# Framework for Sustainable Watershed Management

U.S. EPA Collaborative Science and Technology Network for Sustainability
Washington, DC
December 5 – 6, 2006
Pamela V'Combe, Watershed Planner

# Delaware River Basin

Longest Un-dammed River
East of the Mississippi

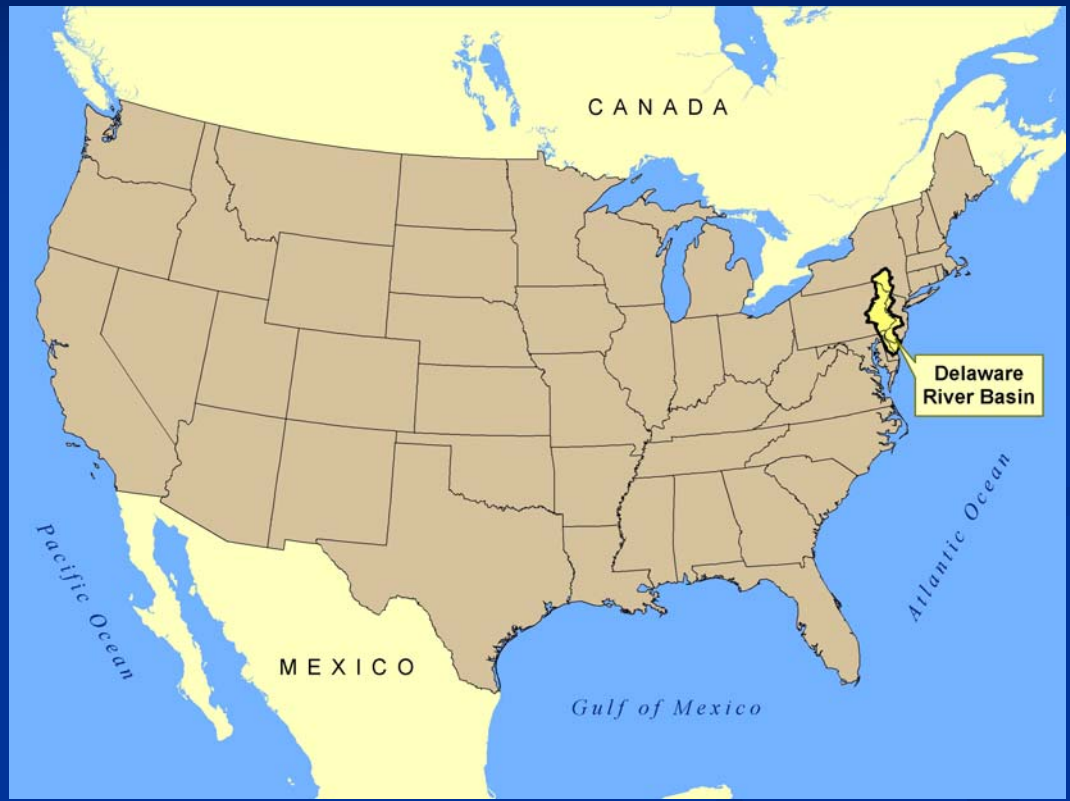
- 330 miles
- 216 tributary streams
- 4 states,
- 42 counties,
- 838 municipalities
- 2 EPA regions

150 miles is included in the
National Wild and Scenic Rivers System.


Delaware River Basin Commission

# Delaware River Basin

- Drains only four-tenths of one percent of the total continental U.S. land area
- Five percent of national water supply – 15 million people




Delaware River Basin Commission

# Basin has Urban Centers with Tall Ships and …

Delaware River Basin Commission

# Historical Significance …

Delaware River Basin Commission

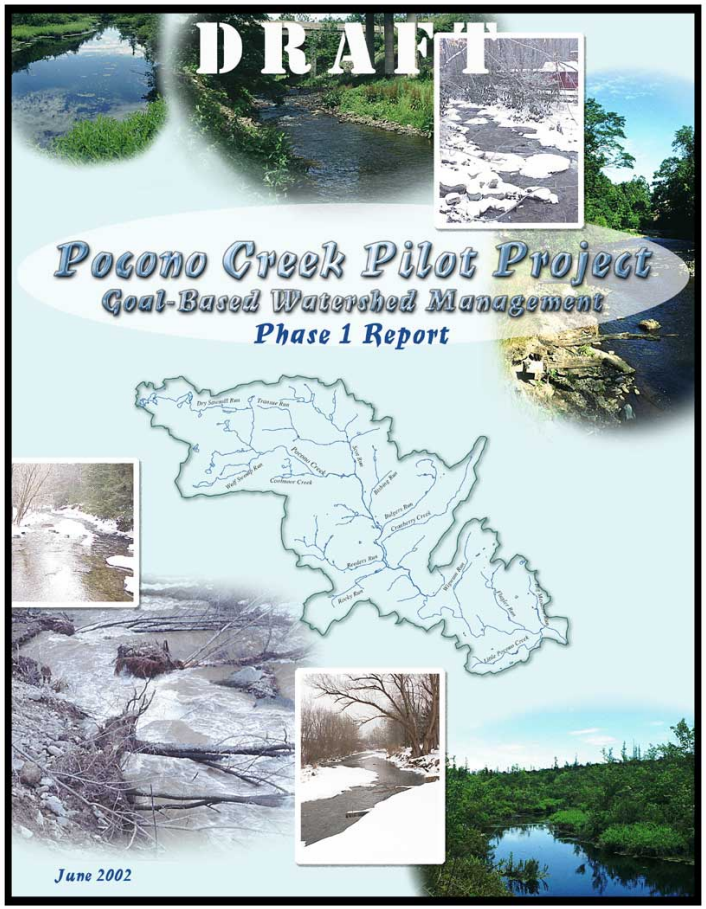
# Important Natural Resources…

Delaware River Basin Commission

# and Outstanding Natural Beauty

Delaware River Basin Commission

# Pocono Creek Pilot Study 2000-2004




## Major Water Resources Issues in Pocono Creek Watershed

- 1. Stream Flow
- 2. Water Quality
- 3. Stream Channel Stability
- 4. Aquatic Ecology

