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Big Creek Water Works – Virgil Mortensen

Big Creek Water Works (BCWW) is a small hydroelectric generating facility that is capable of a maximum production of 5 megawatts (MW). It does not currently have functioning water usage instrumentation.

It is being proposed that based on hydroelectric production that is logged hourly, that the water usage be calculated using industry recognized formulas.

The variables that are used are:

- The head (vertical fall) of the water in the penstock (piping into generator)
- The efficiency of the water delivery system
- The efficiency of the generator

For our case, we will use our average pressure to calculate head – and we will use 90% efficiency figures to observe the resulting water usage.

We observe an average of 300 psi while generating at half power: 2.5 MW. Using the formula:

> pressure in psi times 2.31 equals head in feet

we get, 300 psi x 2.31 = 693 feet, or as we will use later, 211 meters.

Using Google Earth, we see:

Intake 2073’

Plant 1318’

Head 755’ - 230m

For our purposes, we will use the measured pressure to determine head, keeping in mind that Google Earth has many of its values derived from extrapolations.

To keep things simple, we will solve in all cases for the water usage in cubic feet per second for the generation of 1 MW.

According to the water board reports, the following are stated for the generation of power at Big Creek Water Works/Virgil Mortensen:

- Maximum direct diversion rate = 100 cfs
- Maximum collection to storage = 0
- Maximum diversion per year = 60,100 acre-feet

The hydroelectric plant maximum production is 5 MW.

An acre-foot is 43,560 cubic feet

The anticipated maximum operating time for the generator is 6 months:

26 weeks x 7 days/week x 24 hours/day x 60 minutes/hour x 60 seconds/hour

Therefore, a factor of 15,724,800 will be used called max-season-factor.

Hydroelectric Power is a Function of Height and Volume:

$P = \eta \rho Q g h$

Variable Definition

P power [W]

η dimensionless efficiency of the turbine [approx. 0.9]

ρ density of water [1,000 kg/m3]

Q volumetric flow rate [m3/s]

g acceleration due to gravity [9.8 m/s2]

h height difference between inlet and outlet [m]

Using this formula:

P = .9 x 1000 kg/m3 x Q x 9.8 m/sec2 x h

At 1MW:

Q = 1000 / (900 x 9.8 x 239) = 1000 / 1912 = 0.52 cubic meter per second = **18.4 cfs/MW**

At maximum output, the diversion is 5 MW x 18.4 cfs/MW = **92 cfs** (allocation is 100 cfs)

For a maximum season:

92 cfs x year max-season-factor = 92 x 15724800 = **1,446,681,600 cubic feet per season**

1,446,681,600 / 43,560 cubic feet/acre-foot = **33,211 acre-feet per year** (allocation is 60,000 acre-feet)

There are also on-line calculators available.

Since we are using the measured head pressure, some of the inefficiency of the system is already factored in. It is suggested that further derating for the generator itself be an efficiency loss of 10%.

http://www.reuk.co.uk/wordpress/hydro/calculation-of-hydro-power/

that solves for 17.1 cfs or **18.8 cfs/MW** with 10% loss of the generator

https://www.engineeringtoolbox.com/hydropower-d_1359.html

that solves for **17.7 cfs/MW** for 90% efficiency

These two results of online calculators are reasonably close to the formula derived number.

The Big Creek hydroelectric plant also has a weir constructed in the tailrace.

It is proposed that during the off-season when the plant is not operational, that the tailrace be measured and instrumented. During the following operational season, the weir calculations will be compared to the usage numbers derived from the above calculations. If the numbers are reasonably close, the production-based formula will be used. If there is a significant discrepancy, further investigation will be done.