Guidelines for Identifying Reference Basins for UIF Extension or Synthesis

South Carolina Surface Water Quantity Modeling – Unimpaired Flow Development

CDM Smith, April 2015

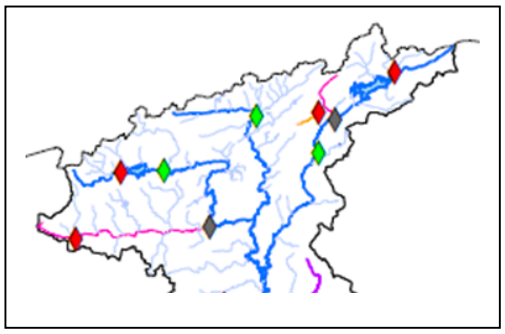
These guidelines are developed to help provide a consistent thought process for selecting reference basins (gaged basins) to estimate flow in ungagged or incompletely gaged basins. This applies to the extension of UIFs at USGS gages, and also to the transposition of UIFs into ungaged basins. Naturally, finding a representative basin with similar hydrologic dynamics is partly objective and largely subjective, and many factors can be considered. The following list can be used as a guideline, with the importance of each factor usually decreasing from top to bottom.

For clarity, we shall refer to ungaged and undergaged sites (needing either full synthesis or gap filling/extension, respectively) all as "ungaged" basins, as opposed to the reference basins, whose gage records will be used for hydrologic transposition.

Consider these factors as guidelines with decreasing importance moving down the list, and refer to the general guidance at the end – There will be cases in which these priorities may need to be adjusted when dealing with certain extreme situations.

Factor 1: Correlated Overlapping Record: If a candidate reference gage and a basin that has a partial gage requiring extension have overlapping periods of record, test the DAILY correlation between the UIFs (UIFs will be a better indicator of hydrologic similarity than the actual gage records). Note that monthly correlation may be a good indicator of overall water budget characteristics (runoff vs. evap and infiltration), but may not necessarily suggest similar daily hydrologic response patterns, which are important for the UIFs.

Factor 2: **Same Basin**: If the ungaged basin is tributary to a gaged basin (or vice versa) and the area ratios are within a factor of 2x to 4x (approximately), the flows should be highly correlated because one is part of the other. Several examples are shown to the right, where the red nodes indicate ungaged basins, and the green nodes are candidate reference basins. The green nodes downstream of the red nodes should be the first candidates as reference gages.



Factor 3: Measured vs. Estimated Reference Data: In some cases, if a basin would otherwise be a very good candidate as a reference basin but a large percentage of its data have already been synthesized (operational data for UIFs, or a UIF itself synthetically extended), preference should

be given to basins with lower amounts of estimated data in the record that would be used for extension.

Factor 4: Basin Area: Because of our daily timestep, this is a critical factor – Large watersheds will exhibit very different daily hydrographs than will small ones in response to the same rain event. It is important that reference basins be comparable in size (generally, within a factor of 2 or 3, if possible).

Factor 5: Land Use: The relative amounts of common land use, and certainly the dominant land use, should be reasonably similar between the reference basin and the ungaged basin to help provide confidence that hydrologic tendencies of the ungaged basin (runoff, infiltration, and evapotranspiration) are well represented by the reference gage.

Factor 6: Basin Slope: The average slope of the basin as determined with DEM's and the stream length in actual river miles can help indicate runoff propensity.

Factor 7: Runoff Curve Number: If the factors above are not sufficient to distinguish several candidate basins, the Soil Conservation Service (SCS) Runoff Curve Number (CN) may be used as a "tie breaker." It can also be used to help determine how adequate the land use similarity (Factor 5) really is as an indicator of runoff propensity.

General Application of Guidelines:

1. It is not recommended that the six factors above be weighted numerically, nor applied with the exact same priorities in every case. Rather, the determination of a good reference gage is largely subjective, and the factors above should be considered in the selection, but the relative importance may vary depending on certain extremes. For example, if a basin is extremely steep, it would not make sense to choose a reference basin that is nearly flat, even if all the other criteria indicate a good match. Likewise, if a basin is well forested, it would not be wise to use a well-developed basin as a reference, even if all the other criteria indicate a good match. In other words, **while the list above provides some general priorities for consideration, we should try to avoid extreme mismatches in any of the criteria.**

2. It is not essential that an ungaged basin use just one reference gage. In fact, it would be impossible to do so unless only the longest gage in the basin were to be used for each ungaged basin. For example, if Basin A is ungaged and must be synthesized back to 1925, and Basin B and C are good candidates for reference basins, we might encounter the following: Basin B is preferred as a reference, but only extends back to 1950, while Basin C is less preferred but extends back to 1925. In this case, use Basin B back to 1950, then Basin C from 1925-1949.