A consideration of channel morphology, flow regime variability and sediment transport relations in determining effective discharge

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Abstract. Since its introduction by Wolman and Miller (1956) the concept of effective discharge (Q_{eff}), or the discharge within a stream that transports the greatest sediment load, has produced a wealth of research and discussion. The concept has proven valuable not just as a scientific theory in fluvial geomorphology but also in the practice of river management and restoration design. More recently, analytical approaches to evaluating the drivers and sensitivities of Q_{eff} have been utilized whereby a flow probability distribution function (PDF) is coupled with a power law sediment transport relation (rating curve) to produce an analytical equation relating the value of Q_{eff} to statistical moments of the flow PDF and sediment rating curve parameters. While this approach to analyzing Q_{eff} has proven helpful in understanding the theoretical drivers behind it, it is also limited in that some of the basic assumptions involved do not apply to most alluvial streams, especially at the tail of the flow PDF. Here we consider how stream flow regime (variability) and sediment transport regime (rating curve exponent) affect both the magnitude of Q_{eff} and the amount of bed material sediment transported above it using the two-parameter lognormal PDF. We also investigate how curtailment or inclusion of the extreme, infrequent flood events located on the tail of the PDF affects Q_{eff} and the amount of sediment transported above Q_{eff}. By incorporating a segmented or broken power law sediment rating curve, we present an approach to calculating Q_{eff} that is more hydraulically and morphologically realistic.