Flood Warning Improvement Recommendations for the Delaware River Basin

Delaware River Basin Flood Task Force Action Plan

Prepared by NOAA/National Weather Service – Eastern Division
In Cooperation With
The United States Geological Survey and the
Delaware River Basin Commission
Delaware River Basin Interstate Flood Mitigation Task Force Report
July 2007

Contains 45 recommendations on preparing, responding to, and recovering from flooding

14 recommendation focus on river forecasting and flood warning

Recommendations Addressed

FW 1.1 - Develop a Comprehensive Inventory of Precipitation Observing Stations in the Delaware River Basin
FW 2   - Evaluate and Upgrade River Gage Network
FW 7.2 - Evaluate the Need for New Forecast Points in the Basin
Interstate Task Force Recommendations

FW-1.1 Inventory and Evaluation of NWS Precipitation Observing Network (NWS) – Complete - (FY08 Funding)
FW -1.2 Evaluate non NWS used gages for inclusion into above network (NWS) – Targeted for any FY09 grant funding.
FW-2 Evaluation of Stream Gaging Network (NWS) - Complete (FY08 Funding)
FW-3 Extend Rating Tables - Begun (USGS) - FY10 grant funding will enable continuation and expansion of effort.
FW-4 Flood Harden Gages (USGS) - Begun with FY08 funding. FY09 grant funding will enable continuation of effort.
FW-5 Improve Flash Flood Forecasting – NWS Binghamton continuing to develop and test procedures for finer delineation of flood and flash flood warnings. Targeted to continue with FY09 funding.
Interstate Task Force Recommendations (cont.)

FW-7.1 Establish flood stages and impacts for potential flood forecast points equipped with real time telemetry. Targeted with FY09 grant funding.

FW-7.2 Evaluate the need for new forecast points and upgraded services at existing forecast points. Complete - (FY08 funding)

FW-9 Develop Flood Inundation Maps - 9 sites targeted with FY08 funding. Awaiting libraries for 8 locations. Work on first site (Trenton) undergoing process evaluation.


FW-11 Education and Outreach Program (DRBC). Targeted with FY09 grant funding.

FW-13 Ice Condition Monitoring and Communications Plan. Continuing with FY09 funding.
Summary of Gages and Major Gaging Networks Located in Basin (FW 1.1)

Precipitation

Automated Surface Observing Systems (ASOS) – 37
Integrated Flood Observing and Warning System (IFLOWS) – 59
NWS Cooperative Observer Program – 38
Community Collaborative Rain, Hail and Snow Network (COCORAHS) – 117
United State Geological Survey – 32
US Army Corps of Engineers - 7
Delaware Environmental Observing System (DEOS) - 7
New York City DEP - 38

Automated Snow Pillow Monitors - 2
Location of All Precipitation Gages Used by the National Weather Service

- Red: Hourly Reporting Station
- Black: Daily Reporting Station

Data Source: National Weather Service
Stream Gages (FW 2)

USGS Real Time Stream Discharge – 166

Stage Only Stream Gages – 6

Lake Level – 10

Tide Gages – 14
• USGS Station Identification Number
• Station Name
• NOAA Handbook 5 ID Code
• State
• County
• Stream Name
• Latitude
• Longitude
• Gage Datum
• Datum Reference
• Drainage Area at Station
• Indication whether site is a Flood Forecast Point (Yes or No) Type of Flood Forecast Point (River or Site Specific)
• Flood Stage if known
• URL Address for Real Time Information from USGS
• URL for NOAA AHPS Real Time Information (If a flood forecast point)
• Type of Telemetry
• Type of Gage (Discharge or Stage)
• Reporting Interval (1-Hour, or 4-Hour)
• Period of Record
• Number of Years of Record
• Funding Source
Location of Real Time Stream Gages in the Delaware River Basin

- Red triangle: Real Time Flow
- Green triangle: Real Time Stage or Lake Level
- Blue triangle: Auto Tide (USGS)
- Pink triangle: Auto Tide (NOS)

Data Source: U.S. Geological Survey
River Flood Forecast Points in the Delaware River Basin as of June 2009

- Crest Only Point
- Flood Only Point
- Daily Point
Four Groups of 44 Separate Improvements and
Recommendations Identified

Precipitation Network Improvements (FW 1.1)

Stream Gaging Network Improvements (FW 2)

Forecast Point Recommendations (FW 7.2)

General
Figure D-1: Recommended Flood Forecast Improvements
Upper Delaware River Basin
Index of Recommended Flood Forecast Improvements for the Delaware River Basin

**Precipitation Gages**

P1a  New precipitation gage – Willowemoc Watershed in the Livingston Manor, NY vicinity
P1b  New precipitation gage – Delaware River above Lackawaxen River near Barryville, PA
P1c  New precipitation gage – Delaware River at Fishs Eddy, NY
P1d  New precipitation gage – Mongaup River at Mongaup Valley, NY
P1e  New precipitation gage – Neversink River at Bridgeville, NY
P1f  New Precipitation gage – Neshaminy Creek at Rushland or Penns Park, PA
P1g  New Precipitation gage – Manatawny Creek near Spangsville, PA
P2a  Automated Snow Monitor – Equinunk vicinity, PA
P2b  Automated Snow Monitor – Hawley vicinity, PA

