INTENSITY-DURATION-FREQUENCY EQUATIONS

In response to considerable interest expressed by counties and municipalities in the Region, Commission staff developed county-specific intensity-duration-frequency (IDF) equations utilizing NOAA Atlas 14 precipitation depth-duration-frequency information. The IDF equations developed are empirical formulas representing the relationship between maximum precipitation intensity, precipitation duration, and frequency.

While the NOAA Atlas 14 depth-frequency information is developed for total precipitation depths characteristic of discrete durations (e.g., 5 minutes, 10 minutes, 15 minutes), the IDF equations developed by Commission staff enable the computation of a rainfall intensity of a given frequency for any duration from 5 minutes to 24 hours. This would be useful to municipalities and consultants using spreadsheets, or other automated approaches, to apply the Rational method to develop peak flows for storm sewer design.

The IDF equations were developed by Commission staff individually for Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Washington, and Waukesha Counties in a manner consistent with the NRCS specification of representative 24-hour precipitation depth-duration-frequency information for each Wisconsin county. That is, the representative location within each county in the Region that was selected by NRCS for determination of 24-hour precipitation depths was used by staff to determine precipitation depths for other durations.

Several commonly used functions are found in the hydrology literature, including both linear and nonlinear regressions. For this particular study, IDF equations developed using non-linear regression were found to provide the best fit to the IDF dataset in Southeastern Wisconsin for recurrence intervals of 1 year to 100 years and durations from 5 minutes to 24 hours. The equation expressed in the following form was utilized (Chow et al., 1988):

$$i = \frac{a}{t^k + b}$$

where i is the rainfall intensity (inches/hour); t is the duration (minutes); a, b, and k are constant parameters. The constant parameters were determined using the statistical method of least squares by minimizing the Root Mean Square Error. The final IDF equations for each of the seven counties can be found <u>here</u>.

References
Chow, V.T., Maidment, D.R. & Mays, L.W. (1988). Applied Hydrology, Mc-Graw-Hill