The Great Easter 1913 "Midwest" Flood in New York State

Trudy E. Bell, M.A., Independent Scholar
1260 Andrews Avenue
Lakewood OH 44107
216-221-5008; t.e.bell@ieee.org

The week following Easter 1913 brought the most geographically widespread natural disaster the United States had suffered up to then in the form of an unusually powerful, long-lived, and widespread winter storm. Although the Midwest, Great Plains, and South were hardest hit by tornadoes and flooding and received most national and international publicity, sympathy, and aid,[1] upstate New York also suffered record flooding that under different circumstances would likely have drawn greater national attention. Primary sources reveal the extent of New York's share in the calamity and the consequences.

In a short talk, it is not possible to survey all the damage and effects of the 1913 Easter week flooding in New York. But at least two different consequences along the Hudson River had long-lasting significance. The 1913 storm system and flood spurred incentive to create the Hudson River Regulating District that, among other things, constructed the Sacandaga Reservoir (now Great Sacandaga Lake) for regulating the flow of the Hudson River. In Albany, as a result of floodwater contaminating the city's water supply, an "explosive" epidemic of typhoid fever was quickly quashed by emergency chlorination of a reservoir of drinking water, an instance later widely cited in engineering, medical, and public health references and influential in encouraging municipal water authorities to adopt chlorination as a means of combating disease.

Unprecedented storm system

The 1913 flood set new record high-water marks and record discharge rates (cubic feet of water per second) in many New York rivers, many of which still stand. It was also

[1] Although nearly forgotten today, the Easter 1913 natural disaster afflicted more than 15 states, with Alabama, Iowa, Indiana, and Nebraska hardest hit by tornadoes and Ohio and Indiana being hardest hit by flooding. The death toll topped 1,000 and at the time the calamity was repeatedly compared to the 1906 San Francisco earthquake and fire, only deemed even worse because the devastation afflicted more than 100,000 square miles. According to the American Red Cross, at least 256,000 people were rendered homeless at least temporarily. The War Department, the Navy, the Marines, the National Guard, the U.S. Public Health Service, and the Red Cross were all involved in rescue and relief. “Instant books” that collated newspaper articles about the disasters include Frederick E. Drinker, *Horrors of Tornado, Flood and Fire* ([no city given]: George W. Bertron, 1913); Marshall Everett, *Tragic Story of America’s Greatest Disaster* (Chicago: J. S. Ziegler Co., 1913); Logan Marshall, *Our National Calamity of Fire, Flood, and Tornado* ([no city given]: L. T. Myers, 1913); and Thomas H. Russell, *America’s Greatest Calamity* ([no city given]: Thomas H. Morrison, 1913). There were also numerous smaller local pamphlets published consisting of photographs of the devastation in individual cities. Today, the 1913 flood still ranks as Ohio's worst weather disaster, and the Easter 1913 Omaha tornado still holds the record as the single deadliest twister ever to have struck Nebraska. The National Oceanic and Atmospheric Administration, Storm Prediction Center, "The 25 Deadliest U.S. Tornadoes," http://www.spc.noaa.gov/faq/tornado/killers.html (accessed June 29, 2009). The author has also published four articles and a book on various aspects of the natural disaster.

the first time record flooding was caused by excessive rainfall alone rather than by the formation or breaking of ice dams.[2]

The winter of 1912–1913 was unusually warm and wet across all the North Atlantic states. Temperatures ranged from 3°F to 10°F above normal, in some sections being "little short of being the warmest March on record,"[3] averaging only an inch of snow all month south of the latitude of Albany. It was also the wettest March on record in New York and Pennsylvania, with no New York weather station recording any monthly rainfall of less than 3.50 inches.[4] The soil was thus nearly saturated, unable to absorb any more rainwater, which flowed as runoff.

The disaster in New York and the eastern half of the nation was delivered as a colossal one-two punch.

