

Delaware River Flood Advisory Committee

A Partnership to Support Flood Mitigation

**Alan Tamm
Pennsylvania Emergency
Management Agency
Bureau of Recovery and Mitigation
atamm@state.pa.us**

**Peter Gabrielsen
Chief, Hydrologic Services
NWS Eastern Region
peter.gabrielsen@noaa.gov**

Outline

- Background
 - Flood Damages
 - Mitigation
 - Flood Warning System
- Delaware River Flood Advisory Committee
- April 2005 Flood

Delaware River Basin

- Flooding has been recorded since 1839
 - Snowmelt
 - Severe Rainfall
 - Noreasters
 - Tropical Storms
 - Hurricanes
- Recent Events
 - Hurricane Floyd, January 1996, Tropical Storm Ivan, and the April 2005 floods produced major damage
 - Delaware main-stem first region wide floods since 1955



Mitigation

- Avoiding or reducing impact of hazards
- Federal Requirement
 - Essential to obtain post disaster assistance
 - Actions and plans need to be coordinated
 - Plan to avoid disaster is permitted by statute on a watershed basis
- Counties affected not eligible for HM because they do not have a “mitigation plan”

What is Mitigation Plan

- What are our hazards? – Flood, Drought
- What is at stake? – People, resources, animals
- What can we do about it?
- Selecting and prioritizing actions

Make ourselves safer and more sustainable

The importance of Flood Warnings in Flood Loss Reductions

- Flood Warning is a necessary piece of flood loss reduction
- NWS estimates flood warning can reduce flood damage by up to 10%
- B/C ratio for the flood warning system in the neighboring Susquehanna River basin is 12:1 (NWS, 1985)
- Effective flood warnings provides lead time
- EMAs and occupants must have lead time
- Flood Warnings are not a substitute for flood loss mitigation:
 - Flood proofing
 - Flood plain property acquisition
 - Flood plain regulations
 - Structural measures



Delaware River Basin Flood Advisory Committee

- DRBC established the Flood Advisory Committee in 1999
- Recommends flood loss reductions strategies
- Basin wide, interstate focus
- Assess, evaluate, and recommend improvements in the basin's flood warning system
- Increase local participation in flood loss reduction and mitigation opportunities.
- Improve distribution of flood loss reduction and mitigation program information.

Flood Advisory Committee

Members:

- Delaware Department of Natural Resources and Environmental Control
- New Jersey Department of Environmental Protection
- New York Department of Environmental Conservation
- Pennsylvania Department of Environmental Protection
- New York City Department of Environmental Protection
- Delaware Emergency Management Agency
- New Jersey Office of Emergency Management
- New York Office of Emergency Management
- Pennsylvania Emergency Management Agency
- Federal Emergency Management Agency
- U.S. Department of Agriculture Natural Resources Conservation Service
- U.S. Geological Survey
- National Weather Service
- U.S. Army Corps of Engineers
- National Park Service
- Delaware River Joint Toll Bridge Commission
- Hydroelectric Industry
- Local Water Resources Agency
- University of Delaware



FLOOD WARNING IMPROVEMENTS



AHPS APPLICATION
BASIN WIDE

PROPOSED STREAM GAGE
TELEMETRY UPGRADES

NYC RAIN GAGES
TO BE UPGRADED

NEW RAIN GAGES
TO BE ADDED

POTENTIAL FLOOD
STAGE MAP PROTOTYPE

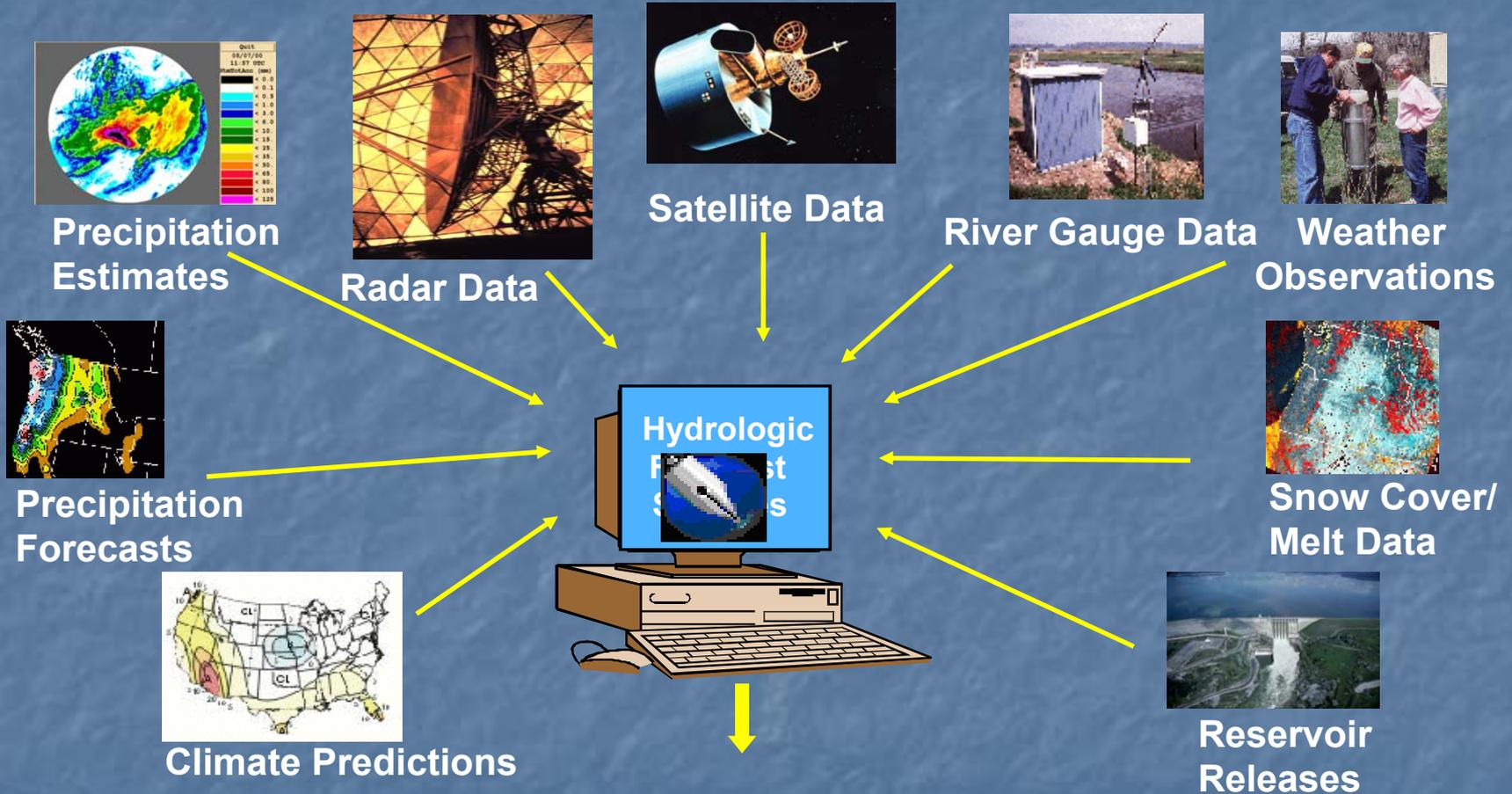
POTENTIAL PROTOTYPE AHPS
FLASH
FLOOD GRAPHICS
APPLICATION
USING GIS AND DOPPLER RADAR

