Design of NYC Reservoirs and Performance During 2005 Flood Event

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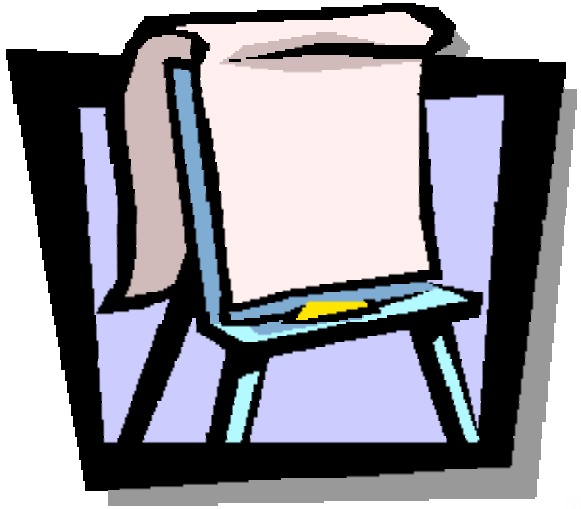
Paul V. Rush, P.E.
Director
West of Hudson Operations Division
Bureau of Water Supply

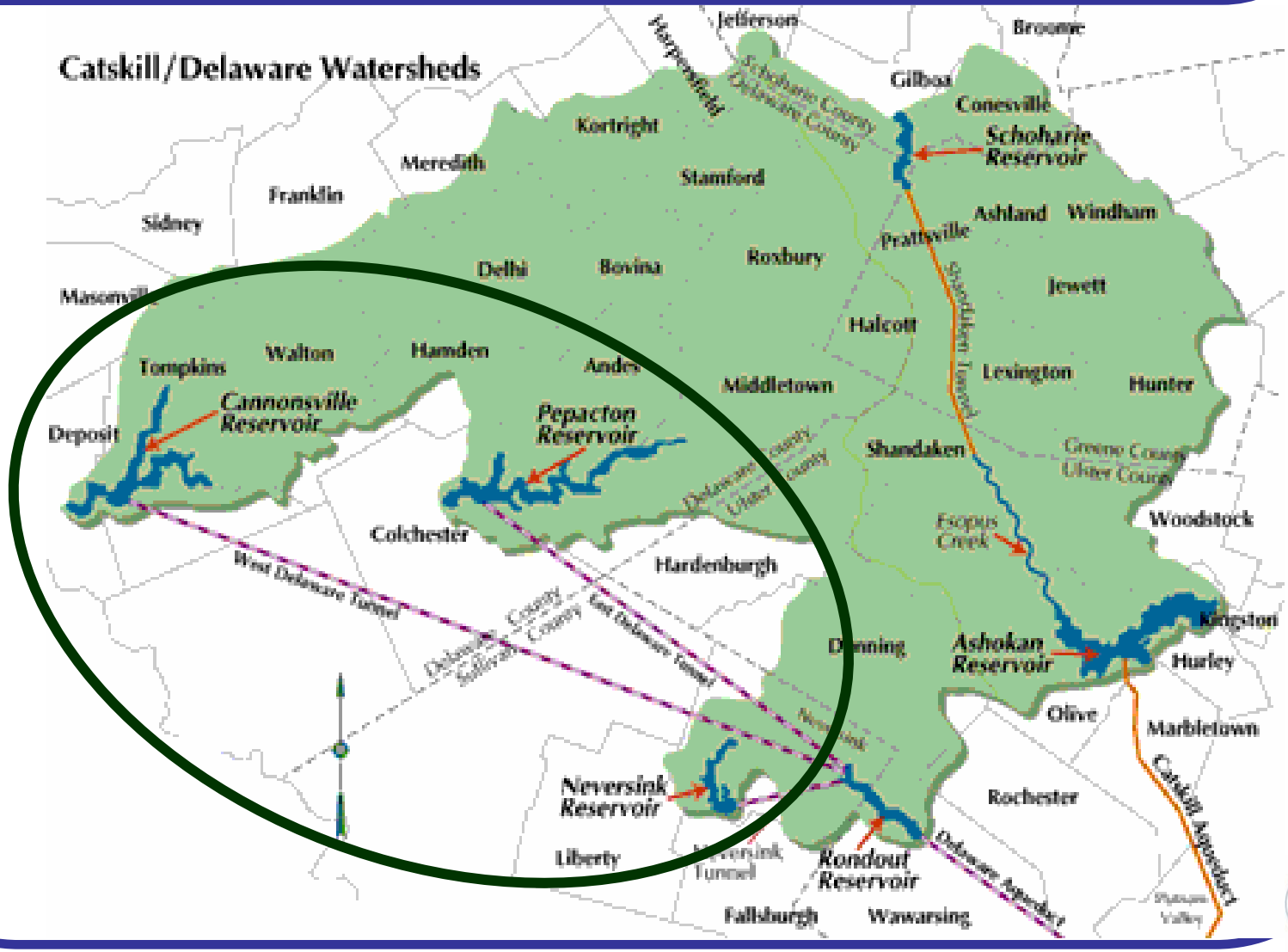
Outline

- NYC Water Supply System Overview
- Review of events prior to April storm
- Temporary spill reduction program
- Reservoir attenuation
- Summary



New York City Water Supply System

NYCDEP Delaware Basin Reservoirs



NYCDEP Delaware Basin Reservoirs

- All reservoirs formed by large earthen dams:
  - Heights: Approx. 200’
  - Lengths: Approx. ½ mile
- Reservoirs in operation approximately 50 years:
- First diversions:
  - Neversink: 1953
  - Pepacton: 1954
  - Cannonsville: 1963