The first punch came on Good Friday, March 21, 1913, when an arctic high-pressure system swooped down from Canada and a violent windstorm swept the eastern half of the United States from Ontario to the Gulf of Mexico. Hurricane-force winds across the Great Lakes reached record-breaking maximum sustained wind velocities, including 90 miles per hour in Buffalo.[5] The interstate wind storm splintered or blew down hundreds of telephone and telegraph poles across half a dozen states; then came sleet that encased everything in thick ice whose weight pulled down hundreds more poles as well as miles of telephone and telegraph wires. The decimated communications infrastructure across the middle of the country prevented the U.S. Weather Bureau from either gathering information or sending warnings about what was to happen next.

The second colossal punch came on Easter Sunday, March 23, as torrential rains began to fall. The Weather Bureau was completely caught off-guard by just how much water fell out of the sky between Easter Sunday, March 23, and Thursday, March 27.[6] Over the watersheds of the Mohawk River and the Hudson River above Albany, the total rainfall averaged up to an inch per day for four or five days—equivalent to 4 to 6 weeks

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[2] Robert E. Horton, "Effects of Recent Flood on New York Streams: Studies of Rainfall and Stream Discharge, with Hydrographs for Fourteen Rivers," *Engineering Record,* April 12, 1913, 401. See also "Richard Lumia and Patricia M. Murray, *Maximum Known Stages and Discharges of New York Streams, 1865–1989, with Descriptions of Five Selected Floods, 1913–85,* U.S. Geological Survey Water-Resources Investigations Report 92-4042, prepared in cooperation with the New York State Department of Transportation, (Albany, New York, 1993), https://www.nysdot.gov/divisions/engineering/design/dqab/hdm/hdm-repository/USGSReport92-4042.pdf (accessed June 29, 2009), 3.

[3] Wilford M. Wilson, "Climatological Data for March 1913. District No. 1, North Atlantic States," *Monthly Weather Review*, March 1913, 328.

[4] Wilson, 328.

[5] Henry J. Cox, "Climatological Data for March 1913. District No. 4, The Lake Region," *Monthly Weather Review*, March 1913, 372. Sustained winds reached 84 and 86 mph in Toledo and Detroit, with winds at Toledo gusting above 100 miles per hour. Although isolated individuals in the southern Great Lakes area were killed by flying debris, at least 49 people died from the ravages of nine tornadoes in Alabama, Georgia, and Mississippi, Alabama - including 27 killed by a single twister that laid waste to the town of Lower Peach Tree, Alabama. Thomas P. Grazulis, *Significant Tornadoes* (St. Johnsbury, Vermont: Environmental Films, November 1990), Vol. II, 131; "District No. 2, South Atlantic and East Gulf States," *Monthly Weather Review*, March 1913, 341–342.

[6] "There was nothing in the meteorological conditions charted on the daily weather maps previous to the downpour of rain that caused the disastrous floods that gave any indication of the tremendous quantity of rain which fell on subsequent dates." Alfred J. Henry, "Rivers and Floods, March 1913," *Monthly Weather Review*, March 1913, 485.

of normal rainfall in half a week.[7] The Mohawk and Hudson Rivers rose with unusual speed from March 25th to the 28th: indeed, at Schenectady, the Mohawk rose 16 feet in three days. The rainfall was so heavy that the discharge of both the Hudson and Mohawk rivers tripled in 48 hours, giving them a combined flow equivalent to that of the Niagara. Between Little Falls to Schenectady, a 60-mile stretch, the entire Mohawk River flats were submerged deeper than ever recorded.[8] Both the Mohawk and the Hudson reached maximum record heights on Friday, March 28; worse, the crests of the two rivers coincided[9] by the time high water reached Albany and Troy. At Albany, the water reached a maximum height of 24.4 feet, a mere 0.09 foot (less than an inch) short of the highest stage on record set in 1857.[10] In western New York, the Genesee broke the 1865 record for volume of water and reached a record height of 8 feet deep over the Court Street Dam[11] as well as a record discharge rate, flooding a large section of downtown Rochester from 1 to 6 feet deep for three days; downtown office basements were flooded 10 to 12 feet deep, putting elevators, lighting, and heating out of commission.[12] Moreover, floodwaters submerged the pumping station of the Rochester water-filtration plant and a main pipeline from the distributing reservoir broke, leaving the city without water for two days (Friday, March 28 and Saturday, March 29).[13]