POTENTIAL FLOOD
STAGE MAP PROTOTYPE

POTENTIAL FLOOD
STAGE MAP PROTOTYPE

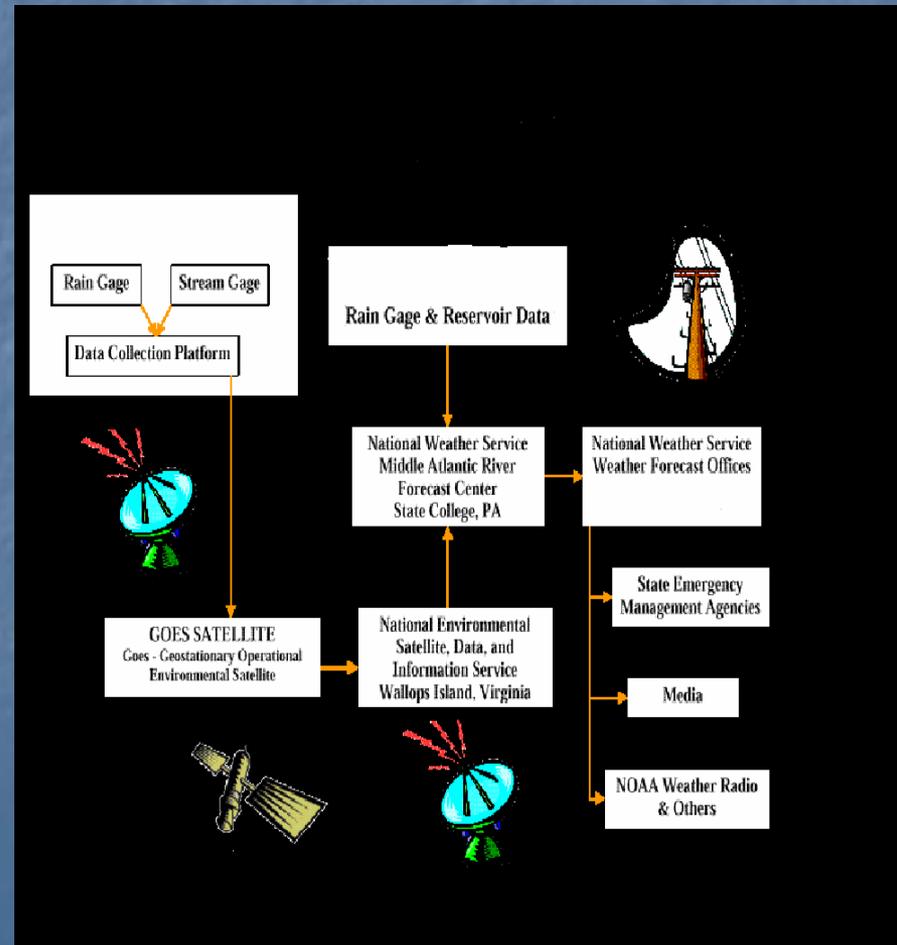
PROPOSED STREAM GAGE
TELEMETRY UPGRADES

Flood Forecasting in the Delaware River Basin



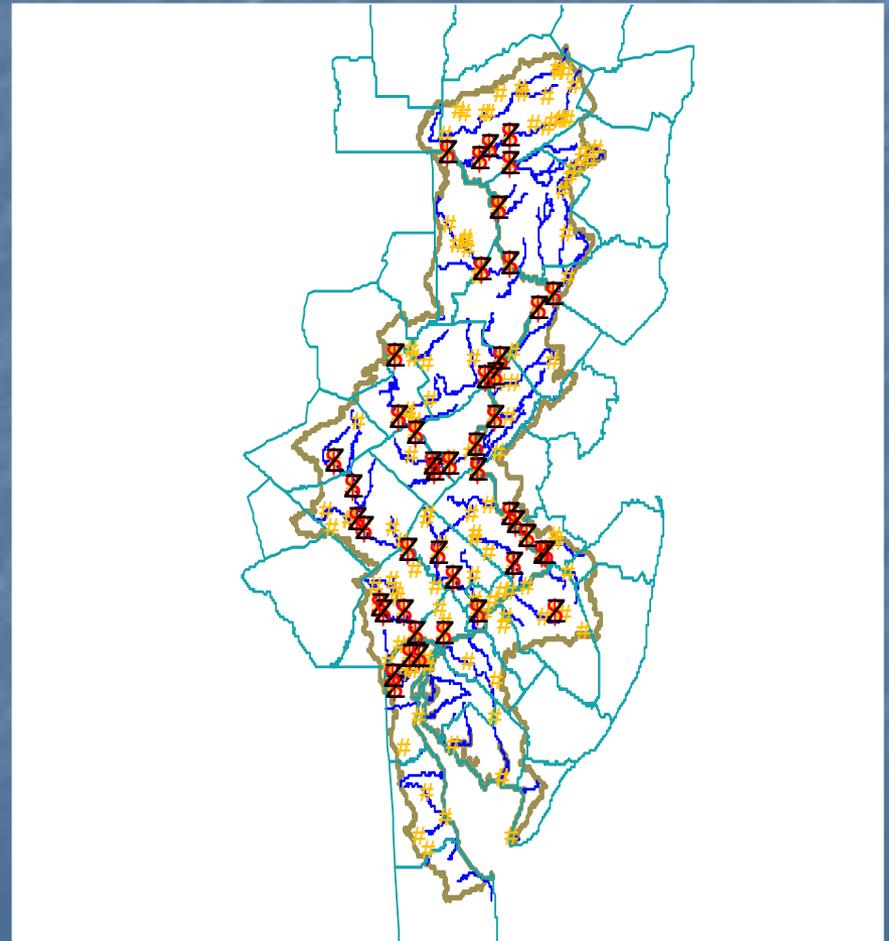
Basin Wide River Flood Warning Network

- Data collected from federal and state cooperators
- Middle Atlantic RFC models river systems to forecast river stages and flows
- NWS forecast offices at Binghamton, NY and Mt Holly, NJ issue forecasts and warnings
- NWS river and flood forecasts disseminated via NOAA Weather Radio, media outlets, Internet



Stream Gages and Flood Forecast Points in the Delaware River Basin

- **Stream Gage Inventory**
- 160 continuous record stream gages
- 118 gages have satellite telemetry
- 46 Flood Forecast Points



Successes from the FAC

- Improved stream gaging and gage telemetry
 - New stream gauge for the Schuylkill River at Norristown, Pa.
 - Re-installation and modernization of a stream gauge at Tocks Island, NJ, in the Delaware Water Gap National Recreation Area.
 - Stream gauge on the Brodhead Creek at Minisink Hills.

