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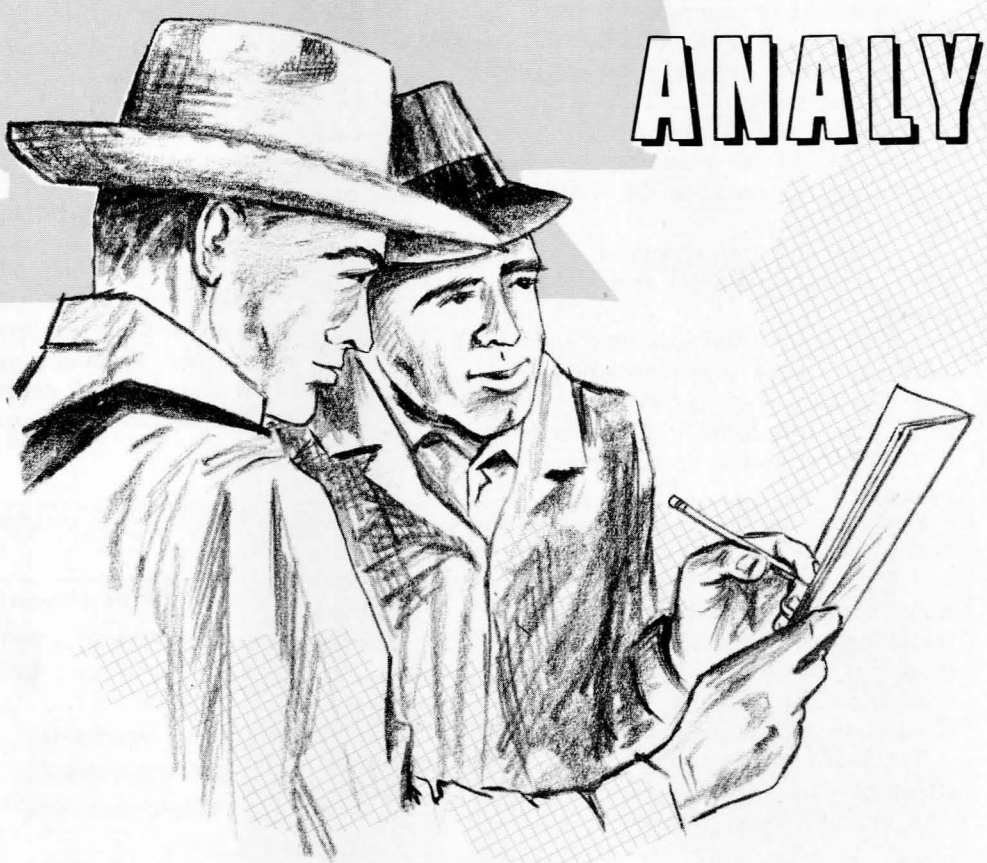
Pump Irrigation ..... COST ANALYSIS



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Pump Irrigation Cost Analysis

By Deon D. Axthelm, Extension Irrigationist and
J. F. Decker, District Extension Irrigationist

SUMMARY

This bulletin will help you figure the various fixed and operating costs of pump irrigation. It is organized into the following sections:

A. General information needed.
B. Investment or fixed costs.
C. Operating or cash costs.
D. Total costs.

Examples and instructions are color coded in each section and in the pumping cost analysis work form located in the back of the bulletin. The form may be used to:

1. Estimate pump irrigation costs for planning new units, if pumping level and yield can be fairly estimated.
2. Determine total pumping costs for an operating unit where operating costs are known.
3. Evaluate costs according to Nebraska Performance Standards following a pumping plant test.
4. Make economic comparisons if selecting a power unit and fuel.

Fixed cost figures are based upon depreciation records available for various parts of the pumping plant and the estimates of Nebraska well drillers. Depreciation schedules are shown in Tables 1 to 7. Cost factors for selected depreciation rates from 6 to 25 years are shown in Table 8.

Nebraska Performance Standards for fuels, oils and repairs are shown in Tables 9 to 11.

Total annual pumping cost may be determined either as cost per hour of pumping or as cost per acre foot of water pumped.

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SECTION A
General Information Needed

Pumping rate in gallons per minute, pumping head in feet, and fuel use per unit of time are figures needed to find the relative performance and operating costs of a pump irrigation unit. These items are listed in Section A of the Pumping Cost Analysis Form at the back of this circular.

