

## INTRODUCTION:

Many large open channels have been historically monitored using a flume or weir structure that has been “rated” using empirical data. Typically this rating is based on the depth of the water running over/through the structure. In recent times, the use of flumes and weirs has been negated somewhat by the advent of cheaper area/velocity methods, such as the MACE Doppler ultrasonic. However, thousands of rated structures are still used worldwide in diverse applications such as large open irrigation channels or small Parshall flumes in wastewater treatment plants.

The MACE FloPro Series3 includes a powerful weir and flume lookup table that enables the user to interface downward looking ultrasonic or submerged depth sensors, and convert the depth readings to flow rate readings. The FloPro includes equations for all major flume/weir types including:

- Parshall flumes
- V-notch weirs (30°, 45°, 60°, 90°)
- Cipoletti weir
- Replogle flume
- Rectangular weir (contracted/suppressed)

## THE PROBLEM:

Quail Mesa Ranch is a large irrigation ranch based near Ehrenberg, Arizona, USA. The irrigation water that is delivered to the ranch by the US Bureau of Reclamation (USBR) is distributed along a large concrete lined trapezoidal canal (approximately 35 ft (10.5m) in width). Water that is not used on-farm is diverted through a rated “slotted” broad-crested weir structure and returned through a pipe to a drainage ditch. This pipe has a very steep gradient and stream velocities often exceed 9 ft/s (3 m/s). The operators of Quail Mesa ranch, wanted to install an instrument at the broad-crested weir that could measure and record the depth of the overflow. Furthermore, they also wanted the ability to monitor the flow through the pipe to get a more accurate measurement than currently provided by the weir structure and it’s rating table.



Figure 1: The broad-crested weir structure at Quail Mesa Ranch, AZ.

## THE MACE SOLUTION:

The priority of the operators at Quail Mesa Ranch was to measure and record the depth of the water going over the weir structure. With the ability to accept multiple sensor inputs, a MACE Series 3 FloPro was installed with a 4-20mA ultrasonic depth sensor (EchoSpan® by Flowline, CA). Although the FloPro contains a powerful flume/weir function to calculate flow rate for the majority of common weir/flume types, the “slotted” nature of this structure negated the use of this functionality.

Because of the highly expandable nature of the Series3 FloPro, highly accurate measurement of these tail-water flows will be available when a Doppler ultrasonic velocity sensor is mounted in the pipe (partially-full) that carries water into the drainage ditch. In addition, because of the extremely fast velocities, an ultrasonic depth sensor will be mounted in the pipe to measure the depth of the cross-section.

An optional MACE FloSI – telemetry interface card will allow the data to be transmitted to a remote collection site in the future.



Figure 2: The Series3 MACE FloPro unit installed on Quail Mesa Ranch. An ultrasonic depth sensor (EchoSpan®) is mounted over the crest of the weir.

## THE MACE FLOPRO BENEFITS:

- 1 Depth recording allows the Quail Mesa Ranch to analyze exactly when water was allowed to escape across the weir structure. These data can be used by the rancher to provide historical usage to the USBR.
- 2 Because of the highly expandable nature of the FloPro, up to three Doppler velocity sensors can be added in the future to allow highly accurate measurement of the tail-water flowing through the pipe into the drainage ditch.
- 3 With the MACE FloPro Series3, not only can flow be measured in multiple pipes or open channels, critical information can be recorded from just about any environmental sensor.
- 4 With the optional telemetry interface, the FloPro Series3 can get all this information back to where the rancher needs it.

