DESIGN FOR HEALTH

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Key Questions:

Water Quality


Ann Forsyth

Version 2.0

DESIGN FOR HEALTH is a collaboration between the University of Minnesota and Blue Cross and Blue Shield of Minnesota that serves to bridge the gap between the emerging research base on community design and healthy living with the every-day realities of local government planning. This Water Quality Key Question is part of a series with a focus on identifying and interpreting evidence-based research linking public health with planning.

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The following people were involved in the development of the Key Questions Series:

Series Editor: Dr. Ann Forsyth
Contributors: Dr. Ann Forsyth, Dr. Kevin Krizek, Dr. Carissa Schively, Laura Baum, Amanda Johnson, Aly Pennucci,
Copy Editor: Bonnie Hayskar
Layout Designers: Anna Christiansen, Tom Hilde, Kristen Raab, Jorge Salcedo, Katie Thering, Luke Van Sistine
Website Managers: Whitney Parks, Joanne Richardson

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Overview

Water quality is important for the health of the ecosystem and the health of humans. Clean drinking water and water-borne diseases are important topics in regards to human health (Frumkin et al. 2004). The areas of most concern are drinking water and water that people contact during recreational and personal activities, such as in swimming or fishing (particularly eating fish that has been caught). Although most drinking water systems are regulated to protect human health, many surface waters and their associated watersheds are not monitored, which can adversely affect water quality. Water cleanliness, known as the absense of microbial and chemical contaminant, can be compromised by both point (i.e. a single leaking pipe or septic tank) and nonpoint (i.e. general runoff) sources (Frumkin et al. 2004). It should be noted that current literature focuses more on the link between water quality and ecological concerns; as a result, we do not know what the effects of ecologically-friendly policies and plan implementation are on humans.

Planners play an important role in protecting ground water and surface water, since a variety of urban planning and design-related features influence water quality, including the use of septic systems, management of wastewater services, location of storm sewers, location of toxic wastes and other pollutants, and level of runoff caused by urban development. A key issue area that planners often consider is controlling the allowable amount of impervious surface to deal with nonpoint sources that cause water contamination. Paved surfaces and buildings reduce natural filtration and exacerbate runoff, which carries wastes, fertilizers, sediments, and other pollutants directly or indirectly into surface and ground waters. While a primary focus is on the ecological impacts of runoff, it can also lead to health problems for humans, such as gastrointestinal illness (diarrhea, vomiting, cramps), pneumonia, increased risks of cancers, and other health concerns (EPA 2006).

In future versions of the Water Quality Key Questions and the corresponding Water Quality Information Sheet, Design for Health will review research that look at the direct link between human health and water quality and also provide additional information about such planning-related themes as decentralized wastewater treatment systems, toxins related to point and stationary sources, etc.

Things for certain (or semi-certain)

- Impervious surfaces have been studied for several decades in an effort to identify the point at which stream quality is affected. This research has mostly been concerned with the health of the stream ecology, however, rather than the health of people. In a review of this literature, Schueler (1995, 19) argues that the "research, conducted in many geographic areas, concentrating on many different variables, and employing widely different methods, has yielded a surprisingly similar conclusion—stream degradation occurs at relatively low levels of imperviousness (10-20 percent)." As the research in the next bullet shows, however, the issue of water quality can be moderated by buffering.

  Example: Based on a study of 23 watersheds of various sizes, Klein (1979, 959) began the trend of attempting to quantify the point at which stream quality degradation occurs: "stream quality impairment can be prevented if watershed imperviousness does not exceed 15 percent."

  Example: A literature review by Arnold and Gibbons (1996, 246) concluded that degradation first occurs around 10-percent impervious surfaces and becomes "almost unavoidable" at 30-percent.

  Example: Using the Index of Biotic Integrity (IBI), Miltner et al. (2004, 87) found that when impervious surfaces exceed 13.8 percent, stream health "declined significantly;" and when it exceeded 27.1 percent, stream quality dropped below Clean Water Act standards.

Things up in the air

- The links between the ecological/water quality effects of impervious serfaces and human health are not clear.

- The issue of imperviousness and its relationship to water quality is complicated by the existence, or absence, of buffers along waterways where buffers are one structural tool that planners and engineers use in a suite of management practices. Like imperviousness, stream buffers have also been studied in an attempt to establish design thresholds. In a study of Toronto-area streams, Steedman (1988) found that forested vegetation at least 20 m (66 ft) wide on both sides of a stream had a positive effect on stream health. Haycock and Muscutt (1995) wrote that buffer-zone widths vary depending on their intended purpose (e.g., stream temperature control, recreation, flood protection) and size (e.g., small ditches, streams, large rivers).

  Example: From a study of riparian buffers along the Tar River Basin in North Carolina, Phillips (1989) expressed the difficultly in identifying a set width for riparian buffers. He suggests a range of 15-80 m (49-262 ft), depending on size, surrounding land use and other factors.

  Example: In a study of land use and stream quality, Tufford (1998) found that changes in land use that occurred over 150 m (492 ft) from the stream had an insignificant impact on stream health, whereas changes within 150 m (492 ft) caused "significant changes in in-stream nutrient concentrations"(109). Tufford's findings highlight the importance of focusing on near-stream elements, such as buffers and nearby impervious surfaces.

- The interrelationship between impervious surfaces and stream buffers makes using thresholds involving either one complicated. The amount of impervious surface that causes stream-quality degradation will vary widely, depending on the amount and quality of vegetated buffer.

  Example: Horner et al. (1997) examined this relationship on Seattle-area watersheds and found that when impervious surfaces exceeded 45 percent, the effect of vegetative buffers could no longer protect the stream's biological integrity.

- Impervious surfaces are an important indicator when studying surface-water quality. When used alone, however, this indicator can be misleading. Impervious surfaces have less of an impact on stream-water quality when riparian buffers are in place (Steedman 1988). These buffers infiltrate water coming off the impervious surfaces, filter pollutants and, thus, reduce the amount of stormwater flowing directly into streams.

Working thresholds for HIA

- Stream buffers should range from 20 to 80 m (66 to 262 ft) (Phillips 1989). As mentioned above, the chosen distance should be based on a series of related factors such as size, land use, etc. This is a threshold that is designed to increase stream health and not necessarily human health.

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