

# Pompton Lake Dam Post-Flood Report

April 15-17, 2007 Nor'easter



**US ARMY CORPS  
OF ENGINEERS**  
NEW YORK DISTRICT

July 11, 2007

**POMPTON LAKE DAM POST-FLOOD REPORT**  
**APRIL 15-17, 2007**

## INTRODUCTION

This report documents the hydrologic, hydraulic and meteorologic aspects of flooding along the Ramapo River during April 15-17, 2007. The Ramapo is a tributary of the Pompton River, which flows into the Passaic River. The latter enters tidewater in the Greater New York Harbor Area. Recorded rainfall varied from 4 inches to slightly more than 9 inches within the study area. The river and flash flooding that resulted from this heavy rainfall damaged residences and businesses in many communities and severely impacted local and state municipal infrastructure. Due to the extent of damage, President Bush declared the area a Federal Disaster Area.

Area residents affected by the flood questioned the impact that the operation of the flood gates at the Pompton Lake Dam had on their area. Wayne, New Jersey Mayor Scott Rumana said “residents reported seeing [flood] water rise faster and sooner [during this most recent April 15-17, 2007 nor’easter flood] than during past floods.” In response to these concerns, on April 18, 2007 Congressman Pascrell requested the Corps of Engineers prepare a post-flood report on the operation of the flood gates for the April 15-17, 2007 Nor’easter and determine if these operations contributed to downstream flooding.

## **DESCRIPTION OF THE STORM**

Heavy rain began to fall across New Jersey during the early morning hours on Sunday, April 15th, 2007. It began as light snow for a short time in the northwestern part of the state. The heavy rain continued through Monday morning, ending as wet snow in some locations. Showers continued throughout the day on Monday and into Tuesday.

### **Precipitation Totals**

The National Weather Service 7-day rainfall total map showed areas of 8-10 inches in parts of Bergen, Hudson and Somerset Counties. The southeast coast received the least amount of precipitation with totals as low as 2 inches. Precipitation gages operated by the USGS recorded as much as 7.19 inches at Pascack Brook at Park Ridge (01377370) to

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slightly less than 2 inches at Cape May (01411390). National Weather Service precipitation gages recorded 6.7 inches at Newark, 5.5 inches at Trenton and 2.7 inches at Atlantic City . Precipitation gages operated by others recorded over 9 inches in Bergen County.

The storm developed over Texas on April 13, and moved off the coast of Virginia on late Sunday, April 15. The storm moved slowly northward, reaching the New York City area Monday morning, April 16. Peak wind gusts were generally in the 40 to 50 mi/hr range in New Jersey. Colder air wrapped around the storm as it moved past New Jersey on Monday morning. Many locations in New Jersey, south and east of Philadelphia, as well as parts of northern and central New Jersey, received anywhere from a trace to an inch of snow on Monday morning. Up to 7 inches of snow accumulated in eastern Pennsylvania.

## **ANALYSIS OF THE EVENT**

### **Development of the Inflow Hydrograph**

Since the purpose of this report is to determine if the operation of the gates contributed to flooding downstream of the gates as compared to the pre-project condition, a precise estimate of the inflow hydrograph is needed.

For this analysis, the inflow hydrograph was developed from the outflow gage data recorded by USGS Gage - Ramapo River at Pompton Lake, 400 ft downstream of the dam (Figure 1). Since the lake level remained fairly constant, the volume of inflow to the gates is assumed to be equal to the outflow volume. In other words, the area under the inflow hydrograph is equal to the area under the outflow hydrograph. This assumption is valid because this is a run of the river dam and cannot be used for detention due to its limited storage capacity. Previous simulations during the design phase (Ramapo River at Oakland, New Jersey Flood Protection Project, Phase II General Design Memorandum (GDM), May 1994) showed that the outflow hydrograph closely follows the inflow hydrograph, with the inflow hydrograph essentially splitting the steps of the outflow hydrograph associated with each gate opening (See Attachment 1).

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The design analysis used the future improved discharges at hydrologic node R17G located at Pompton Lake Dam as inflow to the gate routings. This hydrograph takes into account the increase in discharge due to any loss in storage resulting from the project improvements. Comparisons to unimproved conditions discharge at the dam and immediately upstream of the lake indicate that the storage effects of the lake increased the 10 year peak discharge by only 40 cfs, or 0.42% of the peak flow. The upstream channel work increased the 10 year peak discharge upstream of the lake by an additional 20 cfs, or 0.21 % of the peak flow.

