RemoteTracker

System Overview

The RemoteTracker[1] is an integrated turnout flow measurement, data management and volumetric accounting system developed by H2oTech[2] specifically for agricultural water suppliers in response to CCR 23 §597. The RemoteTracker system is comprised of (1) a wirelessly controlled water velocity sensor, (2) a ruggedized tablet PC in the operator's vehicle and (3) a database running on a file server connected to the internet. The user interface on the tablet PC enables operators to view real time flow data from the wirelessly controlled water velocity sensor via a Bluetooth radio connection while adjusting flows at the turnout gate. Data is automatically transferred over a wireless wide area network (WWAN) to a centralized file server at the District headquarters where it is automatically loaded into a custom database application. The database performs quality control and quality assurance procedures on the data and then develops daily volumes for each customer delivery point (turnout or delivery) within the District.

The wireless water velocity sensor (WWVS) is held in place at a precise location at the pipe outlet by an aluminum or stainless steel mounting bracket. The user interface, shown in Figure 1, was designed with simplicity and ease of use in mind. If 'Auto Locate' is selected, the program automatically populates the three site identification pull-downs at the top of the screen. If the operator needs to select a different site, the pull-downs can be manually changed. The site selection hierarchy is a three digit abbreviation of 'Operator Route' (i.e. ride, beat or division) on the left, a three digit abbreviation of 'Canal' in the middle and site name on the right. The most recently measured flow, and any pending orders are shown on the 'Home' tab. Many useful reports, including (1) Delivery History, (2) Pending Orders, (3) Fulfilled Orders and (4) Canal Management are available on the 'Reports' tab. These reports can be sorted at any spatial or temporal scale. The data sharing and management framework allows water order and delivery data collected by any operator to be automatically available for viewing by other operators or management staff in a matter of minutes.

[1] Patent Pending.

[2] H2oTech is a company based in Chico, California that focuses on the development of innovative technologies to solve water management challenges. Visit www.h2otechonline.com for additional details.