Cannonsville

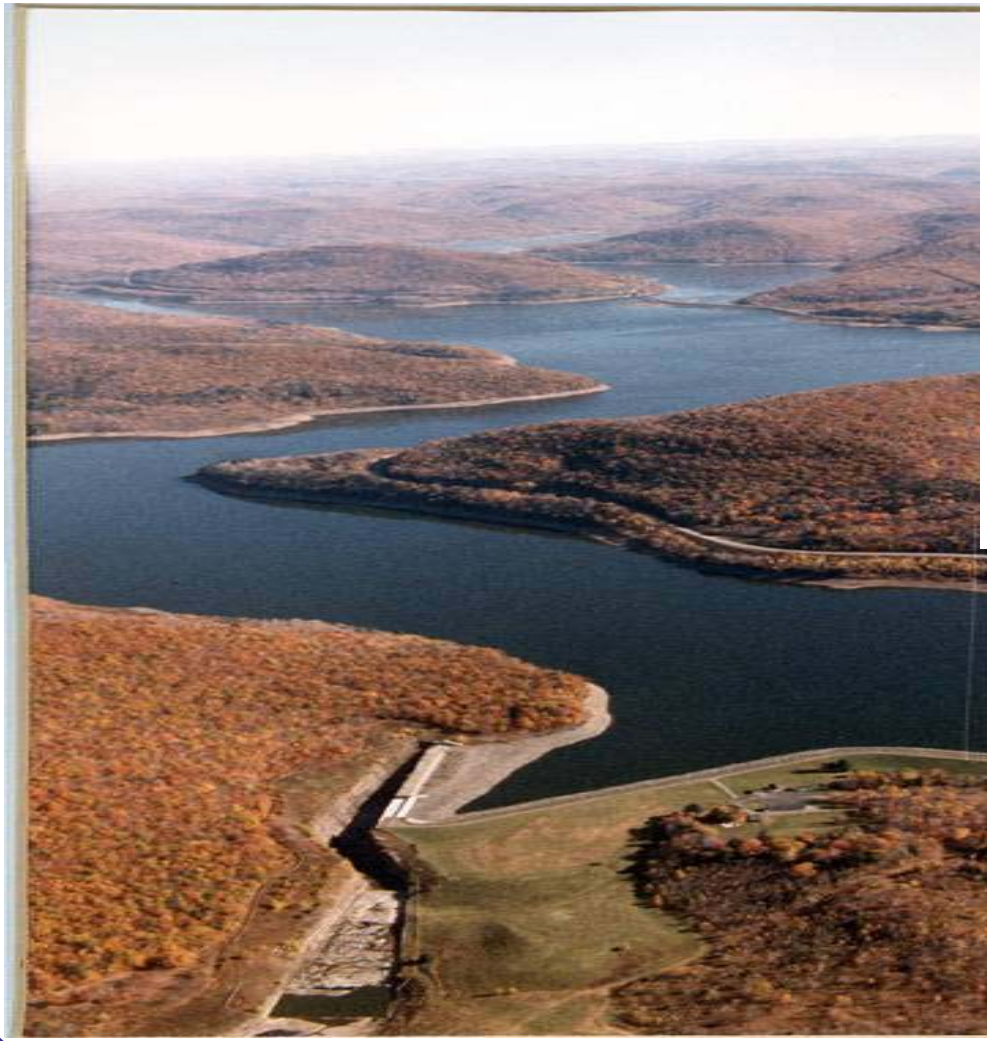
NYCDEP Delaware Basin Reservoirs

- Diversions from reservoirs controlled by outlet works adjacent to Rondout Reservoir
- Releases from reservoirs controlled by control works located at at each dam
- Releases rates based on regulatory requirements:
  - Delaware River Master directed
  - DRBC Fisheries Program/ NYSDEC Regulations
  - Special Programs

