Irrigation
FACTSHEET

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REDUCING PUMPING COSTS BY INCREASING IRRIGATION SYSTEM EFFICIENCIES

An efficient irrigation system can only be achieved by following correct design, installation and management procedures. By selecting the correct pump and pipeline sizes, crop-soil-nozzle combinations, and irrigating according to crop requirements, the irrigator can receive the best return on his initial investment. However, an existing irrigation system can also be made cost-effective by implementing energy saving ideas.

Quite often an irrigation system that appears to be operating satisfactorily may actually have a very poor efficiency. To illustrate this point, let's examine a sample irrigation system, plan 550.002, shown on the back of this factsheet. (Additional information regarding this design can be found at the back of the "B.C. Sprinkler Irrigation Manual". The initial irrigation design correctly matched the crop and soil limitations. The following inefficiencies are selected, as they occur quite frequently for "on-farm" irrigation systems.

a) The irrigation system was installed 10 years ago. Although the plan indicated a pump requirement of 964 gpm at 288 ft., the farmer purchased a 120 h.p. unit capable of 1020 gpm at 305 ft. of head (65% efficient). The rest of the system was installed as per plan.

b) Valves and fittings that matched the pump discharge were used in transition from the pump to the 10" PVC mainline.

c) The past 10 years have worn the nozzles slightly and they are now discharging 9.5 gpm instead of the original 9.0 gpm (107 sprinklers x 9.5 gpm each = 1017 gpm).

d) The number of irrigation days per month averaged at:

May	15 days
June	20 "
July	25 "
August	25 "
September	15 "
	100 days
	at 24 hrs/day
	= 2400 hrs/season

The irrigation system demand is 1017 gpm at 305 ft. of head, which utilizes a 120 h.p. pump operating at 65% efficiency. The power bill for the last irrigation season was:

$$120 \text{ h.p.} \times 0.746 \frac{\text{Kw*}}{\text{h.p.}} \times 2400 \text{ hrs} \times \frac{\$0.0233}{\text{Kw-hr.}}$$

= $5006 per year

= $50 per irrigation day

To lower operating cost by improving irrigation system efficiency, the irrigator could implement any or all of the following alterations.

* For purposes of this report, electric motor efficiencies are assumed to be 100%. Actual motor efficiencies will vary between 80-95%.

Increase Pump Efficiency

The pump selected should be operating at or close to its "Best Efficiency Point". Check to ensure that the correct impeller is used and possibly even change pumps if a different model will provide a much better efficiency at the operating point desired.

In this case, there is a pump available that will provide 1017 gpm at 305 ft. at an efficiency of 80%.

Horsepower required =

$$\frac{1017 \text{ gpm} \times 305 \text{ ft. of head}}{3960 \times .80} = 98 \text{ h.p.}$$

Annual power costs =

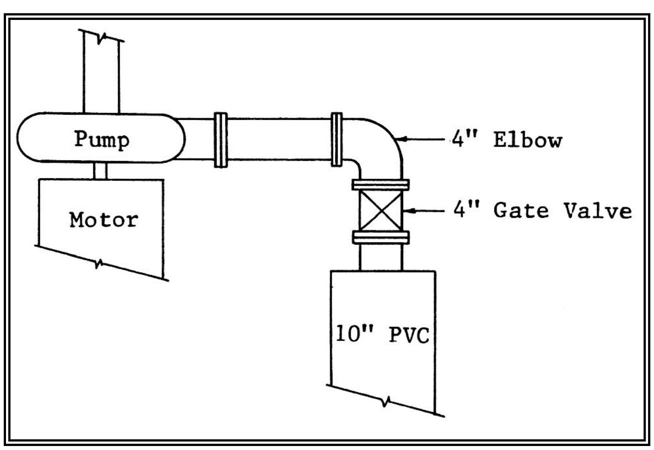
$$98 \text{ h.p.} \times 0.746 \frac{\text{Kw}}{\text{h.p.}} \times 2400 \text{ hrs} \times \frac{\$0.0233}{\text{Kw-hr.}}$$

= $4088 per year   Savings = **$918 per year**

Improve Friction Loss in Fittings at Pump Discharge

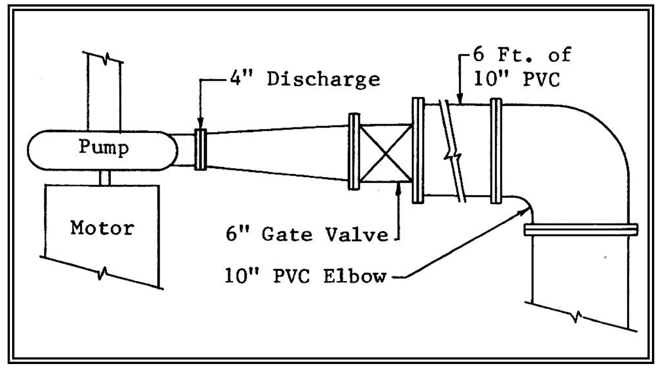
Quite often the fittings at the pump are sized to match the pump discharge opening. The friction loss through these fittings can add a significant amount to the total dynamic head (TDH) that must be produced by the pump.

