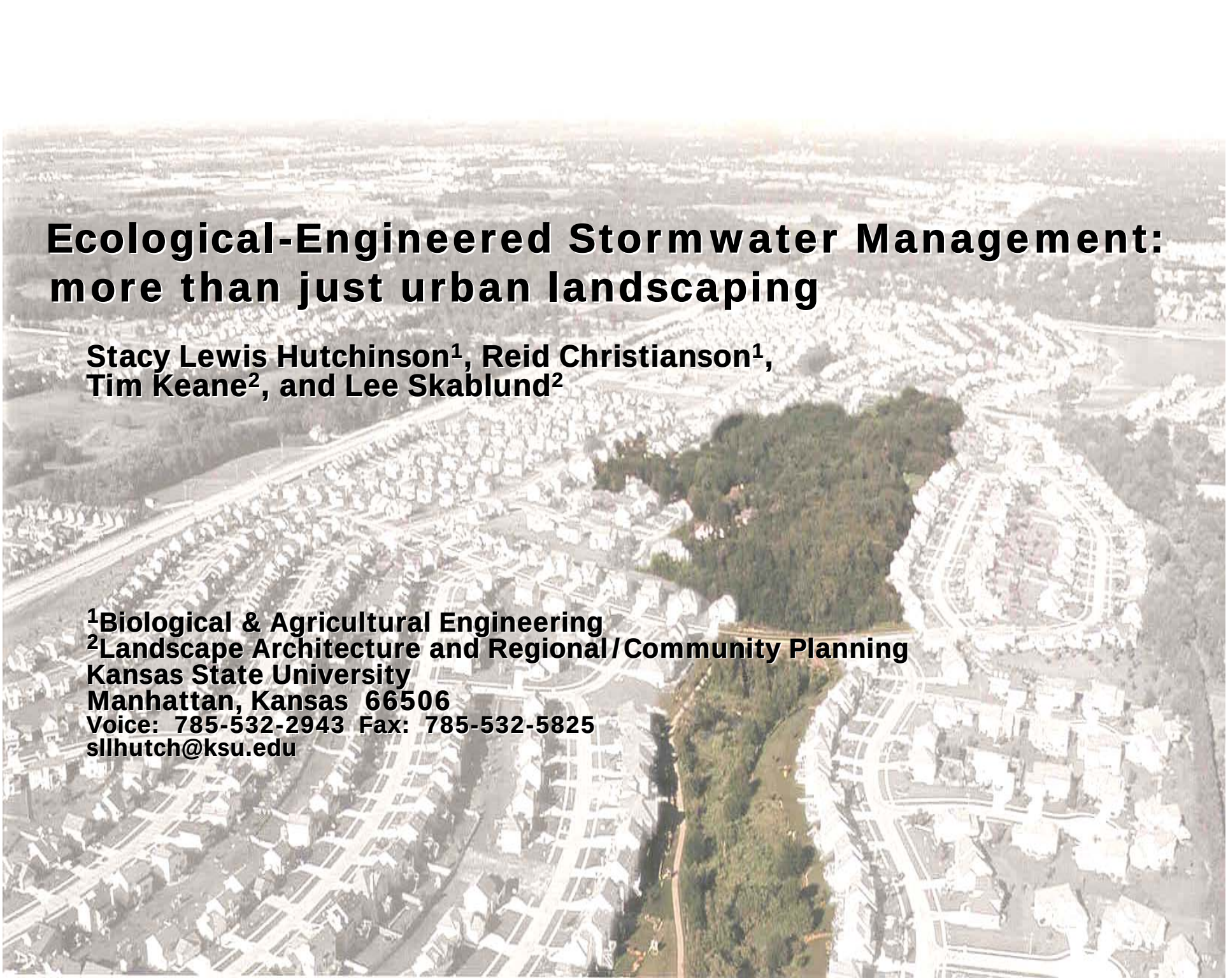

Ecological-Engineered Stormwater Management: more than just urban landscaping

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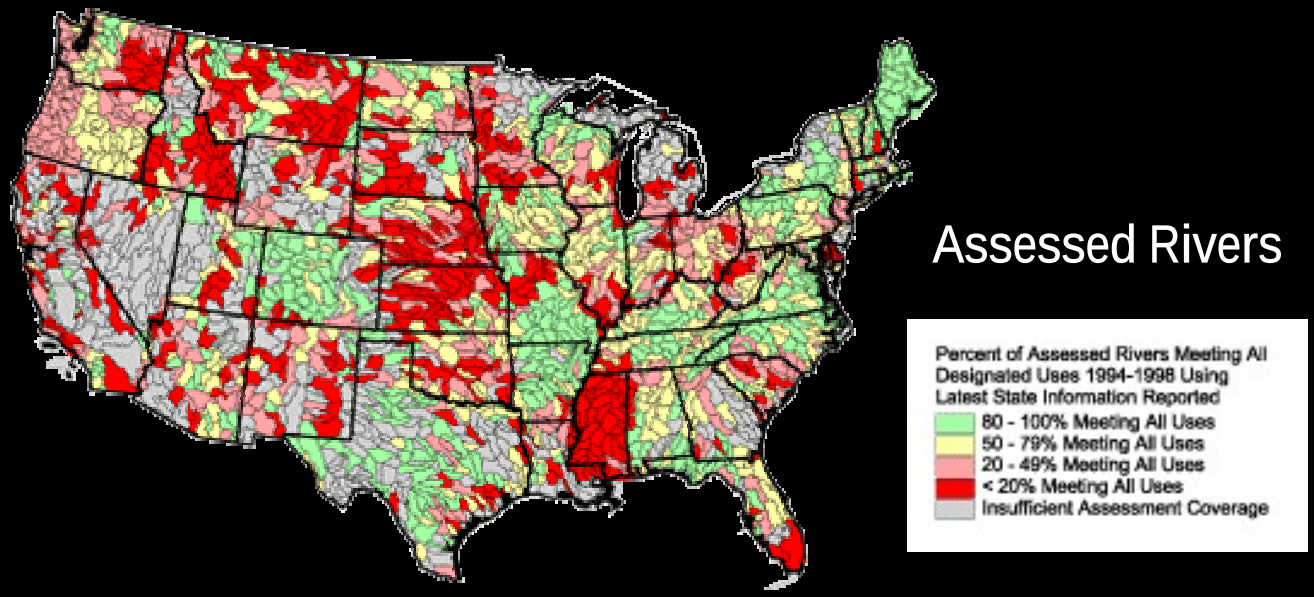
So what's an ecological engineer?

- Biological Engineering (IBE)
  - the biology-based engineering discipline that integrates life sciences with engineering in the advancement and application of fundamental concepts of biological systems from molecular to ecosystem levels.
- Environmental Engineering (AEESP)
  - the application of science and engineering principles to improve the environment (air, water, and/or land resources).
- Ecological Engineering (AEES)
  - the design of sustainable ecosystems with the intent to integrate human society with its natural environment for the benefit of both.

NonPoint Source Pollution

- *NPS = Any pollution source that is not a statutory point source of pollution…includes sources that are diffuse in nature and which are <u>not discharged</u> from a few localized points.*