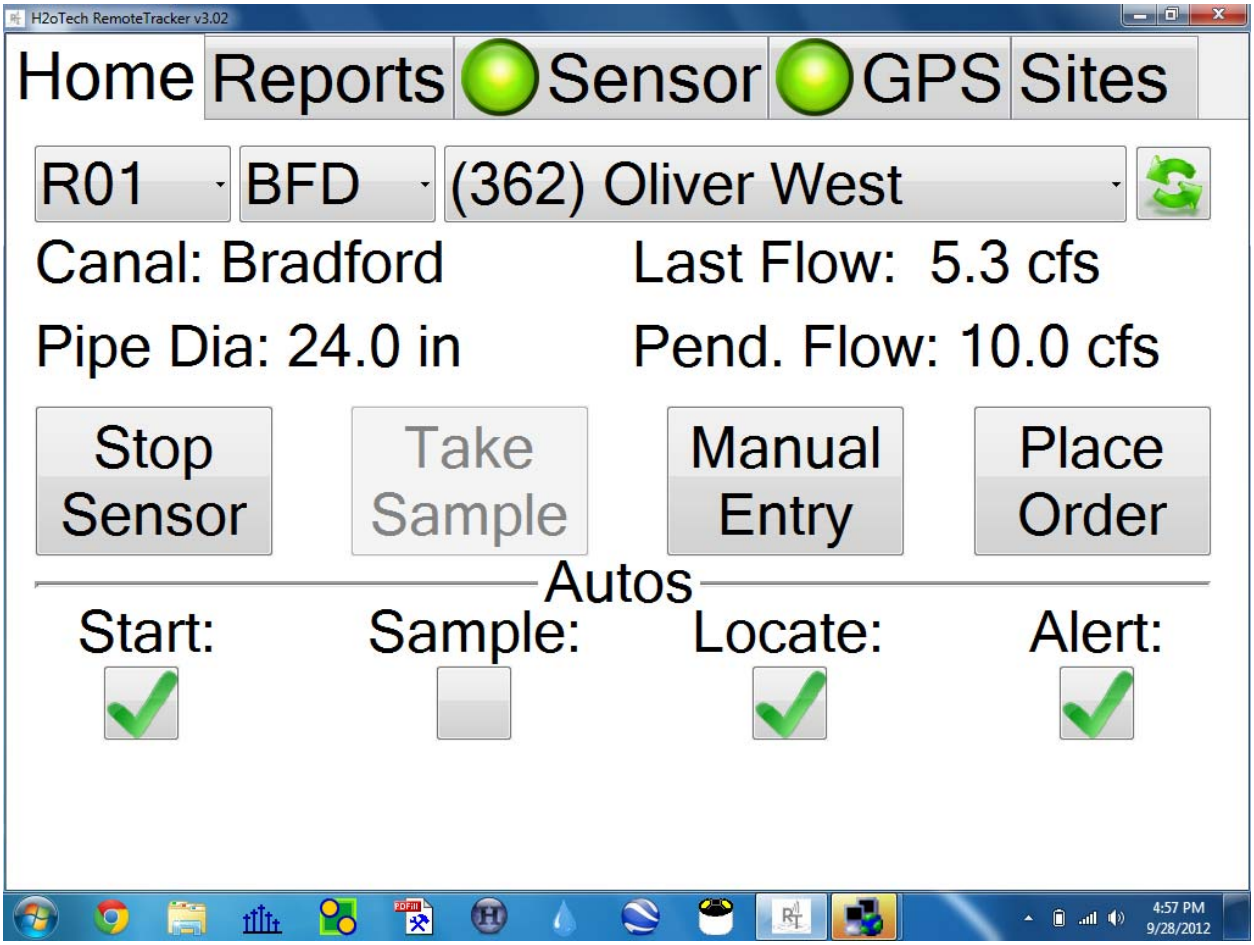

Figure 1. RemoteTracker User Interface - Home Tab Shown

The basic components of the RemoteTracker system are illustrated in Figure 2. Water velocity is collected by a portable acoustic Doppler velocimeter deployed during measurement by hanging it on brackets permanently installed at each turnout. The brackets are precisely positioned such that the sample volume is at the center of the pipe. Data is transmitted via a class 1 Bluetooth radio to a ruggedized tablet PC where it is processed, displayed and stored. Data is then transferred via a WWAN to a file server at the District headquarters. Data from each operator is aggregated with an automated database procedure and then returned to each operator via WWAN, thereby ensuring that delivery and order data is shared and accessible throughout the entire District.

