Conveyance system
Conveyance System Requirements

- Deliver water to every part of the irrigated area at a rate and elevation that permits proper operation of the application system;
- Be compatible with the application equipment;
- Convey the water as economically, efficiently and safely as possible; and
- Be accessible for Operation and Maintenance.
On Farm Conveyance System

Figure 2-65: Delivery system layout for a farm served by a large lateral canal.
Conveyance System Schematic

Figure 2-63 Processes involved in sizing irrigation projects (adapted from Gibbs 1972)

Level of consideration

- Single field
- Single farm
- Multiple farm
- Conveyance system
- Facility design

Available soil-water
- Crop water requirements
- Effective precipitation
- Net irrigation water requirements
- Amount of irrigated land
- On-farm irrigation efficiencies

Cross farm delivery requirement
- Other beneficial uses
- Irrigation delivery time at turnouts
- Multiple farm flexibility factors
- Operational waste

Project conveyance losses
- Size delivery facilities
Conveyance Efficiency

\[ E_c = \frac{Volume \ldots Delivered}{Volume \ldots Diverted} \]

“In irrigation systems, an estimated one-third to one-half of the water diverted for irrigation is lost between the source and point of use”
Conveyance Losses

- Operational spills
- Seepage
- Consumptive Use by vegetation & evaporation
- Leakage around structures
## Typical Conveyance Efficiencies

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Conveyance efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project characteristics</strong></td>
<td></td>
</tr>
<tr>
<td>Continuous supply with no substantial change in flow</td>
<td>90%</td>
</tr>
<tr>
<td>Rotational supply for projects with 7,000 to 15,000 acres and rotational areas of 150 to 800 acres and effective management</td>
<td>80%</td>
</tr>
<tr>
<td>Rotational supply for large projects (&gt; 25,000 acres) and small projects (&lt; 2,500 acres) with problematic communication and less effective management: Based on predetermined delivery schedules</td>
<td>70%</td>
</tr>
<tr>
<td>Based on arranged delivery schedules</td>
<td>65%</td>
</tr>
<tr>
<td><strong>Irrigation field characteristics</strong></td>
<td>Field efficiency</td>
</tr>
<tr>
<td>Irrigated blocks larger than 50 acres with: Unlined canals</td>
<td>80%</td>
</tr>
<tr>
<td>Lined canals or pipelines</td>
<td>90%</td>
</tr>
<tr>
<td>Irrigated blocks smaller than 50 acres with: Unlined canals</td>
<td>70%</td>
</tr>
<tr>
<td>Lined canals or pipelines</td>
<td>80%</td>
</tr>
</tbody>
</table>

For rotational delivery systems with management and communication adequacies of:

- Adequate | 65%
- Sufficient | 55%
- Insufficient | 40%
- Poor | 30%

### Source to Farm
- **Efficiency:** 65% - 95%

### Farm to Field
- **Efficiency:** 70% - 90%

### Source to Field
- **Efficiency:** 30% - 65%
## Distribution Efficiency Study

<table>
<thead>
<tr>
<th>Element</th>
<th>3yr Rounded Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume Diverted, (ac-ft)</td>
<td><strong>355,000</strong> (59 acre-inches)</td>
</tr>
<tr>
<td>Canal Waste (-), (ac-ft)</td>
<td>25,000</td>
</tr>
<tr>
<td>Lateral Waste (-), (ac-ft)</td>
<td>60,000</td>
</tr>
<tr>
<td>System Losses (-), (ac-ft)</td>
<td>50,000</td>
</tr>
<tr>
<td>System Gains (+), (ac-ft)</td>
<td>35,000</td>
</tr>
<tr>
<td>Volume Delivered, (ac-ft)</td>
<td><strong>255,000</strong> (43 acre-inches)</td>
</tr>
<tr>
<td><strong>Distribution Efficiency</strong></td>
<td><strong>72%</strong></td>
</tr>
<tr>
<td><strong>Farm Waste</strong></td>
<td>150,000 (25 acre-inches)</td>
</tr>
<tr>
<td><strong>Application Efficiency</strong></td>
<td><strong>41%</strong></td>
</tr>
<tr>
<td><strong>Overall Farm Efficiency</strong></td>
<td><strong>30%</strong></td>
</tr>
</tbody>
</table>
Conveyance System Components