Based on these parameters, a determination of the inflow hydrograph was made. The results of this analysis indicate that the peak inflow at the gates was approximately 9700 cfs (Figure 2). Based upon the peak discharge vs. frequency in the GDM, this event was approximately equivalent to the 10 year future improved hypothetical event, which had a peak discharge of 9660 cfs at node R17G, the Pompton Lake Dam.

The inflow and outflow hydrographs are plotted together in Figure 3.

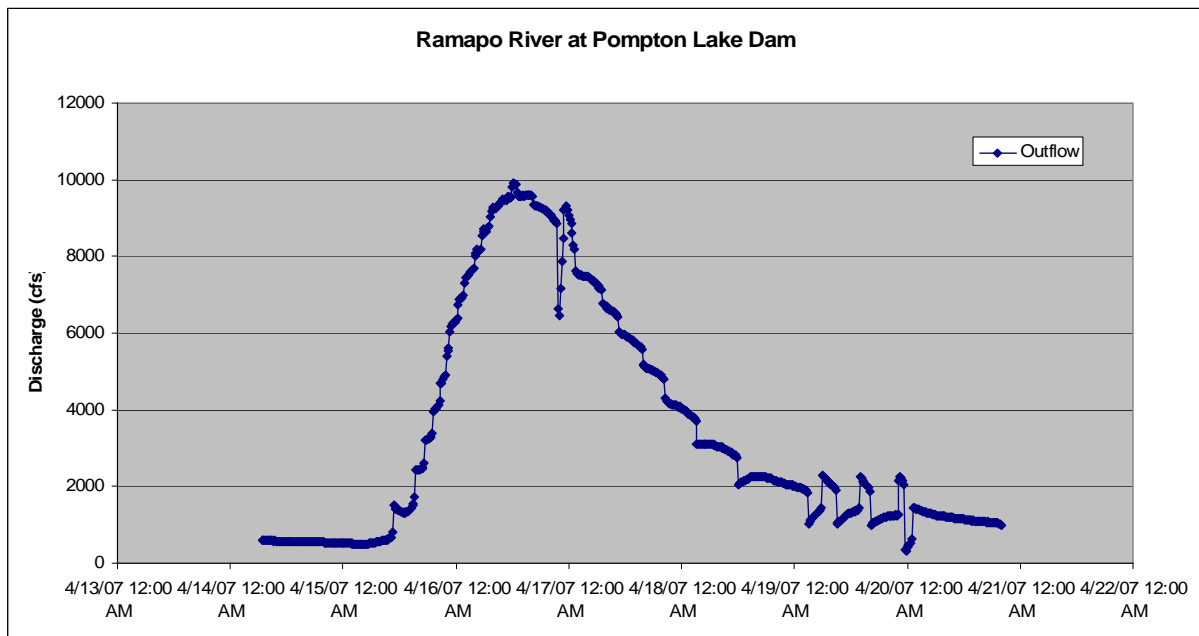


Figure 1

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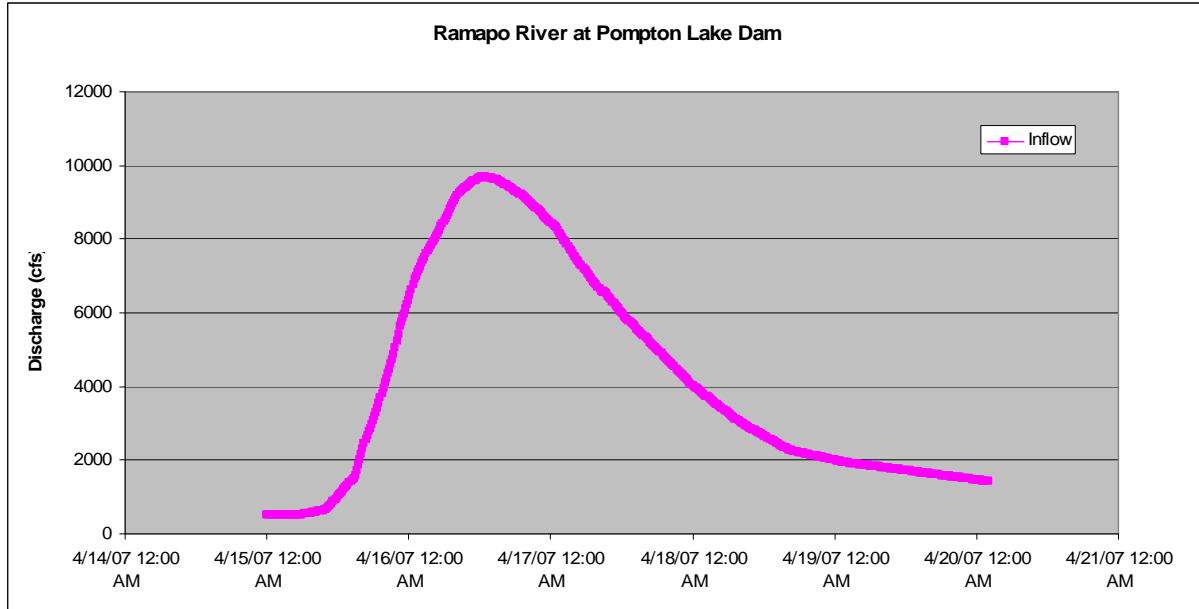


Figure 2.