In summarizing the disastrous flooding around the state, one observer wrote,

> Practically every city and town on a water course in...northern New York was subjected to high water reaching well up into the city streets. The immediate result of such high water was to put out of service the street-car lines, gas and electric companies, power houses, and water and sewer services. As the water rose and acquired velocity and force, it tore out railway embankments, destroyed bridges, buildings, river walls, and, in the few cases where they existed, levees. The floods differed from the ordinary river

[7] In very northern New York, much of the precipitation from 8:00 AM March 25 until 1:00 PM March 27 fell as sleet and freezing rain, encasing everything in solid ice more than 1.5 inches thick in Canton, Gouverneur, Norwood, Ogdensburg, Potsdam, with the heavy ice pulling down trees, poles, and wires. Cox, 373.

[8] Robert E. Horton, in the April 5, 1913 issue of *Engineering Record,* quoted in Alfred J. Henry, *The Floods of 1913 in the Rivers of the Ohio and Lower Mississippi Valleys,* Bulletin Z., U.S. Department of Agriculture, Weather Bureau (Washington: Government Printing Office, 1913), 106.

[9] Robert E. Horton, "Effects of Recent Flood," 401.

[10] George T. Todd, "Flood in the Hudson River, March 27–28, 1913," in Henry, *The Floods of 1913 in the Rivers of the Ohio and Lower Mississippi Valleys,* 105. There were at least two different datums used for measuring the height of the Hudson, and they were not the same, so height numbers in different references differ. But all agree that the 1913 crest height at Albany in 1913 fell just short of the record set in 1857 (which was due to a major ice gorge south of Albany), and the 1913 crest height at Troy still stands as the record height. Moreover, 1913 flood heights have not been equaled since, even during 1996.

[11] E. A. Fisher (City Engineer, Rochester), "The Flood at Rochester, N.Y.," *Engineering News,* April 10, 1913, 741. Both the weeklies *Engineering News* and *Engineering Record* for April 1913 are full of careful reports of damages by the tornadoes and floods in many states. For discharge rate at Rochester, see Robert E. Horton, "Effects of Recent Flood," 402. See also Henry, "Rivers and Floods, March 1913," 491.

[12] "Special Reports Regarding Flood Conditions; From Branch Offices of R. G. Dun & Co., The Mercantile Agency, Throughout the Region Affected by the Great Storms of Last Week," *Dun's Review*, April 5, 1913, 14–15.

[13] "The Floods in New York State and the Work of the State Department of Health," *Engineering News,* April 10, 1913, 743.

> floods in that they rose in many cases to the very center of the city, instead of merely to the river-edge streets, which as a rule are not occupied by very pretentious buildings.[14]

In a special report on flood conditions around the country published on April 5, 1913, *Dun's Review* tallied business property damage and the effects on businesses from the interruption of transportation and industrial activities. The report estimated that business losses in New York State alone exceeded $1 million in 1913 dollars (equivalent to about $22 million today), more than half of it suffered by Troy. But that dollar figure is clearly a significant underestimate: the report includes estimates from only 10 cities and no agricultural concerns;[15] dollar figures were not given for Binghamton or for Rochester, despite the severity of damage in both cities;[16] and other New York cities that suffered flooding according to newspaper accounts were omitted from the analysis, such as Watervliet (where floodwaters reached five feet deep in some streets, flooding houses midway up the first story), Rensselaer, and Green Island (both of whose water-filtration plants were inundated and thrown out of service).[17] Most importantly, the *Dun's Review* report did not include estimates of damage to personal property, even though newspaper reports indicate that thousands of homes and farms also suffered from flooding. It is worth noting that in 1913 - as today - most homes and businesses did not carry flood insurance, especially those regarded as not in danger from flooding (whether or not such an assessment was accurate); thus, most damages were not covered by regular homeowners' or business policies.