Neversink Reservoir & Spillway

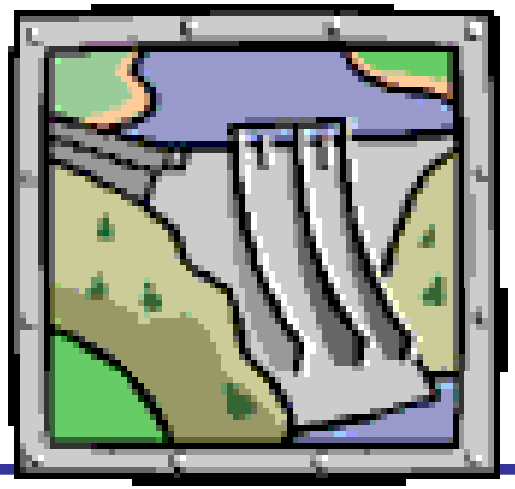
Pepacton Reservoir & Spillway

Cannonsville Reservoir & Spillway



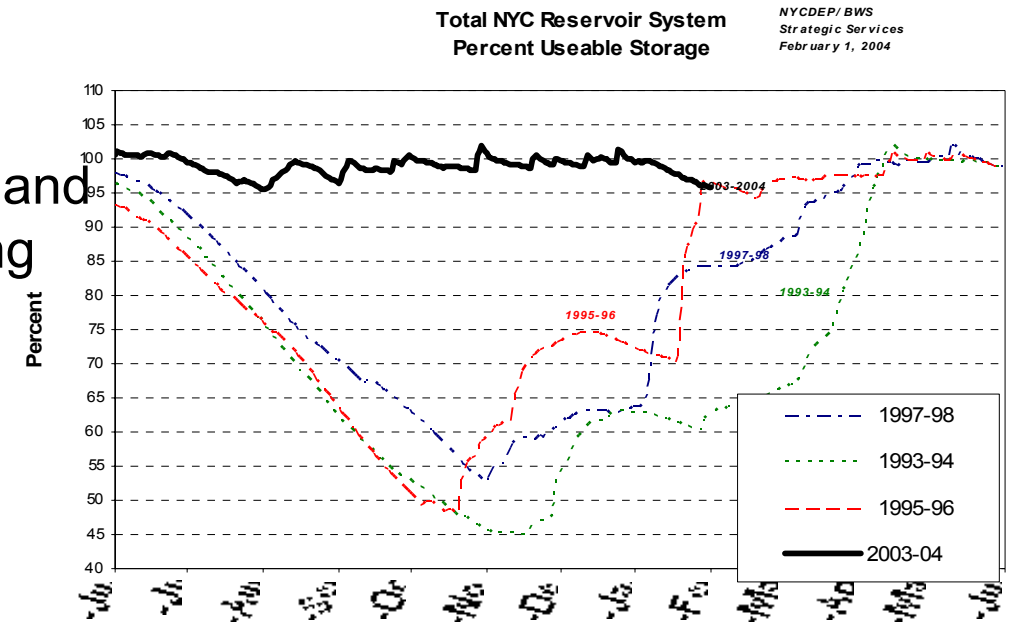
NYC Delaware Basin Reservoirs

- Not designed for flood control
- All NYC reservoirs are single purpose water supply reservoirs
- No capability to release large amounts to create short-term void
- Need Decree Party's consent for any supplemental releases



Water Supply Reservoir Operations

- Goal to delay start of system drawdown to as late as possible in the hydrologic year.
- Preserve storage for use during times of drought conditions.
- Inaccuracy of short and long term forecasting necessitates maintaining highest possible storage.



Drought Conditions since 1980

- Delaware Basin has entered various stages of drought during the following years:
  - 1980
  - 1982
  - 1983
  - 1985
  - 1991
  - 1995
  - 1997
  - 1998
  - 2001

Review of Events Prior to April Storm

Reservoir Status March 27, 2005

- Neversink
  - Elevation 1440.19’
  - 100.3%
- Pepacton
  - Elevation 1274.13’
  - 92.4%
- Cannonsville
  - Elevation 1150.25’
  - 100.4%


Pepacton

Pepacton Storage Less Than Other Reservoirs

- Temporary Spill Reduction Program
  - Limited reduction of storage using supplemental releases
  - Maintain void equal to 50% of water equivalent of snow pack above reservoir
  - Suspend releases when East Branch is at, or is forecasted to be at or above, flood stage, or ice conditions threaten flood prone areas
  - Expired March 31, 2005

Temporary Spill reduction Program – Pepacton Reservoir

- 3/15 - Water equivalent of snow pack – 18.9 BG
- 3/27 - Actual void – 10.6 BG
- 3/30 - Above spill level (due to 3/28 storm runoff)

March 28th Storm

Reservoir	Precipitation	Runoff
Neversink	2.12”	4.5 BG
Pepacton	1.75”	16.2 BG
Cannonsville	2.11”	21.5 BG