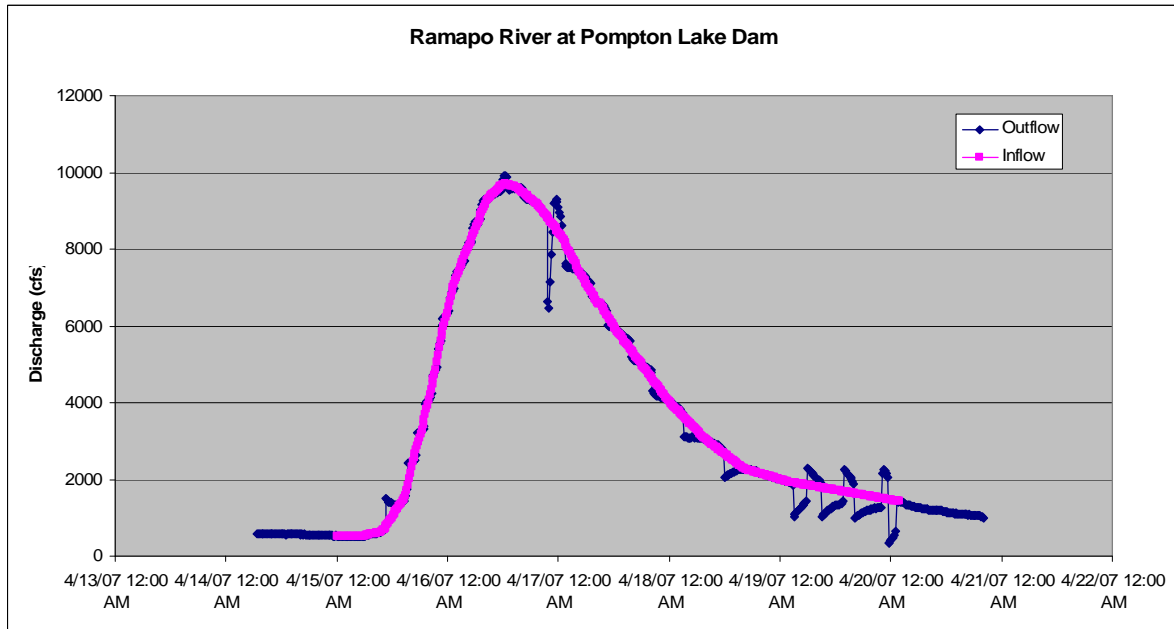


Figure 3.

**Comparison to Other Historic Events**

Gage height and discharge data at two USGS gages adjacent to Wayne NJ, Ramapo River at Pompton Lakes NJ (Figure 1) and Pompton River at Pompton Plains NJ (Figure 4.),

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were examined for the recent April 15-17, 2007 nor'easter flood, and compared to the same data for the recent past floods of April 4-5, 1984, Tropical Storm Floyd (September 15-17, 1999), April 3, 2005, and October 8-9, 2005. In addition, for the USGS gage, Ramapo River at Pompton Lakes NJ, the 40 year design flood of the recently completed Ramapo River at Oakland NJ flood damage reduction project was also examined to see how exceptional this recent April 15-17, 2007 nor'easter storm and flood was in comparison with these earlier storms and floods.

The storms that produced these floods were also compared at two NOAA rain gages, Charlotteburg Reservoir NJ and Caldwell NJ Essex County Airport. Data gathered included total two week antecedent rainfall (inches), total storm rainfall in inches, and maximum storm rainfall intensity in inches per hour.

