Ditch Improvements and Flow Measurement

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NMSU-EBID On-Farm Water Conservation Irrigation Efficiency Workshop

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OBJECTIVES AND TAKEAWAYS

• IMPROVING CONVEYANCE TO INCREASE IRRIGATION EFFICIENCY
• POTENTIAL DITCH IMPROVEMENTS
• PURPOSE AND BENEFITS OF MEASURING FLOW
• OPEN DITCH METERING METHODS
• EBID MEASUREMENT OF DELIVERIES
• EBID SCADA SYSTEM
• METERING WELLS
• EBID SUPPLIED METERS AND RTUS
Irrigation and Conveyance Efficiencies
IRRIGATION EFFICIENCY

• Less water required for the same benefit/Increased benefit from the same water = water conservation

• Reduced unnecessary deep percolation below or away from root zone

• Reduced costs

\[ e(\%) = \frac{ec \times ea}{100} \]

Where
- \( e \) = overall irrigation efficiency
- \( ec \) = conveyance efficiency
- \( ea \) = field application efficiency

Irrigation Efficiency = \( \frac{\text{total water required}}{\text{water delivered to root zone for ET needs}} \)
IMPROVING IRRIGATION EFFICIENCY

• Irrigation techniques
• Less seepage prior to/during delivery
• Level field/correct slope for your soil type
• Faster irrigation/reduced advance time
• Uniform application
• Reduced surface evaporation
• Eliminate runoff
• Smaller blocks
• ET based scheduling
IMPROVING CONVEYANCE EFFICIENCY TO YOUR FIELD

- A clean uniform ditch
- Lined or piped ditch
- Adequate flow
  - Correctly sized canal turnout
  - Adequate pump(s)
  - High flow field turnout
  - Adequate ditch capacity
- Evaluate restrictions
- Pressurize?
### Improving Irrigation Efficiency

- Options for improving on-farm conveyance and delivery:
  - A clean uniform ditch
  - Lined or piped ditch
  - Adequate flow
  - Correctly sized canal turnout
  - Adequate pump(s)
  - High flow field turnout
  - Adequate ditch capacity
  - Evaluate restrictions
  - Pressurize?

### Table 7: Indicative Values of the Conveyance Efficiency (ec) for Adequately Maintained Canals

<table>
<thead>
<tr>
<th>Soil type</th>
<th>Sand</th>
<th>Loam</th>
<th>Clay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canal length</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long (&gt; 2000m)</td>
<td>60%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium (200-2000m)</td>
<td>70%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short (&lt; 200m)</td>
<td>80%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

FAO Irrigation Water Management: Irrigation Scheduling ANNEX 1
IMPROVING IRRIGATION EFFICIENCY
BENEFITS TO IMPROVING A DITCH

- Reduce seepage prior to delivery
- Reduced evaporation
- Less ditch maintenance
- Improved flow
- Improved head
- Less ditch breaks
- Reduce pumping
Measuring ditch flow
Measuring Flow in a ditch

• In channel velocity measurement
• Rated structures
  • Weirs
  • Flumes
  • Circular gate

• Factors to consider
  • Design flow/capacity
  • Range of flow
  • Cost
  • Acceptable headloss
  • Submergence
  • Maintenance
  • Construction and installation
Measuring flow in a ditch using a Weir

- **BROAD CRESTED**
  \[ Q = \frac{2}{3} \cdot c_d \cdot \sqrt{2g \cdot L \cdot H^2} \]

- **SHARP CRESTED**
  \[ Q = c_d \cdot L \cdot H^2 \]

- **V-NOTCH**
  \[ Q = c_d \cdot \tan \left( \frac{\theta}{2} \right) \cdot H^2 \]

Where:
- \( Q \) = flow
- \( c_d \) = discharge coefficient
- \( L \) = length of weir
- \( H \) = measured upstream head
- \( \theta \) = V notch weir angle

Measurement is made by observing or recording an upstream head/depth

**Pros**
- Easy to design
- Easy to construct
- Easy to read
- Low cost

**Cons**
- Requires a relatively high headloss
- Not self cleaning or self draining
- Accuracy can be effected by approach velocity

Photo credits: openchannelflow.com
Measuring flow in a ditch using a Flume

- Long throated
  - Ramp
  - RBC

- Short throated
  - Cutthroat
  - Samani
  - Parshall
  - Montana

Where:

\[ Q = c_d * h^n \]

- Pros
  - Easy to design
  - Easy to read
  - Some are self cleaning
  - Relatively low headloss
  - Can be portable

- Cons
  - Higher cost
  - Significant materials to construct
  - Moderately difficult to construct and install
Measuring flow in a ditch – Samani Flumes

THREE SIMPLE FLUMES FOR FLOW MEASUREMENT:


HTTP://ASCELIBRARY.ORG/DOI/ABS/10.1061/%28ASCE%29IR.1943-4774.0001168

• RECTANGULAR (1) (S-M FLUME)
• TRAPEZOIDAL (2)
• CIRCULAR (3)
EBID Measurement of Deliveries

- Instream measurements
- Direct velocity measurements
- Rated Turnouts
Well Metering & EBID SCADA System
EBID SCADA System

- 480 total field sites
- Sites polled every 30 minutes
- Line of sight FCC radio frequencies
- Six mountain repeater sites
- SCADA Supervisor, RTU Tech Supervisor, 6 RTU Technicians

Monitoring Sites

- Dam Releases
- River Stations
- Diversion Canals
- Lateral Headings
- Spillways and Drains
- Farmer Irrigation Wells
- Groundwater Wells
- Weather Stations
- Rain Gauges
- Flood Control Dams
Well Metering

• Required in the Lower Rio Grande
• Evaluate Performance
• Part of Determining Efficiencies
• Monitoring Efficiencies
• Identify Problems

EBID Meter

• EBID developed meter after OSE meter requirement
• EBID wanted to provide farmers with an accurate and reliable meter that offered historic data and multiple readings
• First site in 2006
• Tested several flow sensors
• Settled on Ag-Rotor flow sensor
• Ag-Rotor covers 6-12” pipe
• 0.5” to 4” and 14” or larger pipe meters are available
Benefits of an EBID Meter

• Real-time password protected data available online
• Historical data can be viewed in 1 year increments
• Assists with monitoring potential over-diversion issues
• EBID submits quarterly OSE readings on behalf of owner
• EBID can provide assistance to well owners in certain situations that may mitigate OSE enforcement affairs
• EBID handles warranty issues on parts and provides free installation of replacement parts for the life of the meter
• EBID maintains meter components and conducts annual calibration of the meter

• The meter calculates:
  • Gallons Per Minute
  • Cubic Feet Per Second
  • Individual Irrigation Time
  • Accumulated Meter Irrigation Time
  • Individual Irrigation Acre Feet Pumped
  • Accumulated Meter Acre Feet Pumped