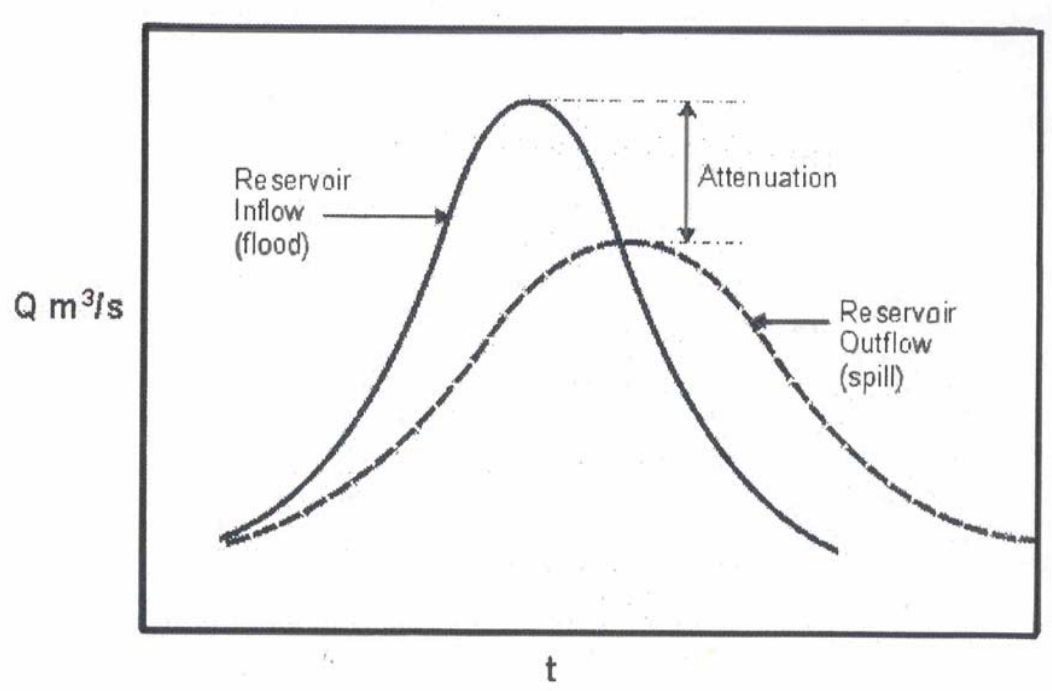
Reservoir Status April 1, 2005

- Neversink
  - Elevation 1440.66’
  - 100.9%
- Pepacton
  - Elevation 1280.76’
  - 101.0%
- Cannonsville
  - Elevation 1153.46’
  - 105.8%

Reservoir Attenuation

Reservoir Attenuation

- **Reservoirs provide attenuation even when full.**