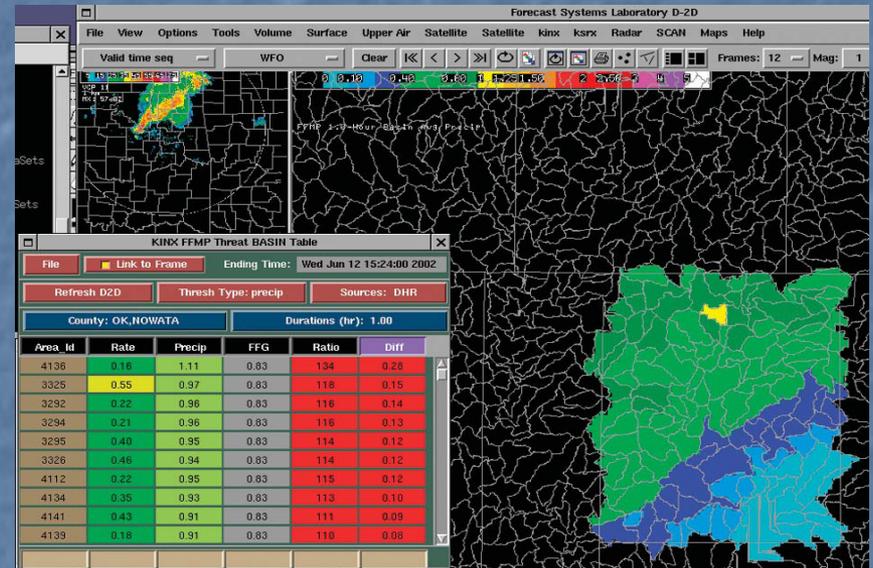
- Improved hydrologic data for stream gauges at four locations:
 - Lehigh River at Lehighton, Pa
 - Schuylkill River at Berne, Pa
 - Brodhead Creek at Minisink Hills, Pa
 - Perkiomen Creek at Graterford, Pa

Successes from the FAC

- Expansion of NOAA All Hazards (weather) Radio (NWR) throughout the entire basin
 - Modernization of NWR system in Philadelphia to improve coverage.
 - Addition of two new NWR transmitters in Sussex County, N.J., and in Sudlersville, Md.

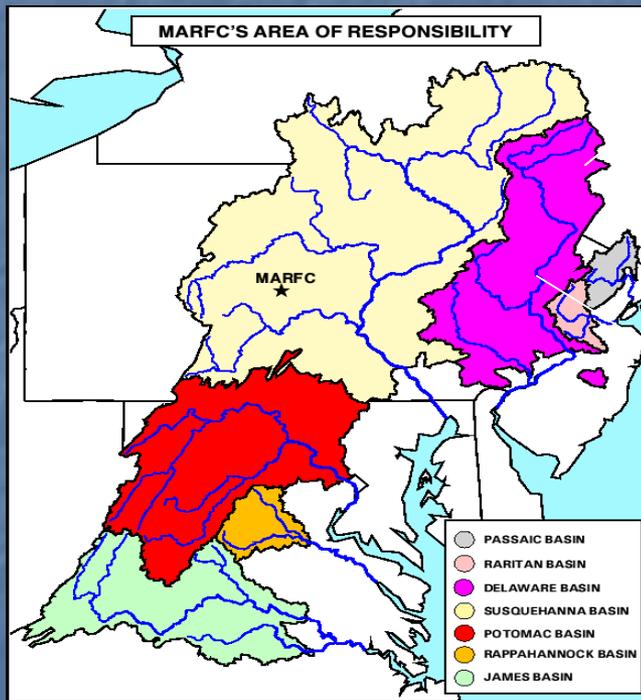
Successes from the FAC

- Improve Flash Flood Warnings for small watershed areas
- Flash Flood Monitoring and Prediction (FFMP) basin threat map and table.



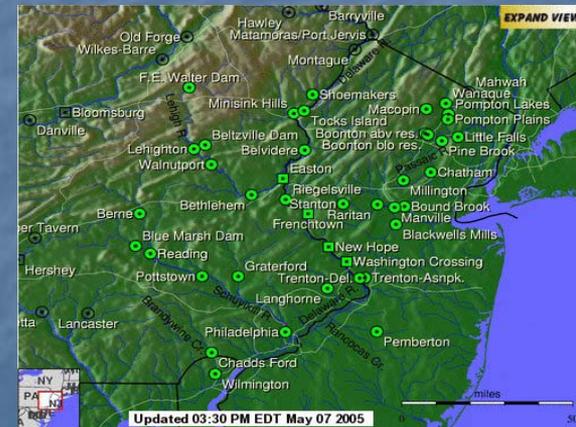
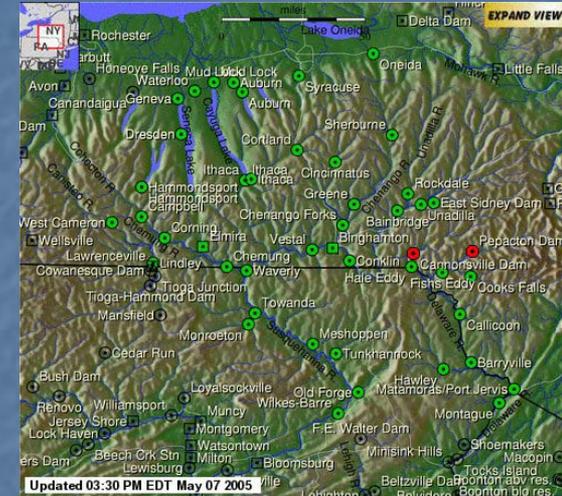
Successes from the FAC

- AHPS Implementation in the Delaware River Basin



BGM

PHI



MARFC



Advanced Hydrologic Prediction Service

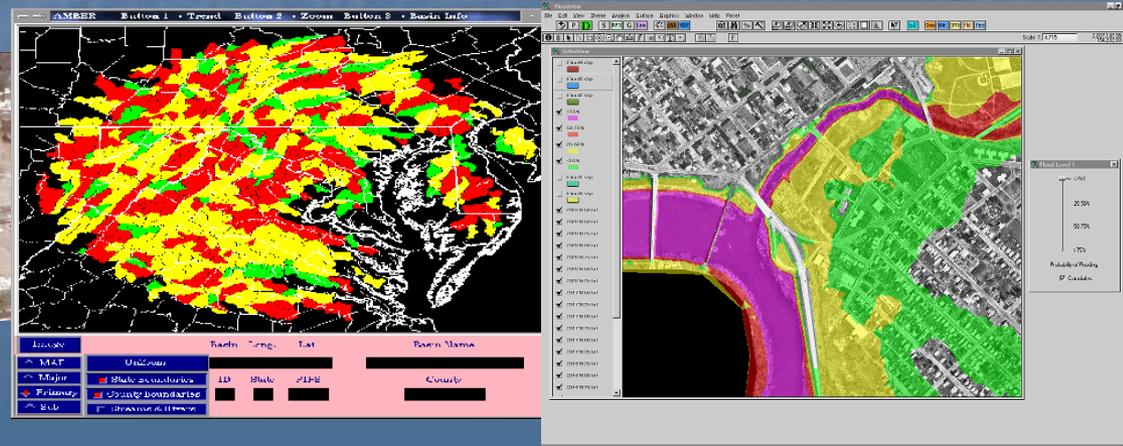


Unmet Customer Needs

- More precise forecasts over all time scales
- Information to make risk based decisions
- Universal access
- Visually oriented products