If planning a new well use estimates of pumping rates and pumping head that would be expected in your area. From these you can determine water horsepower and power unit size. You will need to estimate annual pumping hours, the type of fuel you expect to use and its average cost per unit. Local interest rates are needed to determine fixed costs.

Here's an example of how to fill out Sample Form-Section A.

Assume your well is pumping 900 gallons per minute (GPM) at a pumping head of 100 feet. The pumping rate is in gallons per minute as measured by the Sparling meter, Parshall flume or other measuring device. It may be estimated for wells in the planning stage.

Enter 900 opposite "Pumping rate—gpm."

Operating head for open discharge units means the distance in feet from the water level during pumping to the center of the discharge pipe. If water is distributed by a pipe system, either gated or sprinkler, multiplying the pounds of pressure at the center of the pump discharge by 2.31 will show the additional pumping head in feet which must be added to the pumping lift to determine total operating head or lift.

In our example, the lift from the well is 77 feet. The piping system requires 10 pounds of pressure.

Enter 77 feet opposite "Lift in feet."

Enter 10 pounds x 2.31 = 23 feet opposite "Discharge pressure."

The 77 feet of lift plus the 23 feet discharge pressure equals the total operating head of 100 feet.

Enter 100 feet opposite "Total operating head."

For proposed wells, you will have to estimate the lift and the piping system discharge pressure. You can get help in estimating pressures for gated pipe or sprinkler systems from your county Extension agent, pipe or pump industry representatives or from local Soil Conservation Service offices.

The water horsepower (whp) figure is needed to help find engine size, fuel and oil consumption, and repair and maintenance costs.

To find water horsepower, multiply operating head (in feet) by gallons per minute, and divide by 3960.

$$\text{whp} = \frac{\text{total head (100 ft.) x gpm (900)}}{3960} = 22.7$$

Enter 22.7 opposite "Water horsepower."

To plan for power unit size you need to know the horsepower (bhp) required by the pump.

To find the horsepower used in the pumping operation, divide water horsepower by pump efficiency times drive efficiency. We already have the whp of 22.7 from our form.

Pump efficiency can be assumed to be 75% when

Sample Form — Section A

A. General Information

Pumping rate—gpm	**900**
Pumping head	
Lift in feet = 77	
Discharge pressure 10 x 2.31 = 23	
Total operating head (feet)	**100 ft.**
Water horsepower	**22.7**
$\text{whp} = \frac{\text{Total head (feet) x gpm}}{3960}$	
Horsepower required to the pump	**32**
$\text{bhp} = \frac{\text{whp}}{\text{pump efficiency \% x drive efficiency \%}}$	
Engine size needed	**52**
Estimated annual pumping hours	**900**
Fuel, Propane, cost per unit	**.10**
Interest rate, %	**5½%**

Section A (continued)

planning new units or for existing pumps in good adjustment.

Drive efficiency for either belts or gearheads is approximately 95%.

$$\text{bhp} = \frac{\text{whp}(22.7)}{\text{pump efficiency } (75\%) \times \text{drive efficiency } (95\%)} = 32$$

Enter 32 after "Horsepower required to the pump."

The size engine to buy for a new installation will not be the same as the horsepower required by the pump.

In our example, it will take an engine rated at 52 maximum corrected horsepower to produce the 32 brake horsepower required by the pump. Here are some reasons why.

Engine sizes are usually quoted from the manufacturer's *maximum corrected* power curve. This curve gives the brake horsepower the engine delivers at different speeds under optimum conditions. The engine power decreases when these conditions differ. The engine should produce the required horsepower at a reasonable speed.

To find out why the engine size needs to be rated at 52 horsepower to supply the 32 bhp to the pump, we assume the engine has a radiator, fan and generator; that it will operate at 100 degrees free air temperature at an elevation of 2,000 feet. Find the proper size of power unit from the manufacturer's *maximum corrected* power curve as follows:

(1) For engine accessories, divide bhp by 85 percent.

(2) For 40 degrees of air temperature rise above 60 degrees F. (our example, 100 degrees F.) divide bhp by 96 percent.

(3) For 2,000 feet elevation above sea level, (our example) divide bhp by 94 percent.

