Calculations

OAR 690-014-0100(8): The maximum rate of use shall be determined by actual measurement when possible. Water measurements may be made by weir, meter, rated flume, reservoir capacity table or other method of measurement acceptable to the Department. The report shall describe the method used in making the measurement, the date made and a description of the location where the measurement was taken. It shall contain sufficient information, including current meter notes, rating tables, and/or calibration information to enable the Director to check the quantity of water measured in each case. Computations for capacity of the system shall be submitted for all claims. These computations may suffice to determine the maximum rate of application if the system was not operating when the inspection was conducted.

The Department typically uses the following calculations to determine system capacities:

Flow rate for pumps:

$$Q_{pump}(cfs) = \frac{(horsepower)(pump\ efficiency)}{(total\ head\ in\ feet)}$$

NOTE: Pump efficiency factor for centrifugal pump (75%) = 6.61
Pump efficiency factor for turbine pump (80%) = 7.04

Total head is the sum of suction lift, pressure head, and discharge lift.

If the operating pressure is not measured, varying the assumed operational pressure in the above formulas until the calculated outputs are equal, or nearly so, will generally give the most correct theoretical capacity of the system.

Flow rate for sprinklers:

$$Q_{sprinklers}(cfs) = \frac{(number\ of\ heads)(rate\ per\ head\ in\ gpm)}{449}$$

NOTE: Use the maximum number heads operating at any one time.

448.831 gpm = 1 cfs; use 449

Rate per head in gpm comes from either manufacturer's specifications using orifice size and operating pressure or from OWRD chart.

Calculations of flow in ditches, canals, and gravity flow pipes require a multiplication of the velocity of flow by the area of the wetted perimeter's cross-section. The following two sections deal with the velocity portion of that calculation.

For ditches/canals:

Manning's Formula:

$$v = \frac{1.486}{n} r^{2/3} s^{1/2}$$

v = mean velocity of flow in feet per second
r = hydraulic radius in feet
s = slope of the energy gradient
n = coefficient of roughness

For gravity flow pipe systems:

Hazen-Williams Formula:

$$v = 1.31(c)(r^{0.63})(s^{0.54})$$

v = mean velocity of flow in feet per second
c = coefficient of roughness
r = hydraulic radius in feet
s = slope of energy gradient

For small reservoirs (those not required to submit as-builts and rating curves):

$$v = (\textit{surface area in acres})(\textit{maximum depth})(0.4)$$

The Department has created a series of Excel spreadsheets to solve the equations for the above systems. Those spreadsheets are available for download from the Department's website.