Typhoid vs. chlorination in Albany

In 1913, typhoid fever was still a major scourge in the United States, accounting for between 5,000 and 10,000 deaths nationwide per year and averaging in big cities a fatality rate of between 20 and 75 deaths per 100,000 people, and major typhoid epidemics were still common.[18] In those pre-antibiotic days, typhoid was a protracted, wasting disease lasting as long as half a year and with a fatality rate of about 10 percent. Walter Reed and his coworkers had demonstrated that not only human contact but also

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[14] Francis G. Wickware, editor, "Waterways" in Chapter XXIII "Engineering," *The American Year Book: A Record of Events and Progress 1913* (New York: D. Appleton and Co., 1914), 579.

[15] The 10 cities described were Albany, Binghamton, Elmira, Gloversville, Olean, Rochester, Salamanca, Syracuse, Troy, and Utica. *Dun's Review* estimated Troy's losses at $580,000 from flood and $97,200 from fire. The U.S. Weather Bureau reported that damage in the Hudson and Mohawk River district was estimated at $950,000 with losses at Troy and vicinity amounting to $500,000. Wilson, 329.

[16] Indeed, *Dun's Review* (p. 14) said, "Reliable reports state that Binghamton and its immediate vicinity was not damaged to any extent" whereas Wilson in *Monthly Weather Review* (p. 329) noted that in Binghamton the Susquehanna River rose to 18.5 feet, a foot shy of the 1902 record, and caused damages estimated by the local Weather Bureau official of more than $100,000. In Rochester, the Genesee set a new record for high water. Cox, 371.

[17] "The Floods in New York State," 743.

[18] As late as 1918, the average typhoid rate in East Liverpool, Ohio, was 75 per 100,000, and dropped to essentially zero after the installation of a water purification plant. "How Typhoid Was Cut Down at East Liverpool," *Engineering News-Record,* August 12, 1926, 297. As late as 1927, in the single city of Montreal, Quebec, more than 5,000 people perished in a major typhoid epidemic. "Secrecy as to Typhoid," *Engineering News-Record,* September 8, 1927, 374.

houseflies transmitted typhoid bacilli,[19] and that transmission was linked to unsanitary conditions, including drinking water contaminated by untreated human sewage. By the early twentieth century, U.S. cities were reducing the number of typhoid infections by building water-filtration systems and indoor plumbing to replace outhouses. Some cities had also begun experimenting with the disinfection of water supplies by adding hypochlorite of lime (basically powdered bleach), inspired by the examples of the Jersey City, New Jersey Water Works and the Bubbly Creek Filter Plant, Chicago in 1908, the first municipal water supplies to chlorinate their water. But as late as 1913, the chlorination of drinking water was sufficiently new that its effectiveness in combating typhoid was still something of an open question.[20]

Actions taken during the 1913 flood in Albany offered a dramatic proof of the effectiveness of chlorination in combating typhoid fever in a comparison happenstance that, from a scientific viewpoint, was a positively elegant demonstration.

To set the stage, it is necessary to know that in 1913, much of Albany's drinking water was drawn from the Hudson River, filtered at a riverside filtration plant to remove particulates (so the water would be clear rather than cloudy), and was then chlorinated before being distributed throughout the city. Part of the distribution included pumping the water up to two reservoirs, Bleeker and Prospect, although significantly, much of the water supply to Bleeker Reservoir was actually gravity-fed unfiltered from higher Rensselaer Lake rather than from the Hudson. Each reservoir served about half the city through distribution systems that were entirely separate.

By 8 AM Thursday, March 27, the Hudson River at Albany was rising so high so quickly that workers at the water-filtration plant began to fear that the plant was in danger of being flooded. They barricaded the doors of the pumping station and the preliminary filters, braced the doors of the regulator houses from the inside, and caulked the cracks with oakum to prevent raw river water from entering the effluents of pure water from the filters and thus into the pure-water reservoir. They also hurriedly built a temporary earthen embankment two feet high around the slow-sand filter court. But all precautions were to no avail. About 4 AM Friday morning, water pressure of the swollen Hudson was so great it broke the door to one of the regulator houses and raw untreated river water poured into the pure-water reservoir. Moreover, the river - then a foot higher than the tops of the filters - broke through the embankment and filled the filter courtyard, also halting the operation of the hypochlorite plant.[21] The filters remained flooded for about 30 hours,[22] meaning that for a day and a quarter, raw river water was being pumped to half of Albany's homes and businesses.