(4) For continuous service, divide bhp by 80 percent.

Now, apply these adjustments to select the proper size combustion engine from the manufacturer's *maximum corrected* power curve.

$$\text{Engine size} = \frac{32 \text{ bhp}}{.85 \times .96 \times .94 \times .80} = 52 \text{ maximum corrected hp.}$$

Thus, you would need an engine rated at 52 maximum corrected horsepower for the 32 bhp pump requirement. Selection of an engine larger than 1½ times the calculated corrected horsepower will result in excessive fuel use.

Enter 52 after "Engine size needed."

When selecting your engine follow the steps shown in the example to find the proper engine size from the manufacturer's maximum corrected horsepower curve. However, your operating conditions of air temperature and elevation may be different from those used in the example. **Use the following chart to find the adjustment figures that fit your situation.**

Condition	Divide Horsepower Required to the Pump (bhp) by:	
Engine accessories		.85
Maximum air temperature (degrees)	110	.95
	100	.96
	90	.97
Elevation above sea level (feet)	1000	.97
	2000	.94
	3000	.91
	4000	.88
	5000	.85
Continuous service		.80

If you select an electric motor, the name plate rating should equal the brake horsepower requirement of the pump. In our example, if we use an electric motor connected directly to the pump, we would consider drive efficiency at 100%, making the bhp required, 30. This would be the size electric motor to use.

The Nebraska Inter-Industry Electric Council Irrigation and Wiring Standard allows a 10% overload of electric motors over name plate rating. Thus, if our requirements remain at 32 bhp, a 30 hp name plate rating electric motor would be satisfactory.

To find annual pumping hours estimate the average use per year. Experienced irrigators can help you. In this example, assume 900 hours.

Enter 900 hours opposite "Estimated annual pumping hours."

Enter type of fuel you plan to use after "Fuel" (in this example, propane).

Enter expected cost per unit (in this example, 10¢ per gallon).

Enter interest rate you would currently have to pay if money were borrowed (in this example, 5½%).

SECTION B
Investment or Fixed Costs

Fixed or investment costs consist of depreciation and interest, taxes, insurance, and standby charges for electric motors. Fixed costs of pump irrigation systems are about equal to annual cash costs under normal pumping.

Section B of the Pumping Cost Analysis Form provides a summary of investment costs. Depreciation schedules for the various parts of the irrigation system are shown in Tables 1 through 7.

The estimates from the tables should be adjusted to local conditions. For example, a 10-gauge metal well casing or distribution pipe will last longer than one of 12-gauge thickness. A 10-gauge casing in one area may last longer than in another area because of water and soil composition.

The bowl and impeller pump parts may wear out first if the well pumps sand.

Annual hours of pumping and maintenance affects the life of power units and pumps.

Life of the gear head or belt drive partially depends on correct adjustment.

Other components' life expectancy in part depends on quality of the materials, amount of use, and normal deterioration.

To determine investment costs enter in the Pumping Cost Analysis Form the estimated years of life of the various parts of your irrigation system under Section B, column 1, opposite the appropriate item.

To help you assemble investment costs of a pump irrigation unit, sample form B is provided with step-by step examples.

Assume your well is of 10-gauge steel casing, sand-free, using a propane engine with tank and ¼-mile aluminum gated pipe. The pump has a gear drive.

From Table 1 you see that ten-gauge steel casing has an estimated life of 25 years.

Enter 25 in Column 1 opposite "Well."

Table 2 shows you the estimated life of a turbine pump is 15 to 18 years.

Enter 18 in Column 1 opposite "Pump."

Table 3 tells you the life of a propane engine power unit is 10 years.

Enter 10 in Column 1 opposite "Power unit."

Table 4 shows you the life of a gear drive power transmission is 12 years.

Enter 12 in Column 1 opposite "Power transmission."

Because the example shown is not an electric unit no entry will be made opposite "Electric switches."

Table 5 shows you the life of a propane fuel tank is 20 years.

Enter 20 in Column 1 opposite "Fuel tanks."

Table 1. Well depreciation schedule.

	Casing gauge				Concrete
	8	10	12	14	
Expected life (years)	25+	25	15	12	25+

Table 2. Pump depreciation schedule.

