STORMWATER QUALITY 2

2.1 INTRODUCTION

Understanding treatment begins with the knowledge of the water to be treated, in this case stormwater. Stormwater is highly variable with respect to both flow rate and quality. This variability affects performance. A thorough understanding of stormwater quality aids the selection, design, and maintenance of treatment systems. Conversely, the lack of understanding constrains the ability of the engineer to make cost and environmentally effective decisions. In the fields of water and wastewater treatment, an array of processes allows for the most appropriate decision for each situation. The evolution of this array parallels the growth of the engineer's understanding of the characteristics of the water treated. This is occurring with stormwater treatment.

2.2 CHARACTERISTICS OF INTEREST

Regulated constituents

The objective of stormwater treatment is to reduce the concentrations of constituents regulated in surface water, groundwater, and sediment. Table 2.1 presents several regulated constituents, comparing allowable receiving water concentrations to that typically observed in urban stormwater. Many constituents are regulated but without the ap-

TABLE 2.1
Regulated constituents – freshwater[a,1144]

CONSTITUENT	ACUTE CRITERIA[c]	STORM WATER[b]	CONSTITUENT	ACUTE CRITERIA	STORM WATER
Cadmium	0.95 to 4.3	0.5 to 10	pH	6.5 to 9	5.5 to 8
Chromium	4 to 16	10 to 200	Ammonia	13 to 180[d]	0.1 to 2
Copper	3.6 to 13	5 to 150	Nitrate	10[e]	0.1 to 1
Iron	1,000	1,000 to 10,000	Dieldrin	0.24	0.01 to 0.1
Lead	14 to 65	20 to 500	Chlordane	2.4	0.1 to 10
Mercury	1.4	0.2 to 0.5	Chloropyrifos	0.083	<DL[f] to 0.10
Nickel	145 to 470	5 to 150	TPH	10[g]	1 to 15
Zinc	36 to 120	15 to 600	Turbidity	5 to 10% above background	50 to 100

a. ug/L except ammonia, nitrate, and TPH which are mg/L, and pH which is units
b. Commonly observed ranges as total metals
c. Metals criteria based on dissolved fraction and is a function of hardness
d. Dependent on pH and temperature; values are for pH of 6 to 7.5 and a temperature of 5 to 20^{o}C
e. groundwater standard f. Detection limit g. Effluent standard

plication of broadly applied numeric limits. Rather, decisions are made specific to a particular water body. Constituents that are often regulated in this manner include phosphorus, nitrogen, oil and grease, petroleum hydrocarbons, and floatable debris. In some cases numeric limits are placed on the discharge instead, a common approach with petroleum hydrocarbons.

Nutrients such as phosphorus and nitrogen are regulated to prevent excessive plant or algal productivity. In lakes and estuaries this commonly takes the form of excessive growths of free floating algae and emergent weeds in shallow areas. In streams, excess nutrients cause undesirable growths of periphyton on channel beds. Guidelines have been developed.[1149]

Similarly, floatable debris is a regulated pollutant to the extent that it affects the aesthetics of the receiving water. Moreover, debris may contribute metals, anthropogenic organics, and oxygen demand to the receiving water. It may serve as substrate for the growth of bacteria. Debris includes refuse contributed by a disposal-oriented society and natural organic material such as leaves and pine needles.

While temperature is a regulated constituent, stormwater treatment processes cannot mitigate the effect of impervious surfaces that may elevate the temperature of stormwater. Furthermore, stormwater treatment processes with wet pools may raise receiving water temperatures (Chapter 5).

Freshwater sediment criteria have not been adopted by the USEPA or by many states or provinces. However, guidelines have been developed by various agencies often for the purposes of controlling the disposal of dredge spoils.[348,792,823,852,1128,1140,1142,1197] The guidelines usually consist of a matrix of concentrations for alternative levels of toxicity such as “no effect,” “lowest effect,” and “severe effect.” Table 2.2 presents ranges for several constituents at the “lowest effect” threshold. The ranges are a composite of the cited guidelines. Also presented in Table 2.2 are concentrations in sediments observed in stormwater wet ponds, swales, and wetlands. The comparison indicates that sediments in treatment facilities can exceed desirable levels.

TABLE 2.2
Regulated constituents – freshwater sediment[a]

CONSTITUENT	CRITERIA	SEDIMENT
Cadmium	0.2 to 0.6	0.2 to 2
Chromium	25 to 50	0.08
Copper	15 to 30	10 to 150
Nickel	20 to 35	5 to 45
Zinc	100 to 150	50 to 400

a. mg/Kg

Understanding system performance

Many characteristics of stormwater quality affect the performance of a treatment system. Concentration affects removal efficiency: generally the greater the concentration the higher the efficiency. Loading affects facility sizing and/or maintenance frequency depending upon the type of treatment system.

As sedimentation is one of the primary mechanisms of pollutant removal, characteristics of the particulate solids are of interest. These include settling velocity and chemical distributions. The settling velocity distribution has a direct bearing on treatment efficiency. The extent to which this distribution varies between sites as well as between storms may be a major factor in the observed variation in the performance efficiency of treatment systems.

A pollutant may not be evenly distributed across the size distribution of the particulate solids. Many pollutants are associated more with the smaller particulate solids. This means that the removal of a pollutant may be less than the removal of the particulate solids by the treatment process, given the ability to remove the larger particles. Of relevance to oil/water separators is the rise distribution of dispersed petroleum droplets.

A distinction is made between the dissolved and particulate forms of each pollutant. This distinction is by convention rather than by a chemical form or characteristic. “dissolved” is defined as that which passes through a laboratory filter, commonly 0.45 microns. “Particles”