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[19] Because of its role in carrying typhoid infection from the vaults of outhouses into kitchens, there was actually a move to rename the housefly the "typhoid fly." For early twentieth-century discussion, see the section "Typhoid or house fly," in "Control of Flies and Other Household Insects," *Museum Bulletin 136* (Albany: New York State Museum Education Department Bulletin, No. 465), February 15, 1910, 6–16; see also "Flies as Disseminators of Typhoid Fever," *Medical Record: A Weekly Journal of Medicine and Surgery*, 66 (July 30, 1904): 179–180. For a modern historical account, see Vincent J. Cirillo, "'Winged Sponges': houseflies as carriers of typhoid fever in 19th- and early 20th-century military camps," *Perspectives in Biology and Medicine*, 49 (Winter 2006): 52–63.

[20] "Relation between Water Disinfection and Typhoid Fever," 353.

[21] Wallace Greenalch (Albany Commissioner of Public Works), "The Flooding of the Albany Filtration Plant and Previous High Floods at Albany, N.Y.," *Engineering News,* April 10, 1913, 754–755.

[22] "Albany Filtration Plant during the Flood," *Engineering Record,* April 5, 1913, 374.

Even before this breach, the State Commissioner of Health immediately commanded all State authorities having control of water supplies to use every possible means to safeguard supplies against infection and to warn the public. The Albany Commissioner of Public Works Wallace Greenalch notified all the newspapers to warn the public to boil all drinking water for at least 15 minutes before consuming,[23] notices that appeared on Saturday morning before any raw river water reached the city, and remained in force for two weeks. Plant engineers flushed all water mains by opening the hydrants, and within 24 hours had set up a temporary hypochlorite plant.

Despite everyone's fast action, when the State Department of Health sampled water in the two reservoirs to which the filtration plant pumped pure water for supplying the city, they found B. coli (an animal fecal protozoan that was a proxy for contamination by sewage) in Prospect Reservoir, which served half of Albany. When the gate valve shutting off the reservoir from the water-distribution system could not be closed, the only option left to the engineers was the unusual measure of trying to sterilize the entire reservoir. Desperate times call for desperate measures: they loaded a small boat with bags of hypochlorite of lime, rowed out into the center of the reservoir, punched holes in the bags, and shook them vigorously as they continued rowing, releasing the bleach powder into the water.[24] Initially, Greenalch was hopeful that the "dilution of the raw water was so great during the period the plant was flooded that no danger from typhoid is expected."[25] But in this, he was disappointed.

Although Albany before the flood was "substantially free from typhoid fever," beginning on April 16 for about a week, at least 180 documented cases of typhoid broke out in the city. "Allowing some two weeks for 'incubation' and dating back on the diagram this period of time from April 16, brings us directly to the period when infection of the water-supply took place," wrote Theodore Horton, chief engineer of Albany's State Department of Health, in the weekly *Engineering News*. The outbreak "constitutes one of the most interesting and striking examples of an explosive epidemic due to a sudden... infection of a water supply..."[26]

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[23] The State Commissioner of Health was Eugene H. Porter; the Commissioner of Public Works in Albany was Wallace Greenalch. "Investigation of Outbreaks of Typhoid Fever," *Thirty-Fourth Annual Report of the State Department of Health [For the Year Ending December 31, 1913]. State of New York. No. 64.* 1914, 731–742.

[24] It is not mentioned whether Prospect Reservoir was lined with trees and vegetation or populated with fish. One wonders about the effect on the environment of adding concentrated bleach directly to the reservoir, but it's doubtful such a desperate action would have passed environmental muster today.

