

DRAFT

Stormwater First Flush: A Valid Water Quality Concept?

The first flush concept in urban and highway stormwater runoff water quality management is well-ingrained in the stormwater management literature. Regulatory agencies, environmental groups, consulting firms and others frequently espouse the first flush concept, in which elevated concentrations of chemical constituents are present in the initial stormwater runoff following a period of no precipitation. This concept continues to be foisted on the stormwater community, even though there are numerous studies reported in the literature which show that elevated concentrations of constituents during first flush do not necessarily occur. The presence of elevated concentrations early in a runoff event is very much a site-specific characteristic of the watershed. It should not be assumed that the initial concentrations of constituents at a particular monitoring location will be elevated relative to the concentrations found later in the runoff event.

This first flush concept is carried to an extreme by some regulatory agencies, where it is advocated/mandated that the initial runoff from an area be trapped in detention basins in order to reduce the magnitude of the first flush impacts on “water quality.” Unfortunately, however, the first flush concept is not based on a proper evaluation of the water quality impacts of the constituents in the stormwater runoff. The first flush concept as it relates to water quality is like the urban stormwater runoff BMPs that have been developed largely based on hydraulic considerations, without regard to how chemical constituents in stormwater runoff impact water quality - beneficial uses.

Water quality cannot be evaluated based on concentrations of chemical constituents in water samples. This is especially true for stormwater runoff-associated constituents. The federal and state stormwater runoff water quality regulations and associated management programs require the control of **pollutants**. Pollutants are constituents that impair the beneficial uses of the receiving waters for the stormwater runoff. The beneficial uses frequently of concern are aquatic life, domestic water supply, contact recreation, etc. Since much of the stormwater runoff water quality management efforts are directed toward protecting aquatic life in receiving waters for the runoff, with particular emphasis on potentially toxic heavy metals and organics, the aquatic-life-related beneficial uses of these waters must be assessed in terms of a significant impairment of the numbers, types and characteristics of aquatic life in the receiving waters relative to the receiving water habitat aquatic life carrying capacity.

Stormwater runoff-associated constituents can occur well above US EPA water quality criteria and state standards based on these criteria without adverse impacts on the aquatic-life-related beneficial uses of waterbodies. This arises out of the fact that numerous studies have shown that the heavy metals and some

other constituents in urban area and highway stormwater runoff can be in nontoxic, nonavailable forms, and therefore do not impact aquatic life in the zone of potential impact near the point where the stormwater runoff enters the waterbody.

An important factor affecting the water quality significance of toxic/available forms is the short duration of exposure for aquatic life associated with stormwater runoff events, where typically the exposure that aquatic life can receive in the receiving waters associated with the runoff event is small, compared to the critical concentration/duration of exposure relationships that govern how toxic/available forms of constituents impact aquatic life. While the US EPA in the early 1980s adopted the one-hour average and four-day average as the acute and chronic criteria exposure base for implementing the water quality criteria, it is well-known that these values were arbitrarily selected and have little or no technical validity as a proper base for evaluating the impacts of chemical constituents on aquatic-life-related beneficial uses. While this situation has been well-understood for over 15 years, the US EPA has thus far failed to meaningfully address this very significant problem. Potentially toxic constituents to aquatic life affect aquatic life through a concentration of available form/duration of exposure relationship. High concentrations of available forms of potentially toxic constituents can be present for short periods of time without adverse impacts. As the duration of exposure is increased, the concentrations of available forms must be decreased to avoid toxicity/adverse impacts.

The proper way to regulate stormwater runoff-associated constituents involves assessing whether the concentrations of a constituent exceed US EPA worst-case-based water quality criteria and state standards based on these criteria. If an exceedance occurs, then it is important to distinguish between real and “administrative” exceedances, which relate to the overly protective nature of US EPA worst-case-based water quality criteria and state standards based on these criteria, which fail to consider site-specific conditions that impact how a chemical constituent impacts the beneficial uses of a waterbody. The worst-case nature of the US EPA criteria is mandated by Congress as part of developing national criteria that will be protective under all conditions. The US EPA, however, provides guidance on how to make site-specific adjustments in these criteria to protect beneficial uses without significant unnecessary constituent control. Unfortunately, the Agency’s approach for adjusting the criteria is overly complex, frequently costing on the order of a quarter to a half million dollars for site-specific studies. A more technically valid approach would involve the use of receiving water biological assessment information to evaluate whether the numbers, types and characteristics of aquatic life in the receiving waters are being impacted by the chemical constituents in the runoff water. In making this evaluation, the impacts of the stormwater flow on aquatic life habitat must be considered.

A fundamentally flawed aspect of the US EPA and states' water pollution control programs as they relate to regulating stormwater-associated constituents and, for that matter, other sources of constituents, is the continued use of independent application of chemically based criteria, even though biological assessments show that stormwater runoff-associated constituents are not adversely impacting the numbers, types or characteristics of aquatic life in the receiving waters for the runoff. The US EPA should immediately abandon independent application in favor of conducting appropriate, site-specific evaluations of whether chemical constituents in stormwater runoff are adversely impacting the aquatic-life-related beneficial uses of the receiving waters.

In order to evaluate whether first-flush-associated constituents are adverse to the beneficial uses of the receiving waters for stormwater runoff, it is necessary to determine whether the elevated concentrations in the initial runoff are in toxic/available forms for a sufficient period of time to be adverse to aquatic life. Further, if there is a potential for toxicity to aquatic life, then assessment has to be made as to whether this toxicity represents a significant impairment of beneficial uses – i.e., whether desirable forms of aquatic life in the receiving waters (and, especially, higher trophic level organisms of particular concern to people) are adversely impacted by the toxic constituents in the stormwater runoff.

In summary, it should not be assumed that elevated concentrations of constituents occur in stormwater runoff first flush. If they occur, it should not be assumed that the concentrations of toxic/available forms are present for a sufficient duration of exposure to be adverse to the aquatic-life-related beneficial uses of the receiving waters for the stormwater runoff. Before any funds are spent constructing detention basins, grassy swales, stormwater infiltration systems, etc., to control first-flush chemical constituents, a proper evaluation should be made of whether the elevated concentrations associated with first flush that occur at a particular location are adverse to the aquatic-life-related beneficial uses of the waterbody. Adopting this approach will begin to correct the over-regulation of stormwater runoff that is occurring today as a result of inappropriate evaluation of the water quality impacts of chemical constituents in urban area and highway stormwater runoff.

G. Fred Lee, PhD, PE, DEE
gfredlee@aol.com
www.gfredlee.com