Delaware River Basin Commission

# Pocono Creek Watershed

Monroe County PA – 2nd in Growth

Tourism Based Economy

Population Increased > 50% in past decade

More than 50% Undeveloped

90 minute Drive from Philadelphia & NYC


Delaware River Basin Commission

# Pocono Creek Headwaters

Delaware River Basin Commission

# Pocono Creek - Headed Downstream

Delaware River Basin Commission

# Pocono Creek – Cranberry Bog

Delaware River Basin Commission

# Pocono Creek – Downtown

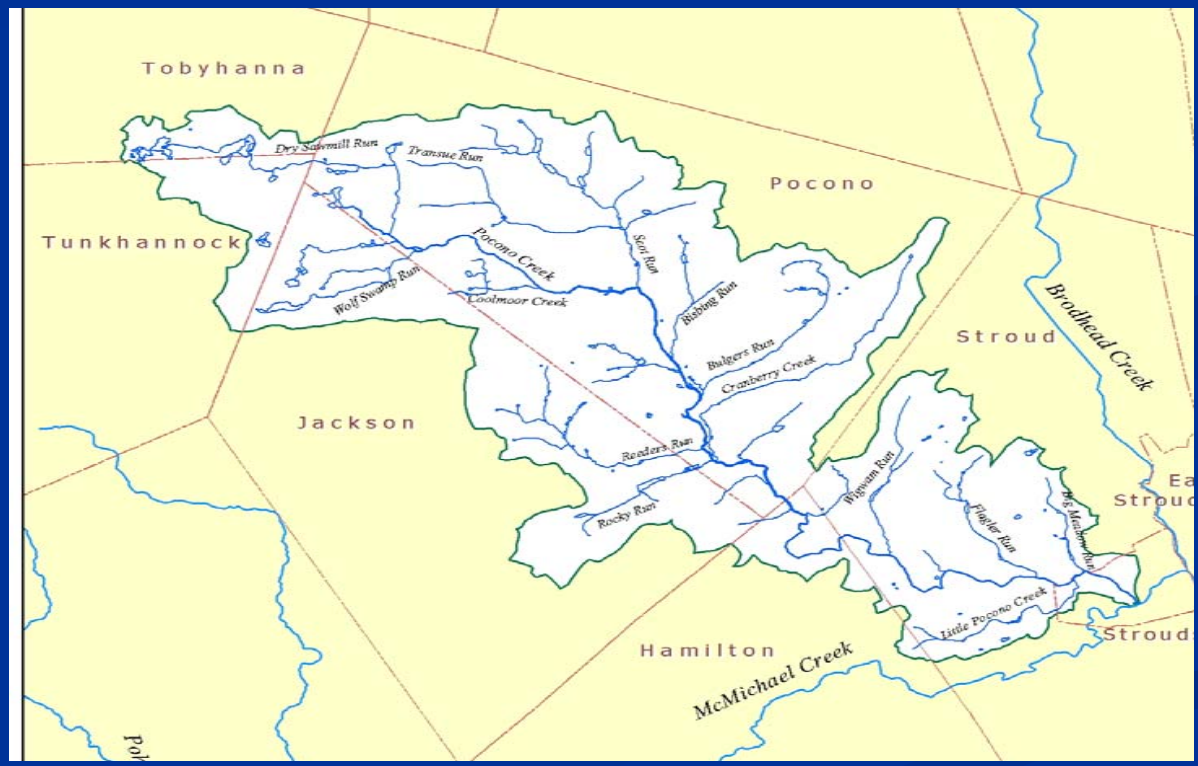

Delaware River Basin Commission

# Pocono Creek Watershed

Pocono Creek is 18 Miles - Watershed 46.5 sq. mi.

HQ & EV Cold Water Stream (PADEP)

Class A Wild Trout Stream (PF&BC)