[25] Wallace Greenalch, "The Flooding of the Albany Filtration Plant," 754. Theodore Horton, "The Typhoid Outbreak at Albany, N.Y., Due to Flooded Filters," *Engineering News* May 15, 1913, 1021–1022. There is a contradiction in the dates of the sterilization: Greenalch says March 31 and April 5, and Horton says (and shows on his diagram) April 3 and April 5.

[26] Theodore Horton, "The Typhoid Outbreak at Albany, N.Y.," 1021. Horton noted, "I believe this is the first case on record of sterilization of a large open reservoir by the hypochlorite method and the results show that two treatments of about 1 part per mission accomplished an entire elimination of B. coli type and acid colonies from the water in the reservoir," and he felt "such emergency means should always be kept in mind." (p. 1022). Horton attributed the fact that there were any cases of typhoid at all from the flooding to "the negligence of those who drank the city water without boiling in utter disregard of the warning given by the authorities in charge." "Investigation of Outbreaks of Typhoid Fever," *Thirty-Fourth Annual Report of the State Department of Health [For the Year Ending December 31, 1913]. State of New York. No. 64.* 1914, 737.

Horton drew a diagram that plotted two curves: one curve profiled the rise and fall of the Hudson river and the times of the infection of the water supply during the flood, along with the times of the sterilization of Prospect Reservoir; the other curve - which perfectly mimicked the first - plotting the rapid rise and subsequent fall of the number of cases of typhoid that developed as a result of first the contamination and then the sterilization of the drinking water in Albany up to May 5.

To test the apparent causality in time, Horton also plotted the typhoid cases on a map of Albany to see where they occurred by location. The resulting map (not appearing in the article), according to Horton, showed "a preponderance of cases on the portion of the [water-supply] system connected with Prospect Reservoir." Bleeker Reservoir, principally supplied by water from Rensselaer Lake rather than from the Hudson River, "was not contaminated... so we have by comparison an indication of the relative significance of the contamination that entered that entered Prospect Reservoir."[27]

Horton's two-humped graph definitively linking typhoid to water contamination - plus the stopping of typhoid by chlorination - was so striking that it was widely reprinted or summarized in engineering journals, medical and public health journals, and reference texts[28] to demonstrate the effectiveness of chlorinating drinking water in preventing typhoid linked to poor sanitation.

Hudson River flood control

The most permanent tangible result of the 1913 record flooding in upstate New York still exists: Great Sacandaga Lake as part of a state-wide system of reservoirs for controlling the flow of the Hudson River.

The lower 150 miles of the Hudson River to the Atlantic Ocean is a tidal estuary: saltwater ocean tides penetrate up to Albany, so water level changes with the tides. Above Albany, the nontidal upper Hudson and the Mohawk join the lower Hudson. Usually floods in the Hudson are due to ice gorges. In the early spring, ice covering the Hudson as well as the Mohawk, the Sacandaga, and other tributaries would begin to thaw, crack, and move downstream; but the incoming tides on the lower Hudson would pile the ice floes on top of one another, forming enormous ice dams that would block the spring melt gushing out of the Adirondacks. Water would back up and spread out behind the ice dam, flooding lowlands and lowland communities including Albany, Green Island, Troy, and Watervliet.[29] Alternatively, when an ice dam broke, the released huge volume of water would sweep downriver. Regardless of cause, minor floods occurred frequently, and less frequent major ones (including in 1818 and 1857), becoming an increasing problem as population grew both in cities and the countryside.

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[27] Theodore Horton, "The Typhoid Outbreak at Albany, N.Y.," 1023.
[28] The report and chart were reprinted as Theodore Horton, "Typhoid Fever at Albany, N.Y.: An Account of the Recent Outbreak Due to Use of Raw Hudson River Water Following Flooding of Filtration Plant," *Public Health Reports* 28 (May 23, 1913), 987–994, and became Public Health Reprint 128. The findings were summarized and the chart itself was reprinted in the fourth edition of the reference book William P. Mason, *Water-Supply (Considered Principally from a Sanitary Standpoint),* (New York: John Wiley & Sons, 1916), 30–32. The findings without the diagram were also summarized as "Typhoid Fever at Albany," *The Boston Medical and Surgical Journal* 169 (July 3, 1913), 26–27. These last two references also refer to a version of the article that appeared in the *Monthly Bulletin of the New York State Department of Health,* May 1913, which I have not yet been able to locate.
[29] Frances F. Dunwell, *The Hudson: America's River* (New York: Columbia University Press, 2008), 237.