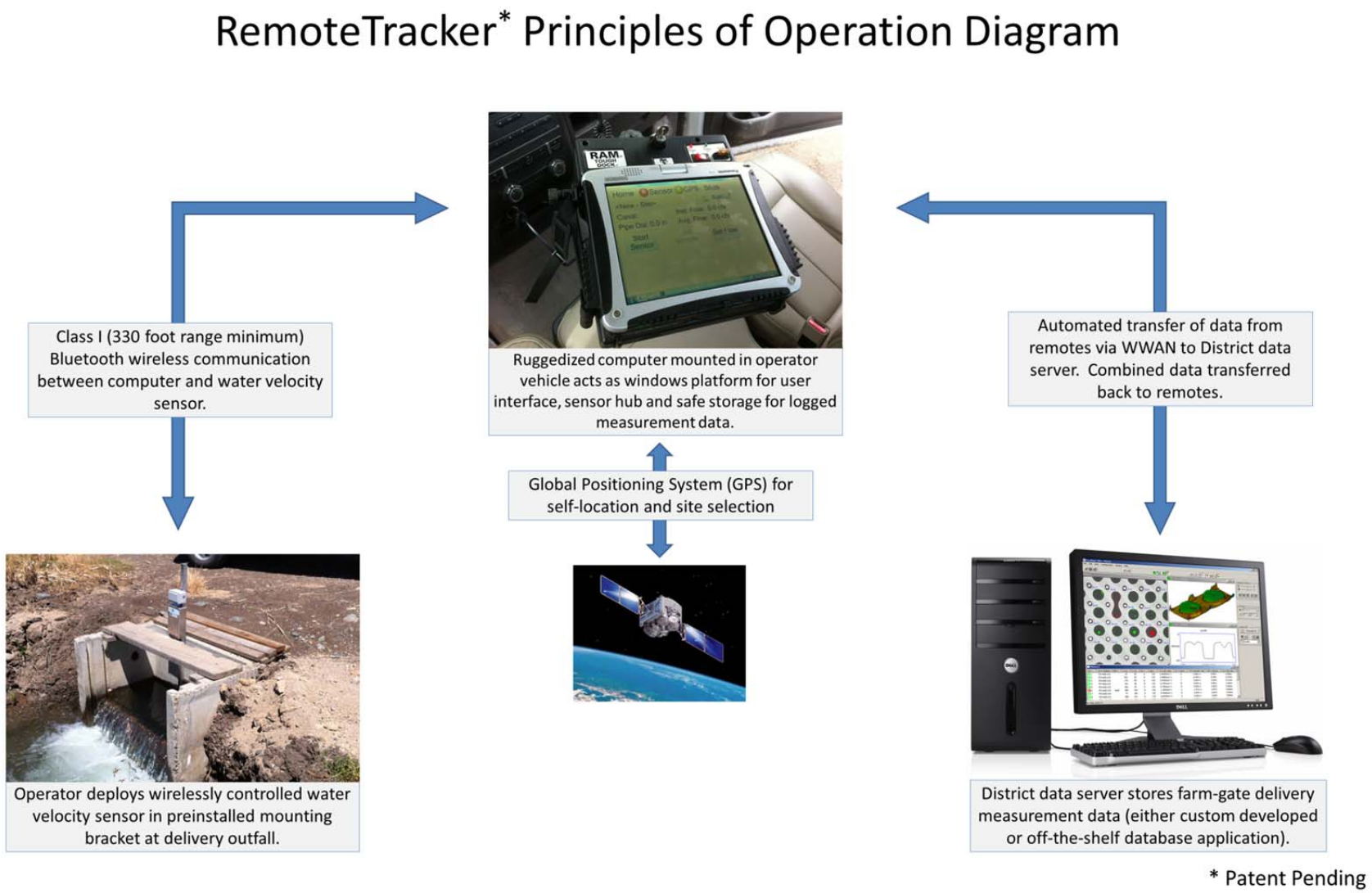

Figure 2. RemoteTracker Principles of Operation Overview

The key to pipe flow measurement using the RemoteTracker is the consistent relationship between a single velocity measurement at the center of the pipe and the average pipe flow velocity shown in Figure 3 derived from 146 measurements of center and mean pipe velocity. Based on this relationship, with the pipe diameter and cross sectional area known, the single point velocity can be accurately and reliably correlated with mean pipe velocity (flow rate).