From " *A Review of the Role of Dams in Flood Mitigation*", a paper submitted to the World Commission on Dams (www.dams.org) in March 2000 by Peter Hawker

Reservoir Attenuation

- **Magnitude of attenuation depends on:**
  - **Reservoir surface area**
  - **Spillway length**

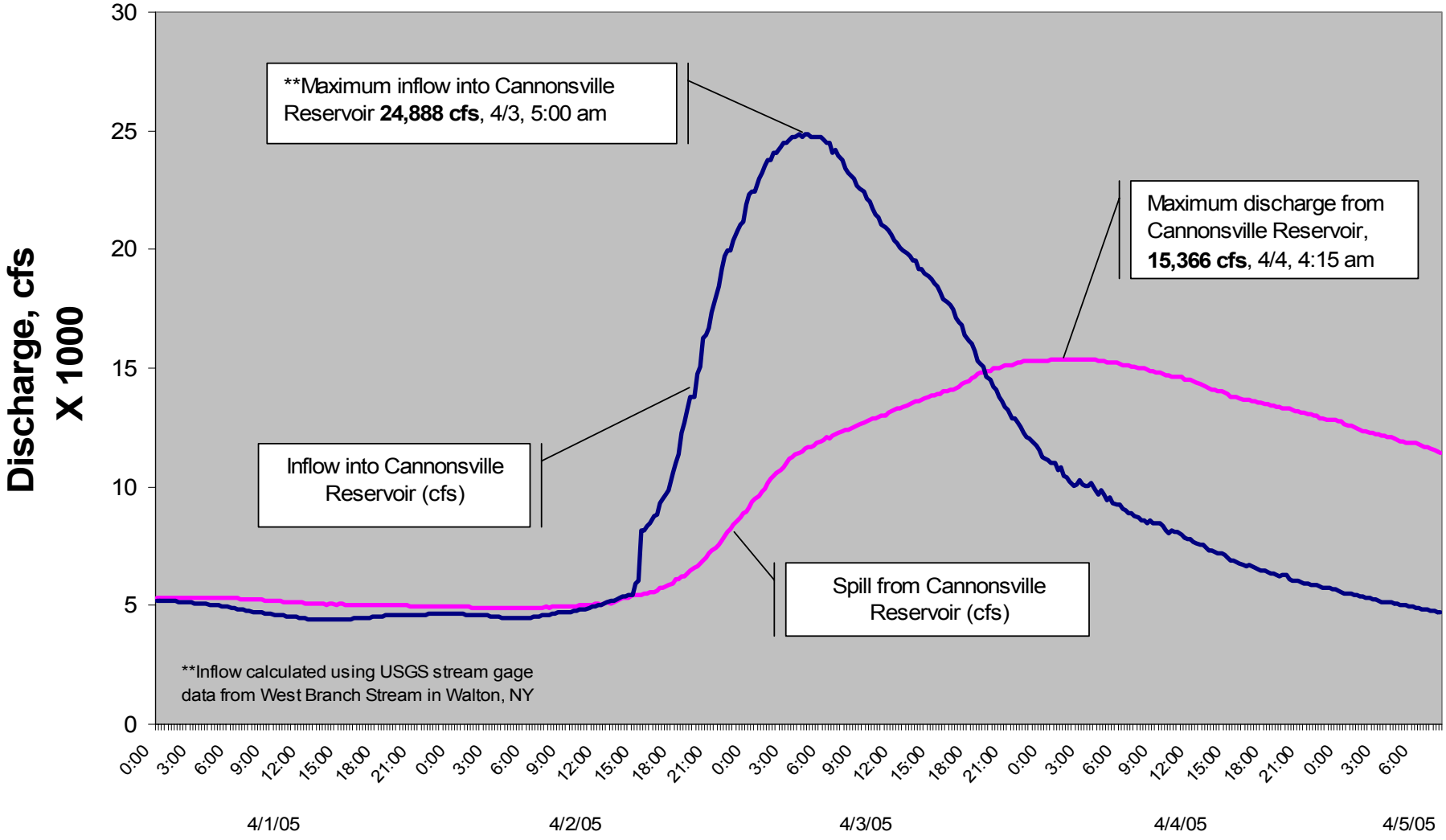
Relative Flood Attenuation Effectiveness