As early as 1867, the concept of flood protection through a series of dams and reservoirs was first proposed to the New York State Legislature by Samuel McElroy. Later, Eugene L. Ashley, president of the Hudson River Water Power Co., conceived the idea of building a dam at across a narrow defile in the Sacandaga River (the largest tributary to the Hudson entering from the west) at Conklingville in Saratoga County about six miles above its confluence with the Hudson. In 1900, Ashley began topographic and property surveys as well as borings for a possible dam foundation. After severe floods in 1902, the Legislature passed Chapter 406 of the Laws of 1902, creating the Water Storage Commission to investigate the causes of floods and recommendations for flood prevention.[30]

Meantime, as the industrial revolution spread in the late nineteenth and early twentieth centuries, paper mills and manufacturing plants built along the river relied both on direct water power and also increasingly on hydroelectric power. Not only was flooding a serious problem for them, but also so was low water during dry summers, especially in the tidal lower Hudson. In 1905, New York State established a Water Supply Commission to examine regulating the flow of the Hudson both during flood and drought to keep the turbines turning. In 1907, the commission concluded that water power could produce an annual profit of $18 million, equivalent to the state's net agricultural profit.[31] It proposed a system of reservoirs throughout the state for storing water during times of excessive runoff and releasing it as needed to maintain a stable flow of the Hudson and other rivers for hydroelectric power. Pulp and paper mills also proposed the building of an enormous water-storage reservoir on the Sacandaga River in the Adirondacks for regulating the flow of the Hudson for power as well as for flood control.

Despite concern about flooding and the eagerness for hydroelectric power, it took the 1913 flood to precipitate action. In November 1913, the Burd amendment to the New York State constitution passed, allowing up to 3 percent of State Forest Preserve land in the Adirondacks to be flooded for State-owned reservoirs constructed to regulate stream flow, provide for water supply, and provide water for canals.[32] Two years later, in 1915, the Machold Storage Law allowed the creation of river regulating districts subject to review and approval by the conservation department's Water Power and Control Commission. In 1919, the Black River Regulating District was formed, followed by the

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[30] Edward Sargent, "Harnessing the Hudson," *The Technology Review*, November 1930, 70–73, 96, 98, 100, 102. Sargent, by the way, was the chief engineer of S. J. Groves & Sons, Minneapolis, and supervised building the Conkingville Dam. "Conklingville Dam Nearing Completion," *Engineering News-Record*, January 9, 1930, 84.

[31] Dunwell, 239.

[32] In 1885, New York State had adopted legislation establishing the Forest Preserve in the Adirondacks that "shall be forever kept as wild forest lands." In 1894, the Forest Preserve was strengthened by giving it constitutional protection, meaning that instead of simply passing a bill in the legislature, an amendment to the state constitution would be required to change its protection. Robert D. Hennigan, "A History of the Adirondacks," *Clearwaters* (magazine of the New York Water Environment Association, Inc.), Spring 2004, http://www.nywea.org/clearwaters/04-1-spring/adkhist.cfm (accessed May 18, 2009). The Burd amendment was adopted on November 4, 1913. *State of New York Conservation Commission Ninth Annual Report for the Year 1919*, 181. http://www.archive.org/stream/annualreport44deptgoog/annualreport44deptgoog_djvu.txt (accessed May 18, 2009). See also *State of New York. Annual Report of the Attorney-General for the Year Ending December 31, 1918,* Legislative Document No. 53, 1919, 252.