	Turbine Pump
Expected life (years)	15–18

Table 3. Power unit depreciation schedule.

	Type of fuel		
	Electric	Diesel	Natural gas or propane
Expected life (years)	25	12	10

Table 4. Power transmission unit depreciation schedule.

	Gear drive or belt head	Belts
Expected life (years)	12	6

Table 5. Electric switches, natural gas lines and fuel-tank depreciation schedule.

	Switch	Gas line		Fuel tank	
	Housed or weatherproof	Iron	Plastic	Propane	Diesel
Expected life (years)	20	20	18	20	18

Sample Form — Section B

B. Investment or Fixed Costs

Item	Column 1 Est. years of life	Column 2 Investment cost		Column 3 Cost factor	Column 4 Annual cost
Well	25	$2000	x	.0675	$135.00
Pump	18	1500	x	.0831	124.65
Power unit	10	900	x	.1275	114.75
Power transmission	12	350	x	.1108	38.78
Electric switches	....	.....	x	.....	.....
Fuel lines or tanks	20	229	x	.0775	17.75
Pipe, main	15	2600	x	.0942	244.92
Sprinkler	....	.....	x	.....	.....
Other	....	.....	x	.....	.....
	Total investment	$7579		Annual cost	$675.85
Additional Annual Costs					
Taxes & insurance (total investment x .01)					75.79
Fixed charges, electric unit; hp..... x $.....hp					.....
TOTAL ANNUAL FIXED COST					$751.64

Section B (continued)

Table 6 shows you that aluminum pipe line life is 15 years.

Enter 15 in Column 1 opposite "Pipe, main."

No entries will be made opposite "Sprinkler" or "Other" items because these do not apply.

The next step is to enter the investment cost of each item in Column 2.

Use your own records or check with your county Extension agent or equipment dealer. The figures shown on the sample form are for example purposes only.

Add items in Column 2 to get the total investment of $7,579.

The third step is to select the cost factors from Table 8 and enter in Column 3. Note the expected years of life for each piece of equipment. Find the cost factor to use under the expected years life opposite the interest rate.

If the current interest charges are 5½ percent the cost factor for Column 3 opposite "Well" is .0675.

The corresponding figure for Column 3 opposite "Pump" is .0831.

The cost factor for Column 3 opposite "Power unit" is .1275.

The cost factor for Column 3 opposite "Power transmission" is .1108.

The cost factor for Column 3 opposite "Fuel lines or tanks" is .0775.

The cost factor for Column 3 opposite "Pipe, main" is .0942.

To find the annual cost (Column 4) multiply the investment cost for each item (Column 2) by the cost factor (Column 3).

Table 6. Water mainline distribution pipe depreciation schedule.

	Underground			Aboveground		
	Concrete	Steel	Asbestos cement	Plastic	Steel	Aluminum
Expected life (years)	25+	20+	25+	18	18	15+

Table 7. Sprinkler system depreciation schedule.

	Hand-move	Side-roll	Skid-tow	Wheel-tow	Boom type	Self-propelled
Expected life (years)	15	12	10	10	12	10

Table 8. Annual investment or fixed cost factors.

		Expected years of life						
		6	10	12	15	18	20	25
Cost factors at varying interest rates	5 %	.1917	.1250	.1083	.0917	.0806	.0750	.0650
	5½%	.1942	.1275	.1108	.0942	.0831	.0775	.0675
	6 %	.1967	.1300	.1133	.0967	.0856	.0800	.0700

Column 4 is then totaled to show the annual cost of $675.85.

Taxes and insurance may be added to the fixed costs section. Multiply total investment by .01 to get an estimate of annual tax and insurance costs.

This amounts to $75.79. This figure, added to annual cost of $675.85 for the over all plant, gives you a total of $751.64 for the total annual fixed costs.

Fixed charges for an electric unit were not added to Section B since the example involved is not an electric unit. For units operated by electric motors, standby or fixed charges may be added to annual fixed cost if that method of billing is used by power suppliers.

SECTION C
Annual Operating Costs

Operation (or cash) costs include fuel, oil, repairs and service costs.

Summarize your annual cash costs in Section C of the Pumping Cost Analysis Form.

