# Briefing on Green Infrastructure for Water Management

## Executive Summary

This document provides a comprehensive overview of a curriculum focused on Green Infrastructure (GI) for Water Management, primarily designed for graduate-level students with backgrounds in engineering or applied sciences. The core of the program is an in-depth examination of stormwater management, utilizing the U.S. Environmental Protection Agency's definition of Green Infrastructure. It integrates hydrology, water quality science, and the impacts of urbanization and climate change within local and regional planning contexts, with a specific emphasis on New Jersey's regulatory requirements.

The curriculum extends beyond stormwater to create a holistic water management framework, encompassing wastewater treatment, sustainable drinking water strategies, and energy recovery from water systems. A critical component is the evaluation of environmental impacts, employing tools like life cycle analysis to balance the benefits of new infrastructure against its ecological footprint. The pedagogical approach is balanced, combining theoretical knowledge and practical application, as evidenced by a grading structure that equally weighs homework, an exam, a presentation, and an independent project.

## I. Core Focus: Stormwater Management

The curriculum's primary concentration is on stormwater, addressing its management through a multi-faceted approach that combines planning, regulation, and engineering design.

- **Foundational Concepts:** The course establishes a baseline understanding of hydrology and water quality, analyzing the effects of urbanization and climate change. It adopts the U.S. EPA's definition of Green Infrastructure as its guiding principle.
- **Planning and Regulatory Framework:** The curriculum is framed within watershed, regional, and municipal planning for both existing and new developments. It places significant emphasis on New Jersey's stormwater management requirements, specifically targeting:
    - Flood control
    - Runoff treatment
    - Groundwater recharge
    - Combined Sewer Overflow (CSO) reduction
    - Urban flood management
- **Key Methodologies and Infrastructure Types:** The program introduces a spectrum of modern stormwater management strategies:
    - **Methodologies:** Low Impact Development (LID), nature-based solutions, structural and non-structural measures, and Stormwater Best Management Practices (BMPs).

    - **Infrastructure Categories:** A distinction is made between green infrastructure (GI), blue infrastructure (BI), and traditional gray infrastructure.
- **Specific Technologies and BMPs:** A wide array of practical, engineered solutions are covered in detail, including:
    - Rain barrels and rain gardens
    - Green roofs
    - Pervious pavements
    - Bioretention and biofiltration basins
    - Infiltration basins and trenches
    - Constructed wetlands
    - Manufactured treatment devices
    - Detention basins and wet ponds
- **Engineering and Economic Analysis:** The program integrates conventional engineering principles such as hydraulics, drainage, piping, pumping, and outfall design. It also covers crucial related topics like soil erosion, sediment control, cost estimation, and benefits analysis.

# II. Expanded Scope of Water Management

While centered on stormwater, the curriculum covers a broader spectrum of water resource topics to provide a complete systems-level perspective.

- **Wastewater Management:** This module addresses the protection and restoration of water environments. Key topics include:
    - Modeling and analysis of receiving water quality.
    - The concept of Total Maximum Daily Loads (TMDLs).
    - Grey water reuse.
    - Sludge management and its beneficial use.
- **Drinking Water:** The focus is on forward-looking, sustainable approaches to drinking water supply. This includes the exploration of "sustainable (soft) paths" and an emphasis on water conservation.

# III. Integration of Energy and Environmental Systems

A significant theme is the interconnection between water infrastructure, energy production, and environmental sustainability.

- **Energy Generation and Recovery:** The curriculum explores methods for extracting energy from water systems, such as:
    - Anaerobic digestion.
    - Hydropower generation from existing infrastructure, including low head dams, outfalls, and channels.
- **Environmental Impacts and Sustainability Tools:** This section focuses on assessing and mitigating the environmental effects of infrastructure. Key areas of study are:
    - Formal environmental impact assessment procedures.

- Integrating new infrastructure with existing ecosystems.
- Analyzing the balance between benefits and environmental impacts of large-scale gray infrastructure (dams, canals, pipelines, treatment plants).
- Design adaptations like fish ladders to minimize ecological disruption.
- The use of life cycle analysis tools to quantify sustainability metrics such as equivalent carbon emissions, energy usage, and costs during the design process.

# IV. Course Structure and Resources

The program is structured to provide a rigorous academic experience supported by authoritative resources and a balanced assessment model.

## Course Administrative Details

| Detail | Information |
|---|---|
| **Course Title** | Green Infrastructure for Water Management |
| **Course Code** | 16:180:592 |
| **Institution** | Rutgers University-New Brunswick, School of Engineering |
| **Department** | Civil and Environmental Engineering |
| **Instructor** | Dr. Q. Guo |
| **Semester** | Fall 2024 |
| **Schedule** | Monday 6:00 pm - 9:00 pm |
| **Prerequisites** | Undergraduate degree in engineering or applied sciences |

## Key References and Tools

The curriculum draws upon a combination of regulatory manuals, specialized software tools, and academic texts:

- **Regulatory Manual:** New Jersey Department of Environmental Protection (2024). *New Jersey Stormwater Best Management Practices Manual* (updated March 2024).
- **Valuation Tool:** Center for Neighborhood Technology, *The National Green Values™ Calculator*.
- **Core Textbooks:**
  - Davis, A. P., Hunt, W. F., and Traver, R. G. (2022). *Green Stormwater Infrastructure: Fundamentals and Design*, Wiley.
  - Cahill, T. H. (2012). *Low Impact Development and Sustainable Stormwater Management*, Wiley.
  - Chin, D. A. (2021). *Water-Resources Engineering*, 4th Edition, Pearson.

## Assessment and Grading

Student performance is evaluated through a mix of assignments that test theoretical understanding, practical application, and independent research.

| Assessment Component | Weighting |
| --- | --- |
| Homework | 30% |
| Exam | 30% |
| Presentation | 20% |
| Independent Project | 20% |