Reservoir	Watershed Area (sq miles)	Surface Area (sq miles)	Length of Spillway (feet)
Cannonsville	454	7.5	240*
Pepacton	372	10	800
Neversink	93	2.3	600

*does not include emergency spillway

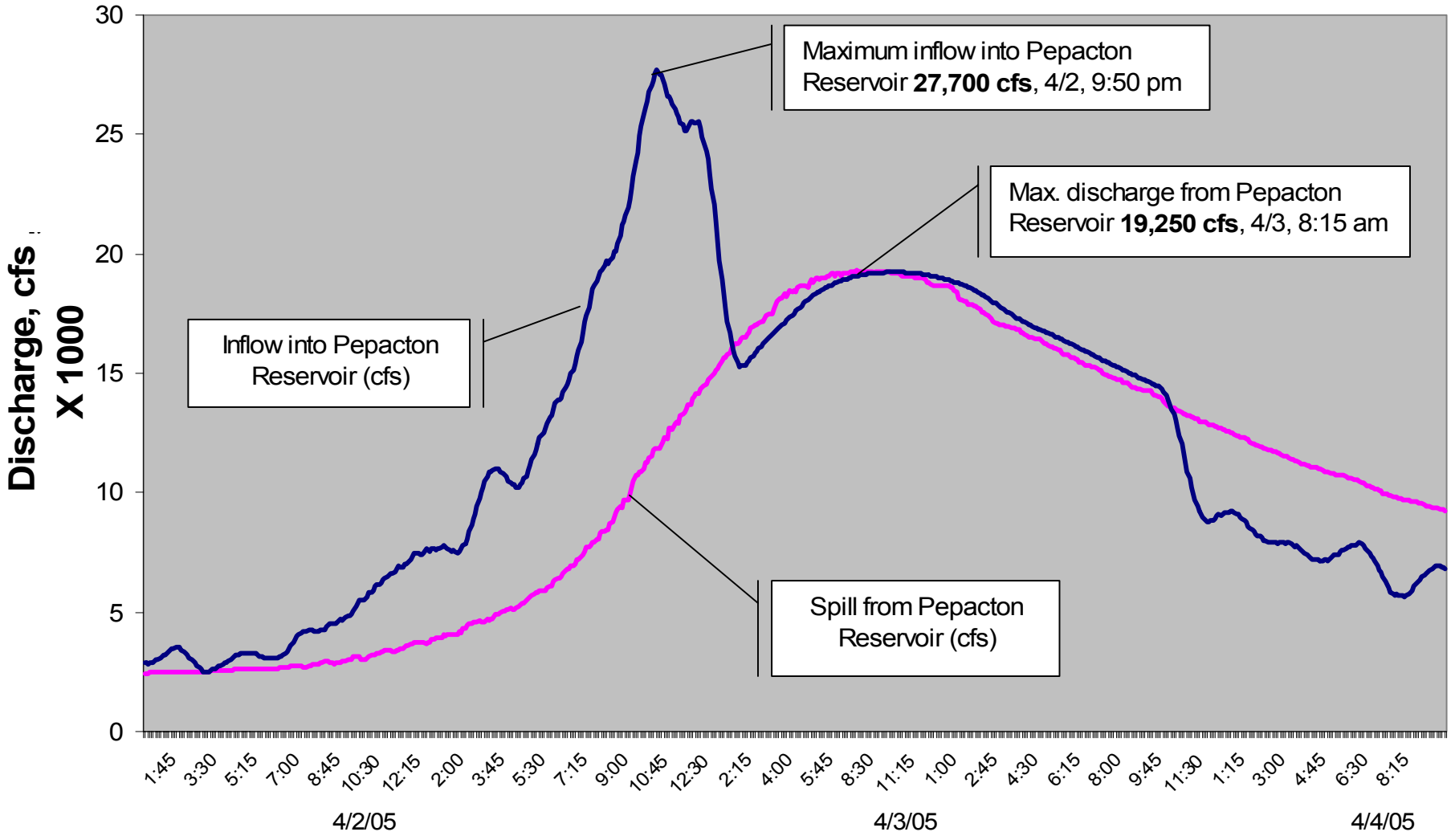
Cannonsville Reservoir, Inflow vs. Spill Discharge