If you have a cost record of fuels, oils, and repairs enter them on the appropriate lines of 1a, 2a, 2c and 3a, respectively. Service charges for labor on internal combustion engines is estimated at four percent of pumping hours and at $10 per season for electric units. Enter proper charges in item 4. Enter the sum of items 1, 2, 3, and 4 opposite total annual operating costs.

If you do not have cost records or if you wish to estimate annual cash costs from a pumping test or a typical standard unit, use Nebraska Performance Standard figures for fuel use, oil consumption and repairs and maintenance as shown in Tables 9, 10 and 11.

To estimate cash costs according to Nebraska Performance Standards use items 1b, 2b, 2d, and 3b of Section C. If a fuel consumption test has been made on your pumping plant, use that figure in item 1c of Section C in lieu of 1a or 1b.

Here is a step-by step example of how to fill out Section C.

Your well is pumping 900 gallons per minute at a head of 100 feet. Water horsepower developed by the pump is 22.7. The power unit burns propane and performance is at Nebraska Performance Standards.

The object is to determine annual operating costs when the pump is used 900 hours per season.

To find fuel costs with propane at 10¢ per gallon, use formula 1b, Section C; water horsepower, 22.7, times 900 hours pumping times 10¢ per gallon divided by water horsepower hours per unit of fuel, 6.89 (Table 9).

Enter the result, $296.52 opposite item 1b, Section C.

Next, estimate cost of engine oil by use of formula 2b, Section C; water horsepower, 22.7, times 900 pumping hours, times $1, divided by water horsepower hours per unit of oil, 800 (Table 10).

Enter the result, $25.54, opposite 2b, Section C.

Estimate oil cost for the pump gear head by use of formula 2d, Section C; water horsepower, 22.7, times 900 pumping hours, times $1, divided by water horsepower hours per unit of oil, 4,000 (Table 10).

Enter the result, $5.11, opposite 2d, Section C.

Now estimate cost of repairs and maintenance by use of formula 3b, Section C; water horsepower, 22.7, times 900 pumping hours, times cost per water horsepower, .0016 (Table 11).

Enter the result, $32.69, opposite 3b, Section C.

Next, estimate service charges according to formula 4, Section C. Assuming labor at $1.50 per hour, 900 pumping hours, times .04, times $1.50, equals $54.

Enter the result, $54, opposite item 4, Section C.

To find total annual operating costs add items in Section C.

Enter $413.86 opposite "Total Annual Operating Costs."

Table 9. Fuel consumption.

Nebraska Performance Standards	
Fuel	whp.-hrs. per unit of fuel
Diesel	10.94 per gallon
Gasoline	8.66
Tractor fuel	7.86
Propane	6.89
Natural gas	66.7 per 1000 cu. ft.
Electric	0.885 per kw-hr.

Table 10. Oil consumption.

Type engine	whp.-hrs. per gallon
Gasoline, tractor fuel, diesel	700
Propane, natural gas	800
Electric	7000
Right angle gear drive	4000

Table 11. Repairs and maintenance.

Type engine	Cost per whp.-hr.
Gasoline, tractor fuel	$.0021
Propane, natural gas	.0016
Diesel	.0025
Electric motor is assumed to be $10.00 per year	

Sample Form — Section C

C. Annual Operating Costs	
1. Fuel: kind	
a. From your records, amount used ..... **@ $**..... **per unit**	**$** .....
b. If records not available, estimate from Performance Standards whp 22.7 x hrs. pumping 900 x $ .10/unit of fuel ÷ 6.89 whp-hrs/unit of fuel	**$296.52**
c. If engineering well test has been made, fuel/hr. ..... **x hrs. used** ..... **@ $**..... **unit**	**$** .....
2. Oil—Engine	
a. From your records, amount used ..... **x $**...../**gal.**	**$** .....
b. Estimate from Performance Standards whp 22.7 x hrs. pumping 900 x $1.00/gal. ÷ 800 whp-hrs./gal.	**$ 25.54**
Oil—Electric Motor or Gear Drive	
c. From your records, amount used ..... **@ $**...../**gal.**	**$** .....
d. Estimate from Performance Standards, whp 22.7 x hrs. pumping 900 x $1.00/gal. ÷ 4,000 whp-hrs./gal.	**$ 5.11**
3. Repairs and Maintenance	
a. Amount spent during season	**$** .....
b. Estimate from pumping test or Performance Standards whp 22.7 x hrs. pumping 900 x $.0016/whp hr.	**$ 32.69**
4. Service Charges	
Hrs. pumping 900 x .04 x labor cost $1.50/hr. (electric units—$10.00 per year)	**$ 54.00**
TOTAL ANNUAL OPERATING COSTS	**$413.86**

SECTION D
Cost Summary Totals

Annual fixed and operating costs are figures needed in finding the total cost figure for your pumping operation. These items are found in Section D of the Pumping Cost Analysis Form.