- Largest water quality problem in United States.
  - 40% of streams, lakes, estuaries not clean enough for basic uses
  - Agriculture is the largest contributor to NPS.
  - Agriculture impairs 25% of stream miles and 19% of lake acreage in U.S.

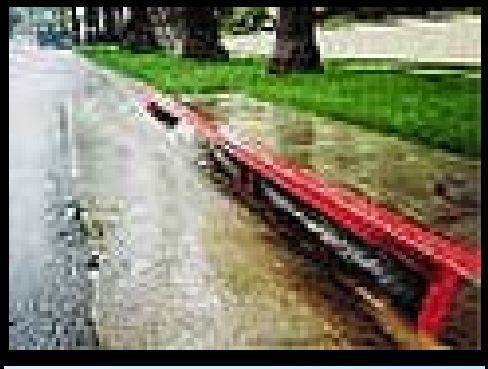


http://www.epa.gov/iwi/2000may/iv1_usmap.html#rivers

Rural NPS Pollution

- Sediment
  - 4 billion tons/year
  - Approx. half from natural geologic erosion and remainder from human activities (e.g., agriculture).
- Nutrients
  - Nitrogen – 6.8 million tons/year
  - Phosphorus – 2.6 million tons/year
- Fecal Coliform
  - Approx. 98% from NPS, including septic tanks and animal production facilities.
  - Point sources less significant → treatment facilities.
- Pesticides
  - Problems generally caused by misuse/misapplication.
  - Only 2-3% of pesticides reach target organism.