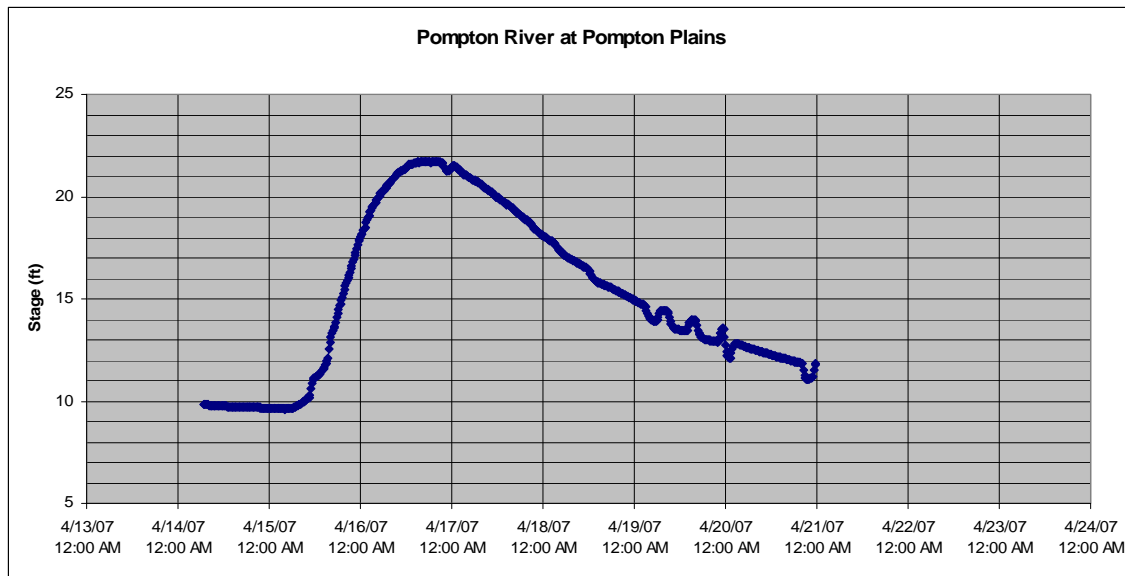


Figure 4.

The data is summarized in Table 1. For the two USGS stream gages, and the aforesaid six floods, data consists of:

- Peak discharge, cfs, and peak gage height, feet
- Rank by size among floods in table, based on peak discharge and gage height

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- Base flow in cfs and initial gage height in feet before each flood, as an indicator of drought to saturated initial condition
- The average rate of rise, in feet per hour, between the initial and peak gage height.

The following conclusions can be drawn from the data presented in Table 1:

- The greatest average rate of rise observed among the six floods in the table for the two USGS stream gages for which data is presented, is 0.48 feet per hour at the Ramapo River at Pompton Lakes NJ gage, for the 40 year design flood. The average rate of rise of the April 15-17, 2007 nor'easter flood at the Ramapo River at Pompton Lakes NJ USGS gage, 0.27 feet per hour, is surpassed by the average rates of rise for the 40 year design flood, 0.48 feet per hour, and that of the April 1984 flood, 0.40 feet per hour, and Floyd (mid-September 1999), 0.31 feet per hour.
- A similar result is obtained at the Pompton River at Pompton Plains NJ, USGS stream gage, about a mile downstream of the Ramapo River at Pompton Lakes NJ gage (Figure 4). There, the average rate of rise for the April 15-17, 2007 nor'easter flood, 0.29 feet per hour, is equaled by the average rate of rise for Floyd (0.29 ft. per hour) and surpassed by that of the April 1984 flood, 0.37 feet per hour, and that of the October 2005 flood, 0.31 feet per hour.

In terms of pre-flood saturation, the April 15-17, 2007 nor'easter flood ranked third most saturated (third highest base flow) among the floods presented in Table 1, at both the Ramapo River at Pompton Lakes NJ, and the Pompton River at Pompton Plains NJ, USGS stream gages.

At the Ramapo River at Pompton Lakes NJ USGS stream gage, due to gate operation, the discharge jumped up abruptly from 9,550 cfs at 1145 hrs. Monday April 16 2007 to the peak of 9930 cfs at 1215 hrs. See Figure 1. The peak discharge that would have occurred at this gage without gate operation was estimated at 9700 cfs. However, further downstream, at the Pompton River at Pompton Plains NJ, USGS stream gage, the abrupt increase in discharge to the

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peak, due to gate operation, is damped out, and the flood hydrograph is seen to rise smoothly, leveling off to its peak of 18,000 cfs and gage height of 21.71 feet at 1800 hours on Monday April 16, 2007. See Figure 4.

The following comparisons can be made in terms of storm rainfall :

At the Charlotteburg Reservoir NJ rain gage (in the Pequannock River Basin, to the west of the Ramapo River Basin :

- The two-week total antecedent rainfall of 2.06 inches for the April 15-17, nor'easter storm was exceeded by that of the April 4-5 1984 storm (3.7 inches), Floyd (Sept. 15-16, 1999) (2.2 inches) and April 1-2, 2005 (3.9 inches).
- The April 15-17, 2007 storm total of 5.68 inches is exceeded by that of the April 4-5, 1984 storm (6.10 inches) , Floyd (8.1 inches), October 7-9, 2005 (9.2 inches) and the 40 year design storm (5.76 inches).
- The April 15-17, 2007 storm estimated maximum hourly intensity of 0.46 inch per hour is exceeded by that of all the other storms for which data is presented in Table 1 at this rain gage, ranging from 0.50 inch per hour for the April 4-5, 1984 storm to 1.77 inches per hour for the 40 year design storm.