Storm Event April 1-5, 2005



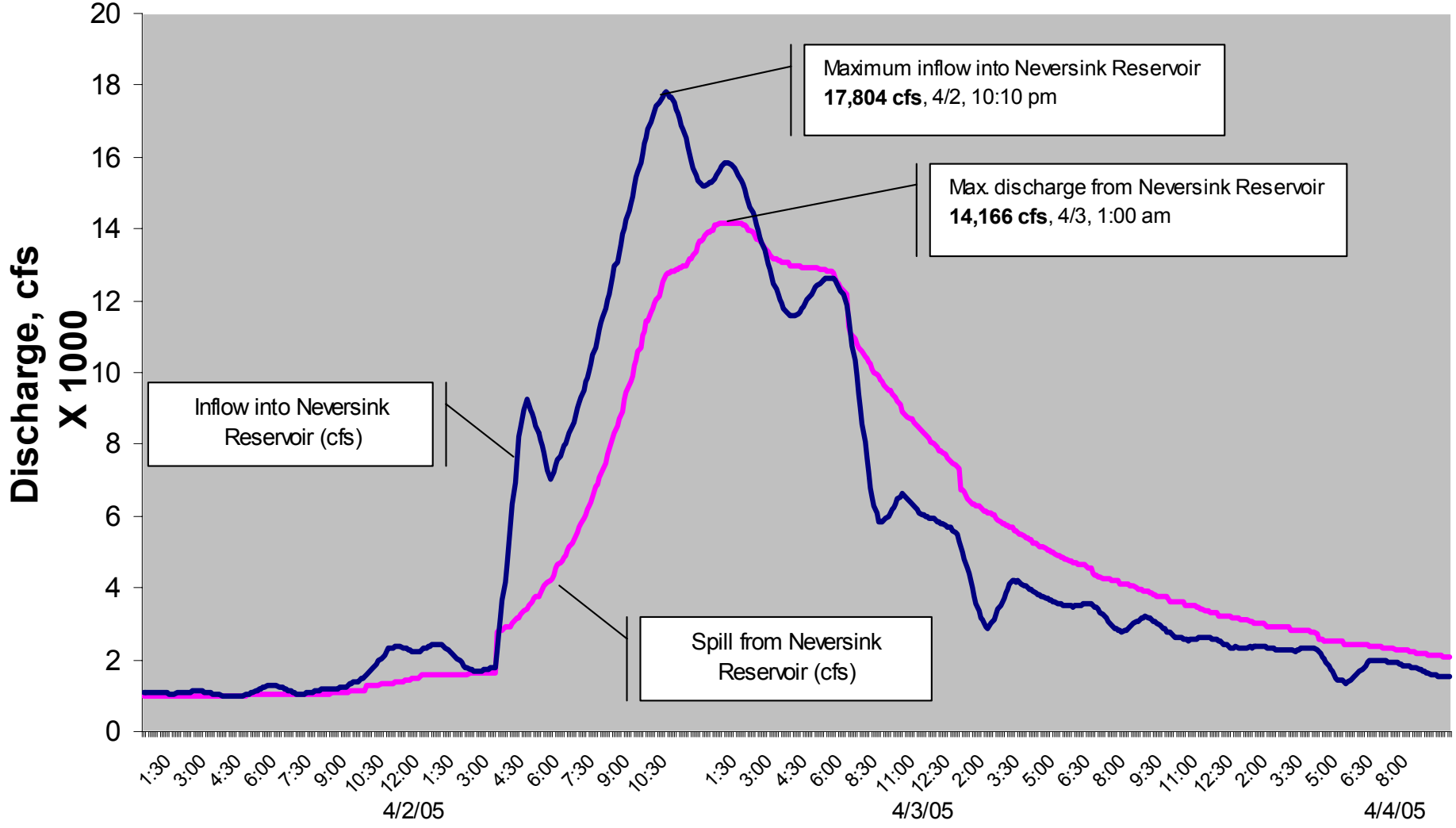
Pepacton Reservoir, Runoff vs. Spill Discharge