Urban NPS Pollution

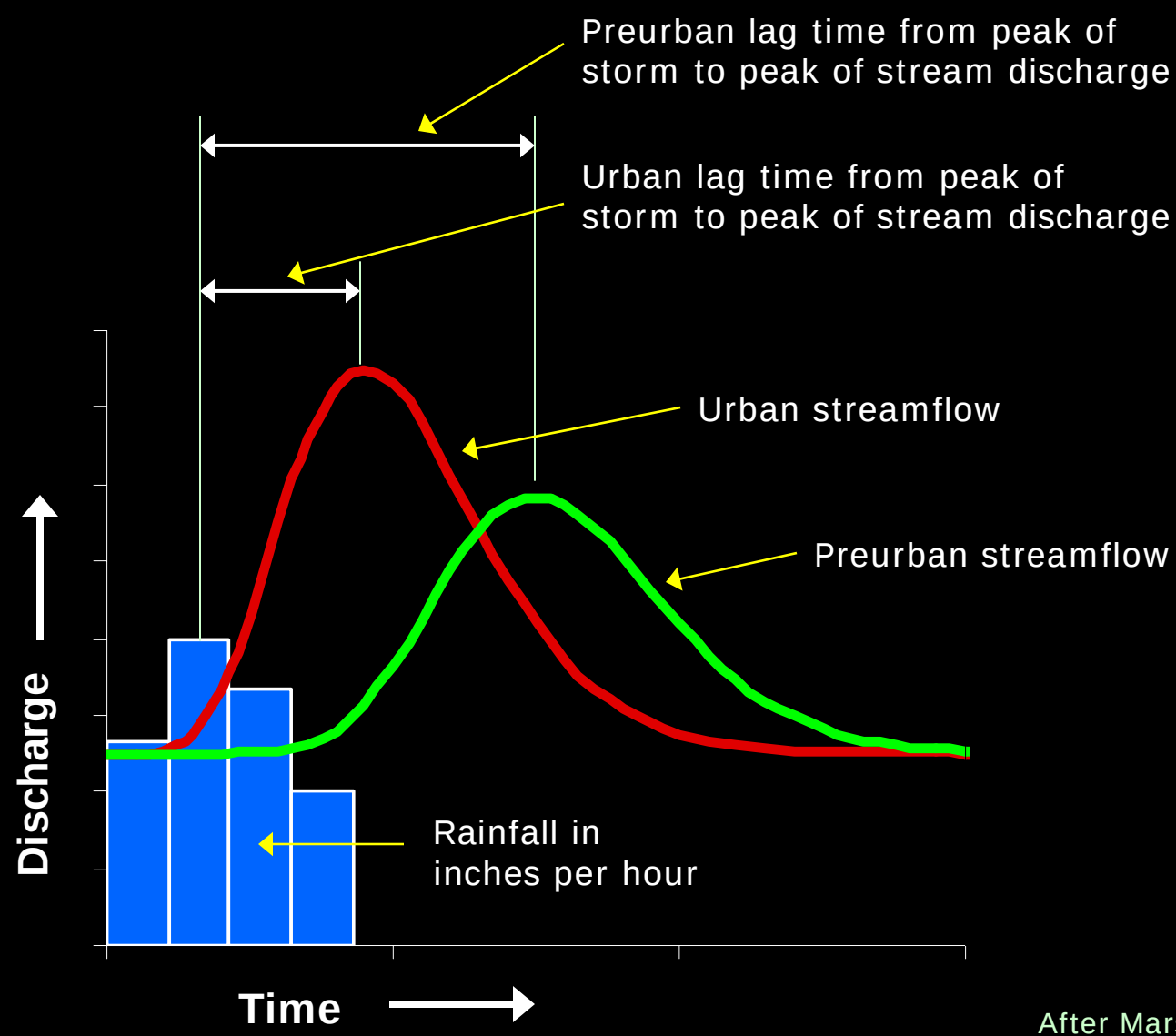


- Urban stormwater runoff is the 4th and 3rd most extensive cause of U.S. river and lake water quality impairment, respectively.
- The main difference between urban and non-urban areas is the degree of imperviousness of the land surface.
- Reduced erosion from soil surface (except construction sites), but increased channel erosion due to higher runoff rates.
- Pollutant loadings are controlled by dust and litter accumulation and atmospheric deposition.
- Reduced groundwater recharge and lower stream base flows.