At the Caldwell NJ Essex County Airport rain gage just south of Wayne NJ and the Ramapo and Pompton River Basins:

- The two-week total antecedent rainfall of 2.31 inches for the April 15-17, nor'easter storm was exceeded by that of the April 1-2, 2005 storm, 3.86 inches. Data was unavailable at this gage for the April 4-5, 1984 storm.
- The April 15-17, 2007 storm total of 5.82 inches is exceeded by that of Floyd (10.82 inches), and the October 7-9 2005 storm, 6.63 inches. Data was unavailable at this gage for the April 4-5 1984 storm.
- The April 15-17, 2007 storm maximum hourly intensity of 0.47 inch per hour was exceeded by 1.77 inches per hour for Floyd, and 1.06 inch per hour for the



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October 7-9, 2005 storm. Data was unavailable at this gage for the April 4-5, 1984 storm.

**Comparison of Inflow and Outflow Hydrographs**

A comparison of the inflow and outflow hydrographs to the gates indicates that the peak outflow of 9930 cfs, as determined from downstream gage data, was 230 cfs greater than the peak inflow of 9700 cfs (Figures 3, 5). This peak outflow occurred when the gate opened 0.5 ft to 6.5 ft, the maximum opening for this event. The gates remained at this opening for 1 hour, at which time the gates were closed 0.5 ft to 6.0 ft.. The timing of the peaks was such that the peak outflow occurred 15 minutes prior to the estimated peak inflow. Preconstruction outflow would have been 60 cfs less, or 9640 cfs, yielding a maximum increase in discharge of 290 cfs.

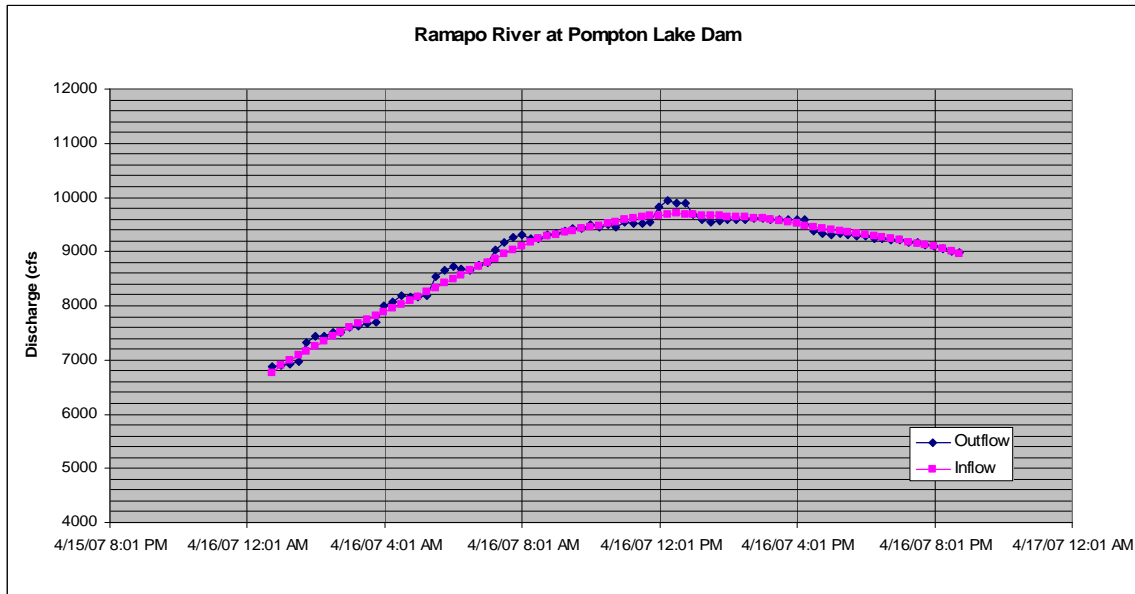


Figure 5.

**Gate Operation**

The Pompton Lake reservoir is regulated to provide flood damage reduction benefits to the reach immediately upstream of the lake as well as to satisfy the existing water supply operation. Reservoir regulation to prevent upstream damages is a unique situation; the majority of flood damage reduction reservoirs are regulated to prevent damages

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downstream of the reservoir by retaining peak discharges. As would be expected, the operation of the Pompton Lake Dam gates to release flow is quite different than most gate operations.