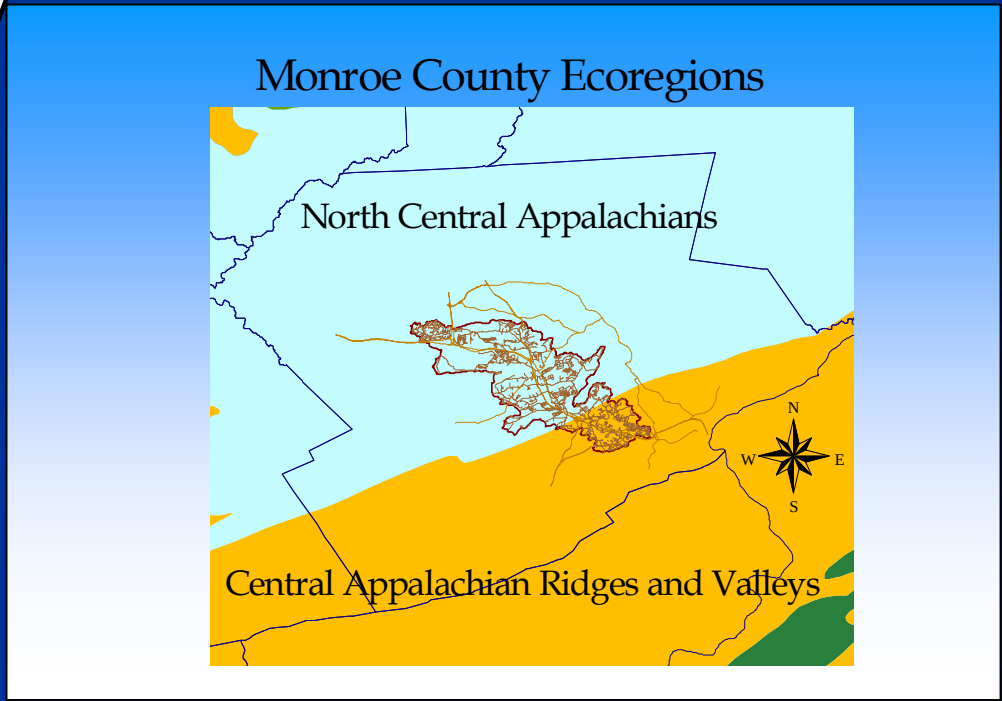



Delaware River Basin Commission

# Two Ecoregions

Appalachian Plateau

Ridge & Valley




Delaware River Basin Commission

# Pocono Creek Watershed Goals

- Maintain high quality water quality
- Preserve stream corridors and floodplains
- Coordinate watershed planning process with other levels of government
- Maintain existing stream flow
- Develop using village centers conservation design
- Establish an economy compatible the environment
- Preserve open space




Delaware River Basin Commission

# Water Quantity Goals

**Maintain existing stream flows**

**&**

**Support natural ecosystems**

Delaware River Basin Commission

# Framework for Sustainable Watershed Management

## Manage the Water Resources to Meet Current and Future Needs

This research is funded by U.S. EPA - Science To Achieve Results (STAR) Program Grant #

Delaware River Basin Commission

Brodhead Watershed Association

Preparing Monroe County for the future... MONROE 2020

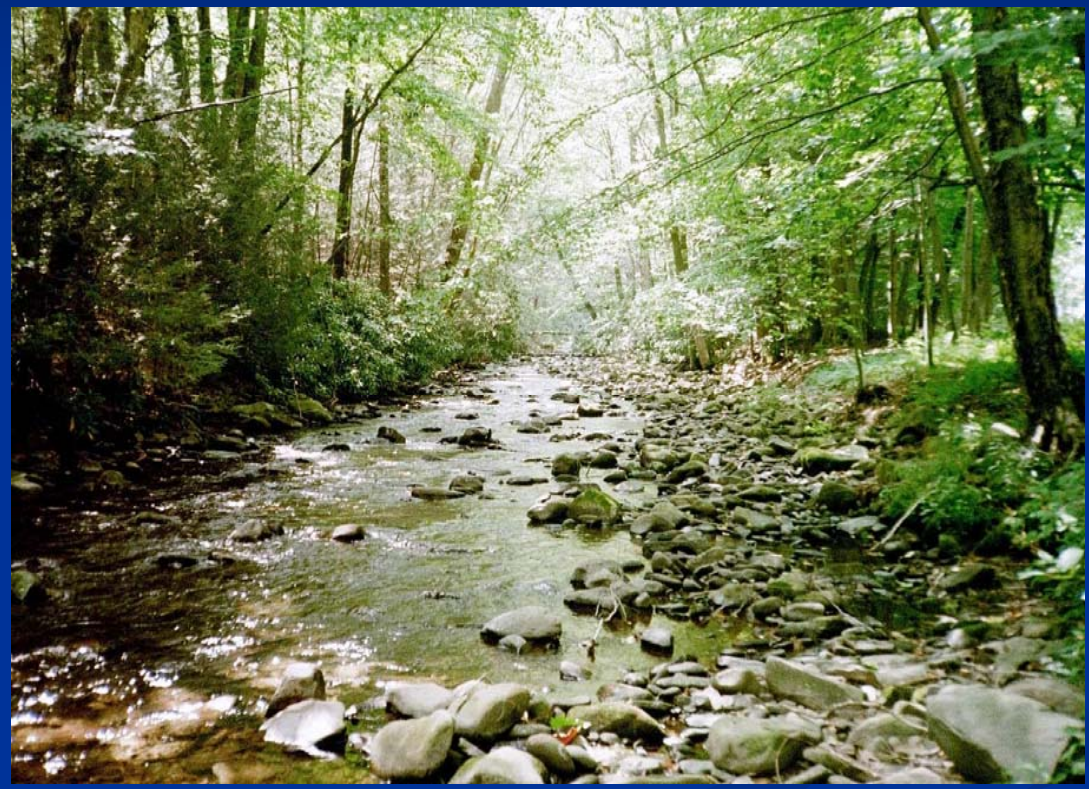
MONROE COUNTY CONSERVATION DISTRICT ENVIRONMENTAL EDUCATION CENTER

USGS science for a changing world

PENNSYLVANIA FISH & BOAT COMMISSION

# Sustainable Watershed Conditions

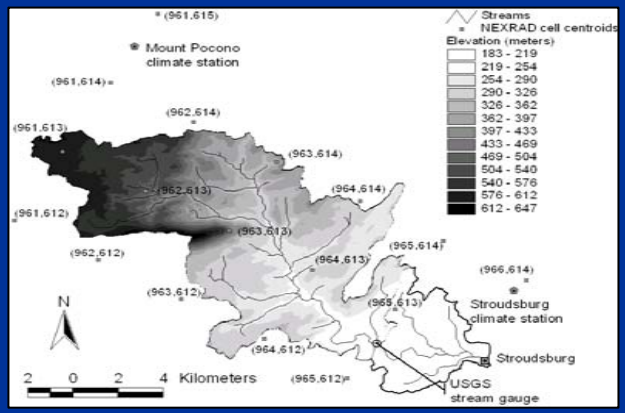
Water Resources to Support Human Needs & Ecological Habitat

