Analysis of the Municipal Water Supply Network in the Lower Rio Grande Valley

Presentation Prepared for the Region M Water Planning Group

November 19, 2003
McAllen, Texas
Municipal Water Supply Network

“MSN” (municipal supply network) will be used in this presentation to refer to:

- the portions of the irrigation district distribution networks which also carry municipal water
- Defined by the locations of existing control structures (gates, valves, etc.) which can isolate the MSN
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Professor and Extension Agricultural Engineer

Biological and Agricultural Engineering Dept.,
Texas A&M University, College Station
(since 1988)

Director of the *Irrigation Technology Center*,
a newly formed center under the Texas Water Resources Institute
Regional Water Planning Experience in the Lower Rio Grande Valley

Conducted the analysis of water savings potential in irrigated agriculture for the:

- **Lower Rio Grande Integrated Water Resources Plan Project - Phase II**
  (final report: December 22, 1998)
- **Region M Water Plan**
  (final report: December 22, 2000)

These reports are posted at [http://idea.tamu.edu](http://idea.tamu.edu) and the full text of our reports was included in the appendixes of each final project reports.
Incorporating some existing programs into the ITC, including our *Irrigation District Engineering and Assistance Program*

For more information:
http://itc.tamu.edu
Irrigation District Engineering and Assistance Program

Engineering analysis, technical assistance, applied research, workshops and short courses

(see handout for more information)

IDEA Team

Wesalco
Eric Leigh - Extension Associate
Martin Barroso - Ag Technician
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Collage Station
Dave Flahive - System Analyst/Programmer
Dr. Yanbo Huang - Extension Associate (1/2 time)
Irrigation District Engineering and Assistance Program

**Funding**

- About 2/3 of current funding is from the federal legislative initiative: “Irrigation Conservation in the Rio Grande Basin”
  
  (for more information, see http://riogrande.tamu.edu)

- About 1/3 of funding is from grants, contracts, and fees for services and products
Irrigation District Engineering and Assistance Program

Activities Related to the MSN Analysis

- This year, we have provided assistance to 18 irrigation districts in Region M on seepage loss testing of canals, and analysis of the need for and water savings of rehabilitation projects.

- Released updated GIS-based maps of irrigation districts
Maps

- New, 3-map series of irrigation districts in the LRGV
- Maps of all districts in the Rio Grande Basin
- Complimentary copy of our “location map”
- See handouts for additional map information
Municipal Supply Network Analysis

- Over the last year, received numerous requests for assistance on determining “push water” requirements

- Included the MSN analysis in my work plan for the second year of the Rio Grande Initiative, which runs: May 15, 2003 – May 14, 2004
Municipal Supply Network Analysis

Are our interests in this analysis the same?
Municipal Supply Network Analysis

Concerns

- Definition of “push water”
- Data is not easily obtainable
- Planned and unanticipated use of the data
- Degree of accuracy needed

(accuracy should be related to the planned use of the data)
Municipal Supply Network Analysis

Concerns (continued)

- Complexity of task and labor/effort necessary to produce accurate results
- Details on types of data and analyses needed
- Limited funds from Rio Grande Initiative available for this effort
Municipal Supply Network Analysis

Procedures Used
Procedures

1) Identification/verification of districts with municipal water deliveries

2) Met with districts to:
   - define MSN by locating control structures
   - obtain sizes, dimensions and capacities of MSN components
Procedures

Out of the 14 districts

1 district - all needed information was readily available

2 districts - much of the needed information was readily available

Our GIS database has

- top width of most canals,
- but not the water depths and actual water span widths under normal operational conditions

(needed for MSN calculations)
Procedures

3) With district staff, took field measurements of MSN
4) Determined the surface areas of reservoirs and resacas using aerial photographs
5) Determined segment lengths from GIS
Procedures

6) Computed initiate MSN estimates
7) Summarized data and produced tables and maps for districts to review
8) Dropped off materials at district offices and followed-up to collect comments/corrections
Procedures

9) Took follow-up field measurements and other efforts to develop complete data sets

10) Completed final MSN estimates under normal operational conditions:
    - static volume
    - evaporation
    - seepage losses