Defining the gate operation as a function of gate opening and lake level allows the gates to be operated manually, without the benefit of computers and gage data, should those systems become inoperable for any reason. Under such a situation, the gate operator need only check the gate opening and staff gage at the dam site, to determine the required gate operation.

The gate operation is a function of the difference between the lake elevation and the target elevation. If the lake level is more than 0.25 ft above the target elevation, the gates are to be opened 0.5 ft; if the lake level is more than 0.5 ft above the target elevation, the gates are to be opened 1.0 ft. Similarly, if the lake level is more than 0.25 ft below the target elevation, the gates are to be closed 0.5 ft; if the lake level is more than 0.5 ft below the target elevation, the gates are to be closed 1.0 ft. The gates can be adjusted every 15 minutes to avoid any large fluctuations in lake pool and provide outflow rates essentially the same as inflow rates for a broad range of runoff hydrographs, and to avoid sudden increases in discharge that would represent a threat to life or property.

The April 15-17, 2007 Nor'easter flood was the inaugural operation of the flood gates (aside from test operations) at Pompton Lake Dam. The gates were operated to maintain a target pool elevation of 201.75 NGVD. Automatic operations initiated at 1030 hours on 15 April 2007 when the lake level reached an elevation of 202.0 or 0.25 ft above the target elevation resulting in an initial gate opening of 0.5 ft. The gates continued to open gradually, until a maximum gate opening of 6.5 feet was reached on 1145 hours on 16 April 2007. In response to local officials concerns regarding the gate operation and inundation of the Paterson-Hamburg Turnpike Bridge, once the peak of the flood had passed, manual operations were initiated as an overall systems check. Automatic operations were resumed at 2130 hours on 16 April 2007.

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However, upon resumption of automatic operations, a programming safety feature for areas downstream of the gates caused the gates to reinitialize back to zero opening. The gates automatically reopened in steps every 15 minutes thereafter in accordance with the gate operation rules. The abrupt closing and opening of the gates resulted in a brief perturbation in the outflow hydrograph at Pompton Lake (Figure 1.), but did not increase peak flood levels. The hydrograph at Pompton Plains (Figure 4.) shows the perturbation to be greatly diminished. Gate operations essentially concluded on 20 April 2007.

**Downstream Impacts of Gate Opening**

Immediately downstream of the gates, in the pool above the Paterson-Hamburg Turnpike Bridge, the maximum water surface was 188.34 at a discharge of 9930 cfs. The maximum flow at the dam would have resulted in a stage of 188.08. So the 290 cfs increase in discharge resulted in an increase in water level of 0.26 ft, approximately 3 inches (Figure 6). The magnitude of this increase is exacerbated by the restricted opening of the bridge which creates a steeper stage discharge rating curve. This increase diminishes as it travels downstream.

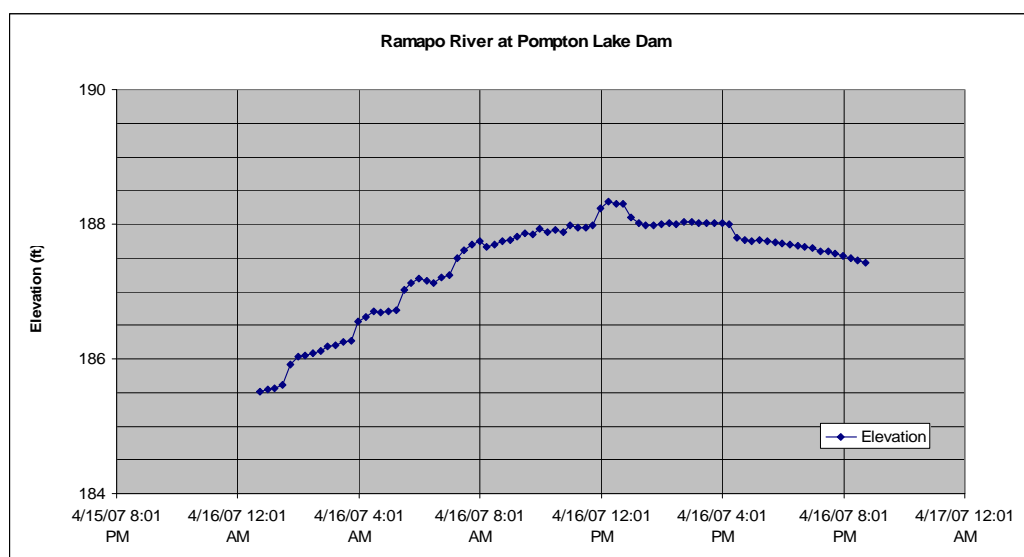


Figure 6.