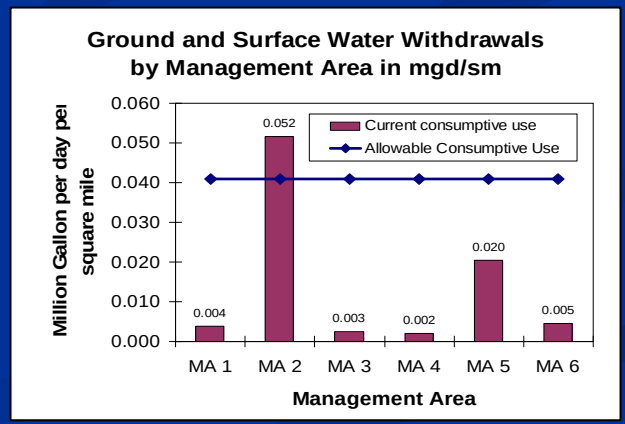


Delaware River Basin Commission

# Framework for Sustainable Watershed Management

**Approach:** To use sound science to develop water resource management strategies and polices that are adopted and implemented by decision makers.



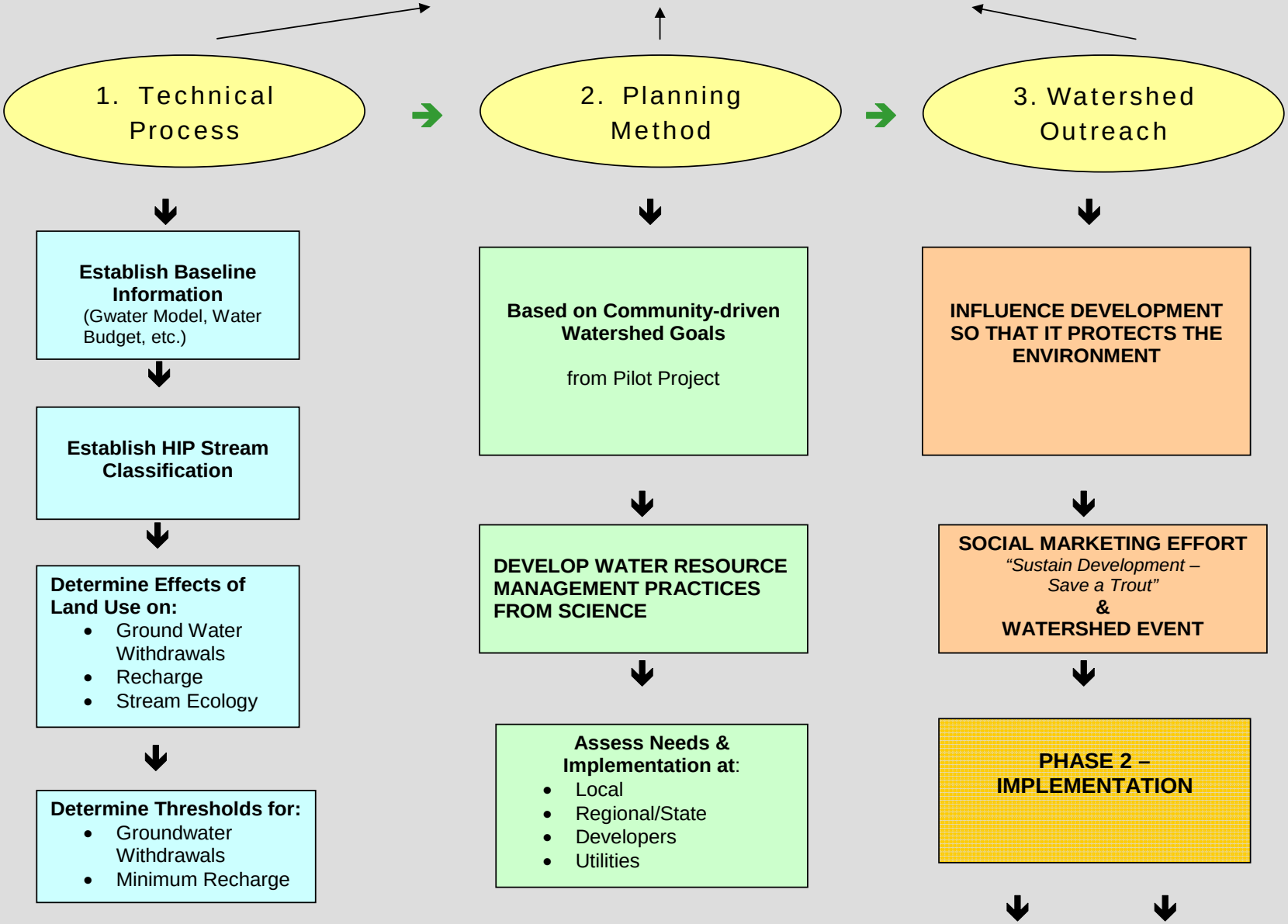

Delaware River Basin Commission

# Framework for Sustainable Watershed Management

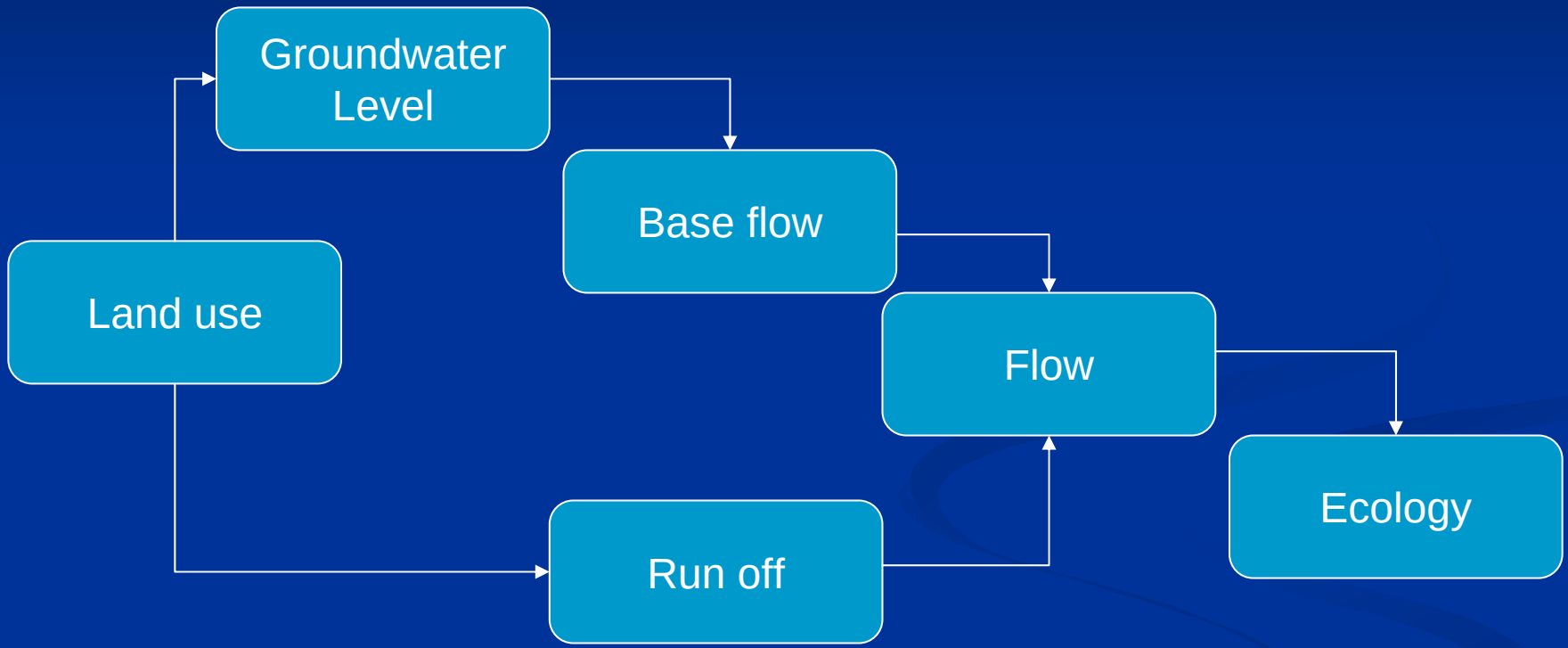
- Stage 1 – Technical & Scientific Research
- Stage 2 – Development of Management Strategies & Planning Tools
- Stage 3 – Community Outreach

Delaware River Basin Commission

# The Framework for Sustainable Watershed Management



# Models and HIP Process




Delaware River Basin Commission

# Technical Stage

- Baseline for:

Existing Water Budget
Ground Water/Surface Water Interface
Streamflow Statistics
Hydrologic Conditions
Existing Water Demands

- Determine necessary conditions to maintain sustainable flows in Pocono Creek Watershed
- Characterize hydrologic relationships between baseflows and withdrawals
