HISTORIC WADDELL DAM BREACHED (IN 1992)

On the cold, rainy morning of December 4, 1992, Waddell Dam was breached, and a large part of this historic structure sunk below the waves of Lake Pleasant. Although the weather proved to be a deterrent (probably a frigid 50 degrees) for many less hardy souls, representatives from the Phoenix Area Office, Maricopa Water District, Central Arizona Water Conservation District, Arizona Game and Fish Department, Maricopa County Parks and Recreation Department, and even the Coast Guard, braved the elements to witness the breaching of the original dam. Members of the local news media documented this historical event. Why would anyone, especially the Bureau of Reclamation (Reclamation), want to breach a dam as beautiful as Waddell Dam?

Reclamation completed construction of New Waddell Dam, located about 1/2 mile downstream of Waddell Dam, in October 1992. The historic Waddell Dam, constructed in 1927 by private interests, was the largest multiple arch dam in the world. New Waddell Dam was constructed to store Colorado River water delivered by the Hayden-Rhodes Aqueduct (formerly the Granite Reef Aqueduct) under the Central Arizona Project. With New Waddell Dam, the Central Arizona Water Conservation District could perform scheduled maintenance on the canal between Lake Havasu on the Colorado River to the turnout for the reversible Waddell Canal to the new dam while deliveries continued to downstream customers of the district. The dam could also provide flood protection by controlling riverflows into the Phoenix metropolitan area from the Agua Fria. The new reservoir added 6,300 surface acres to Lake Pleasant, tripling the size of the lake and greatly increasing the recreational value of Lake Pleasant Regional Park. Maricopa Water District, the owner of the original Waddell Dam, was provided an outlet to allow diversions into their canal distribution system.

Because the new reservoir's water level may fluctuate as much as 125 feet during a year's operation, the recreation facilities would need to be accessible during both high and low water periods. A new marina was located between the original dam and the new downstream dam. With the top of the original dam being exposed during low water levels, plans were to cut a breach in Waddell Dam to allow boaters to safely travel to the marina and provide storage continuity to the new dam.

First, the old roadway deck, spillway gates, piers, and miscellaneous machinery were removed. Then, a subcontractor, Advanced American Diving Service, Inc., of Oregon was hired to create a breach 224 feet wide and 70 feet deep in the original dam. The breach consisted of cutting through the concrete structure with a diamond-wire saw. Four arch barrels and three buttresses were cut using these methods. A few bolts were installed to hold the large blocks of concrete in place until all the cutting was complete. The bolts were then blasted with demolition charges which allowed the separated sections to fall safely into the lake.

The following photos are courtesy of the Department of the Interior, Bureau of Reclamation, Phoenix Area Office and Arizona Projects Office.

Historic Waddell Dam, constructed in 1927.

New Waddell Dam, completed in 1992, and historic Waddell Dam before the breach.

Blocks of concrete at historic Waddell Dam begin to fall away after cuts to create breach.

Blocks of concrete from historic Waddell Dam sink into Lake Pleasant.

A breach is created in historic Waddell Dam.

USING RECLAMATION'S NEW *WATER MEASUREMENT MANUAL* TO SAVE WATER

By Clifford A. Pugh[1]

Figure 1.—Weir box turnout with Cipolletti Weir.

What is the *Water Measurement Manual*?

The *Water Measurement Manual*, Third Edition, is a reference updating water measurement information previously published by the Bureau of Reclamation. Previous editions date back to 1913. The 1997 edition contains information about several new technologies, including acoustic and electromagnetic flow meters, as well as contributions from the Agricultural Research Service and the Natural Resources Conservation Service.

The new manual places increased emphasis on the use of long-throated flume measurement structures. Ramp flumes are a form of long-throated flume. These structures can be applied in situations where Parshall flumes might have been used in the past, but they are easier to

[1] Technical Specialist, U.S. Bureau of Reclamation, Denver, Colorado.

fabricate and more tolerant of high tailwater conditions. Therefore, they are ideal for installation in existing canal systems, where available head (elevation) may be limited. Long-throated flumes are also preferable because they can be installed within the existing canal section. Information on Parshall flumes has been reduced in the new manual and incorporated into the more general "Flumes" chapter.