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At Dawes Ave, approximately 3000 ft downstream of the gates, the peak flow was assumed to be the same as at the dam. This is a reasonable assumption since any increase in discharge due to the additional contributing drainage area could be offset by additional attenuation in the flood plain. Utilizing the rating curve immediately downstream of the Dawes Ave Bridge (Figure 7.), an increase of 290 cfs would result in an increase in stage of less than 0.13 ft. It should be noted that the estimate of a 290 cfs increase in discharge at Dawes Ave is conservative, since the volume of flow in the flood plain would result in an attenuation of the peak caused by the gate opening.

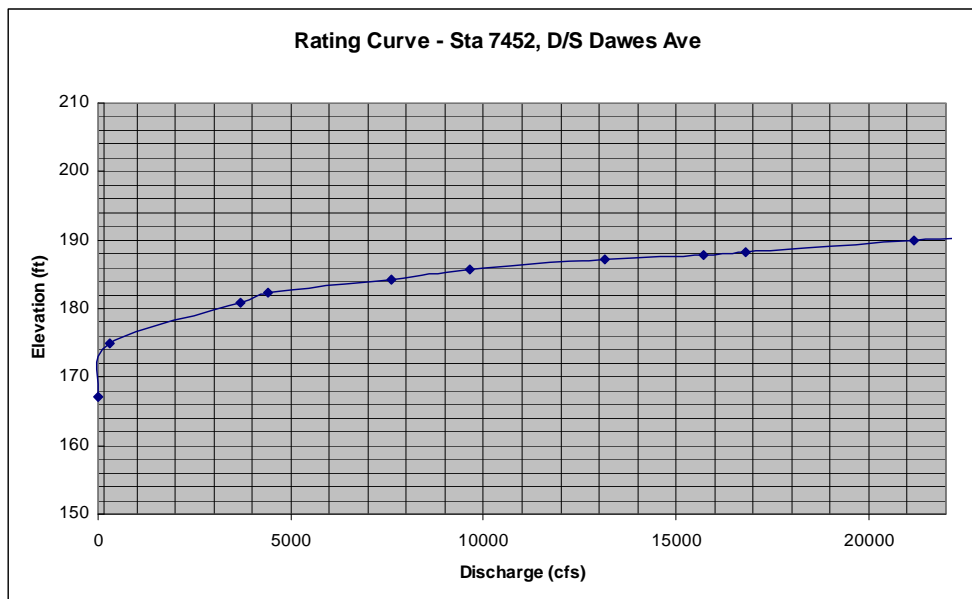


Figure 7.

The gage at Pompton River at Pompton Plains (Figures 4, 8) shows a smooth curve at the peak of the hydrograph, indicating that there is no discernable increase in discharge or stage due to the gate opening. The peak discharge at Pompton Plains was about 18,000 cfs, the increase in discharge being the result of both increased drainage area and the inflow from the Pequannock River.

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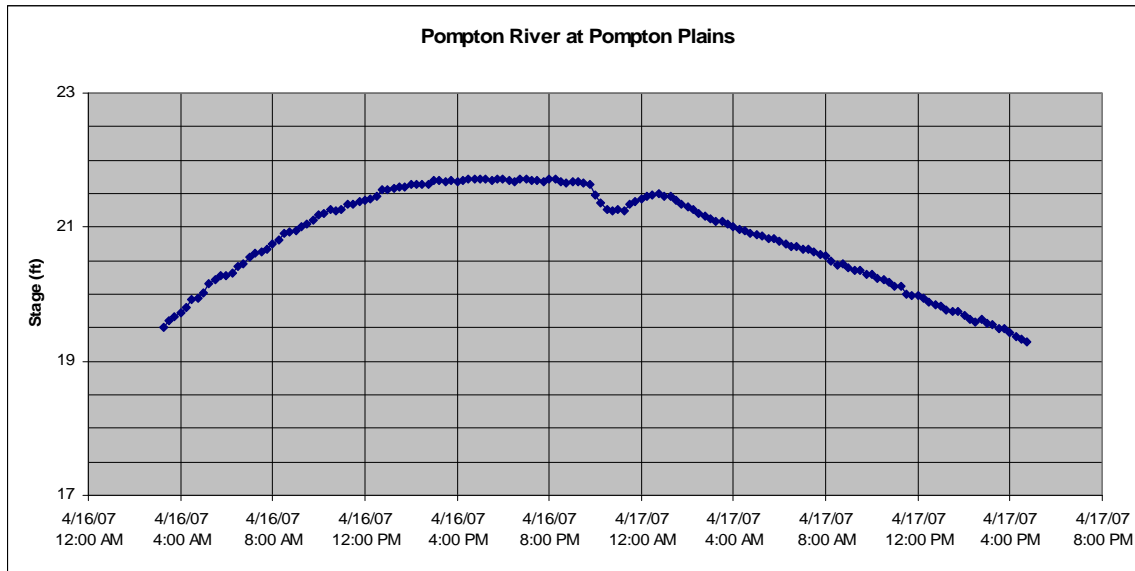


Figure 8.