- Identify stressors for existing habitat

Delaware River Basin Commission

# Technical Stage

- Baseline for:

Existing Water Budget
Ground Water/Surface Water Interface
Streamflow Statistics
Hydrologic Conditions
Existing Water Demands

- Determine necessary conditions to maintain sustainable flows in Pocono Creek Watershed
- Characterize hydrologic relationships between baseflows and withdrawals
- Identify stressors for existing habitat

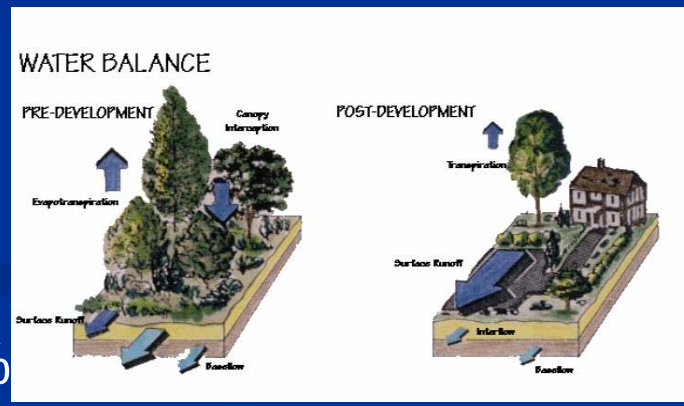
Delaware River Basin Commission

# HYDROLOGY MODEL STUDY

RESULTS  Based on Projected Build Out -

Recharge reduced in 26 out of 29 recharge areas

Daily Base Flow <  31%
Low Flow 7Q10 < 11%,
Monthly Median Daily Flow < 10%




Monthly Peak of Daily Flows  > by 21%
Annual Maximum of Daily Flow > 19%

Watershed-averaged Groundwater Recharge < 31%

Delaware River Basin Commission

# HYDROLOGY MODEL STUDY


Soil and Water Assessment Tool (SWAT) calibrated and validated for Raingauge & Next Generation Weather Radar (NEXRAD) hourly precipitation data