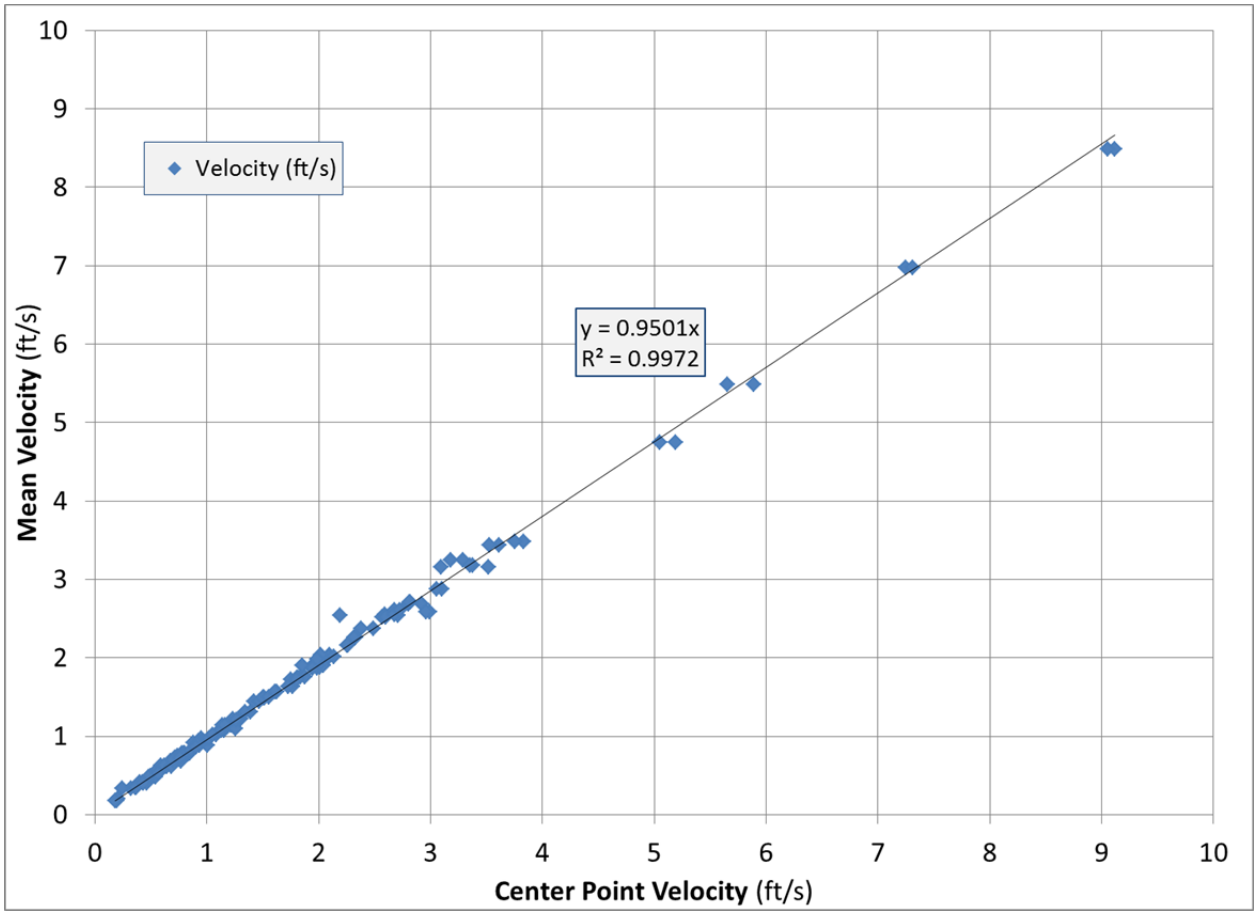

Figure 3. Relationship between Average and Center Point Pipe Flow Velocity

As with weir and orifice gate measurement, full pipe flow is required for the RemoteTracker to measure correctly. Therefore, a weir box is needed at each turnout to ensure full pipe flow as well as to accommodate the mounting bracket to hold the wireless water velocity sensor so that the sample volume is at the center of the pipe.

The RemoteTracker system can also be integrated with existing or new data management systems at the District office for report generation, accounting and billing. This capability can be added later to provide additional efficiencies in water billing and accounting procedures.

Initial Testing Results

Laboratory Testing

Additional testing was performed at the California State University Chico Agricultural Teaching and Research Center (CSUC ATRC) in July of 2012. Flow data obtained from the RemoteTracker was compared to measurements taken with a 10-inch diameter magnetic flow meter manufactured by Water Specialties. Figure 4 shows the Water Specialties Magnetic meter with an Endress & Hauser Transit-Time Meter installed just upstream as an additional check. The 3 foot wide by 3 foot deep concrete flume was modified to simulate a typical delivery configuration by forcing all the flow through a 20 foot length of 18 inch HDPE smooth interior wall pipe submerged in the concrete flume. The RemoteTracker wireless water velocity sensor was installed at the pipe outfall using a temporarily constructed headwall with a mounting bracket as shown in Figure 5.

