An Integrated Framework to Restore Small Urban Watersheds

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Module 1: Organizing to Restore Urban Watersheds

Learning Objectives

By the end of this section, you will be able to:

- **Define** the primary unit of restoration (the subwatershed) and distinguishing characteristics of urban watersheds based on impervious cover.
- **Evaluate** the regulatory and environmental drivers necessitating the shift from point-source to nonpoint source pollution control.
- **Formulate** realistic restoration goals (prevention, repair, or improvement) based on specific subwatershed constraints and stakeholder capability.

Executive Summary: Watershed restoration has shifted from a focus on point-source controls to managing nonpoint source pollution through an integrated framework. The "subwatershed" (typically 5 to 10 square miles) is the optimal unit for planning because it allows for rapid assessment and implementation within a single political jurisdiction. Successful engineering solutions rely not only on technical design but also on aligning diverse stakeholder interests—ranging from regulatory agencies to the general public—toward measurable goals defined by specific impervious cover thresholds.

Fundamental Terminology

To ensure engineering designs align with restoration objectives, you must distinguish between the following technical terms.

- **Urban:** Any watershed or subwatershed possessing more than 10% total impervious cover.
- **Watershed:** A large land area (20 to 100+ square miles) draining to a downstream waterbody. These often cross multiple political jurisdictions and contain mixed land uses.
- **Subwatershed:** The primary unit for restoration. These areas typically span 5 to 10 square miles or less.
    - **Why use the subwatershed?** They can be mapped/assessed in months, projects can be implemented within years, and they usually fall under a single local jurisdiction.

Stream Classification

Urban subwatersheds typically contain first to third order streams:

- **First Order:** Small stream with no tributaries.
- **Second Order:** Formed when two first order streams combine.
- **Third Order:** Formed when two second order streams join.

Components of the Subwatershed

1. **Stream Corridor:** The existing network of stream channels and immediately surrounding lands.
2. **Upland Areas:** The remaining area draining to the corridor. As urbanization increases, the stream corridor shrinks, and upland areas dominate.

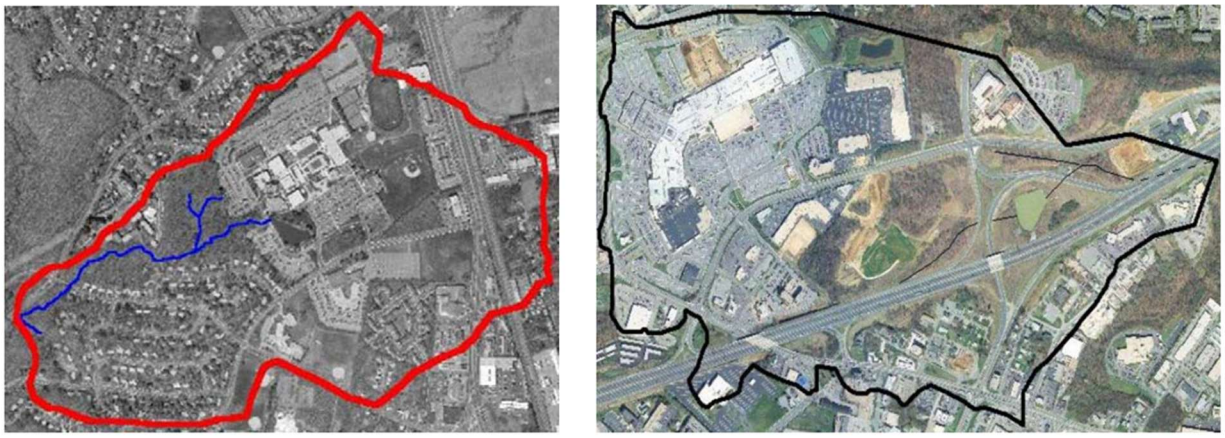

Figure 1: The Stream Corridor and Upland Areas in Urban Subwatersheds

The photo on the left illustrates a lightly developed subwatershed that has a relatively intact stream corridor and stream network, which can be compared to a highly urban subwatershed where both features have been virtually eliminated.

Restoration and Practices

- **Restoration:** A broad term for applying practices to improve stream health indicators (physical, hydrological, chemical, ecological, or social). It does not imply returning a stream to a pre-development, pristine state.
- **Restoration Practices:** The specific engineering and management techniques applied.
    - *In-Corridor Practices:* Storm water retrofits, stream restoration, riparian management, discharge prevention.
    - *Upland Practices:* Pollution source control, pervious area management, municipal stewardship.

Trends Driving Restoration

Engineers must recognize the drivers behind restoration projects to secure funding and regulatory approval.