New chapters added to the manual are

- Basic Concepts Related to Flowing Water and Measurement
- Selection of Water Measuring Devices
- Measurement Accuracy
- Inspection of Water Measurement Systems
- Acoustic Flow Measurement
- Discharge Measurement Using Tracers

Other chapters with applicable information for farm installations are

- Weirs
- Flumes
- Submerged Orifices
- Special Measurements in Open Channels
- Measurements in Pressure Conduits

Why do we Need to Measure Water?

The ultimate goal of water measurement is to conserve water through improved management of its distribution and application. Accurate water measurement helps in the distribution because it is very difficult to manage something when you do not know precisely how much you are using.

Management of water supplies is changing. Increasing competition exists between power, irrigation, cities, industry, recreation, aesthetic, and fish and wildlife uses. Within the United States, critical examinations of water use will be based on consumption, perceived waste, population density, and impact on ecological systems and endangered species. Water districts and farmers will need to document their use of water and seek ways to extend the use of their share of water by the best available technologies. Best management measures and practices without exception include conservation of water.

Rather than finding and developing new sources, water often can be supplied more economically by conservation. Each cubic foot of water recovered as a result of improved water management costs less than supplying the same amount from a new source. Better measurement procedures extend the use of water because lack of information usually results

in the delivery of excess water or loss through waste. Attention to measurement, management, and maintenance will take advantage of the farmer's water and help prevent reduced yields and other crop damage caused by underwatering or overwatering.

How to use the *Water Measurement Manual* to Conserve Water

The "Flumes," "Weirs," and "Measurements in Pressure Conduits" chapters will provide much of the information and illustrations needed to install flow measurement devices on farms and canals. Tables in the text and the appendix also list flows for some of the more common measuring devices, making the manual a valuable asset in the field.

Special attention should be given to the "Long Throated Flumes," section 8-8, since these flumes are the most adaptable to existing canals and require less complicated construction forming (figure 2). Usually, the farmer can construct the device in place. The flumes have few problems with debris, sediment, and downstream submergence. Measurement of the flow is simple since only the upstream water depth is needed. The new manual provides standard designs for typical situations, and straightforward computer software is also available for developing customized flume designs.

The *Water Measurement Manual* can be accessed on the World Wide Web at http://ogee.do.usbr.gov/fmt/wmm/ or a hard bound version can be purchased from the Government Printing Office, Superintendent of Documents (202) 512-1800, fax (202) 512-2250, PO Box 371954, Pittsburgh PA 15250-7954. The stock number is S/N 024-003-00180-5. The price for U.S. customers is $34.00. For customers outside of the U.S., the price is US$42.50. Reclamation offices can order copies from the warehouse in Denver, mailing code D-7913, attention: T Marvel.