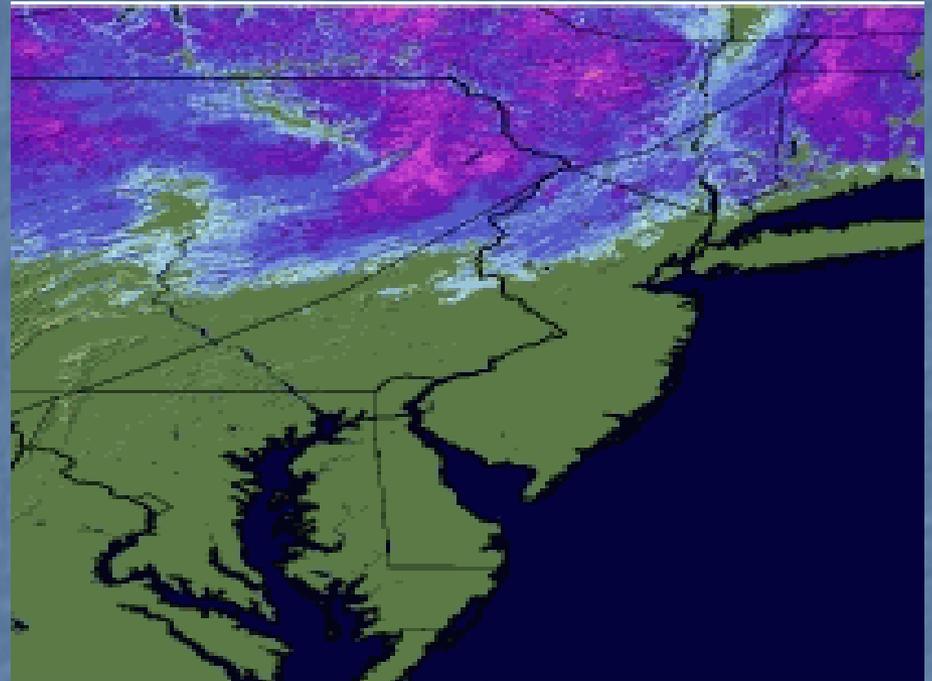
AHPS Provides

- Flash-flood to seasonal forecasts
- Forecast certainty
- Improved product delivery (Internet, wireless)
- Flood-forecast mapping



Successes from the FAC

- Snowmelt forecasting enhancements
- Expanded annual snow surveys to improve estimates of snowmelt used for river forecast models.



Successes from the FAC

- Collaboration between NOAA's NWS and NYC DEP
 - Semi-annual meetings since 2001 to discuss data sharing
 - Design and Implementation of NYC Reservoir Precipitation Network
 - Added 26 state-of-the-art rain gages with radio telemetry
 - Design based on NWS system specs for climate network
 - Improve quality data for DEP management of NYC Reservoir System
 - Provide timely data for issuance of NWS Flood Warnings
 - NHORSC improved snow water equivalent estimates
 - NWS sharing HAZMET information with DEP

Spring Flood of April 3-4, 2005

- Most extensive flooding along the main stem of the Delaware in nearly 50 years
- Capitalize on Flood Improvement recommendations from FAC
- Better advanced warnings on floods in PA, NJ, NY, and DE
- Improved flood response by county EMAs
- NWS AHPS/DRBC web-sites provided expanded information on flooding in the Delaware Basin

Spring Flood of April 3-4, 2005

Two early spring rainstorms - the first on March 28-29 and a second on April 2-3, 2005 - combined with snowmelt to cause major flooding in the Delaware River Basin. Along the main stem of the Delaware River, the flood crests exceeded those reached in Tropical Storm Ivan only six and a half months earlier, and again caused evacuations, bridge and road closures, and extensive damage.

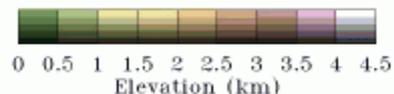
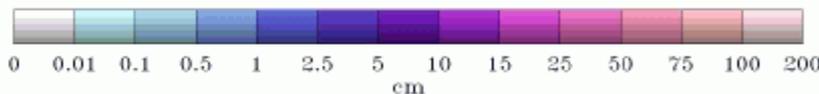
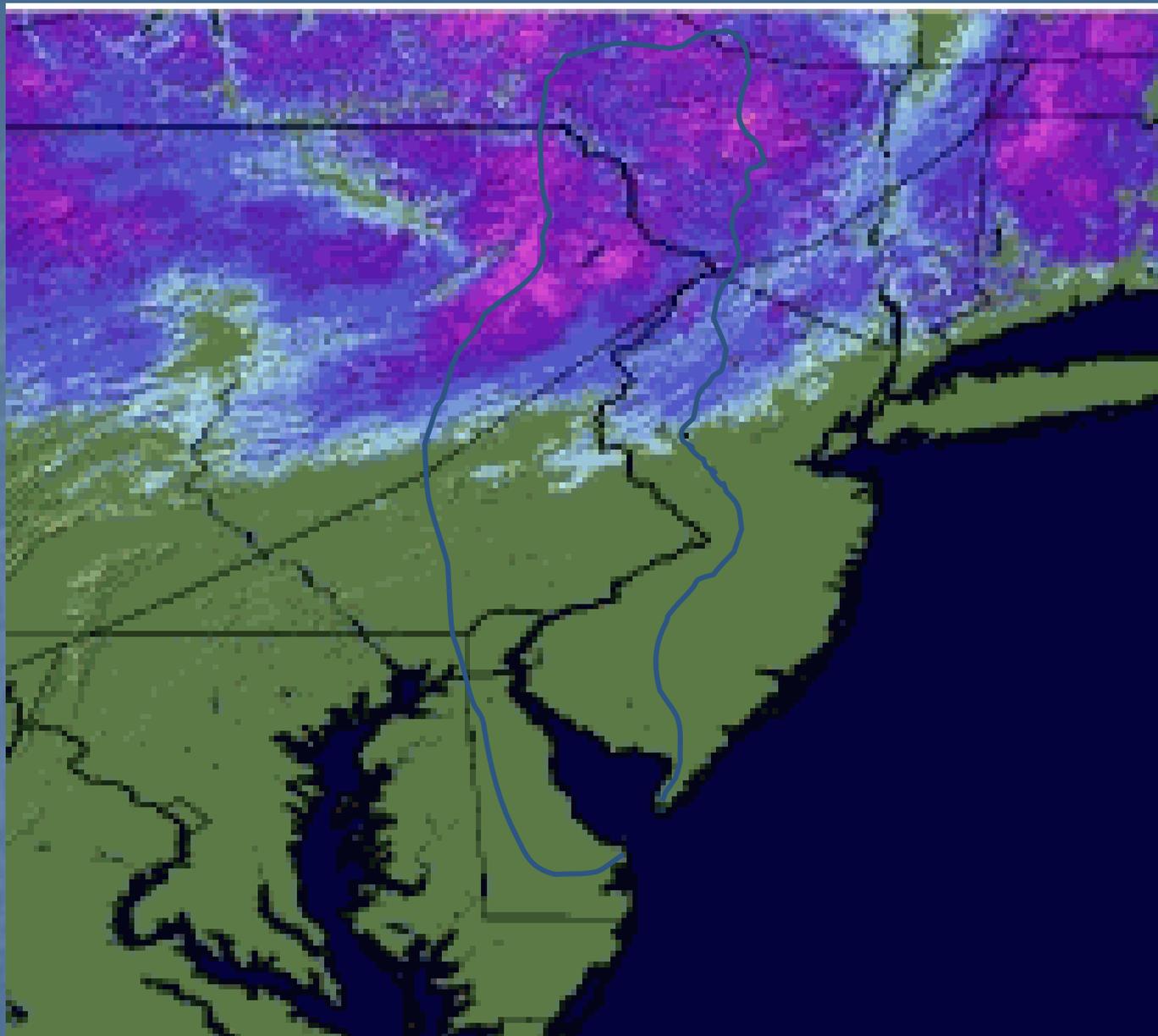


Delaware Canal at Yardley, Pa. – one half mile upstream of Afton Avenue Bridge – 8:30 am, April 4, 2005
Canal bank overtopped by Delaware River. River stage at U.S. Geological Survey (USGS) Trenton gage = 25 ft.

Snowpack Water Equivalent

March 27, 2005

Prior to the first storm, some watersheds in the upper Delaware basin had in excess of three inches water equivalent in the snowpack.