Shift to Nonpoint Source Control

Conventional control of point sources (WWTPs, industrial discharges) has reached a point of diminishing returns. Urban streams often fail water quality standards due to storm water runoff. Control efforts now focus on watershed-scale treatment of runoff.

Regulatory Drivers

- **TMDLs (Total Maximum Daily Loads):** Mandate specific pollutant load reductions when waters violate Clean Water Act standards.
- **NPDES Storm Water Permits:** Require communities >50,000 population to manage storm water, detect illicit discharges, and monitor runoff quality.
- **Federal Mandates:** CSO/SSO controls, Safe Drinking Water Act source controls, and Endangered Species Act requirements (e.g., salmon recovery).

💡 **Design Tip:** Align your restoration designs with specific regulatory drivers (like a TMDL target) to prioritize them for state or federal grant funding.

Local Capabilities Municipalities have ramped up restoration activities. A recent survey indicates high activity levels in mapping and planning, though comprehensive subwatershed integration remains rare.

Table 1: Selected Results of National Survey of Municipal Watershed Restoration Activity

Restoration Activity or Practice	Communities Reporting Activity (%)
Small Watershed Planning	55
Subwatershed GIS Mapping	80
Rapid Stream Assessment	49
Storm Water Retrofitting	53
Stream Restoration	51
Discharge Prevention	63
Urban Forestry	49
Watershed Education	65
Hotspot Pollution Prevention	35
Public Involvement	71

Notes: 50 + communities surveyed, with populations ranging from 25,000 to 2,000,000. Restoration activity tended to be slightly higher in communities with larger populations and in those covered by Phase I storm water NPDES permits. For complete survey results, consult CWP (2004)

Defining Restoration Goals

Goals drive the engineering design. You must classify goals based on the desired outcome and the limitations of the subwatershed.

Goal Ambition Levels

1. **Prevention:** Keeping problems from occurring (e.g., preventing spills or flood damage).
2. **Repair:** Fixing specific problems (e.g., stabilizing an eroding bank, removing a fish barrier).
3. **Improvement:** Seeking measurable enhancement in stream health indicators through comprehensive application of practices.

⚠️ **Safety Constraint:** Goal selection depends on restoration potential. Do not propose "Improvement" goals for a subwatershed with high impervious cover unless you can realistically treat a significant fraction of the drainage area.

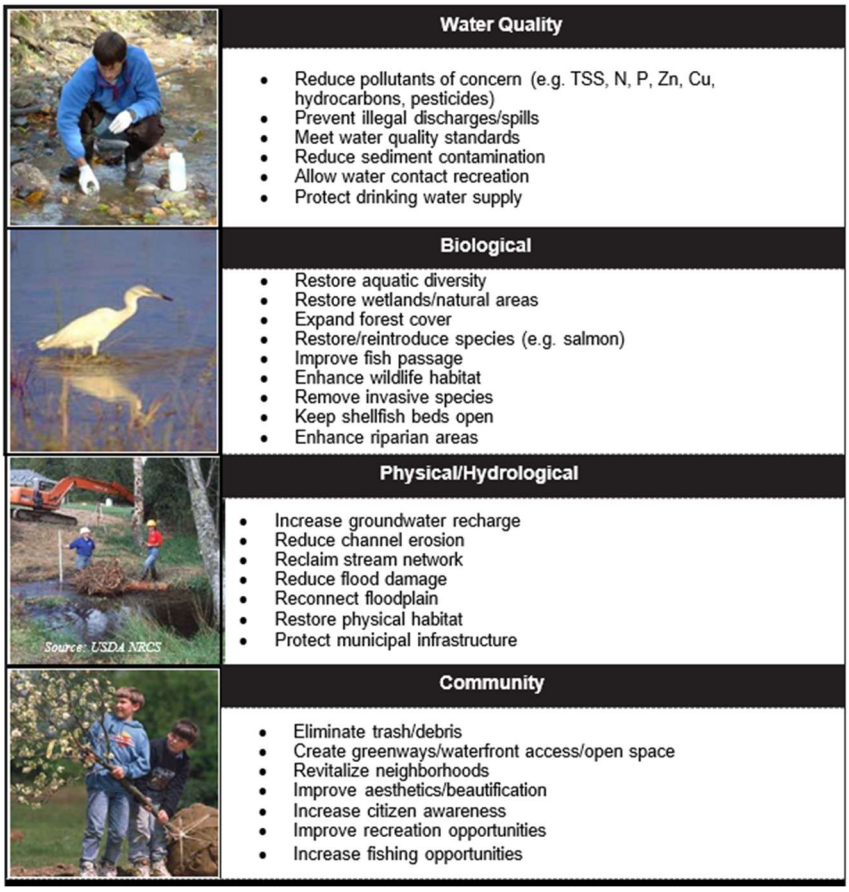

Figure 2: General Classification of Watershed Restoration Goals

Many different goals can be selected to guide watershed restoration; most communities choose several different goals relating to water quality, biological, physical, and community indicators.