Figure 4. Water Specialties Magnetic Flow Meter at CSUC ATRC

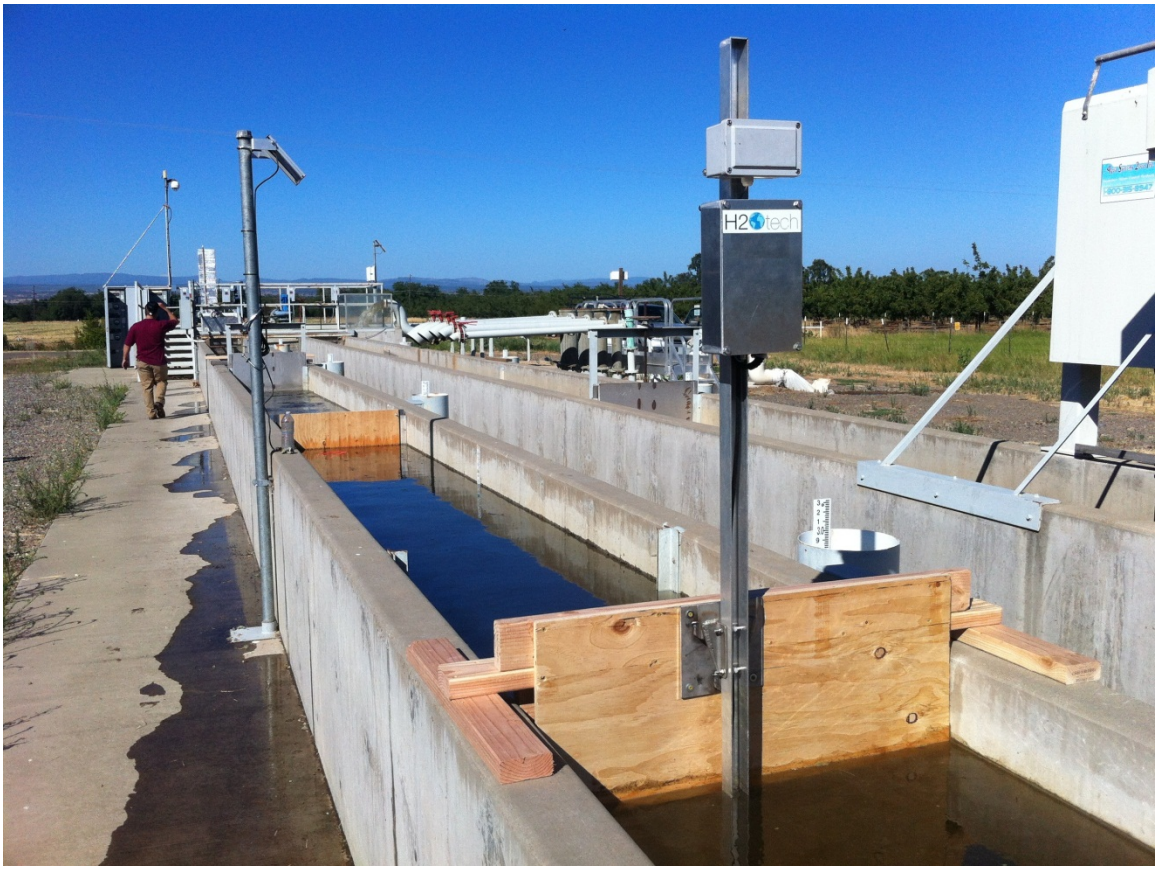

Figure 5. RemoteTracker Wireless Water Velocity Sensor Installed at CSUC ATRC

Seven comparison measurements were made between the RemoteTracker and magnetic meter ranging from 0.5 cfs to just over 3.0 cfs (the maximum pump capacity). The percent difference between the two measurements averaged roughly -2.6 percent with a range of -10.2 to 2.8 percent indicating that the RemoteTracker measurement methodology compares very well with the magnetic meter. Note that the -10.2 percent difference occurred at the lowest flow rate of approximately 0.5 cfs and represents an absolute flow rate difference of just 0.05 cfs between the two measurement methods. The results of the comparison measurements are presented in Figure 6 where the blue bars represent flow rates obtained with a magnetic meter, the red bars represent flow rates obtained with the RemoteTracker and the green triangles represent the percent difference between the two (secondary vertical axis).