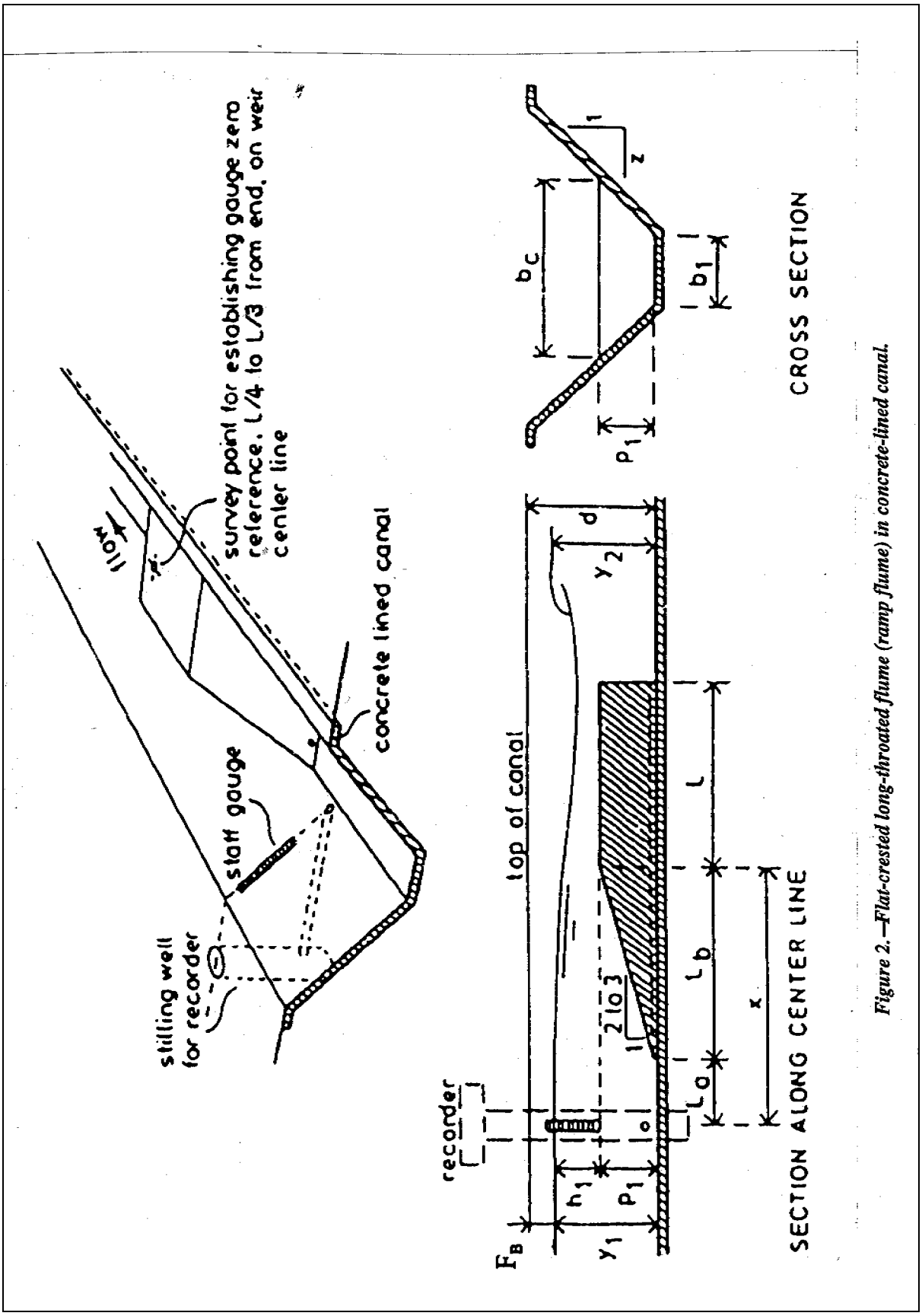

Figure 2.—Flat-crested long-throated flume (ramp flume) in concrete-lined canal.

Mission

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

The purpose of this bulletin is to serve as a medium of exchanging operation and maintenance information. Its success depends upon your help in obtaining and submitting new and useful operation and maintenance ideas.

Advertise your district's or project's resourcefulness by having an article published in the bulletin—let us hear from you soon!

Prospective articles should be submitted to one of the Bureau of Reclamation contacts listed below:

Jerry Fischer, Technical Service Center, ATTN: D-8470, PO Box 25007, Denver, Colorado 80225-0007; (303) 445-2748, FAX (303) 445-6381; email: jfischer@do.usbr.gov

Vicki Hoffman, Pacific Northwest Region, ATTN: PN-3234, 1150 North Curtis Road, Boise, Idaho 83706-1234; (208) 378-5335, FAX (208) 378-5305

Dena Uding, Mid-Pacific Region, ATTN: MP-430, 2800 Cottage Way, Sacramento, California 95825-1898; (916) 978-5229, FAX (916) 978-5290

Bob Sabouri, Lower Colorado Region, ATTN: BCOO-4844, PO Box 61470, Boulder City, Nevada 89006-1470; (702) 293-8116, FAX (702) 293-8042

Don Wintch, Upper Colorado Region, ATTN: UC-258, PO Box 11568, Salt Lake City, Utah 84147-0568; (801) 524-3307, FAX (801) 524-5499

Tim Flanagan, Great Plains Region, ATTN: GP-2400, PO Box 36900, Billings, Montana 59107-6900; (406) 247-7780, FAX (406) 247-7793