4.6 Cost Effectiveness for Agricultural Water Users

The table on the next page shows a simplified example that estimates the annual cost that an agricultural producer will incur to replace an earthen ditch used to convey water to an irrigated field with a buried PVC pipe. It lists the information and calculations needed to determine the annual cost per acre-foot of water saved from installing the proposed pipeline. Narrative information regarding each item in the table is included.

For this example the Net Annual Cost per Acre-Foot of Water Saved equals $11.51. The actual cost per acre-foot of water savings could be smaller or larger depending on actual cost information. Under conditions of high water loss in the existing ditch and/or high energy cost for well water, the Net Annual Cost per Acre-Foot of Water Savings could be a negative value (the cost of the proposed pipeline would both save water and increase the agricultural producers net revenue).

Cost Effectiveness Evaluation for Replacement of an Earthen Ditch with Buried PVC Pipeline.

Item	Description		Units
1	Water Source:	Irrigation Well	
2	Typical Irrigated Crop:	Alfalfa	
3	Gross Water Application for Crop:	4.00	ac-ft/yr
4	Energy Cost per Acre-Foot of Water from Irrigation Well:	$20.00	$/ac-ft
5	Irrigated Area:	120	ac
6	Design Flow Rate for Pipeline:	800	gpm
7	Gross Annual Water Application:	480	ac-ft
8	Time Required to Apply Irrigation Water:	136	days/yr
9	PVC Pressurized Irrigation Pipe (Class 100) Pipe Diameter:	10	inches
10	Pipeline Length:	5,280	ft
11	Assumed Capital Recovery Period for Project:	20	yr
12	Assumed Interest Rate for Capital:	6.00%	%
13	Annual Water Savings:	136	ac-ft
14	Capital Cost for Pipeline:	$10.00	$/ft
15	Capital Cost for Pipeline:	$52,800	$
16	Annual Change in Maintenance Cost (Earthen Ditch to PVC Pipeline):	-$1,500	$/yr
17	Energy Cost for Pipeline Friction (@0.10 $/kwhr, and 70% Pumping Efficiency, 0.32 ft/100ft headloss):	$1,182	$/yr
18	Change in Annual Energy Cost for Well Water:	-$2,720	$/yr
19	Change in Annual Energy Cost (Earthen Ditch to PVC Pipeline):	-$1,538	$/yr
20	Total Change in Annual Energy and Maintenance Costs:	-$3,038	$/yr
21	Annual Capital Recovery Cost:	$4,603	$/yr
22	Net Annual Cost of Pipeline:	$1,565	$/yr
23	Net Annual Cost per Ac-Ft of Water Savings:	$11.51	$/yr

1) **Water Source.** The source of water for this example is from an irrigation well. The source of water is important in determining the amount of energy savings from reduced pumping requirements as a result of the water conservation effort.
2) **Typical Irrigated Crop.** The type of crop proposed to be grown on the irrigated area. Crop type can be used to estimate the annual irrigation water requirement.
3) **Gross Water Application for Crop** is the annual amount of water anticipated to be applied to the field per acre of irrigated area and includes any water that may run off the field or infiltrate past the crop root zone.
4) **Energy Cost per Acre-Foot of Water from Irrigation Well**. The energy cost per acre-foot of water pumped from the irrigation well can be estimated based on the total pumping depth, discharge pressure, energy loss in the pump column, pump efficiency, motor or engine efficiency, and fuel or energy cost. (*See* Texas Agricultural Extension Service Publication L-2218).
5) **Irrigated Area** is the irrigated acreage of the field for which water will be supplied by the proposed pipeline.
6) **Design Flow Rate for Pipeline**. The design flow rate of the pipe is typically matched to amount of water available from the supply source (in this case an irrigation well) and the requirements of the irrigation system. For this example the design flow rate was assumed to be 800 gpm.
7) **Gross Annual Water Application** is the product of the items 3 and 5.
8) **Application Time** is the amount of time required to delivery the Gross Annual Water Application (item 7) using the Design Flow Rate of the Pipeline (item 6).
9) **PVC Plastic Irrigation Pipe Diameter** is commonly calculated as the commercially available pipe diameter that results in a water velocity in the pipeline of approximately 3 feet per second for the Design Flow Rate (item 6).
10) **Pipeline Length** is the length of the earthen ditch being replaced with pipe.
11) **Capital Recovery Period for Project.** The Capital Recovery Period is assumed to be either the cost of borrowing money for the project or the value of the lost opportunity that might have been realized had the capital funds been invested.
12) **Interest Rate for Capital Investment** was assumed to be 6 percent per year.
13) **Annual Water Savings** equals the amount of water lost to evaporation and seepage in the earthen canal. Losses from a properly installed PVC pipeline are approximately zero. The earthen ditch in the example was assumed to lose water at 1 acre-foot per mile per day the ditch is used to convey water.
14) **Installed Capital Cost** (including valves, air release, and other items). The cost of installing the proposed pipeline per linear foot. The cost includes all mobilization, equipment, labor, material, and other construction costs.
15) **Project Capital Cost** (including valves, air release, and other items) equals the product of item 14 and item 10.
16) **Annual Change in Maintenance Cost** (Earthen Ditch to PVC Pipeline): Earthen ditch usually requires periodic maintenance to remove vegetation and wind blown

sediments. Buried PVC pipe usually requires minimal maintenance but can require the occasional repair of leaks. The net decrease in cost was assumed.

17) **Energy Cost for Pipeline Friction**. Typically, there is minimal energy cost for using an open ditch to convey water. Energy loss in pipelines is proportional to the velocity of the water in the pipeline and the type of pipe material. Converting from an earthen ditch to a buried pipeline will increase the amount of energy needed to convey the water from the irrigation well to the field.

18) **Change in Energy Cost for Well Water.** The annual amount of water pumped by the irrigation well to be delivered to the field is reduced by the amount of water saved by installing the pipeline. The water savings results in a proportional reduction in energy cost for water supplied by the irrigation well.

19) **Change in Annual Energy Cost** (Earthen Ditch to PVC Pipeline) equals the sum of items 17 and 18.

20) **Total Change in Energy and Maintenance Costs** equals the total of items 16 and 19.

21) **Annual Capital Recovery Cost** equals the annual payment that would be required to service a loan for the amount of capital required to construct the proposed project (item 15).

22) **Net Annual Cost of Pipeline** equals the sum of items 20 and 21.

23) **Net Annual Cost per Ac-Ft of Water Savings** equals item 22 divided by item 13.

I. References for Additional Information

1) Texas Agricultural Extension Service, L-2218, "Pumping Plant Efficiency and Irrigation Costs."

2) University of Tennessee, Agricultural Extension Service, "Irrigation Cost Analysis Handbook."