I-3 THE IMPERVIOUS COVER MODEL

AT A GLANCE

Imperviousness is a metric that represents the sum of roads, parking lots, sidewalks, rooftops, and other impermeable surfaces that prevents water from infiltrating into the soil, which increases stormwater runoff.

Even low levels of imperviousness (~10%) in a watershed degrades the health and function of local streams.

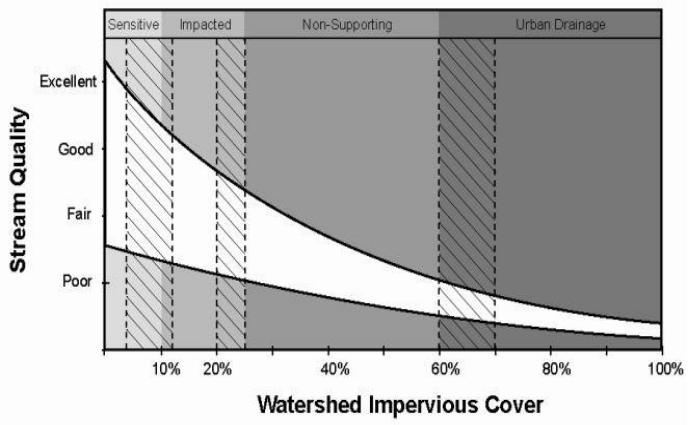
Classifying subwatersheds based on their impervious cover can help predict impacts on stream health.

A wide range of planning, engineering, regulatory and economic tools are available to respond to the impervious cover model.

EVOLUTION OF THE IMPERVIOUS COVER MODEL

Imperviousness represents the footprint of urban development on a landscape and is composed of the rooftops and structures we live in and the roads, sidewalks and parking lots that connect them. Even low levels of imperviousness within a watershed can impact pollutant loads, temperatures and biological diversity within our streams (See I-2). Therefore, the imperviousness of a subwatershed serves as a useful metric we can use to predict stream health and function and help determine management actions.

The Impervious Cover Model (ICM) was first proposed in 1994 as a management tool to diagnose the severity of future stream problems in urban subwatersheds. It was developed using hundreds of research studies on first to fourth order streams and modified in 2009 to reflect more recent research on the relationship between subwatershed impervious cover (IC) and various indicators of stream quality.

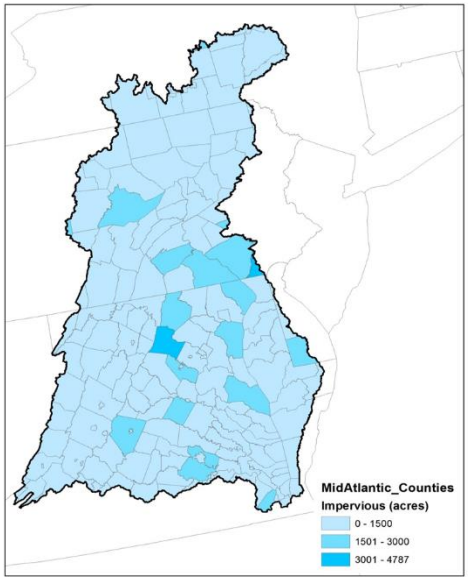


The model proposes a classification system for urban streams based upon the percent impervious cover in the subwatershed. Those classifications can then be used to inform management actions. However, it should be noted that urban streams are notoriously variable, so the ICM represents a guide, not a guarantee. In general, the model should only be used for headwater streams in subwatersheds within the same physiographic region. Major point sources of pollutant discharge, or extensive impoundments or dams located within the stream network are also likely to impact the usefulness of the ICM.

WATERSHED STRATEGIES FOR SENSITIVE STREAMS

Sensitive streams are located in subwatersheds with <10% impervious cover. These streams should be expected to maintain their structure and function and continue to score well when stream health indicators are assessed. To ensure these streams are protected, consider the following management approaches:

- Restrict subwatershed impervious cover to less than 10%
- Extensive land conservation – retain more than 65% forest, meadow or wetland cover in the subwatershed
- Ensure forest or native cover on at least 75% of the stream network, including zero order streams
- Avoid more than one crossing per stream mile, and none that create a barrier at migration
- Require runoff reduction practices on new development and roadside ditches to treat the two year storm
- Apply conservation practices to all croplands and keep livestock out of streams
- Use limited stream restoration to restore habitat, remove legacy sediments and reconnect floodplains



Projected increase in Impervious Surfaces by 2025. Source: CBPO, 2017

WATERSHED STRATEGIES FOR IMPACTED STREAMS

Impacted streams are located in subwatersheds with 11-25% impervious cover. The objective for these streams is to mitigate impacts to the greatest extent possible and support continued health and function of downstream waters. Aim to consistently achieve good water quality indicators, maintain floodplain storage, and provide stable, biodiverse stream channels. Consider the following management approaches:

- Require stormwater practices for all new land development that can maintain predevelopment hydrology
- Conserve forests to achieve tree canopy of 50% or greater in the watershed
- Conserve stream network and floodplain in a natural state and in public ownership
- Apply better site design practices to reduce impervious cover and turf cover by 25% for each zoning category
- Install stream restoration and storage practices to serve untreated impervious cover areas
- Maintain streets and sewers to minimize pollutant discharges