Storm Event April 2-4, 2005



Neversink Reservoir, Runoff vs. Spill Discharge

Storm Event April 2-4, 2005



Would a spill reduction program have made a difference at other reservoirs?

Potential Reservoir Status if Spill Reduction Program at Cannonsville

- 3/15 - Water equivalent of snow pack – 13.6 BG
- 3/27 - *Potential void – 6.8 BG*
- Actual inflow 3/28- 4/1:
  - 21.5 BG
- *Potential outflow 3/28- 4/1*:
  - *1 BG*
- 4/2– *Above spill*

Potential Reservoir Status if Spill Reduction Program at Neversink

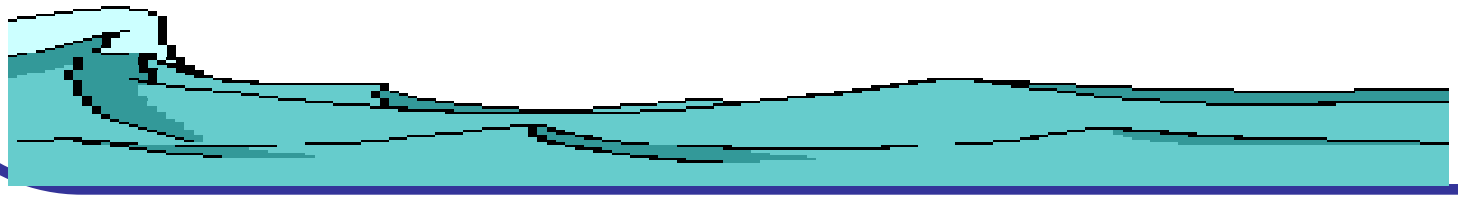
- 3/15 - Water equivalent of snow pack – 7.8 BG
- 3/27 - *Potential void – 3.8 BG*
- Actual inflow 3/28- 4/1:
  - 4.5 BG
- *Potential outflow 3/28- 4/1*:
  - *0.4 BG*
- 4/2– *Above spill*

Void Programs at Multiple Reservoirs Increases Supply Risk

- Not all snow in a reservoir watershed will make it to the downstream reservoir
- Largest risk of a snow pack void program at only Pepacton Reservoir is to drinking water quality
- If snowpack voids are maintained at multiple reservoirs risk increases and shifts to downstream users as well

Summary

- NYC Reservoirs designed for water supply
- Reservoirs attenuate flow even when full
- Attenuation during April storm:
  - Cannonsville - 38% of peak inflow
  - Pepacton – 30% of peak inflow
  - Neversink – 20% of peak inflow
- Magnitude of attenuation would not have changed significantly had a snow pack based void program been in effect at Cannonsville and Neversink Reservoirs
- Increased risk to supply if programs implemented at multiple locations



Questions