9) Collected available info on the types, sizes and operational criteria of municipal takeout structures

10) Define additional analysis needed (in progress)
Municipal Supply Network

Produced two maps illustrating the extent of the MSN Network
Notes on MSN Maps

- Locations of the 39 municipal treatment plants were not confirmed (based on data provided by the Rio Grande Watermaster office)
- Did not map the municipal supply systems that carries water from the district take-out point to plant
### MSN Network Characteristics
*(see table 1 for details)*

<table>
<thead>
<tr>
<th>component</th>
<th>widths/diameters</th>
<th>lengths</th>
<th>Surface area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lined canals</td>
<td>4 - 80 ft</td>
<td>92 mi</td>
<td></td>
</tr>
<tr>
<td>Unlined canals</td>
<td>10 - 150 ft</td>
<td>168 mi</td>
<td></td>
</tr>
<tr>
<td>Pipelines</td>
<td>14 - 72 in</td>
<td>25 mi</td>
<td></td>
</tr>
<tr>
<td>Resacas</td>
<td></td>
<td></td>
<td>377 ac</td>
</tr>
<tr>
<td>Reservoirs</td>
<td></td>
<td></td>
<td>3845 ac</td>
</tr>
</tbody>
</table>
Municipal Supply Network

Static Volume of the MSN Network
Municipal Supply Network

Static Volume of the MSN Network

The volume of water needed to fill the system to normal operational levels used for agricultural water delivery
Canal Shapes and Capacities

- few districts had data readily available on canal shapes and related dimensions
  - (such as bottom width - for trapezoidal)
  - surface area of resacas

- Some did not have reservoir surface area at normal operating depths
Canal Shapes and Capacities

For unknowned canal shapes or canals with incomplete data, assumed:

- parabolic shape (low volume estimate)
- rectangular shape (high volume estimate)
Municipal Supply Network

Static Volume of the MSN Network

15,000 – 17,300 ac-ft
## MSN Network Characteristics

*(see table 2 for details)*

<table>
<thead>
<tr>
<th>component</th>
<th>Static volume (ac-ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lined canals</td>
<td>722 - 866</td>
</tr>
<tr>
<td>Unlined canals</td>
<td>4,382 - 6,527</td>
</tr>
<tr>
<td>Pipelines</td>
<td>26.6</td>
</tr>
<tr>
<td>Resacases</td>
<td>2484</td>
</tr>
<tr>
<td>Reservoirs</td>
<td>8216</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>15,001 - 17,291</strong></td>
</tr>
</tbody>
</table>

*These are the preliminary estimates of static volume of water (ac-ft) needed to charge the MSN for normal agricultural water deliveries (excludes siphons, culverts)*
Municipal Supply Network

Evaporative and Seepage Losses of the MSN
Municipal Supply Network

Evaporative and Seepage Losses of the MSN

(at normal operational levels for agricultural water delivery)
Evaporative Loss Calculations

- Peak evaporation rate:
  - **canals, resacas**
    \[ 0.8 \times \text{pan evaporation} \times \text{surface area} \]
    (avg. peak evaporation rate is 0.25 in/day in July)
  - **reservoirs**
    \[ \text{lake evaporation} \times \text{surface area} \]
    (avg peak evaporation is \(~0.33\) in/day in the LRGV)
Peak Evaporative Losses
(preliminary data)

<table>
<thead>
<tr>
<th>component</th>
<th>Evaporation (ac-ft/ day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canals/resacas</td>
<td>33</td>
</tr>
<tr>
<td>Reservoirs</td>
<td>100</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>133</strong></td>
</tr>
</tbody>
</table>

These are estimates of the total peak evaporation (ac-ft/day) of the MSN at normal operational levels.
# Peak Evaporation Losses

<table>
<thead>
<tr>
<th>component</th>
<th>Evaporation (ac-ft/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canals/resacas</td>
<td>33</td>
</tr>
<tr>
<td>Reservoirs</td>
<td>40</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>73</strong></td>
</tr>
</tbody>
</table>

Excluding Delta Lake (58 ac-ft/day)
Seepage Loss

- Most districts have water loss charges based on percentage - ranging 15 - 30%
- 1 district has a higher charge for municipal deliveries when there is no ag water
- 2 districts use rates based on the gallons delivered