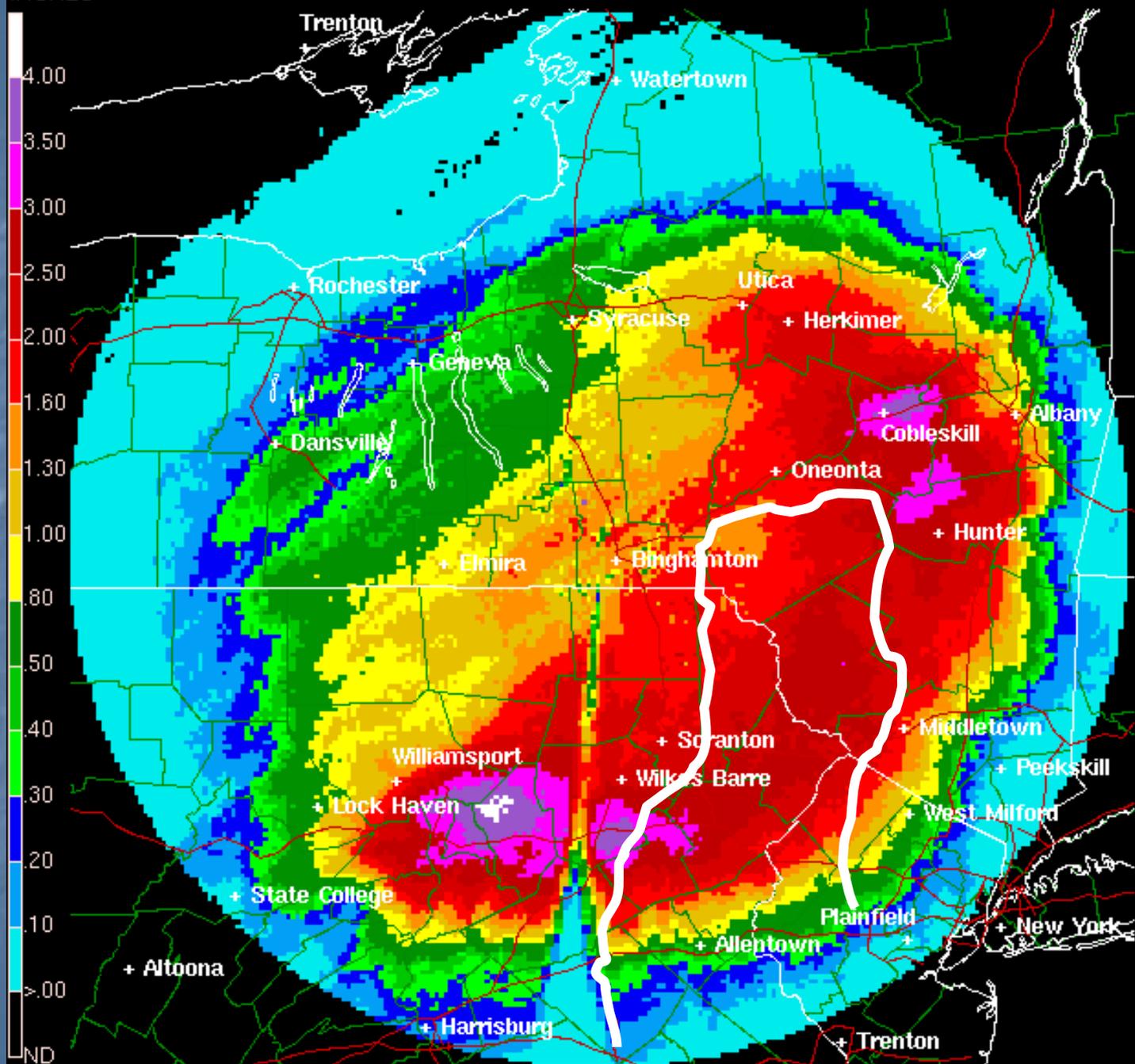
INCHES

Radar Image from National Weather Service: KBGM 14:44 UTC 03/29/2005

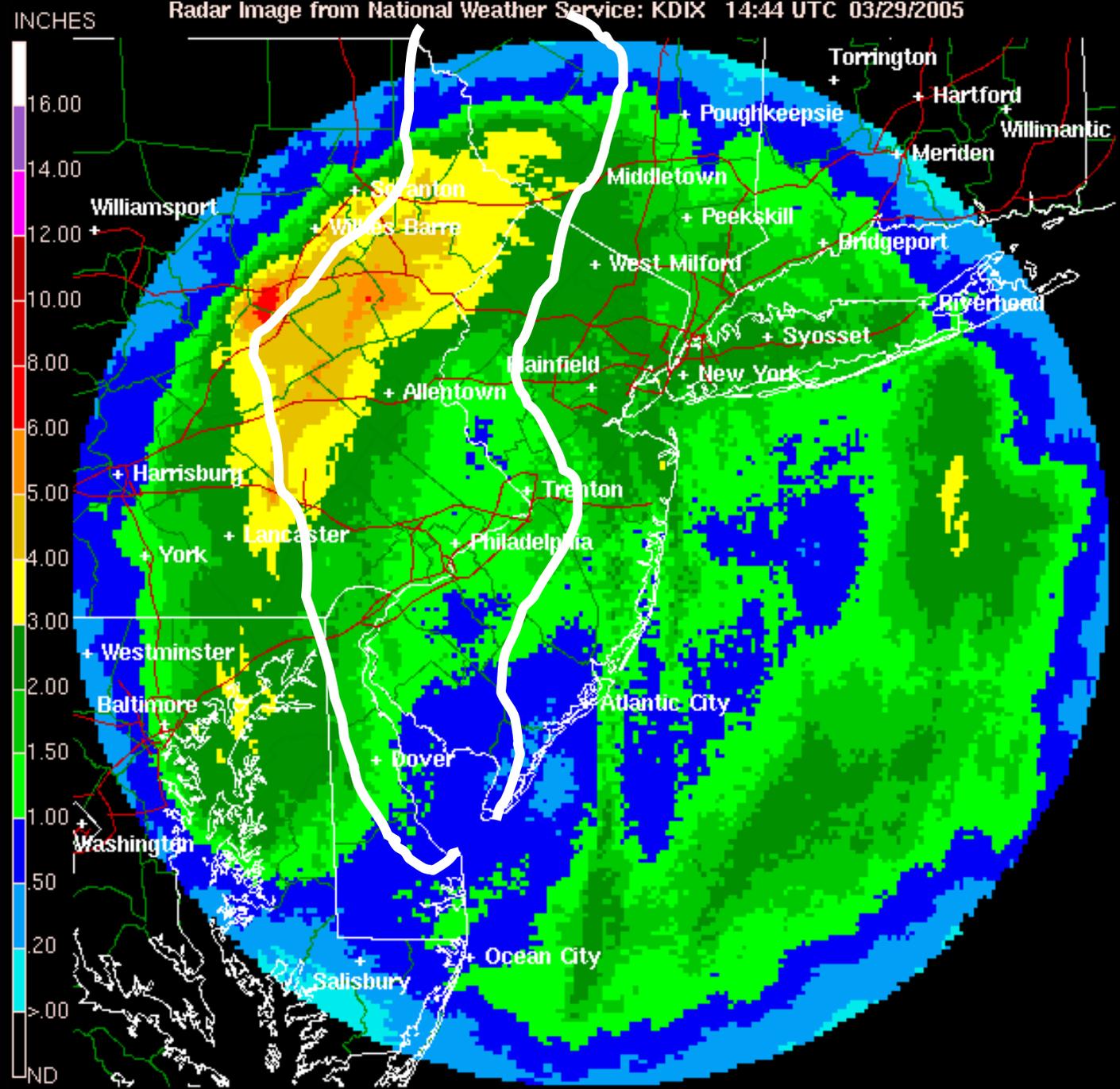
Upper Basin March 28-29, 2005

Doppler Rainfall Estimate

The first storm brought over two inches of rain to western and northern portions of the basin. Warm temperatures melted about half of the snowpack, which totaled over three inches water equivalent in some northern watersheds.