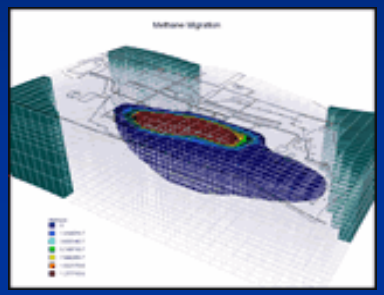
*"The results clearly show that NEXRAD is an effective and economic alternative source of spatio-temporal precipitation, and that future modeling studies in ungauged watersheds may benefit from the use of NEXRAD rainfall data."*

**TRANSFERABLE!**

Delaware River Basin Commission

# USGS MODFLOW-2000 Groundwater Flow Model

## Measured Effects on Stream Base Flow from



Ground-Water Withdrawals

&

Reduced Recharge from Land Use Change

- Three-dimensional
- Entire Pocono Creek watershed
- Used EPA-ORD hydrology model recharge values for 2000 land use & 2020 land use.

Delaware River Basin Commission

# USGS MODFLOW-2000 Groundwater Flow Model

Model used to simulate base flow for 2000 & 2006

- 2 sets of steady-state simulations were run:
  - 2.25-mi2 Bulgers Run subwatershed
  - 6.1-mi2 Scot Run watershed.

- 5 hypothetical wells added to each subwatershed to simulate consumptive pumping.

Delaware River Basin Commission

# USGS MODFLOW-2000 Groundwater Flow Model

**Initial Findings:**

- Effects of ground water withdrawals are related to drainage area
- Base flows decreased at build-out
- Simulated base flows decreased 38 to 100% at streamflow-measurement sites
- Base flow decreased 31% at streamflow-gaging station
- Groundwater withdrawals and surface water withdrawals equally affect stream flow

Delaware River Basin Commission

# Hydrology Model & Ground Water Model Agree!

The results indicate that…

*Kalim A. Bhatti for the New York Times*

*Traditional Development Patterns in the Pocono Creek Watershed will Decrease Base Flows in Pocono Creek by >30%!*

Delaware River Basin Commission

# Hydroecological Integrity Assessment Process

## Links Streamflow and Stream Health

Purpose is to:

- Sustain or Restore Stream Communities

- Sustain or Restore Stream Integrity

In order to maintain healthy aquatic ecosystems in streams

Delaware River Basin Commission

# Hydroecological Integrity Assessment Process (HIP)

*"Streamflow is .."master variable" … Limits the distribution, abundance, and diversity of many aquatic plant and animal species."*

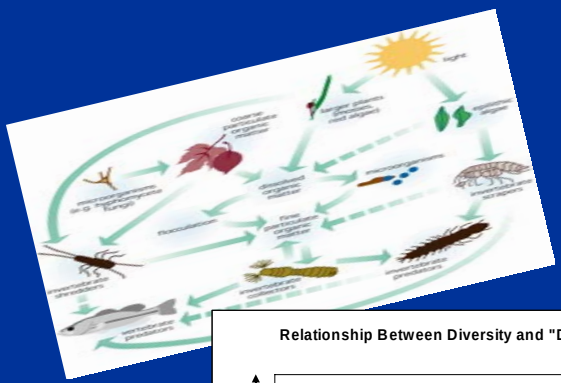
Conducts hydrologic classification of streams,
Addresses instream flow needs, and
Assesses past and proposed hydro-logic alterations on;

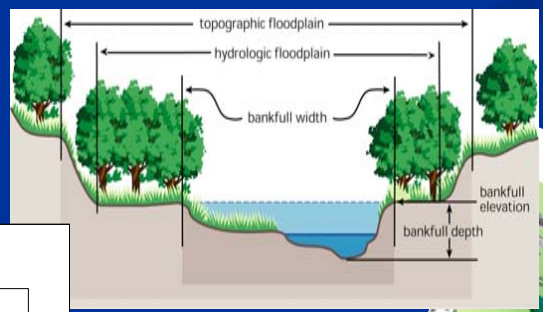
- streamflow and
- ecosystem components.

