

# IRRIGATION MANAGEMENT

# Irrigation Formulas and Conversions

**Danny H. Rogers**  
Extension Irrigation Engineer

**Mahub Alam**  
Extension Irrigation Specialist

## Water Measurement

- 1 cubic foot = 7.48 gallons = 62.4 pounds of water
- 1 acre-foot = 43,560 cubic feet = 325,851 gallons = 12 acre-inches
- 1 acre-foot covers 1 acre of land 1 foot deep; 1 acre-inch = 27,154
- 1 cubic meter = 1,000 liters = 264.18 gallons
- 1 acre-inch = 450 gallons per minute (GPM)  
hour or 1 cubic foot per second (cfs)
- 1 gallon = 128 ounces = 3,785 milliliters
- 1 pound = 454 grams

## Pressure

- 1 pound per square inch (psi) = 2.31 feet of water
- A column of water 2.31 feet deep exerts a pressure of 1 psi
- feet of head = psi x 2.31
- Total Dynamic Head (TDH) includes: Pumping Lift, Elevation Change, Friction Loss, and Irrigation System Operating Pressure
- TDH = Lift + Elevation + Friction + System Pressure

## Area/Length

- 1 acre = 0.405 hectare (ha) = 43,560 feet<sup>2</sup>
- 1 inch = 2.54 centimeters

## Horsepower

**Water Horsepower (WHP)** — power required to lift a given quantity of water against a given total dynamic head.

$$\text{WHP} = \frac{Q \times H}{3,960}$$

where: Q = flow rate, GPM  
H = total dynamic head, feet

**Brake horsepower (BHP)** — required power input at the pump.

$$\text{BHP} = \frac{\text{WHP}}{E}$$

where: E = pump efficiency

### Power Unit Horsepower

Electric Units: approximate name plate horsepower =  $\frac{\text{BHP}}{0.9}$

Internal combustion units:

- Must derate 20% for continuous duty
- 5% for right-angle drive
- 3% for each 1,000 feet above sea level
- 1% for each 10° above 60°F

Approximate Engine

$$\text{Horsepower Required} = \frac{\text{BHP}}{0.80 \times 0.95 \times 0.91 \times 0.96}$$

cont. drive 3,000' 100°F  
duty elevation

## Nebraska Performance Criteria (NPC)

Energy source	WHP-hours per unit of fuel
Diesel	12.5 WHP-hrs per gallon
Propane	6.89 WHP-hrs per gallon
Natural gas:	
925 BTU/ft <sup>3</sup>	61.7 WHP-hrs per 1,000 ft <sup>3</sup> (MCF)
1,000 BTU/ft <sup>3</sup>	66.7 WHP-hrs per 1,000 ft <sup>3</sup> (MCF)
Electric	0.885 WHP-hrs per kilowatt-hour

## Water Application

$$\text{Average Application (inches)} = \frac{QT}{A}$$

where: Q = Flow Rate, Acre-Inches/Hour or GPM/450

T = Length of Application, Hours

A = Area Irrigated, Acres

Set Size (Acres) is computed by the formula:

$$\frac{\text{No. of Rows} \times \text{Width of Row (Feet)} \times \text{Length of Run (Feet)}}{43,560 \text{ Feet}^2/\text{Acre}}$$

## Approximate Acreage Covered by Center Pivot

$$\text{Acres Covered} = \frac{(\text{Radius of wetted area, feet})^2 \times 3.14}{43,560}$$

For radius:

Without end guns — add 40 feet to length of machine

With end guns — add 75 feet to length of machine

## Irrigation Delivery Rate\* per Acre (gpm/acre)

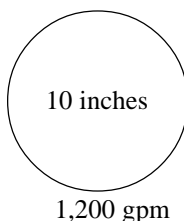
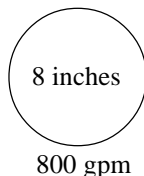
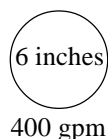
Net irrigation application (inches/day)	System efficiency (percent)					
	50	60	70	80	90	100
	gpm/acre					
0.10	3.77	3.14	2.69	2.36	2.10	1.89
0.15	5.66	4.71	4.04	3.54	3.14	2.83
0.20	7.54	6.29	5.39	4.71	4.19	3.77
0.25	9.43	7.86	6.73	5.89	5.24	4.71
0.30	11.31	9.43	8.08	7.07	6.29	5.66
0.35	13.20	11.00	9.43	8.25	7.33	6.60
0.40	15.09	12.57	10.78	9.43	8.38	7.54
0.45	16.97	14.14	12.12	10.61	9.43	8.49
0.50	18.86	15.71	13.47	11.79	10.48	9.43

Field delivery rate = gpm/acre x acres irrigated

Net irrigation = gross irrigation x system efficiency

## Maximum Economical Pipe-flow Capacities

A rule of thumb for coupled and gated pipe:



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