Radar Image from National Weather Service: KBGM 14:44 UTC 03/29/2005

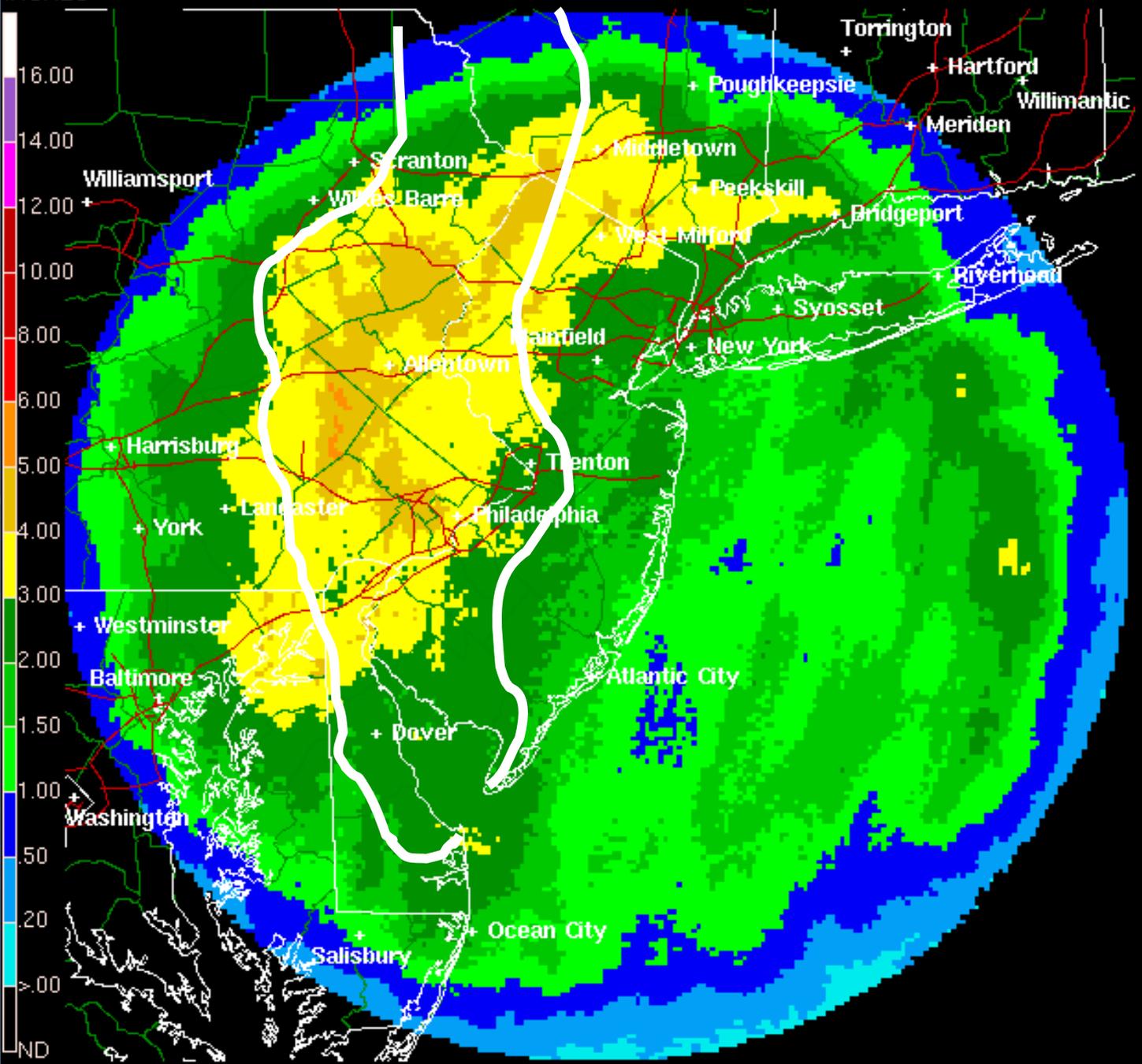


Lower Basin
March 28-29, 2005

Doppler
Rainfall
Estimate

Lower Basin
April 2-3, 2005

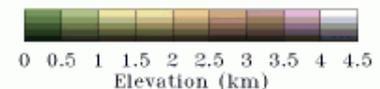
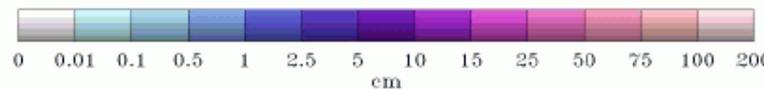
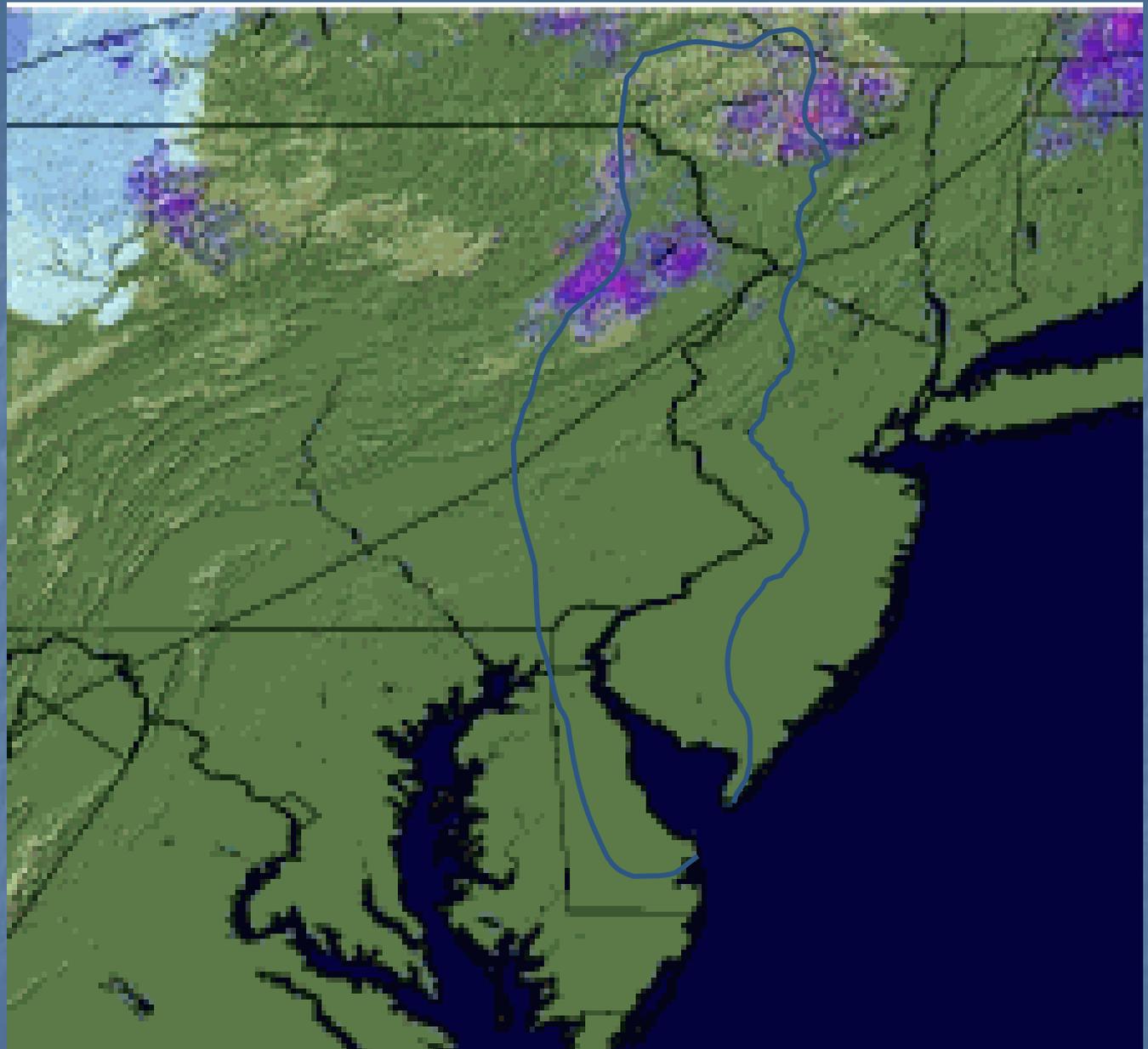
Doppler
Rainfall
Estimate