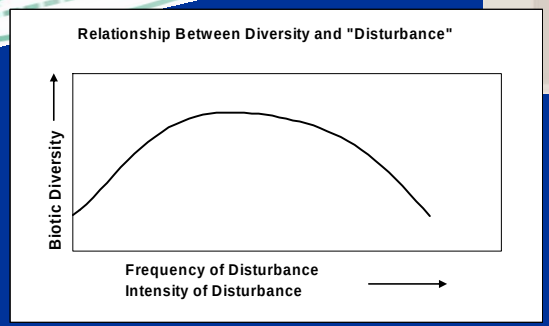
Delaware River Basin Commission

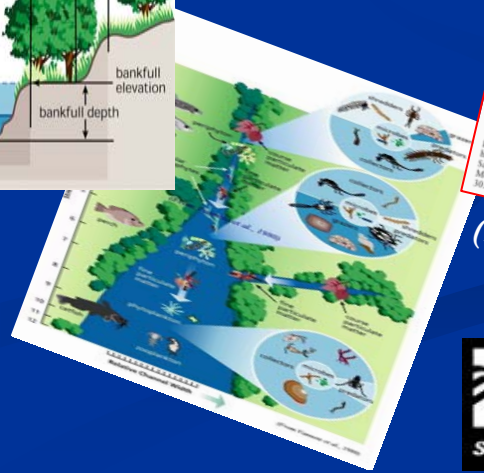
# Natural flow regime paradigm

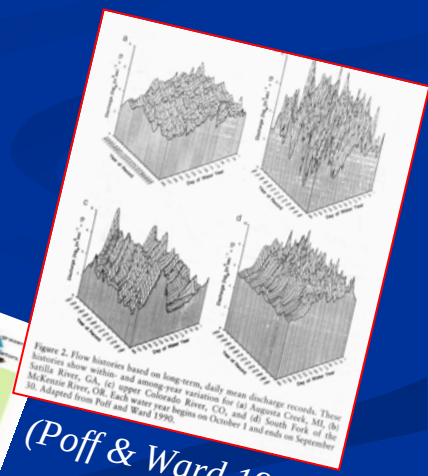
- River continuum concept *(Vannote 1980)*
- Flood pulse concept *(Bayley 1991)*
- Hierarchical, multi-scale *(Frissell 1986)*
- Network dynamics hypothesis *(Benda et al. 2004)*
- *Intermediate-disturbance hypothesis (Ward & Stanford 1983)*





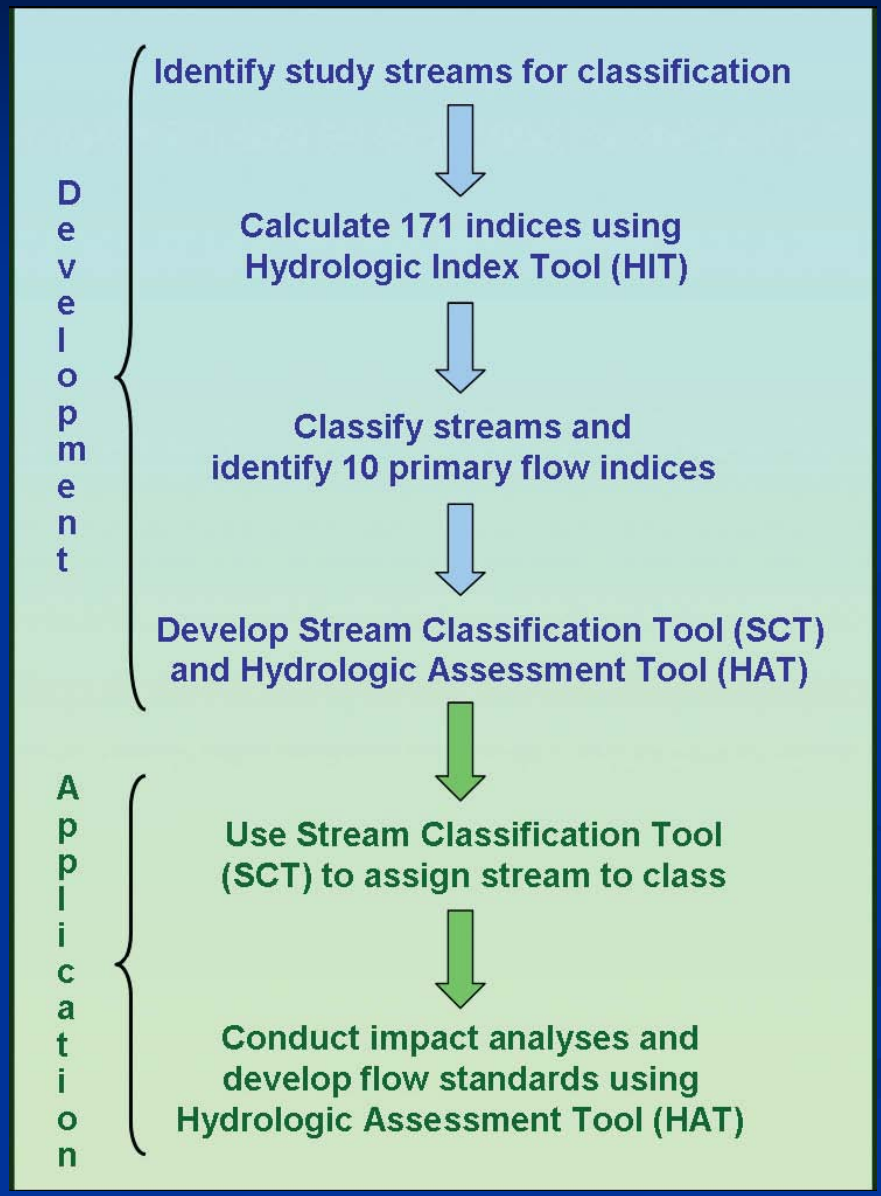





(Poff & Ward 1990)

USGS science for a changing world

# HIP PROCESS




Delaware River Basin Commission

# SURPRISES!

- **Experiencing Technical Difficulties!**

  Selected Methodology Didn't Work -
  - IFIM Model replaced by HIP
  - Product deliverable changed from Flow Curves for Trout to HIP Stream Classification
  - Will Attempt to Apply HIP to Habitat Species
  - New Partners

- **New Infrastructure Coming to Town!**

  Local Partners Concerned with Impacts, Distracted by "Battle"

- **Social Marketing as Outreach!**

  EPA R-3 Workshop Re-energized Watershed Group

Delaware River Basin Commission

# Contributions towards Sustainability are…

A 3-Staged **Framework for Sustainable Watershed Management** that Allows Development while Protecting Ecological Flows

