Irrigation District Engineering and Assistance

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Task 1 and 3 Extension Engineering
Task 1: Irrigation District Studies

- Provide technical assistance, applied research and educational programs to improve water management and promote water conservation and modernization.

Task 3: Institutional Incentives

- Evaluate irrigation district infrastructure needs and develop strategies to efficiently deliver water for agricultural use, and to facilitate the adoption of efficient irrigation technologies.
Highlights 2007 - 2008

- Technical Assistance & Infrastructure Assessment
- Training
- Short Courses: GIS, Advance GIS, GPS Surveying
- Water Measurement Workshop
Highlights 2007 - 2008

*Discussed today...*

- GIS Program
- Automation/Telemetry Demonstrations
- Aquatic Vegetation Study
- Canal Lining Evaluation
Legislative Districts map release:

- Texas House
- Texas Senate
- U.S. Congressional
2008 – 2009 GIS Program

- Update district maps
- Develop new maps and datasets related to regional water planning
- Integrate GIS with automation/telemetry programs
- Continue work in developing GIS-based tools for improved district management

Website: http://idea.tamu.edu
GIS/MAPPING
Map Ordering Information & Map Order Form

GIS Shapefiles
Year 2004 data sets are finalized and are now available. Order Form

Texas Legislative District Maps
Legislative district boundaries in reference to the Texas Irrigation Districts along the Rio Grande River Basin.

110th U.S. Congress (2007-2009)
- Lower Rio Grande Basin (Valley)
- Middle Rio Grande Basin
- Upper Rio Grande Basin

Texas Senate (2003-2012)
- Lower Rio Grande Basin (Valley)
- Middle Rio Grande Basin
- Upper Rio Grande Basin

Texas House (2003-2012)
- Lower Rio Grande Basin (Valley)
- Middle Rio Grande Basin
- Upper Rio Grande Basin

Regional Maps
Click on the map that you would like to preview (JPEG Format)

Lower Rio Grande Basin
Map 1: Service Areas of the Irrigation District
Map 2: Main Water Distribution Networks
Map 3: Entire Water Distribution Networks
Automation, Telemetry, and Flow Measurement
Automation/Telemetry Benefits

Real time data at a central location for improved operation of system
And the ability to quickly respond to changing situations
- Reduces losses due to spillage
- Improves conveyance efficiency
- Better customer service (added flexibility)
- Improved water delivery to farm turnout which contributes to better on-farm efficiency
Objectives of Demonstrations

- Create in-house capacity in canal operation and control concepts, and automation applications

- Demonstrate cost-effective and alternative technologies for SCADA

- Assist districts in designing/implementing projects which have a water conservation/management purpose

- Evaluate and advise districts on equipment/software options and other technical issues
Automation/Telemetry Demonstrations

Underway
- United Irrigation District
- Mission #6
- Los Fresnos

In Planning Stage
- Delta Lake
- San Benito
Los Fresnos Irrigation District

- Telemetry system to allow monitoring of flow into main canal at the District office (~20 miles away)
- Sonic water level at weir located at main pumping plant
Los Fresnos Irrigation District

Uses simple, inexpensive equipment/software and telephone communications.
Results

- Real-time flow data access in the district office
- Web-based flow monitoring system where water use can be accessed through internet
Los Fresnos Main Weir

Monday, June 02, 2008 4:45:10 PM

Real-Time Readings and Flow Rates:

<table>
<thead>
<tr>
<th>Water Level</th>
<th>CFS per foot</th>
<th>Total CFS</th>
<th>Total Acre-ft per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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<td>2</td>
<td>0.00</td>
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<td>1</td>
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<tr>
<td>0</td>
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<tr>
<td>-1</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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<tr>
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<tr>
<td>-5</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.0 (ft)</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Past Hour Average Readings and Flow Rates:

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Head (Foot)</th>
<th>04/24 12:09</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>3</td>
<td>0.00</td>
</tr>
<tr>
<td>80</td>
<td>2</td>
<td>0.00</td>
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<tr>
<td>60</td>
<td>1</td>
<td>0.00</td>
</tr>
<tr>
<td>40</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>20</td>
<td>-1</td>
<td>0.00</td>
</tr>
<tr>
<td>0</td>
<td>-2</td>
<td>0.00</td>
</tr>
<tr>
<td>-10</td>
<td>-3</td>
<td>0.00</td>
</tr>
<tr>
<td>-20</td>
<td>-4</td>
<td>0.00</td>
</tr>
<tr>
<td>-40</td>
<td>-5</td>
<td>0.00</td>
</tr>
<tr>
<td>0.0 (deg F)</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Total Volume

<table>
<thead>
<tr>
<th>Total (Cubic-Ft)</th>
<th>0.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total (Acre-Ft)</td>
<td>0.00</td>
</tr>
</tbody>
</table>

***Note: Weir blade is at 0 water level.***
SCADA Systems

**Components**

- Master Station
- RTU
Terminology

**SCADA** - Supervisory Control and Data Acquisition Systems

A term that includes remote control and automation systems (such as controlling gates in a canal system)

Usually including remote monitoring and collection of data (such as water levels) upon which decisions are made
**Terminology**

**RTU (Remote Terminal Unit)**
Deployed in the field and typically includes PLC, radio, power supply, and other electronic devices.

**PLC (Programmable Logical Controller)**
Monitors the automation site, and based on sensor data and operational rules, decides if adjustments are required, and makes adjustments as needed.
Typical RTU
United Irrigation District

Initial Work

- Replacement of old, manually operated gates on a main canal with a radial gate
- Lean how to operate system based on FLOW
United Irrigation District

- Set up new gate for remote control from District office

- District will move to total automation (or “full SCADA”)
  - once new gate is calibrated for flow
  - as operational rules are defined
Flow Monitoring

- In June 2008, we installed a flow meter downstream of the gate.
- District personnel can now see flow data and gate openings at the same time in district office.
Calibration of Gate

Matching flow with the gate opening (a 4-20mA analog output signal from the actuator) as a percentage of opening
Calibration of Gate

Investigating the use of much cheaper water level sensors instead of a flow meter for gate control and calibration
Hidalgo County
Irrigation District No.6

- Full automation with remote control options of main gates and reservoir system

- Purpose:
  - Prevent flooding of area neighborhoods during rain events
  - Improve system management
Results

- A new actuator and motor was installed on the gate for automatic/remote control.
- Radio system is being installed to provide communications with the district office (~30 miles).
- A program for automatic gate control based on water level has been developed and ready to be implemented.
Future Plans

- Continue the project with automating two additional gates on reservoir system and a flow monitoring station after second lift pump.

- Implementation of *Clear SCADA* (Human-Machine Interface software) in district office for the gate control, real time data display, store and analysis.
Evaluating the Effects of Aquatic Vegetation on the Flow Capacity of Canals

Larry Demich
(former PhD student)

Guy Fipps
Problem Statement

- Invasive weeds such as *hydrilla verticillata* are, in essence an ineradicable part of the canal systems in South Texas.
- Methods of dealing with this weed are expensive and frequently perpetuate the problem, as mechanical removal sends fragments downstream, which can then take root and create new plants.
- Without maintenance, plants grow to choke the waterways and greatly reduce the capacity of canals.
Aquatic Weed Study

Problem Statement

• Infested irrigation canals are difficult to manage because the mass of the weed disrupts normal water level (stage) and flow relationships.

• Knowing when to remove the weed for maximum cost effectiveness—requires knowing when infestation reaches a level that significantly affects flow.