- Open Channels
- Pipelines
- Conveyance Structures
  - Diversions & Pumps
  - Headgates, Wasteways, Division Boxes, Turnouts …
  - Water Measurement Devices
  - Check & Grade Control Structures
  - Flumes, Siphons & Culverts
Headgates, Turnouts & Other Ditch Structures

They should:
- Provide the required flow rate & elevation or pressure
- Screen excessive or undesirable debris
- Accommodate expected sedimentation
- Provide opportunity for water measurement
- Perform without excessive Operation & Maintenance

And if they don’t:
- Plan repairs, replacement; or
- Develop IWM strategy to deal with the constraint.
Headgates & Turnouts
Headgates & Turnouts
Headgates, Turnouts & Other Structures
Headgates, Turnouts & Other Structures
Headgates, Turnouts & Other Ditch Structures
Other Ditch Structures
Other Ditch Structures
Canals & Ditches

They should:
• Have capacity for the required flow rate
• Screen excessive or undesirable debris
• Accommodate expected sedimentation
• Limit Losses to an acceptable amount
• Perform without excessive Operation & Maintenance

And if they don’t:
• Plan repairs, replacement; or
• Develop IWM strategy to deal with the constraint.
Canals & Ditches

Features:

- Used for main canal, laterals & on farm transport
- Open channel, gravity flow
- Water surface controls the delivery elevation
- Natural earth or lined channels
Canals & Ditches
Canals & Ditches
Canals & Ditches

Benefits:

• Accommodate small to large flows
• May accommodate large debris
• Many alternatives for water measurement
• Low to moderate construction cost (unlined)
• Intercept runoff & groundwater
• May provide some storage capacity
• May support some riparian functions
Canals & Ditches

**Disadvantages:**

- Must have adequate slope
- May require checks & grade control structures
- Prone to operation waste (up to 50% pass through)
- Seepage, vegetative & evaporation losses
- Seepage may damage adjacent land & property
- May occupy a large area & require crossing structures
Canals & Ditches

Disadvantages: cont.

- May provide source of weed seed
- Susceptible to erosion, sedimentation, flood damage, & rodents
- Higher maintenance than pipelines
- Poor maintenance reduces capacity
- Can be a safety concern
Canals & Ditches
Typical Unlined Canal/Ditch Losses

Seepage Loss
0.2 – 6 ft³/ft²/day

Loss to Ditch-side Vegetation
0.5% - 1% per mile

Loss to Ditch Evaporation
~ ≤ 0.5% per mile

NRCS Irrigation Water Management Training
Fort Collins, CO; July 11-15, 2005
Ditch Canal Lining Alternatives
Ditch Canal Lining Alternatives

- Traditional Canal Linings
  - Compacted Clay
  - Concrete Lining
  - Buried Geomembrane
  - Exposed Geomembranes
  - Concrete Covered Geomembranes
  - Spray-applied Membranes

- Reduce seepage loss by 90 – 95%

- Service life 20 to 50 years.
Ditch Canal Lining Alternatives

PAM Canal Treatment
• Cost ~ $.005 to $0.02 / sq ft
• May reduce seepage loss by 30% – 50%
• May require annual treatment
• Doesn’t work in all situations
Pipelines

They should:
• Deliver the required flow at the required elevation/pressure
• Provide opportunity for water measurement
• Perform without excessive operation & maintenance

And if they don’t:
• Plan needed maintenance, replacement; or
• Develop IWM strategy to deal with the constraints
Pipelines

Features:

• Gravity or Pressure Flow
• Available *head* / *pressure* controls delivery elevation
• Above ground or underground installations
• PVC, PE, Concrete, Steel & Aluminum materials
Pipelines

Benefits:

- Less dependent on topography than ditches
- Greater flow control = less operational waste
- Very small water losses (0.01 – 0.15 ft³/ft²)
- Little to no loss of land use
- Eliminate weed seed production
- Less susceptible to environmental damage
- Typically fewer maintenance & safety concerns
Pipelines
Pipelines
Pipelines
Pipelines
Pipelines

**Disadvantages:**

- Moderate to high cost compared to unlined ditch
- Not feasible for large flows
- Must screen out debris and prevent sedimentation
- Fewer and more expensive alternatives for water measurement
- Provides no riparian function values
Pipelines
Summary

“No irrigation system is worth a hill of beans if the water is not available to the crop at the time that the plants require it”

Questions?