Appendix A2

# Application of the Extended Time Series (ETS) Precipitation and Evaporation

April 2003

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King County Regional Infiltration/Inflow Control Program

April 23, 2003

## A2.1 Issue

Mean annual precipitation and infrequent rainfall event volume is not uniform within the KCRIICP study area. Program stakeholders have expressed concern about the appropriateness of using the 60-year rainfall record from Sea-Tac to determine design I/I flows from each model basin. This concern is based on available documentation that indicates a variation in rainfall from Sea-Tac in terms of both annual average and specific duration storm events. An alternative long-term precipitation time series is desired to avoid the application of the Sea-Tac rainfall record to the entire service area.

## A2.2 Proposed Solution

As a result of similar issues facing WSDOT and Pierce County, a method has been developed by MGS Engineering to modify the Sea-Tac rainfall record for use in areas of Washington with different mean annual precipitation that have similar storm characteristics.

The full ETS time series developed for Puget Sound are 158 years in length. This long-term record was achieved by combining records from distant precipitation stations. For application within the KCRIICP, only the first 60 years of the ETS that are based on the Sea-Tac rainfall record will be used. The 60-year record is adequate since desired design flows are based on a 20-year return period, which can be estimated by interpolating between modeled peaks. The full 158-year records were originally developed for surface water applications where flows with 100-year return periods are often the analysis objective.

The ETS time series consists of sets of rainfall time series related to zones of mean annual precipitation (MAP). ETS's for Puget Sound have been developed for the Washington State Department of Transportation (WSDOT) and for Pierce County By MGS Engineering Consultants (http://www.mgsengr.com).

MAP zones that provide the basis for determining which ETS to use are produced and published by Oregon State University's Spatial Climate Analysis Service for the entire United States using the PRISM Model (http://www.ocs.orst.edu/prism/prism_new.html).

## A2.3 Alternatives Considered

1. Use of a scaled version of the Sea-Tac rainfall record based on the relationship from specific time duration (i.e. 24 hour, one week, one month etc.) to a specific rain gauge near the model basin.
2. Extended Time Series (ETS) for mean annual precipitation values corresponding to the mean annual precipitation in the study area. ETS applicable to the King County study area are available for the following zones of mean annual precipitation: 36, 38, 40, 42, 44, 46, 48, 50, 52, 56 and 60 inches.

## A2.4 Discussion

ETS was developed using a series of statistical scaling functions rather than a single scaling factor. The scaling functions provide for scaling of rainfall amounts at the 2-hour, 6-hour, 24-hour, 72-hour, 10-day, 30-day, 90-day, and annual durations. The ETS that are applicable to the King County study area were developed by scaling the Sea-Tac rainfall record to match the storm statistics of the time series records at over 50 precipitation gauges located in the lowlands of western Washington. Therefore, the storm characteristics contained in the ETS are based on a very large sample set of storms and stations rather than the record from a single station.

Results obtained from continuous rainfall-runoff modeling, as is being used for the KCRIICP, is sensitive to rainfall within individual events as well as the antecedent rainfall preceding each event. The amount of infiltration flow present during a given storm may be dependent on the rainfall that occurred over the preceding 6 months or year. A limitation of scaling the Sea-Tac rainfall record using only one or two characteristics is that the result may be valid for specific durations, but will incorrectly estimate intensity and rainfall volume at other durations. Therefore, to maintain the integrity of model results when using a scaled precipitation time series it is important to preserve the rainfall characteristics for a wide range of durations, as was incorporated into the development of the ETS.

Other factors supporting the credibility of using ETS in KCRIICP include:

1. ETS provides a method for using long-term continuous modeling to develop design flow estimates while also considering the variation of rainfall throughout the study area.
2. ETS is an analytically sound procedure based on available rainfall data collected throughout the study area.
3. DOE has approved ETS for continuous Stormwater Modeling in the Puget Sound region.
4. Use of the ETS is an application of the most current available published information and would be more defendable that the use of a project-specific approach.