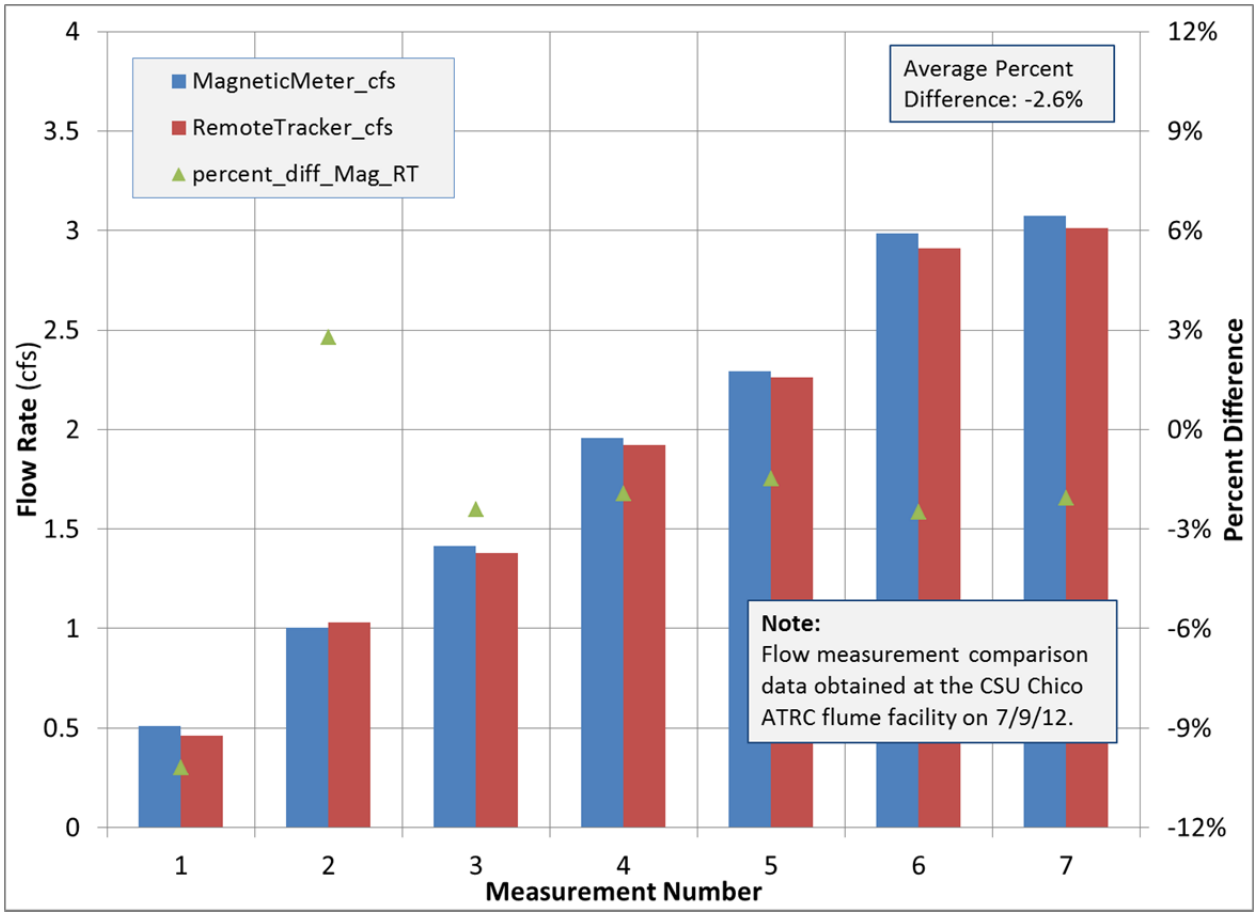

Figure 6. RemoteTracker and CSUC ATRC Magmeter Comparisons

Field Testing

Five comparison measurements between the RemoteTracker and USGS mid-section method measurements with a SonTek ADV were performed at two turnouts in two irrigation districts (one turnout in each District) in Northern California during the 2011 irrigation season. The turnouts were selected because the delivery spilled into a field ditch (or head ditch) rather than a field, so both a RemoteTracker and a USGS mid-section method measurement (Rantz 1982) could be taken and compared. Figure 7 shows the cross section report for one of the measurements in a typical earthen head ditch, in this case with a maximum depth of 2.5 feet, top width of 14 feet and bottom width of 5 feet. Typically, velocity measurements were performed at 0.5 foot intervals with velocities averaged over a 40 second period.

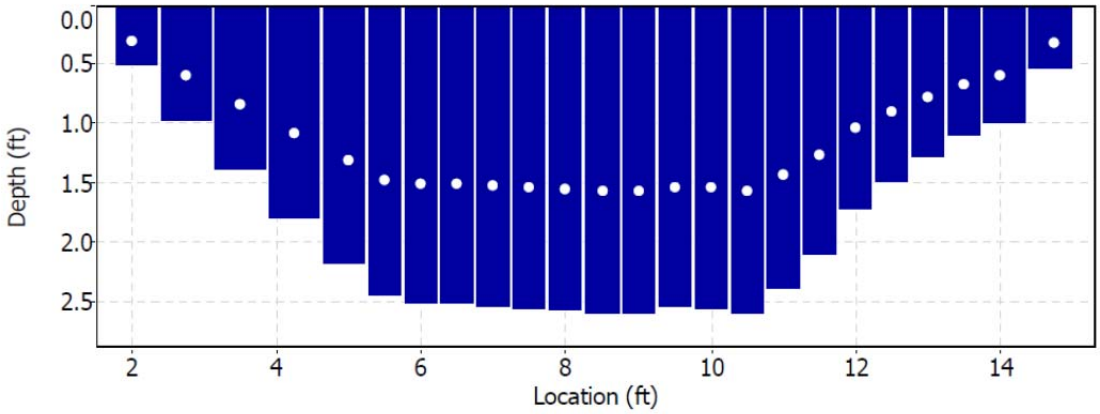

Figure 7. SonTek ADV Cross Section for Canal Verification Measurement

The percent difference between the RemoteTracker and the USGS mid-section method averaged roughly 0.9 percent with a range of -0.8 to 3.4 percent, indicating that the RemoteTracker measurement methodology compares very well with the standard mid-section open channel methodology. The results of the comparison measurements are presented below in Figure 8 where the blue bars represent flow rates obtained with a SonTek ADV in an open channel downstream of the turnout, the red bars represent flow rates obtained with the RemoteTracker and the green triangles represent the percent difference between the two (secondary vertical axis).