For calculating seepage losses

- we need a rate such as $\text{gal/ft}^2/\text{day}$

*(most common loss rate used)*
Seepage Loss Tests

We have conducted about 50 ponding tests since 1988 to measure seepage and total losses from canals.
Seepage Loss Tests
Seepage Losses

These are the locations of our tests
Seepage Losses

However, only a few have been on the MSN
Seepage Losses

- I do not know what the seepage loss rates are of the MSN.
- Extrapolating from ponding test results, I expect that losses will be in the same range of seepage losses as the majority of tested canals.
## Expected seepage loss ranges (gal/ft$^2$/day)

<table>
<thead>
<tr>
<th>component</th>
<th>Low</th>
<th>High</th>
<th>High with leaks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unlined canals</td>
<td>0.15</td>
<td>3.14</td>
<td>4.71</td>
</tr>
<tr>
<td>Lined canals</td>
<td>0.25</td>
<td>4.62</td>
<td>6.93</td>
</tr>
<tr>
<td>Reservoirs/resacás</td>
<td>0.15</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Leaks for pipelines

- Tested only 1 pipeline
- Loss rate depends on type of materials, type of joint materials (if used), and how full pipe flows
- I expect that total losses in the 26 miles of pipeline is 0.25 - 18.0 ac-ft/day, but more work is needed to confirm this estimate
Seepage Losses
Preliminary Analysis, excluding pipelines

117 ac-ft/ day (low)
808 ac-ft/ day (high)
1171 ac-ft/ day (high with leaks)
# Seepage Losses

## Preliminary Analysis (acre-feet/day)

<table>
<thead>
<tr>
<th>component</th>
<th>Low</th>
<th>High</th>
<th>High with leaks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unlined canals</td>
<td>27</td>
<td>556</td>
<td>834</td>
</tr>
<tr>
<td>Lined canals</td>
<td>9</td>
<td>171</td>
<td>257</td>
</tr>
<tr>
<td>Reservoirs/resacas</td>
<td>81</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td>117</td>
<td>808</td>
<td>1171</td>
</tr>
</tbody>
</table>
No Agricultural Water

- Operational levels for some districts is lower when only supplying municipal water.
- This would reduce both the static volume and seepage losses:
  - Seepage loss rates, in many cases, are lower at shallower depths.
  - The wetted perimeter (or the effective area) decreasing very rapidly with lower depths.
No Agricultural Water

Out of the 14 districts,

- 4 have the data on operational levels needed for just municipal water
- 1 district temporarily raises canal levels during municipal diversions

Remaining data would need to be collected from water utilities
No Agricultural Water

Estimating static volume at less than normal operational levels is difficult

- The static volume of the MSN is not necessarily in direct proportion to the reduction of water level at the municipal take-out point
- Distribution network control structures, siphons and culverts also affect static volumes and flow calculations
No Agricultural Water

No calculation have been made.....
Summary

- An initial analysis of the Municipal Supply Network was completed.
- Defined the MSN based on the location of existing control structures that can be closed to isolate the MSN.
- Collected information on the sizes and extent of MSN components (canals, pipelines, resacas, reservoirs).
Summary

- Computed the static volume of the MSN under normal operational levels
- Calculated peak evaporative losses using pan and lake evaporation data
- Extrapolated seepage losses of MSN based on ponding test data
- Estimated losses from the pipeline component of the MSN
- Checked with districts to see how much data was available on operational levels needed just for municipal water
Next??
Next??

**Improve seepage loss estimates**

- Complete the RAT (rapid assessment tool) for seepage loss
  - RAT combines a visual rating of canal condition with:
    - a) soils information,
    - b) maintenance and usage data
    - c) existing ponding test data
- This work is in progress and will be ready to test in about 2 months
- Can then be used to refined MSN seepage loss rates
Next??

**Considering**

- obtaining complete data sets on 1 or two districts
- determining operational requirements for just municipal water deliveries using
  - GIS tools and
  - DNM *(an Irrigation District Distribution Network Simulation Model)*
Next??

Producing a MSN Report for the Region M Planning Group?

Cooperative Work with the Region M Planning Group?