**CONCLUSION and RECOMMENDATIONS**

The April 15-17, 2007 nor'easter storm, and the flooding it produced on the Ramapo and Pompton Rivers, downstream of the recently completed Ramapo River at Oakland NJ flood damage reduction project, though severe and extensive, was surpassed by several earlier recent storms and floods, ranging in time from that of April 1984 to October 2005. Without the effect of gate operation, it was surpassed in terms of average rate of rise by the floods of April 1984, Floyd (mid-September 1999) and the 40-year design flood at the Ramapo River at Pompton Lakes NJ USGS stream gage. Further downstream, at the Pompton River at Pompton Plains NJ USGS stream gage, it was equaled in terms of average rate of rise by Floyd, and surpassed by the floods of April 1984 and October 2005.

The findings indicate that the changes in the timing and flow due to the operation of the flood gates during the April 15-17, 2007 flood had no measurable impact downstream. The change in timing and flow resulted in a minor increase in peak stage in the pool immediately downstream of the gates. A warning system utilizing signage and an audible

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siren tone to warn people that the spillway gates are about to open and discharge water downstream was operational during the April 15-17th flood.

The impact on the Ramapo River is small (less than 0.13 feet) and cannot be measured within the accuracy of any modeling effort. Differences of this amount are considered to represent a no-change condition.

Since impact of the gate operation on the downstream rivers is negligible, no additional dredging would be warranted on the Wanaque, Pequannock, Ramapo and Pompton Rivers. Areas that were flooded downstream during the storm would have been flooded to the same levels whether the project had been operating or not.

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Table 1							
April 15-19 2007 nor'easter storm and flood compared to four earlier recent storms and floods							
and to Oakland NJ built project 40 year design flood (Ramapo River at Pompton Lakes only)							
GAGE	PARAMETER :	FLOOD :					
		Apr-84	FLOYD	Apr-05	Oct-05	Apr-07	40 YR DESIGN
Ramapo River At Pompton Lakes New Jersey	Peak discharge cfs	15,400	14,000	6,930	6,600	9,930	15,700
	Peak gage height ft.	20.1	19.38	14.22	14.39	16.99	20.25
	Rank among floods in table	2	3	5	6	4	1
	Initial flow, cfs	1150	41	865	28	504	100
	Initial gage height, ft.	8.86	6.81	8.57	6.65	8.16	7.24
	Average rate of rise, feet per hour						
	between initial and peak gage height :	0.4	0.31	0.16	0.25	0.27	0.48
Pompton River at Pompton Plains New Jersey	Peak discharge cfs	25,400	16,400	15,300	10,600	18,000	NONE
	Peak gage height ft.	24.77	21.01	20.42	17.86	21.71	"
	Rank among floods in table	1	3	4	5	2	"
	Initial flow, cfs	2020	56	2360	74	918	"
	Initial gage height, ft.	11	7.43	11.11	7.57	9.66	"
	Average rate of rise, feet per hour						"
Charlotteburg Reservoir New Jersey	between initial and peak gage height :	0.37	0.29	0.25	0.31	0.29	
	Total two-week antecedent rain, inches	3.7	2.2	3.9	0.5	2.06	0
	Total storm rainfall, inches	6.1	8.1	2.5	9.2	5.68	5.76
Caldwell New Jersey Essex County Airport	Maximum hourly rain inches	0.5	1.1	0.6	0.7	0.46	1.77
	Total two-week antecedent rain, inches	Not available	1.52	3.86	0.24	2.31	-
	Total storm rainfall, inches	Not available	10.82	2.21	6.63	5.82	-
	Maximum hourly rain inches	Not available	1.77	0.26	1.06	0.47	-
<b>Notes :</b>							
1. Ramapo River at Pompton Lakes NJ gage height is, for all floods in Table 1, at the new gage downstream of the Pompton Lakes Dam.							
2. The 40-year design storm is a 40-year hypothetical storm with no antecedent storm precipitation. One inch initial loss was assumed for the watershed to be fully saturated before the maximum hour of precipitation.							
3. The maximum hourly rain in inches for Charlotteburg Reservoir NJ rain gage, 0.46 inch per hour, is an estimated value.							

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