Urbanization

- Conversion of rural land to urban land usually increases erosion and the discharge and volume of storm runoff in a watershed.
- Changes a watershed's response to precipitation:
  - Reduces infiltration
  - Decreases travel time
- Impervious surfaces cover a considerable area.
  - Roads
  - Sidewalks
  - Parking lots
  - Buildings
- Natural flow paths may be replaced or supplemented by paved gutters, storm sewers, and/or other elements of artificial drainage.

Runoff Comparison



After Marsh, 1998

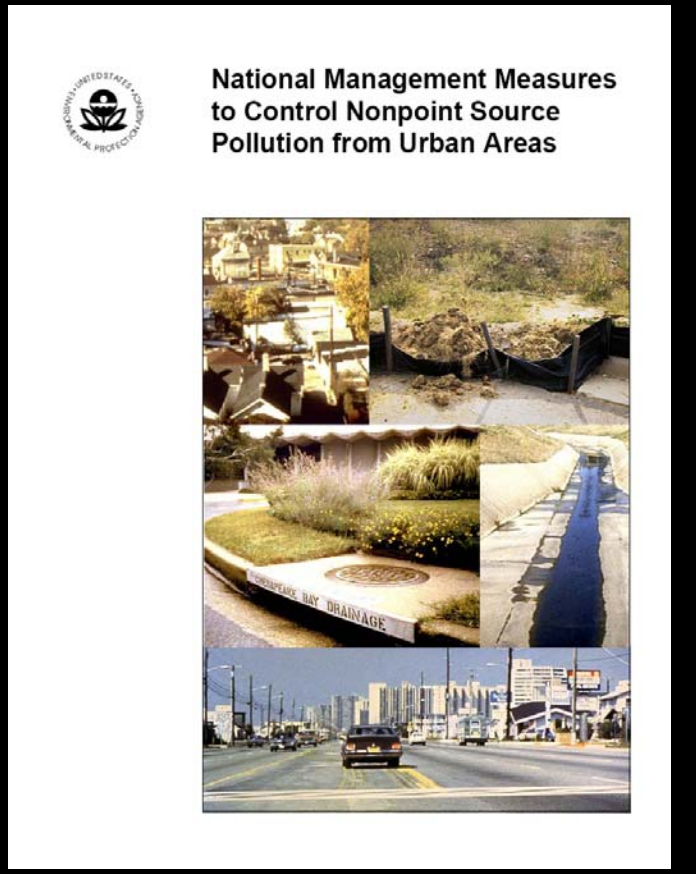
The Problem

Natural Solution

Sustainable Stormwater Management:

- Low Impact Development is a new, comprehensive land planning and engineering design approach with a goal of maintaining and enhancing the pre-development hydrologic regime of urban and developing watersheds.

- Best Management Practices:
  - Infiltration Basins
  - Bioretention Cells
  - Water Gardens
  - Bioswales with Underdrains
  - Soil Amendments
  - Permeable Pavement
  - Roof Gardens
  - Development Changes