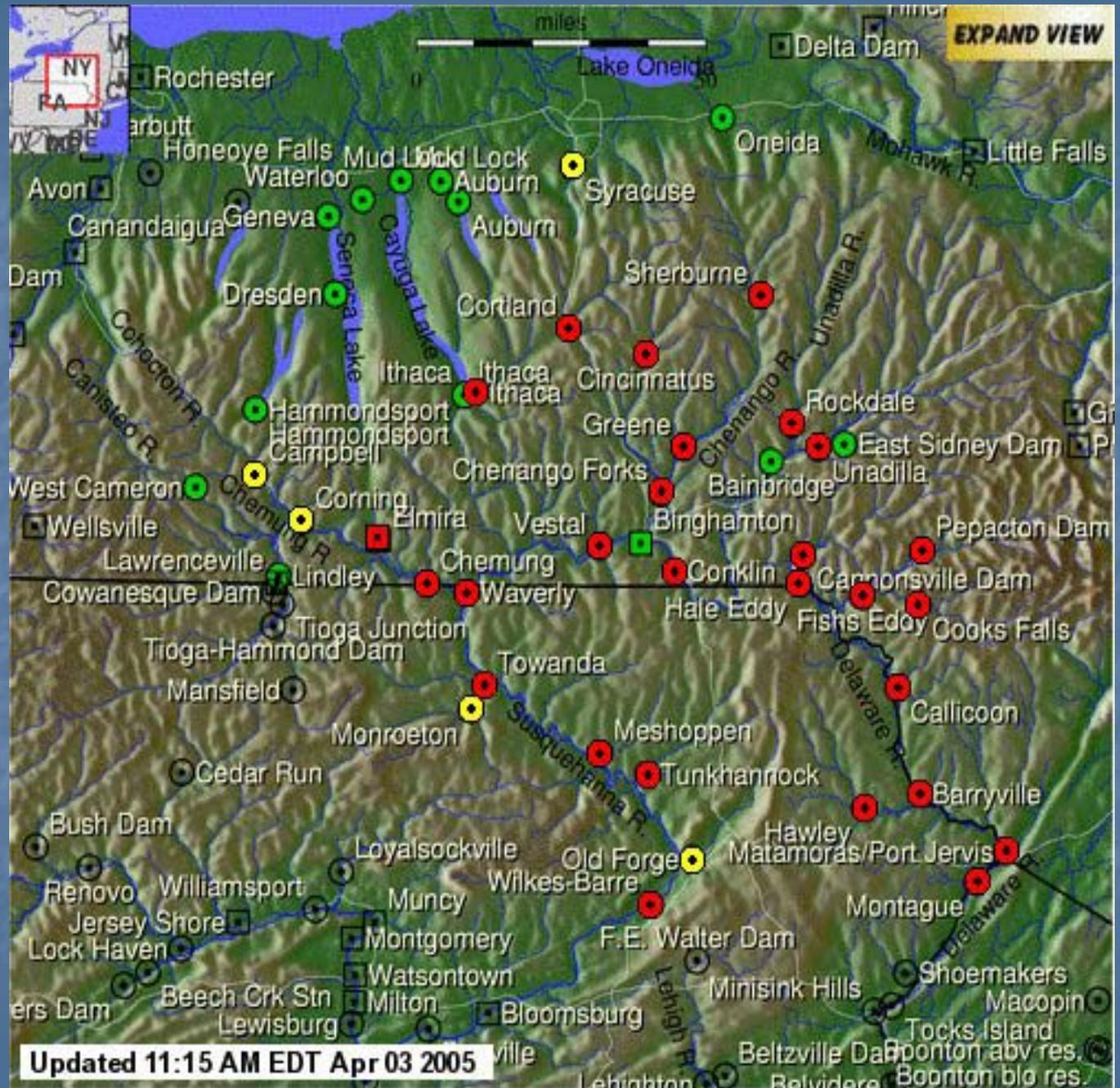
Snowpack Water Equivalent

April 3, 2005

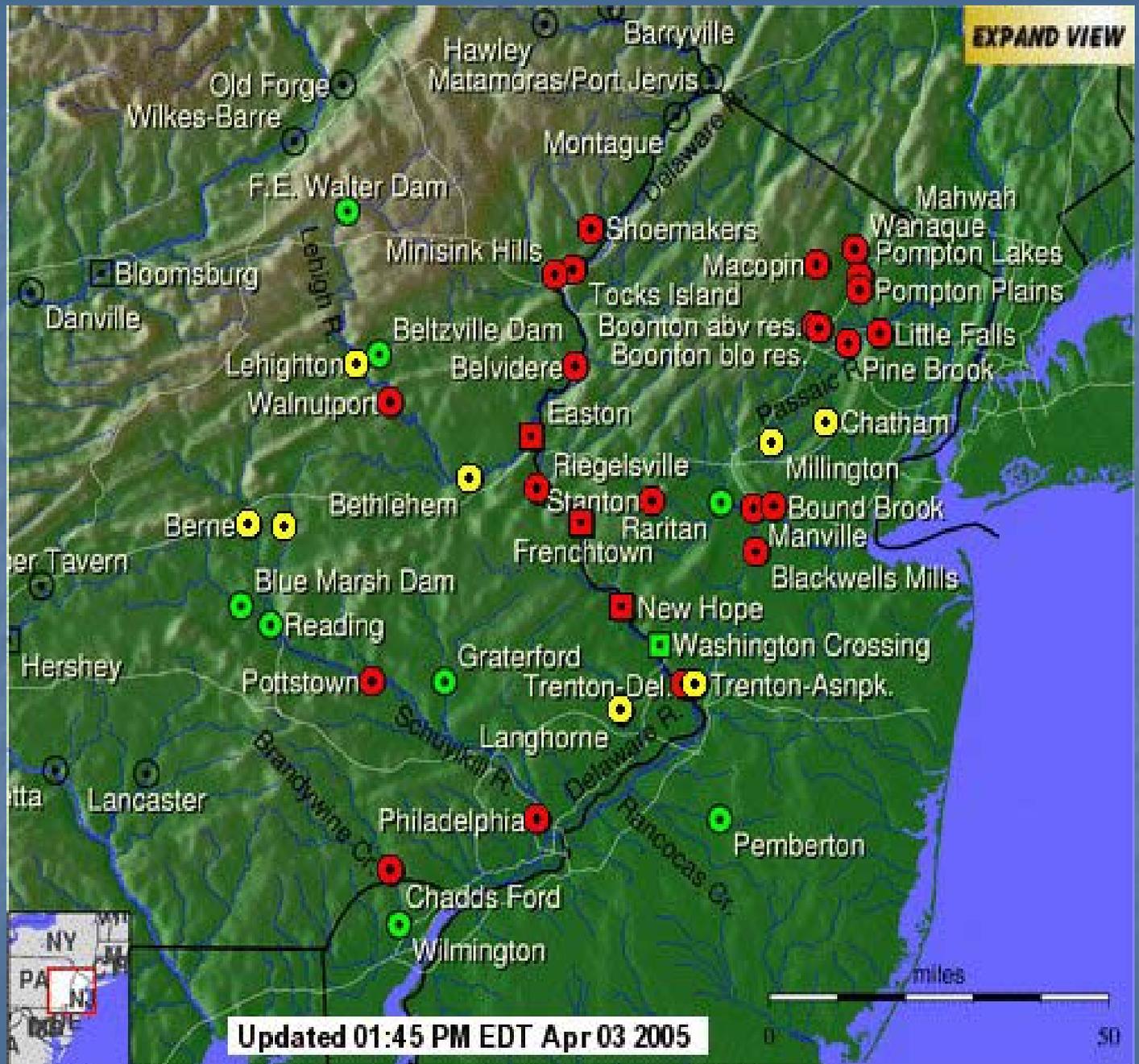
By the end of the
second storm, most
of the snowpack had
melted.



By April 3rd, flood stages were exceeded on rivers and streams throughout the Delaware River Basin. Flooding was the most severe along the main stem Delaware River and headwater tributaries.

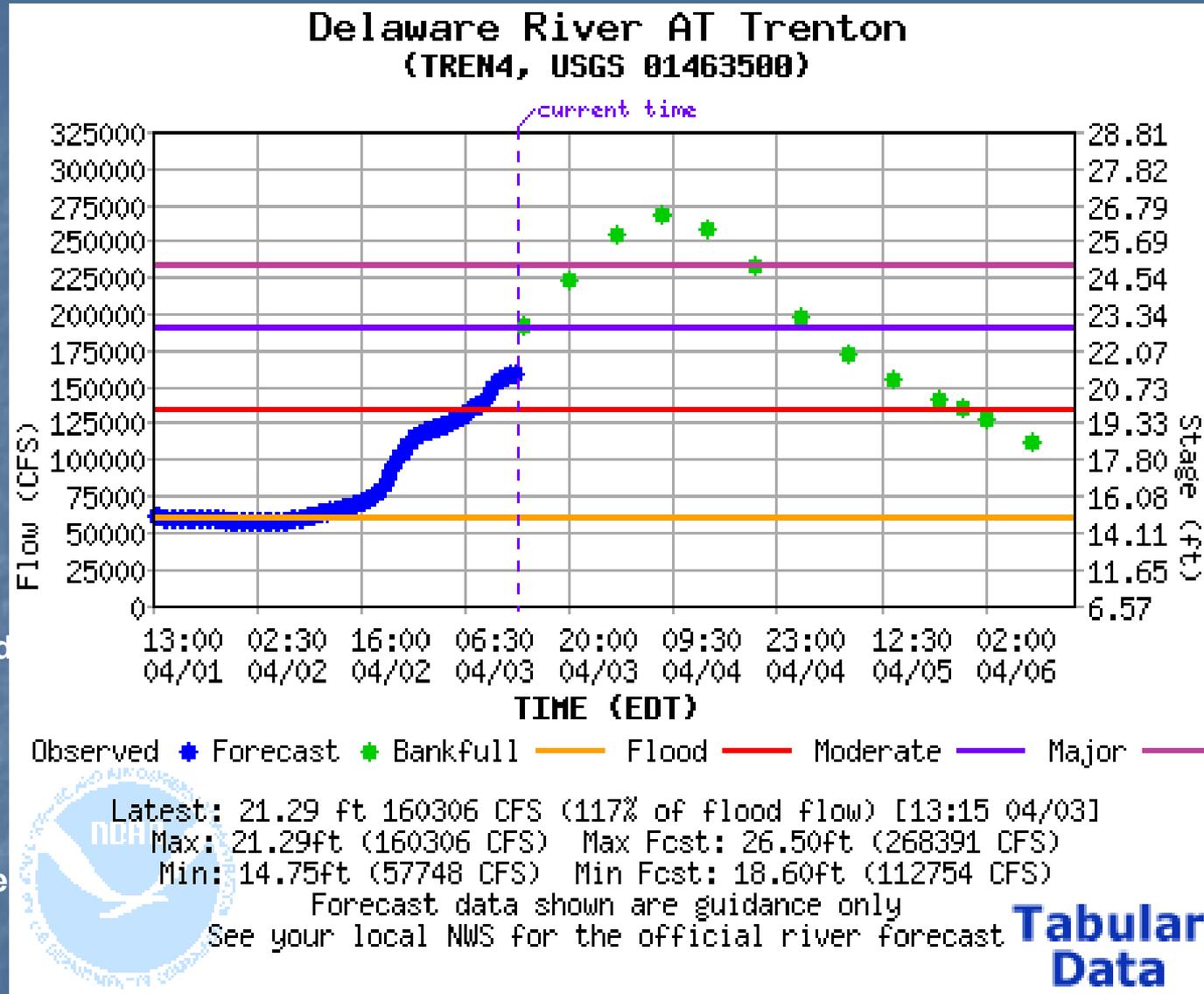


Flood watches were posted two days in advance of the second storm by the National Weather Service. Advance flood crest forecasts also were made and adjusted upward along the main stem Delaware as rainfall totals and streamflow data from U.S. Geological Survey (USGS) stream gaging stations were received.



This is an example of the flood crest forecast hydrographs posted on-line by the National Weather Service prior to and during the flood event.

These forecast products are a result of the National Weather Service's Advanced Hydrologic Prediction Services, combined with stream monitoring by the USGS. The forecasts are made for real time gaging stations maintained by the USGS. During this severe flooding, forecasts also were made at Delaware River bridges operated and monitored by the Delaware River Joint Toll Bridge Commission.



FLOOD PEAK COMPARISON AT SELECT BRIDGES ON THE DELAWARE RIVER

BRIDGE	AUG '55 PEAK	SEPT '04 PEAK	APR '05 PEAK
Phillipsburg- Easton	43.70'	33.45'	E36.5'
Frenchtown	27.80'	20.70'	22.55'
Stockton	28.40'	22.50'	E26.75'
New Hope	24.30'	*	19.70'
Washington- Crossing	27.80'	20.20'	E26.7'

*gage was removed for construction during 2004.

E=estimated

SOURCE: National Weather Service.
Data is provisional and subject to change.

FAC Recommendations have provided

- Enhanced and improved data collection
- Excellent cooperation
- Longer lead times
- Accurate and timely flood forecast information dissemination