Managing Stakeholders

Effective planning requires organizing stakeholders into four functional groups. Think of each group as a "pyramid" of involvement.

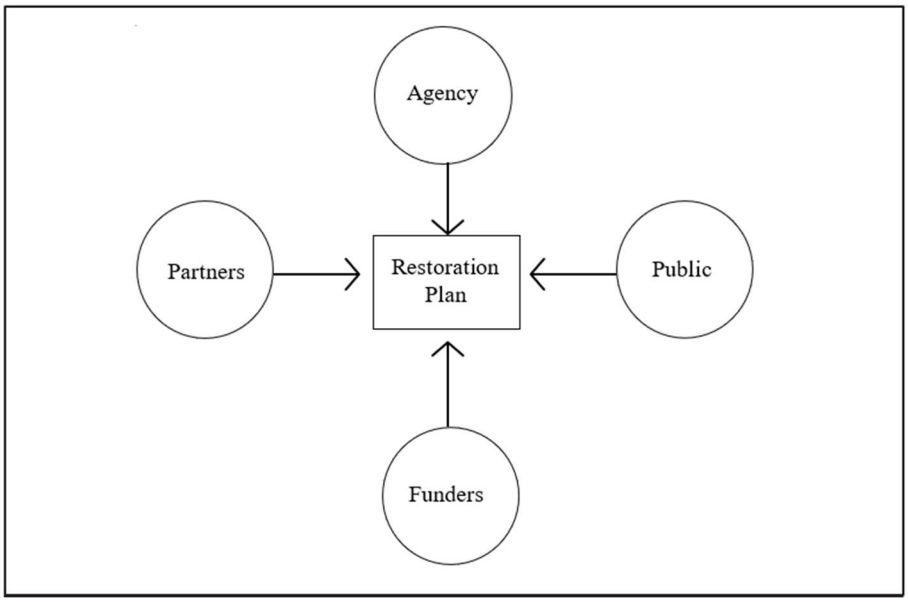

Figure 3: Four Types of Stakeholders Involved in Watershed Restoration Plans

Agency Stakeholders

Local government leads restoration, but authority is fragmented.

- **Apex:** Elected officials (budget approval) and Lead Agencies (DPW/DEP).
- **Base:** State/Federal regulators (permitting).

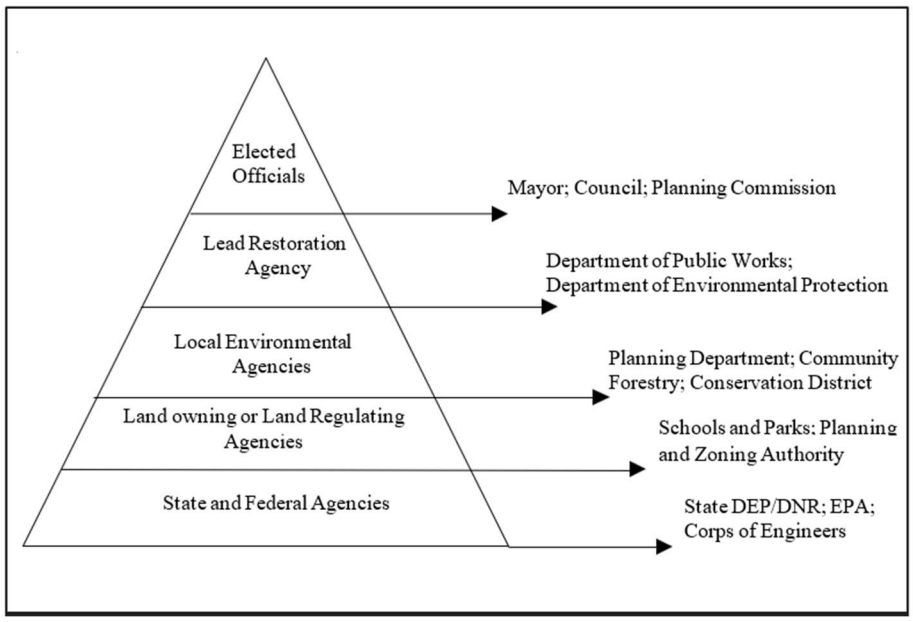

Figure 4: The Agency Stakeholder Pyramid Dozens of local, state and even federal agency stakeholders need to be involved to coordinate effective local restoration planning.

Purchase this course to see the remainder of the technical materials.