single input $500  
  3 sensor input $1100  
  multiple input $1200 - $2500  
  (10-16 sensor)

Note: The use of brand names (shown in italics) is illustrative only and does not imply endorsement.
# Possible Sources of Instrumentation and Equipment

## Water Measurement Flumes:

<table>
<thead>
<tr>
<th>Company</th>
<th>Address</th>
<th>Phone</th>
<th>Phone (800)</th>
<th>FAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTECH CONSTRUCTION</td>
<td>1935 North 900 West, Salt Lake City, UT 84115</td>
<td>(801) 487-7741</td>
<td>(800) 452-1457</td>
<td>(801) 487-4517</td>
</tr>
<tr>
<td>FIBERGLASS STRUCTURE INC.</td>
<td>119 Washington Avenue, Laurel, MT 59044</td>
<td>(406) 628-8208</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HINDE ENGINEERING</td>
<td>P.O. Box 737, Aromas, CA 95004-0737</td>
<td>(408) 726-2644</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PLASTIFAB</td>
<td>P.O. Box 100, Tualatin, OR 97062</td>
<td>(503-692-5460</td>
<td></td>
<td></td>
</tr>
<tr>
<td>POWLUS MANUFACTURING</td>
<td>269 ½ Addison Avenue, West Twin Falls, ID 83301</td>
<td>(208) 734-2060</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WATERWORKS EQUIPMENT</td>
<td>801 West 12th Street, Ogden, UT 84233-5124</td>
<td>(800) 233-5124</td>
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Note: Also check with local sheet metal shops, etc. Adherence to standard dimensions are a must!

## Staff Gages:

<table>
<thead>
<tr>
<th>Company</th>
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<tbody>
<tr>
<td>PORCELAIN ENAMEL FINISHERS, INC.</td>
<td>3221 West 30th Street, Chicago, IL 60623</td>
<td>(312) 247-3221</td>
</tr>
<tr>
<td>FRESNO VALVES &amp; CASTINGS</td>
<td>(Formerly ARMCO) 7736 East Springfield Avenue, Selma, CA 93662</td>
<td>(800) 233-5124</td>
</tr>
<tr>
<td>WATERMAN INDUSTRIES SALES</td>
<td>6466 Supply Way, Boise, ID 83705</td>
<td>(208) 343-5478</td>
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</table>

## Flow/Velocity Meters:

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<tbody>
<tr>
<td>MARSH-MCBIRNEY</td>
<td>4539 Metropolitan Court, Frederick, MD 21701</td>
<td>(800) 368-2723</td>
<td>(310) 874-2172</td>
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</table>

## Water Measurement and Other Instrumentation, Flowmeters and Flumes

<table>
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<tbody>
<tr>
<td>COOL EQUIPMENT COMPANY</td>
<td>353 West 3880 South 3500 South Main, Salt Lake City, UT 84115</td>
<td>(801) 487-7741</td>
<td>(801) 487-4517</td>
<td></td>
</tr>
<tr>
<td>GOBLE, SAMPSON ASSOC., INC.</td>
<td>S3500 South Main Street, Suite 200, Salt Lake City, UT 84115</td>
<td>(801) 268-8790</td>
<td></td>
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</tr>
<tr>
<td>INTERMOUNTAIN ENVIRONMENTAL</td>
<td>601 West 1700 South, Logan, UT 84321</td>
<td>(435) 755-0774</td>
<td>(435) 755-0794</td>
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## Trimmer Engineering

<table>
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<tr>
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<th>Phone (800)</th>
<th>FAX</th>
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</thead>
<tbody>
<tr>
<td>TRIMMER ENGINEERING</td>
<td>800 NW Starker Ave., #34, Corvallis, OR 97330</td>
<td>(503) 754-2819</td>
<td>(503) 754-0301</td>
<td></td>
</tr>
</tbody>
</table>
IRRIGATION AND WATER MEASUREMENT EQUIPMENT:

BULLENS, INC.
1427 North Main
Logan, UT 84321
Phone: (801) 752-7301

HADFIELD SPRINKLER & SUPPLY
50 South 1350 East
Lehi, UT 84043
Phone: (801) 768-3551

HARWARD IRRIGATION SYSTEMS INC.
1350 North Main
Spanish Fork, UT 84663
(800) 451-3201

MAIL ORDER CATALOGS FOR A VARIETY OF INSTRUMENTATION, FLOW METERS, WEATHER INSTRUMENTATION, ETC.:

BEN MEADOWS COMPANY
P.O. Box 80549
Atlanta (Chamblee), GA 30366
Phone: (800) 241-6401

FORESTRY SUPPLIERS, INC.
205 West Rankin Street
P.O. Box 8397
Jackson, MS 39284-8397
Phone: (800) 360-7788

NOVALYNX CORPORATION
P.O. Box 240
Grass Valley, CA 95945-0240
Phone: (916) 477-5226

WATER LEVEL RECORDING DEVICES AND ELECTRONIC DATA LOGGERS:

CAMPBELL SCIENTIFIC, INC.
P.O. Box 551
Logan, UT 84321
Phone: (435) 753-2342

LEUPOLD & STEVENS, INC.
P.O. Box 688
Beaverton, OR 97075-0688
Phone: (503) 656-9171

INTERMOUNTAIN ENVIRONMENTAL
601 W 1700 S
Logan, UT 84321
Phone: (435) 753-7300
FAX: (435) 755-0794

LUNDAHL INSTRUMENTS
4295 South Main
Logan, UT 84321
Phone: (435) 753-7300

Note: The generalized categories of vendors shown herein is not meant to imply any limits in available products or services. Several companies listed are dealers for a variety of instrumentation and devices.

BIBLIOGRAPHY


GLOSSARY - WATER MEASUREMENT TERMS

Acre Foot - A volume equal to one acre uniformly covered by water one foot deep. Equivalent to 12 acre inches. Also equal to 43,560 cubic feet, or about 325,850 gallons.

Acre Inch - A volume equal to one acre uniformly covered by water one inch deep.

CFS - See flowrate.

Continuity Equation - The notion that the same flowrate of water comes out of a system as went in; Qout = Qin, in a steady state. A steady state condition exists when there is no variation with time.

Flowrate - The product of cross-sectional area multiplied by average velocity of water moving through the cross-section, Q = AV. Typically expressed as cubic feet per second (cfs, also called second-feet); Q = ft² x ft per second or ft³/sec.

Head - Depth of water above a reference point or datum, as in, “There is 10.1 feet of head on that pipe.”

Staff Gage - A “ruler” used for measuring water depth or head. Usually, a porcelain coated flat steel strip with graduations marking feet, tenths and hundredths.

qt = ad One of the most important equations in irrigation engineering:

\[ \text{flowrate x time} = \text{area x depth}. \]

In English units: cfs x hour = acre x inch.

Exact equations are:

\[ \frac{q(\text{cfs}) \times \text{Hours}}{1.0083} = \text{Acres} \times \text{Inches} \]

\[ \frac{q(\text{qpm}) \times \text{Hours}}{452.54} = \text{Acres} \times \text{Inches} \]