**Stream Gages**

S1a  Extend and maintain rating curve – Delaware River at Tocks Island/Delaware Water Gap
S1b  Extend and maintain rating curve – Delaware River at New Hope/Lambertville, NJ
S1c  Extend and maintain rating curve – Delaware River at Stockton, NJ
S1d  Extend and maintain rating curve – Delaware River at Reigelsville, NJ
S1e  Extend and maintain rating curve – Delaware River at Montague, NJ
S1f  Extend and maintain rating curve – Brandywine Creek at Wilmington, DE
S1g  Extend and maintain rating curve – North Branch Rancocas Creek at Pemberton, NJ
S2a  Install new stream gage – Willowemoc Creek near Livingston Manor, NY
S2b  Install new stream gage – Little Beaver Kill near Livingston Manor, NY
S3a  Flood hardening – Flat Brook, NJ
S3b  Flood hardening – Musconetcong River at outlet to Lake Hopatcong, NJ
S4  Re-activate stream gage on Mongaup river downstream of Rio Reservoir

**Flood Forecast Points**

F1  Convert from crest only to flood only forecast point – Delaware River at Easton/Phillipsburg
F2a  Establish a River Flood Forecast Point - West Branch Delaware River at Walton, NY
F2b  Establish a River Flood Forecast Point - Neversink River at Goddefroy, NY
F3a  Extend forecasting from 48 to 72 hours – North Branch Rancocas Ck. At Pemberton, NJ
F3b  Extend forecasting from 48 to 72 hours – Schuylkill River at Reading, PA
F4a  Establish site specific flood forecast point - East Branch Delaware River at Margarettville, NY
F4b  Establish site specific flood forecast point – Dry Brook at Arkville, NY
### Table D-1: Index of Recommended Flood Forecast Improvements for the Delaware River Basin

#### Flood Forecast Points (Continued)

<table>
<thead>
<tr>
<th>F5a</th>
<th>Evaluate Stage vs. Flood Impact - West Branch Delaware upstream of Hale Eddy</th>
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<tbody>
<tr>
<td>F5b</td>
<td>Evaluate Stage vs. Flood Impact - East Branch Delaware upstream of Harvard</td>
</tr>
<tr>
<td>F5c</td>
<td>Evaluate Stage vs. Flood Impact – Neversink River upstream of Bridgeville</td>
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<tr>
<td>F6</td>
<td>Develop Implementation Plan for SSHP. Include small watersheds throughout the basin in the evaluation</td>
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<tr>
<td>F7a</td>
<td>Evaluate for probability forecasting – Delaware River at Easton/Phillipsburg</td>
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<td>F7b</td>
<td>Evaluate for probability forecasting – Delaware River at Frenchtown</td>
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<tr>
<td>F7c</td>
<td>Evaluate for probability forecasting – Delaware River at New Hope/Lambertville</td>
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<tr>
<td>F7d</td>
<td>Evaluate for probability forecasting – Delaware River at Stockton, NJ</td>
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<tr>
<td>F7e</td>
<td>Evaluate for probability forecasting – Delaware River at Washington’s Crossing, PA</td>
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#### General Recommendations

<table>
<thead>
<tr>
<th>G1</th>
<th>Update and maintain the gage and flood forecast point inventories and GIS on an annual basis.</th>
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<tbody>
<tr>
<td>G2</td>
<td>Develop public information documenting steps and considerations for establishing flood forecast points.</td>
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<tr>
<td>G3</td>
<td>Expand ice observation network</td>
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<tr>
<td>G4</td>
<td>Continue work to increase stream gage reporting frequency from 4 hours to 1 hour. Maintain existing telephone capabilities.</td>
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<td>G5</td>
<td>Continue work to extend forecast to 72 hours for all river flood forecast points.</td>
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<tr>
<td>G6</td>
<td>Continue development of probability based ensemble forecasting.</td>
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<tr>
<td>G7</td>
<td>Continue development of distributed hydrologic modeling for application to small streams.</td>
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**Precipitation Network**

- 7 new observing sites recommended to improve real time watershed monitoring
- 2 new snow pillows/automated snow water equivalent monitors for snowmelt modeling

**Stream Gage Network**

- Develop and maintain full rating curves at 7 high priority forecast sites to improve forecast accuracy
- New stream gages at 2 locations
- Flood harden 2 high priority sites to improve reliability during floods
- Reactivate gage downstream of Rio Reservoir to improve main stem forecasts
Forecast Point Recommendations

Seven recommendations impacting 15 sites including:

- Forecast frequency upgrades
- 2 new river forecast points
- Extending forecasts from 48 to 72 hours at 2 sites
- Develop site specific forecasts for fast responding locations
- Additional flood impact documentation at three sites
- Evaluating the development of probability forecasts at 5 sites
General Recommendations

- Yearly update of gage inventory

- Development of public information brochure or web page on considerations and steps in establishing flood warning points and warning services

- Continue building on existing ice jam reporting network

- Increase reporting frequency of stream gages that report greater than once an hour

- Examine increasing forecasts to 72 hours at all forecast points

- Continue development of probability based forecasts for water resource management

- Continue development and advances in distributed hydrologic modeling to provide capacity to issue flood forecasts for small fast responding basins
What Has Been Accomplished?

Precipitation and stream gage inventories completed and current as of June 2009

Several of the larger more general Interstate 2007 Report recommendations broken down into smaller location specific addressable tasks for action

Some of tasks recently addressed:

- Crest only to flood only forecasts at 4 locations
- New forecast point at Walton NY
- AHPS probability forecasts added to 4 of 5 recommended sites
- Increase in stream gage DCP reporting frequency to one hour at all NJ basin sites
- River forecasts extended from 48 to 72 hours at 9 forecast points.
Delaware River
Select the points:

- All
- at Callicoon
- at Barryville
- at Matamoras/Port Jervis
- at Montague
- at Tocks Island
- at Belvidere
- at Easton
- at Riegelsville
- at Frenchtown
- at Stockton
- at New Hope-Lambertville Bridge
- at Washington Crossing
- at Trenton
- at Pier 12 Philadelphia
Trenton on Development Site