Figure A



FRICTION LOSS = 19 ft.

FIGURE B



FRICTION LOSS = 2 ft.

The use of a two-stage pipe expansion has been shown to reduce friction losses by 75%. Also, a 10" elbow vs. the 4" elbow and a 6" valve instead of a 4" valve makes a significant difference. By changing the pump discharge fittings from Figure A to Figure B, the pump TDH has been reduced by 17 ft.

The power cost savings achieved are:

$$\frac{1017 \text{ gpm} \ @ \ 288 \text{ ft.}}{3960 \times .80} = 93 \text{ h.p.}$$

Annual power costs =

$$93 \text{ h.p.} \times 0.746 \frac{\text{Kw}}{\text{h.p.}} \times 2400 \text{ h.p.} \times \frac{\$0.0233}{\text{Kw-hr.}}$$

= $3880 per year

Additional savings = **$208 per year**

Replace Worn Nozzles

Worn nozzles will apply more water than required, quite often exceeding the available water storage capacity (AWSC) and allowable infiltration rate of the soil. The sample irrigation system was designed to match the soil and crop limitations that exist. Therefore, any water applied that exceeds the soil capacity is wasted and unnecessarily increasing power costs. The cost saving achieved by replacing the old nozzles would be:

107 sprinklers x 9.0 gpm/ea = 963 gpm

$$\frac{963 \text{ gpm} \times 288 \text{ ft.}}{3960 \times .80} = 87.5 \text{ h.p.}$$

$$87.5 \text{ h.p.} \times 0.746 \frac{\text{Kw}}{\text{h.p}} \times 2400 \text{ hrs} \times \frac{\$0.0233}{\text{Kw-hr}}$$

= $3650 per year (annual power cost)

Additional savings = **$230 per year**

Reducing Sprinkler Pressure Requirements

The use of spray nozzles on center pivots and low pressure nozzles for impact sprinklers on handlines and wheelmoves is a potential energy saver by reducing the T.D.H. required by the pump. Low pressure nozzles for sprinklers, operating at 35 psi, distribute water in a similar pattern as the conventional double nozzled sprinklers but with a reduction in wetted diameter. Sprinklers must therefore be spaced closer together. This short fall can be overcome by offsetting the lateral from its normal set every other time it crosses the field.

For example, a wheelmove on a 40' x 60' spacing would traverse the field at 60 ft. intervals, but the next time it crosses the field it would be set halfway between the initial settings. (i.e. The first move would be 30 ft., but subsequent moves would be 60 ft.).

In our sample plan, the difference in elevation from x_3 to x_5 accounts for 11 psi. Therefore, reducing the sprinkler pressure on the laterals operating in this area by 11 psi will reduce the pump TDH by 25 ft., but will still allow the laterals at the lower end of the system to continue operating as before. (For the sample plan, the nozzles should be changed from 3/16" x 3/32" to 3/16" x 1/8").

Reducing the pump TDH by 25 ft. will save:

$$\text{h.p} = \frac{963 \text{ gpm} \times 263 \text{ ft.}}{3960 \times .80} = 80 \text{ h.p}$$

$$80 \text{ h.p} \times 0.746 \frac{\text{Kw}}{\text{h.p.}} \times 2400 \text{ hrs} \times \frac{\$0.0233}{\text{Kw-hr}}$$

= $3337 (annual power cost)

Additional savings = **$313 per year**

Note: **Reducing the pump discharge head will not be a benefit unless the pump impeller is trimmed or another pump selected.** Also, the allowable pressure loss along a lateral will be reduced when low pressure nozzles are used.

Use a Systematic Irrigation Scheduling Program

Unless soil moisture is monitored, it is virtually impossible to tell if a field is being over-irrigated. Under-irrigation can usually be detected by visual signs in the crop, but this may not be the case for over-irrigation, especially in well-drained soils. Applying too much water may leach nutrients out of the soil, but in amiable conditions still maintain a good crop.

To reduce operating costs, some methods of irrigation scheduling that could be used are:

- Water budget (record the amount of rainfall, irrigation and evapotranspiration on a daily basis).
- Tensiometers – measure the amount of soil moisture in the soil.
- Soil moisture observation holes – physically assess the soil moisture condition.

For our sample plan let's assume that irrigation scheduling has reduced the number of irrigation days per month to:

May	12 days
June	15 "
July	25 "
August	23 "
September	12 "
	87 days at 24 hours/day = 2088 hours

Operating Cost =

$$80 \text{ h.p.} \times .746 \frac{\text{Kw}}{\text{h.p}} \times 2088 \text{ hrs} \times \frac{\$0.0233}{\text{Kw-hr}}$$

= $2903 per year Savings = **$434 per year**

The above reduction in operating days is easily achieved (most likely conservative) with proper management and irrigation scheduling.