Naval District Washington


Naval District Washington

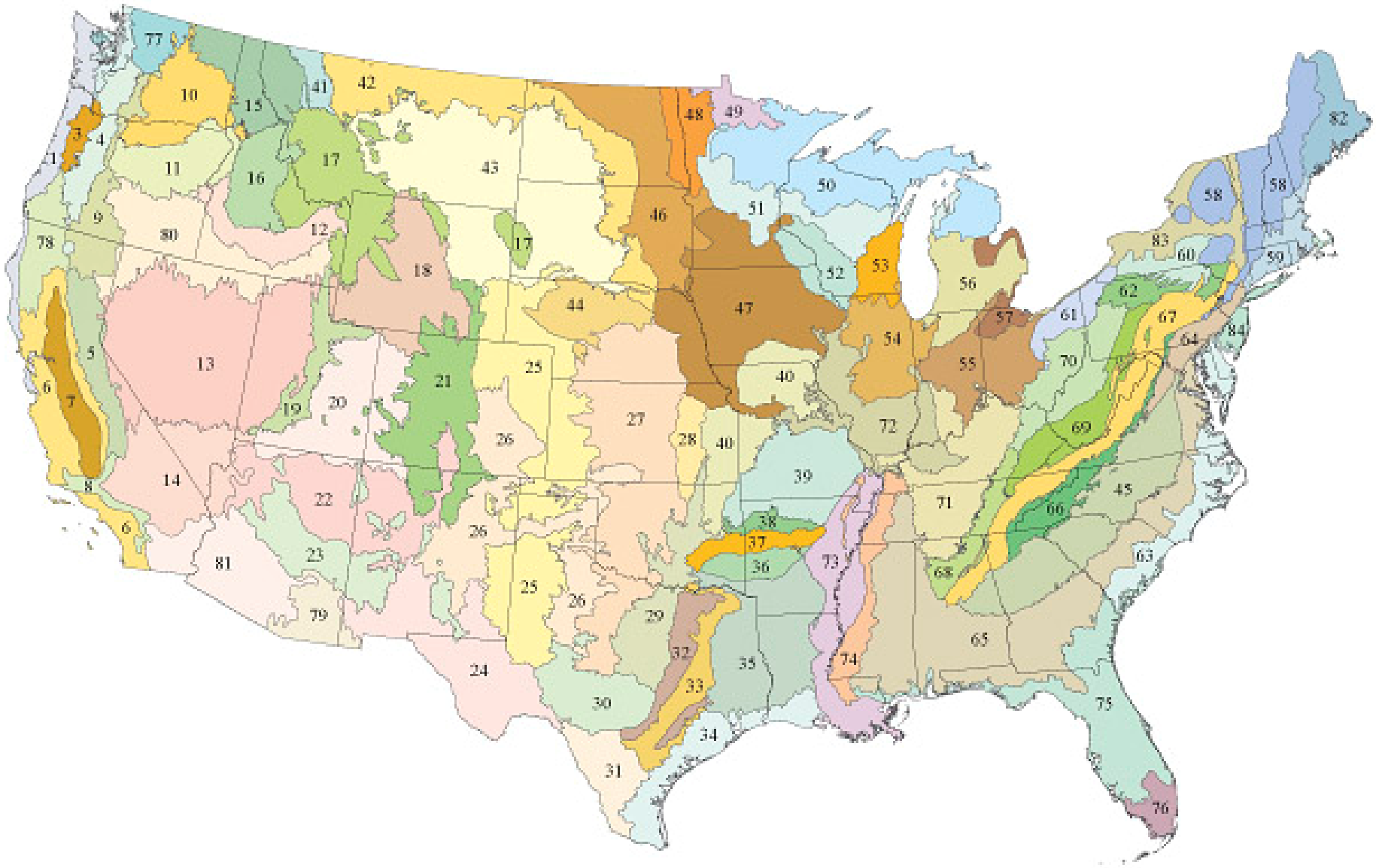
Naval District Washington

Local Example (Kansas)

Bioretention Cell – Hillcrest Community Center, Topeka, KS

http://www.greentopeka.org

Level III Ecoregions of the Conterminous United States



Map Source: USEPA, 2007

Bioretention Cell – Hillcrest Community Center

Then

http://www.greentopeka.org

Now:

- Native vegetation
- No wood mulch

Bioretention / Inline-Retention
Jackson Street

Quinton Heights

Ecological Stormwater Systems

- A few challenges to successful implementation of ecologically-designed stormwater systems:
  - Maintenance
    - The performance of ecologically-designed systems relies upon ecosystem processes;
    - These systems require different management regimes to insure sustainability of these functions
  - Long-term monitoring
    - Typical monitoring (if any) considers hydrologic and chemical aspects of system performance
    - Can be time and cost-prohibitive
    - Ecosystem health not considered

Current Research: Ecological Health Assessments

Quinton Heights, Topeka, KS
Vegetation established spring 2004

Johnson County Transit Center
Vegetation established spring 2007

- Goal: develop an ecological health assessment tool that is…
  - Easy to use
    - Target users are municipal stormwater managers
  - Relevant to ecological stormwater system design and intended performance
    - Selected indicators should provide insight to the ability of the system to maintain desired ecosystem processes (i.e. infiltration)

Ecological Health Assessments

- Health assessment consisted of four main categories:
  - Vegetation Health
  - Soil Health
  - Erosion Indicators
  - Biotic Health
- Indicators chosen to provide insight to ability of system to maintain desired ecological functions, namely infiltration (to reduce runoff volume) and sedimentation (to improve quality)

Future Issues for Local Design

- Self Design
- Design Storm:
  - For stream forming event – water quantity
  - For water quality
- Vegetation
- Growing media
  - Infiltration rates
  - Sorptive capacity
- Watershed Model
  - BMPs
  - Integration of Geographic Information Systems (GIS)
  - Proper planning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