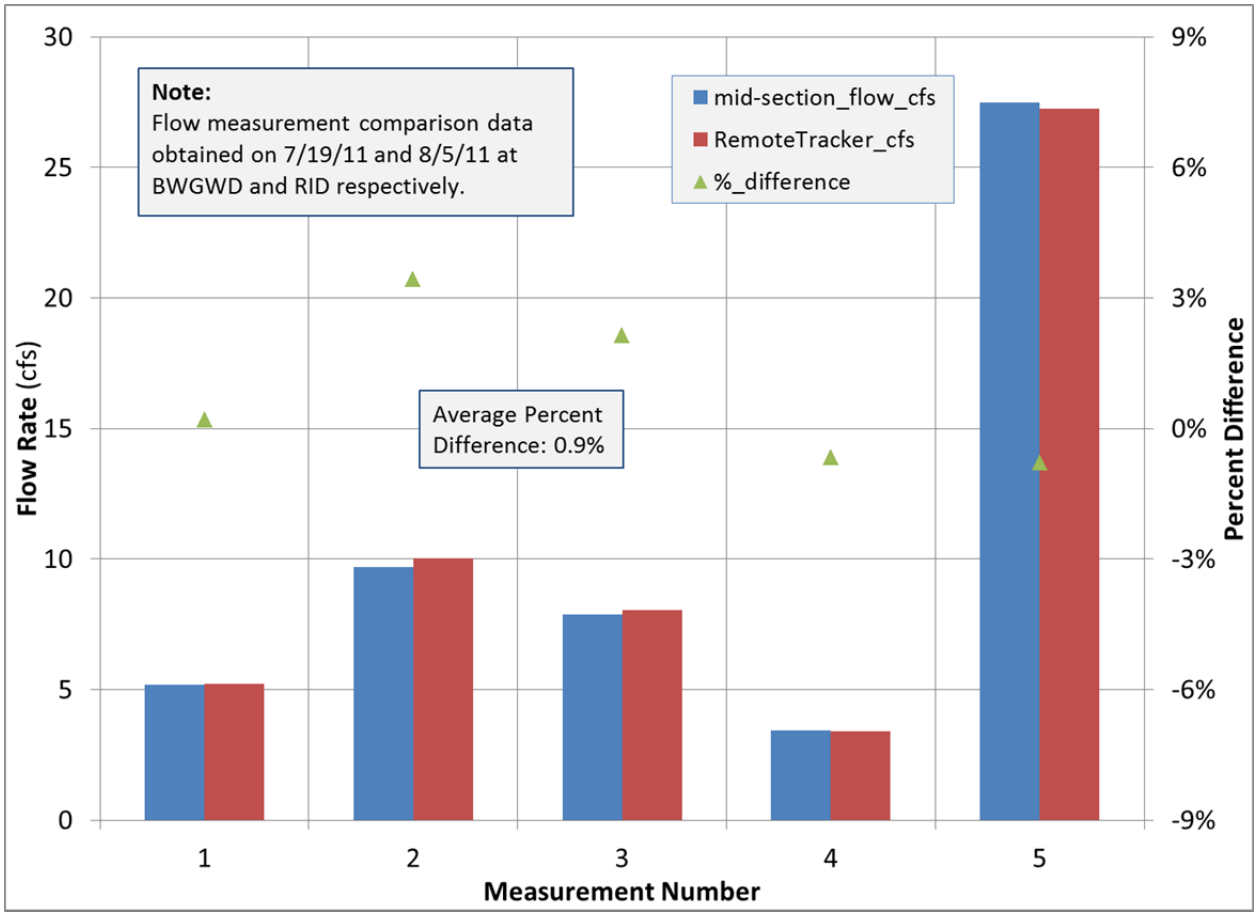

Figure 8. RemoteTracker and Mid-Section method Comparisons