Summary

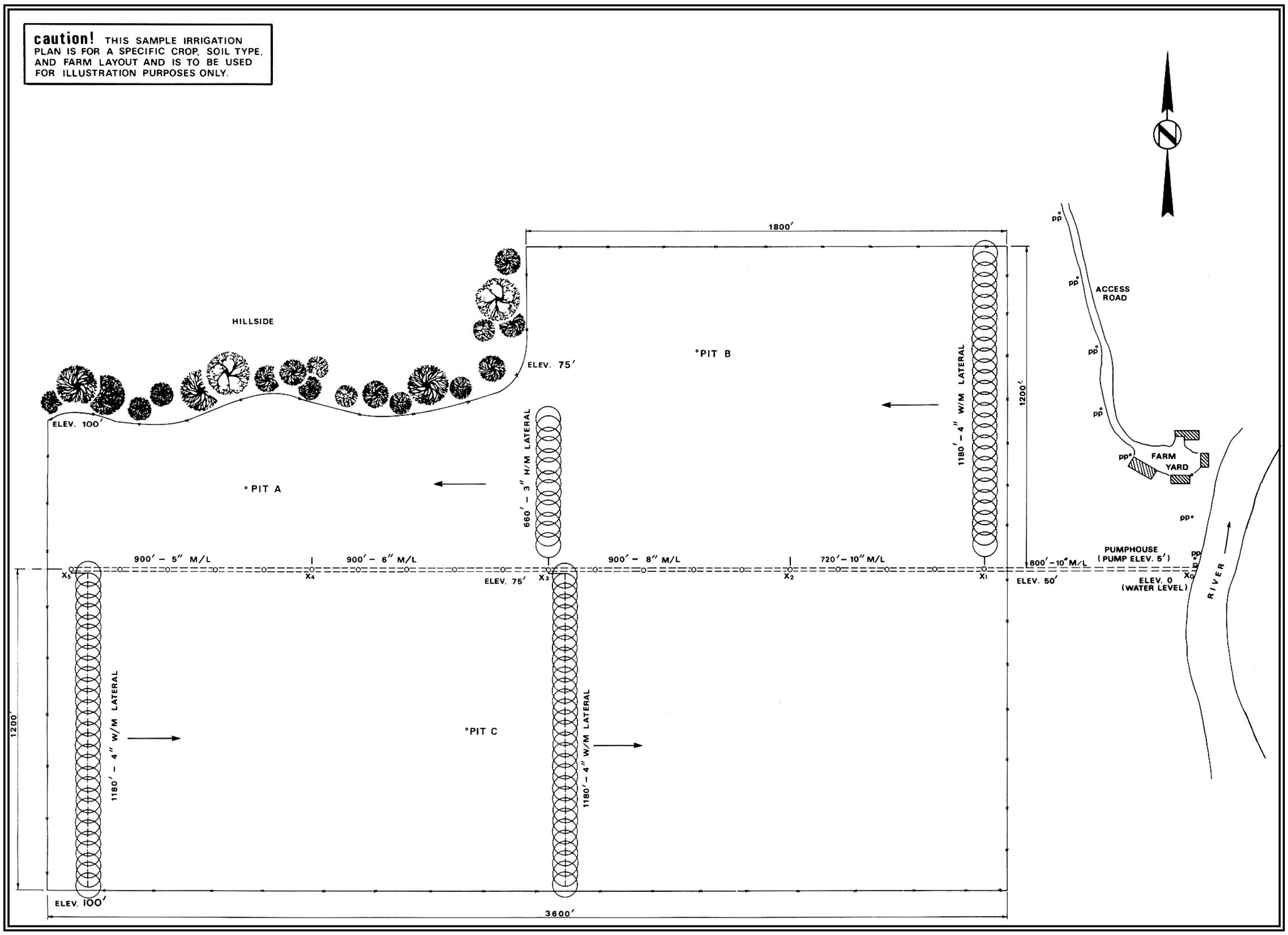
By applying some energy saving techniques, we have reduced the horsepower requirement of the pump from 120 h.p. to 80 h.p. The operating hours per year have been reduced to 2088 hours from 2400 hours.

The total operating cost saving is:

$5006 per year - $2903 per year = **$2103 per year**

(This is a remarkable 42% reduction in power cost. Cost reductions for other systems may vary substantially depending upon site-specific situations).

An irrigator should be sure that the changes he is implementing are not detrimental to the crop or soil. Changes in cropping practices (i.e. from hay to alfalfa) can alter design parameters; perhaps rendering some of the efficiency changes suggested useless. Farmers wishing assistance in "tuning" their irrigation system can contact the Resource Management Branch, BC Ministry of Agriculture and Food.



FOR FURTHER INFORMATION CONTACT:
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