• Existing knowledge on the interaction of aquatic weeds (such as hydrilla) with the flow in canals is limited.
Goals of Aquatic Weed Study

- To better understand the effects of hydrilla on flow in canals
- Develop a method (i.e., equation) to calculate flows in canals infested with hydrilla
- Work was carried out by Larry Demich as part of a PhD thesis research
Research Plan

• Observe and measure flows of infested canals in the LRGV of Texas and Jamaica
• Construct laboratory and field scale canal systems for controlled experiments
  ➢ bench scale canal
  ➢ Greenhouse canal
  ➢ Field canal
Hydrilla bending and drag coefficient
Mathematical modeling of real canals
Simple relationship was found between the reduction in flow and the area of vegetation.

\[ \frac{Q_{\text{veg}}}{Q_{\text{open}}} = 0.85 \left( \frac{A_{\text{veg}}}{A_{\text{open}}} \right)^{1.757} \]
Aquatic Weed Study

• Larry Demich successfully defended his dissertation and complete PhD degree requirements in Biological and Agricultural Engineering in May 2008

• Demich and Fipps are currently working on two publications from this research:
  ➢ Description of the effects of hydrilla on canal systems
  ➢ Mathematical modeling and prediction of the effects on flow of hydrilla
Canal Lining Evaluation

Yearly evaluations and ratings to determine durability and long-term viability of new canal linings.
Purpose of Lining Evaluations

• Ensure continued water savings

• Help districts select durable canal lining material

• Develop guidelines for maintaining performance
  ➢ vandalism
  ➢ material installation
  ➢ maintenance/repair
Activities

• Identified 28 lining segments, totaling 20 miles in 7 irrigation districts with 6 different lining materials

• Inspected each project segment at least once a year for 3 years

• Where possible, performed pre- and post-seepage loss tests to document actual water savings from lining existing canals
Example of Water Savings

• Performed pre- and post- re-lining seepage loss tests on Lateral A canal of Hidalgo County Irrigation District No.2
• 7 mile long section of concrete canal in poor condition was re-lined with Polyester/shotcrete
• Water losses were reduced after lining by 94%

<table>
<thead>
<tr>
<th>before</th>
<th>after</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.98 gal/ft²/day</td>
<td>1.17 gal/ft²/day</td>
</tr>
<tr>
<td>11.20 ac-ft/mi/yr</td>
<td>227.14 ac-ft/mi/yr</td>
</tr>
</tbody>
</table>
## Lining Materials

Table 1. Descriptions of lining material components

<table>
<thead>
<tr>
<th>Material ID</th>
<th>Manufacturer’s Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC Alloy</td>
<td>The membrane is co-polymer alloy comprised of a polyvinylchloride blend. 40 mil (1mm) membrane is reinforced with high strength, 18 x 14 pattern, weft inserted, and polyester scrim.</td>
</tr>
<tr>
<td>Polyester</td>
<td>Canal3 HGC-8208-PET is a geocomposite geotextile that consists of two (top and bottom) 8 oz/yd2 polyester nonwoven bonded to 20 mils of olefinic co-polymer geomembrane.</td>
</tr>
<tr>
<td>EPDM rubber</td>
<td>Non-reinforced EPDM (ethylene propylene diene monomer) 45 mil (1.15 mm), 0.29 lb/ft2 (1.4 kg/m2) geomembrane is accrued single-ply pond lining geomembrane.</td>
</tr>
<tr>
<td>Polyurethane</td>
<td>Liner consists of 2 layers of 3-oz, heat-bonded, non-woven geotextile saturated with liquid polyurethane resin for a total minimum thickness of 40 mils.</td>
</tr>
<tr>
<td>Polypropylene</td>
<td>It consists of a reinforced polyester scrim (woven) between polypropylene barrier layers. 16 oz/yd2 (542g/m2) +/- 5%. Nominal thickness 24 mils – 0.024” (0.61 mm).</td>
</tr>
<tr>
<td>PVC</td>
<td>Poly Vinyl Chloride (PVC) manufactured by the calendaring or extrusion process. Its highly flexible, non-reinforced and comes with 20 year performance warranty by the manufacturer.</td>
</tr>
</tbody>
</table>
Results

Best performance is with a geo-membrane overlaid with a protective barrier (shotcrete, concrete, etc.)