Annual fixed costs from Sample Form B and annual operating costs from Sample Form C are shown here.

Add the total annual fixed costs and total annual operating costs from Sections B and C.

Enter $1,165.50 after "Total Annual Pumping Costs."

You find total cost per hour of pumping by dividing total cost by hours of pumping. For example, $1,165.50 divided by 900 equals $1.30 per hour.

Enter $1.30 after "Cost per hour."

A very useful figure is cost per acre foot of water. Determine acre feet by multiplying gallons per minute (900) times hours pumping (900) and dividing by 450 times 12 (equals 150 acre feet pumped). Total annual pumping cost ($1,165.50) divided by 150 acre feet pumped equals $7.77 cost per acre foot of water.

Enter $7.77 after "Cost per acre foot of water."

Sample Form — Section D

D. Cost Summary Totals		
Total Annual Fixed Costs (B)	**$751.64**	
Total Annual Operating Costs (C)	**$413.86**	
Total Annual Pumping Costs		**$1165.50**
Cost per hr: Total annual cost ÷ annual hrs. pumping		**$ 1.30**
Cost per acre foot of water		**$ 7.77**
Total annual pumping costs ÷ acre feet pumped		
Acre feet = gpm x hrs. pumping / 450 x12		

PUMPING COST ANALYSIS FORM

A. General Information

Pumping rate—gpm ..... _____

Pumping head

Lift in feet _____

Discharge pressure _____ x 2.31 = _____

Total operating head (feet) ..... _____

Water horsepower ..... _____

$$\text{whp} = \frac{\text{Total head (feet) x gpm}}{3960}$$

Horsepower required to the pump ..... _____

$$\text{bhp} = \frac{\text{whp}}{\text{pump efficiency \% x efficiency drive \%}}$$

Engine size needed ..... _____

Estimated annual pumping hours ..... _____

Fuel, _____, cost per unit ..... _____

Interest rate, % ..... _____

B. Investment or Fixed Costs

Item	Column 1 Est. years of life	Column 2 Investment cost		Column 3 Cost factor		Column 4 Annual cost
Well	_____	$_____	x	_____	=	_____
Pump	_____	$_____	x	_____	=	_____
Power unit	_____	$_____	x	_____	=	_____
Power transmission	_____	$_____	x	_____	=	_____
Electric switches	_____	$_____	x	_____	=	_____
Fuel lines or tanks	_____	$_____	x	_____	=	_____
Pipe, main	_____	$_____	x	_____	=	_____
Sprinkler system	_____	$_____	x	_____	=	_____
Other	_____	$_____	x	_____	=	_____
	Total investment	$_____			Annual cost	$_____

Additional Annual Costs

Taxes & Insurance (total investment x .01) $_____

Fixed charges, electric unit; hp_____ x $_____/hp $_____

TOTAL ANNUAL FIXED COST $_____

C. Annual Operating Costs

1. Fuel: kind _____
   a. From your records, amount used _____ @ $_____ per unit $_____
   b. If records not available, estimate from Performance Standards, whp _____ x hrs. pumping _____ x $_____/ unit of fuel ÷ _____ whp-hrs/ unit of fuel $_____
   c. If engineering well test has been made, fuel/hr. _____ x hrs. used _____ @ $_____/unit $_____
2. Oil—Engine
   a. From your records, amount used _____ x $_____/gal. $_____
   b. Estimate from Performance Standards, whp _____ x hrs. pumping _____ x $_____/gal. ÷ _____ whp-hrs./gal. $_____