**Technical Process**

- Understanding Limit of Resource

**Planning Method**

- Development of Management Strategies Based on Science

**Community Outreach**

- Influence Development that Protects the Environment

Delaware River Basin Commission

# Partners' Updates & Transferable Products

- **US EPA**
  Hydrology Model, Water Quality and New Flow Data, Statistics
- **Delaware River Basin Commission**
  SPECIAL PROTECTION WATERS Regulatory Guidance Manual
- **Monroe County Conservation District**
  Stormwater Management Plan Adopted by PADEP
- **Brodhead Watershed Association**
  Social Marketing Training
- **Monroe County Planning Commission**
  Active Regional Planning Groups
- **USGS**
  Application o HIP to Ecology
- **PA DEP**
  Statewide Interest in IMIP & HIP

Delaware River Basin Commission

# EPA TRUE PARTNER


**GOAL MADE POSSIBLE:**
**To Establish a Collaborative Community Process to Develop Sustainable Watershed Practices Based on Sound Science.**

**EPA Funded Project:** USGS and DRBC

**EPA – ORD Edison NJ and Cincinnati OH:** Developed tools that will be useful in other watersheds; Provided training, equipment, and technical support.

**EPA – ORD, EPA Region 3 and EPA – ORD CNS:** Excellent support and collaboration, No-Cost Extension, networking opportunities, patience and good humor.

New Linkages with **PA DEP, USGS** Science Center, Ft. Collins CO

Delaware River Basin Commission

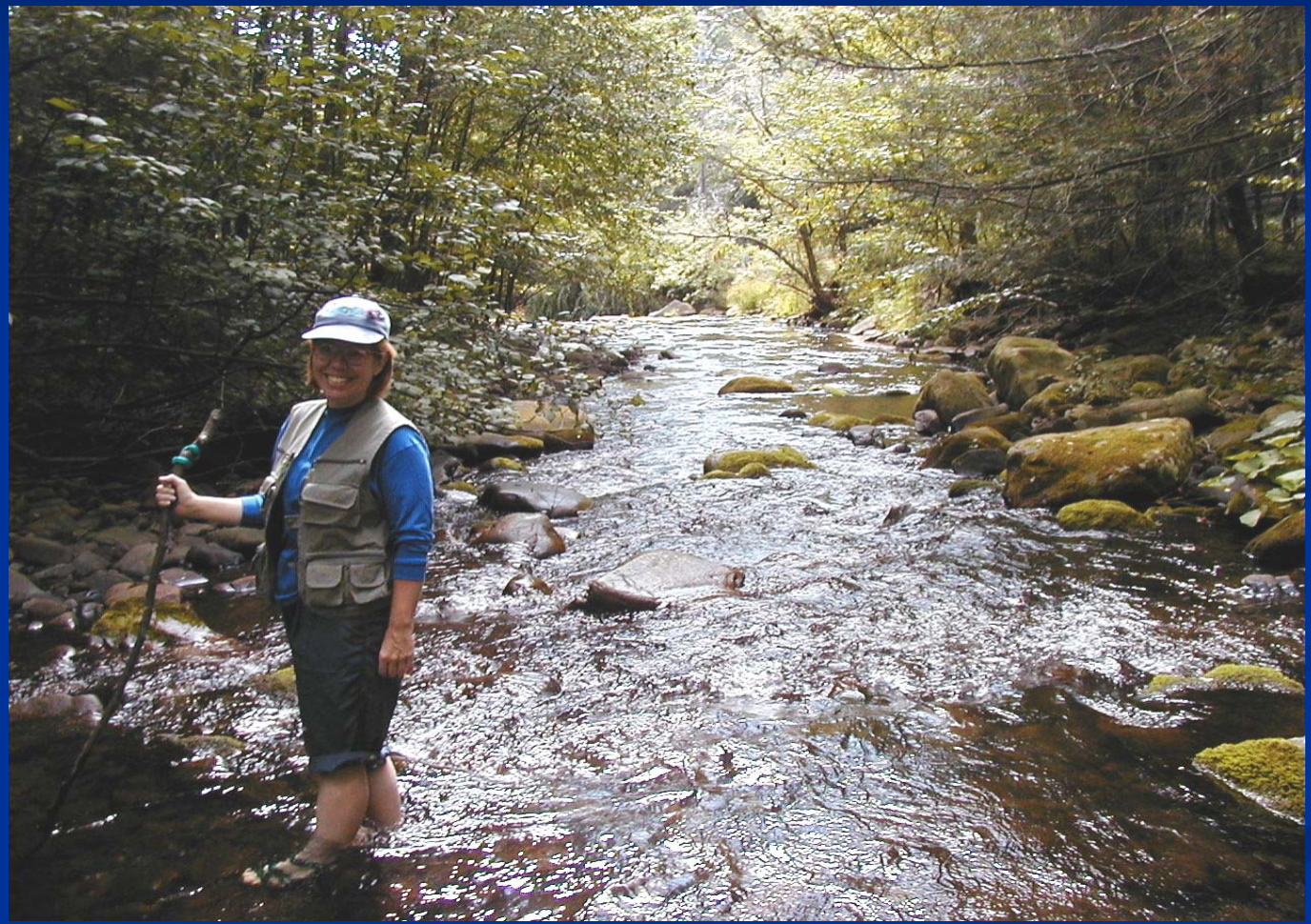
# PEER FEEDBACK

1. What are good examples of stream flow statistics and/or stream classifications being applied to stream ecology or habitat?

2. How can we ensure that the non-technical effort needed after completion of the technical stage retains project momentum?

Delaware River Basin Commission

**Pamela V'Combe, Watershed Planner**
**Delaware River Basin Commission**
**pvcombe@drbc.state.nj.us**
**(609) 883-9500 x226**



Delaware River Basin Commission