• Polyester with shotcrete
• PVC with shotcrete
Results (no cover)

Polypropylene
- Good performance
- Some installation problems observed
Results (no cover)

PVC alloy:
- Good performance
- Not very susceptible to vandalize, difficult to cut
Results (no cover)

EPDM rubber

- Poor performance
- Problems observed: vandalism, mowing damage, rotting, inadvertent damage, vegetation under the material
Results (no cover)

Polyurethane

- Worst performance
- Problems observed: vandalism, mowing damage, rotting, inadvertent damage, installation problems)
Conclusion

• Regular maintenance is required for all non-covered materials
• Inspections should be carried out at least once a year during non-irrigation season (December-January)
• The materials without a shotcrete layer are exposed to vandalism and other damage, and may be inadvertently damaged by animals/people
• Poor installation of any of the materials makes the product more susceptible to vandalism by leaving folds and loose areas that are easy to cut
**Canal Lining Evaluation Form**

<table>
<thead>
<tr>
<th>Field</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation district</td>
<td></td>
</tr>
<tr>
<td>Section ID</td>
<td></td>
</tr>
<tr>
<td>Material type</td>
<td></td>
</tr>
<tr>
<td>Installation date</td>
<td></td>
</tr>
<tr>
<td>Inspection date</td>
<td></td>
</tr>
<tr>
<td>Inspector</td>
<td></td>
</tr>
<tr>
<td>Inspection number</td>
<td></td>
</tr>
<tr>
<td><strong>Sidewall of Canal</strong></td>
<td></td>
</tr>
<tr>
<td>Stains or Joins and Surface of Material</td>
<td></td>
</tr>
<tr>
<td>Type of attachment (please circle): nails, bolts, or glue (tar), weld, other (please specify)</td>
<td></td>
</tr>
<tr>
<td>Number of holes in the section</td>
<td></td>
</tr>
<tr>
<td>Number of cuts in the section</td>
<td></td>
</tr>
<tr>
<td>Number of tears in the section</td>
<td></td>
</tr>
<tr>
<td>Types of Damage to the material (please circle): Animal, Vandalism, Equipment, other (please specify)</td>
<td></td>
</tr>
<tr>
<td>Deterioration (please circle and describe in detail): UV Damage, Abrasion, Other (please specify)</td>
<td></td>
</tr>
<tr>
<td>Installation Problems (please circle and describe in detail): Blistering, Wrinkles, Other (please specify)</td>
<td></td>
</tr>
<tr>
<td><strong>Top anchor attachment area</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Bottom of Canal</strong></td>
<td></td>
</tr>
<tr>
<td>Stains or Joins and Surface of Material</td>
<td></td>
</tr>
<tr>
<td>Type of attachment (please circle): nails, bolts, or glue (tar), weld, other (please specify)</td>
<td></td>
</tr>
<tr>
<td><strong>Lining around Structure</strong></td>
<td></td>
</tr>
<tr>
<td>Material</td>
<td></td>
</tr>
<tr>
<td>Number of holes</td>
<td></td>
</tr>
<tr>
<td>Number of cuts</td>
<td></td>
</tr>
<tr>
<td>Number of tears</td>
<td></td>
</tr>
<tr>
<td>Types of Damage to the material (please circle): Animal, Vandalism, Equipment, other (please specify)</td>
<td></td>
</tr>
<tr>
<td>Deterioration (please circle and describe in detail): UV Damage, Abrasion, Other (please specify)</td>
<td></td>
</tr>
<tr>
<td>Installation Problems (please circle and describe in detail): Blistering, Wrinkles, Other (please specify)</td>
<td></td>
</tr>
</tbody>
</table>
Future Plans

• Provide guidance for districts on installation procedures and scheduling regular maintenance of lining sections as damage occur
• Assist districts on the use of a Lining Inspection Form so they can evaluate conditions of materials by themselves
• Expand inspection and evaluation program to other types of district projects
Irrigation District
Engineering and Assistance

www.idea.tamu.edu