   Oil—Electric Motor or Gear Drive
   c. From your records, amount used _____ @ $_____/gal. $_____
   b. Estimate from Performance Standards, whp _____ x hrs. pumping _____ x $_____/gal. ÷ _____ whp-hrs./gal. $_____
3. Repairs and Maintenance
   a. Amount spent during season $_____
   b. Estimate from pumping test or Performance Standards, whp _____ x hrs. pumping _____ x $_____/whp-hr. $_____
4. Service Charges
   Hrs. pumping _____ x .04 x labor cost $_____/hr.
   (electric units—$10.00 per year) $_____

TOTAL ANNUAL OPERATING COSTS $_____

D. Cost Summary Totals

Total Annual Fixed Costs (B) $_____

Total Annual Operating Costs (C) $_____

Total Annual Pumping Costs $_____

Cost per hr.: Total annual cost ÷ annual hrs. pumping $_____

Cost per acre foot of water $_____

Total annual pumping costs ÷ acre feet pumped

$$\text{Acre feet} = \frac{\text{gpm. x hrs. pumping}}{450 \text{ x } 12}$$

PUMPING COST ANALYSIS FORM

A. General Information

Pumping rate—gpm ..... _____

Pumping head

Lift in feet _____

Discharge pressure _____ x 2.31 = _____

Total operating head (feet) ..... _____

Water horsepower ..... _____

$$\text{whp} = \frac{\text{Total head (feet) x gpm}}{3960}$$

Horsepower required to the pump ..... _____

$$\text{bhp} = \frac{\text{whp}}{\text{pump efficiency \% x efficiency drive \%}}$$

Engine size needed ..... _____

Estimated annual pumping hours ..... _____

Fuel, _____, cost per unit ..... _____

Interest rate, % ..... _____

B. Investment or Fixed Costs

Item	Column 1 Est. years of life	Column 2 Investment cost		Column 3 Cost factor		Column 4 Annual cost
Well	_____	$_____	x	_____	=	_____
Pump	_____	$_____	x	_____	=	_____
Power unit	_____	$_____	x	_____	=	_____
Power transmission	_____	$_____	x	_____	=	_____
Electric switches	_____	$_____	x	_____	=	_____
Fuel lines or tanks	_____	$_____	x	_____	=	_____
Pipe, main	_____	$_____	x	_____	=	_____
Sprinkler system	_____	$_____	x	_____	=	_____
Other	_____	$_____	x	_____	=	_____
	Total investment	$_____			Annual cost	$_____

Additional Annual Costs

Taxes & Insurance (total investment x .01) $_____

Fixed charges, electric unit; hp_____ x $_____/hp $_____

TOTAL ANNUAL FIXED COST $_____

C. Annual Operating Costs

1. Fuel: kind _____
   a. From your records, amount used _____ @ $_____ per unit $_____
   b. If records not available, estimate from Performance Standards, whp _____ x hrs. pumping _____ x $_____/ unit of fuel ÷ _____ whp-hrs/ unit of fuel $_____
   c. If engineering well test has been made, fuel/hr. _____ x hrs. used _____ @ $_____/unit $_____
2. Oil—Engine
   a. From your records, amount used _____ x $_____/gal. $_____
   b. Estimate from Performance Standards, whp _____ x hrs. pumping _____ x $_____/gal. ÷ _____ whp-hrs./gal. $_____

   Oil—Electric Motor or Gear Drive
   c. From your records, amount used _____ @ $_____/gal. $_____
   b. Estimate from Performance Standards, whp _____ x hrs. pumping _____ x $_____/gal. ÷ _____ whp-hrs./gal. $_____
3. Repairs and Maintenance
   a. Amount spent during season $_____
   b. Estimate from pumping test or Performance Standards, whp _____ x hrs. pumping _____ x $_____/whp-hr. $_____
4. Service Charges
   Hrs. pumping _____ x .04 x labor cost $_____/hr.
   (electric units—$10.00 per year) $_____

TOTAL ANNUAL OPERATING COSTS $_____

D. Cost Summary Totals

Total Annual Fixed Costs (B) $_____

Total Annual Operating Costs (C) $_____

Total Annual Pumping Costs $_____

Cost per hr.: Total annual cost ÷ annual hrs. pumping $_____

Cost per acre foot of water $_____

Total annual pumping costs ÷ acre feet pumped

$$\text{Acre feet} = \frac{\text{gpm. x hrs. pumping}}{450 \text{ x } 12}$$