WATERSHED STRATEGIES FOR NON-SUPPORTING STREAMS

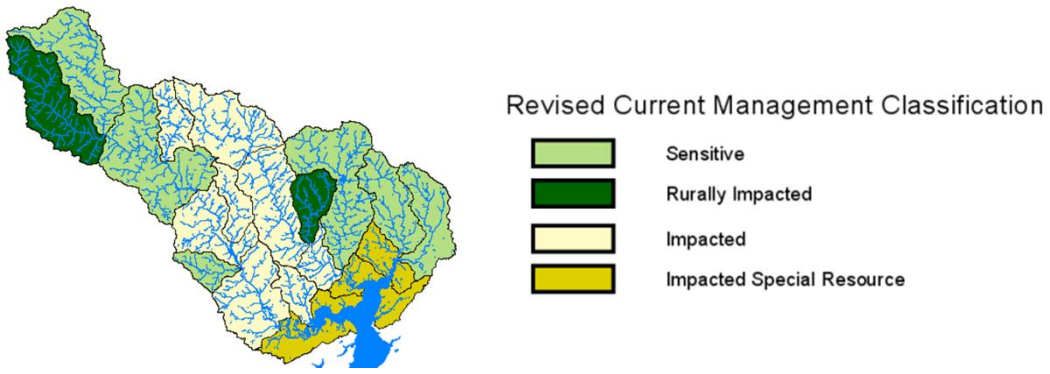
Non-supporting streams are located in subwatersheds with 25-60% impervious cover. The primary resource objective is to protect downstream water quality by removing urban pollutants. Restoration can still partially restore some aspects of stream health, so try to maintain fair to good stream quality indicators. However, more effort can be spent trying to protect other sensitive or impacted streams. Here are some management goals to keep in mind:

- Evaluate streams in the 25-40% impervious cover range for possible restoration
- Install stormwater retrofits in older ponds and open spaces to capture and treat runoff
- Implement pollution prevention practices at stormwater hotspots
- Manage the remaining stream corridor as a green way

WATERSHED STRATEGIES FOR URBAN DRAINAGE

Urban drainage is located in subwatersheds with >60% impervious cover. Designed primarily to move stormwater runoff efficiently, urban drainage should still allow good water quality conditions in downstream receiving waters. Try to attain fair water quality during wet weather, and good water quality in dry weather. Here are some management goals to keep in mind:

- Encourage redevelopment and community development
- Install green infrastructure practices to treat the first two inches of rainfall
- Require pollution prevention at municipal and industrial stormwater hotspots
- Clean streets and storm drains to control pollutants and trash.
- Achieve at least 15% forest canopy in the subwatershed
- Search for illicit discharges and sewer exfiltration in the subwatershed



The Impervious Cover Model can be used as a tool to classify and manage urban streams

Watershed Planning Approach

Step 1: Assess

Take a stream inventory to assess current physical, biological and chemical processes.

Step 2: Map

Map the imperviousness of each subwatershed and project future development.

Step 3: Classify

Designate the future stream quality for each subwatershed based on the urban stream classification scheme.

Step 4: Implement

Implement policies and practices to align with management objectives for each subwatershed.

OTHER IMPLICATIONS FOR WATER MANAGERS

Urban stormwater treatment practices can help reduce stream health impacts from lower levels of imperviousness. However, even when these practices are widely applied, a threshold is eventually crossed, beyond which predevelopment water quality cannot be maintained using stormwater treatment and stream restoration alone.

Smart watershed planning is a process through which water managers identify the current health of their streams and concentrate future growth in watersheds that are already "non-supporting". This process helps to preserve stream health in the surrounding, sensitive and impacted watersheds. Managers can choose specific threshold values to discriminate among stream categories based on actual monitoring data for their ecoregion, stream indicators of greatest concern and the predominant predevelopment regional land cover.

There are also a number of regulatory and economic tools that can be used to mitigate impervious cover impacts. They are summarized in Table 1.

The Many Tools to Mitigate the ICM	
Planning and Zoning Tools	*Engineering Tools*
• Better Site Design • **Large-lot Zoning** • Site-based IC Caps • Watershed-based IC Caps • Development Intensification • **Watershed-based Zoning** • Extreme Land Conservation	• **Enhanced Stormwater Treatment Criteria for Runoff Reduction** • Watershed Restoration Plans and Stormwater Retrofits • Stream and Floodplain Restoration
Regulatory Tools	*Economic Tools*
• Anti-Degradation Provisions • **IC-Based TMDLs** • **Watershed-Based MS4 Permits with IC Treatment or Load Reduction Requirements**	• IC-Based Utilities • Public Private Partnerships • IC Mitigation Fees

RESOURCES

Type of Resource	Title of Resource
Webcast	The Impervious Cover Model: Revisited (2017)
CSN Report	Technical Bulletin 3: Implications of the Impervious Cover Model (2008)
Journal Article	The Importance of Imperviousness (1994)
Journal Article	Is Impervious Cover Still Important: Review of Recent Research (2009)