Hudson River Regulating District in 1922 (combined in 1959 into today's Hudson River–Black River Regulating District).[33]

The Hudson River Regulating District prepared a plan for controlling the flow of the Hudson through sixteen storage reservoirs on the Cedar, Hudson, Indian, Sacandaga, and Schroon Rivers and other tributaries, having a total capacity of more than 80 billion cubic feet and an estimated cost of more than $30 million. The plan was approved (with modifications) in June 1923. The largest reservoir - indeed to be created by damming the Sacandaga at Conklingville - would occupy 42.3 square miles, about the same as the area of Lake George; it alone would store nearly half the water for the district (38 billion cubic feet). For a safety margin, it included a 400-foot concrete spillway, the largest siphon spillway then yet built, with a capacity for handling a flow 50 percent greater than the 1913 flood even if the reservoir were full at a flood's start. This monumental project required clearing more than 12,000 acres of timber, relocating 3,800 gravesites from 26 cemeteries, and constructing more than 40 miles of new roads around the shores of the reservoir as well as highway bridges at Northville and Batchellerville.[34]

The gates of the new Conklingville Dam were closed on March 27, 1930,[35] the seventeenth anniversary of the 1913 flood, and the Sacandaga Reservoir - since renamed Great Sacandaga Lake - began to fill. News items in New York papers asserted: "There will be no serious floods in the Hudson River Valley this spring."[36] Had the storage capacity of Great Sacandaga Lake existed in 1913, the flood height at Albany could have been lowered by three feet and its water treatment plant would have been spared.[37]

Hudson River flood control

Even though most of the nation's attention after the Easter 1913 supercell storm system focused on death and destruction in the Midwest and (during April) down the Mississippi River as the flood crests traveled south, New York was hard hit with still-record high water. The most lasting tangible result is Great Sacandaga Lake, a product of the political will aroused by the devastation of the 1913 flood.

Trudy E. Bell (M.A. in history of science/American intellectual history, New York University, 1978) has been researching the 1913 Easter disaster and its consequences since 2003. Articles of hers on the 1913 flood have been published in *Traces* of the Indiana Historical Society, *Timeline* of the Ohio Historical Society, and the engineering quarterly *The Bent*; her picture book *The Great Dayton Flood of 1913* was published by Arcadia Press in 2008. Most recently (May 2009) she was named a 2009 Filson Fellow by the Filson Historical Society (Louisville, KY), to support research on the 1913 flood in Kentucky and the Ohio Valley.

A professional science and engineering journalist, she is a former editor for *Scientific American* magazine and a former senior editor for *IEEE Spectrum* magazine. She is the author of *Weather* (Smithsonian Science 101 series, HarperCollins, 2007), the recipient of the David N. Schramm Award of the American Astronomical Society for science journalism (2006), and a two-

[33] Glenn A. LaFave, "State of the Regulating District," Hudson River–Black River Regulating District, http://www.hrbrrd.com/sotrd09.html (accessed June 29, 2009).
[34] Sargent, 100.
[35] Bob Gardinier, "Epic flood led to Sacandaga Reservoir," *Albany Times-Union*, November 27, 2006, http://www.timesunion.com/AspStories/story.asp?storyID=538962 (accessed June 29, 2009).
[36] "Checking Floods," *Engineering News-Record,* April 3, 1930, 549.
[37] Sargent, 72.

time recipient of the Herbert C. Pollock Award of the Dudley Observatory to support research in the history of astronomy (2004, 2007).

CAPTION: Theodore Horton's much-reprinted (and often redrawn) double-humped graph showing the dates of the contamination of Albany's water supply by floodwaters, the dates of sterilization and measurement of decreasing contamination, and two weeks later—the incubation period for typhoid fever—an explosive outbreak of typhoid in Albany, New York. This particular version of the diagram was printed in "Investigation of Outbreaks of Typhoid Fever," *Thirty-Fourth Annual Report of the State Department of Health [For the Year Ending December 31, 1913]. State of New York. No. 64.* 1914, 742. No mention is made in the document's description why some of the histogram bars are crosshatched in gray rather than black, an artifact that is real judging from the fact that the bar for April 23 is half gray and half black. Redrawn versions generally omit the distinction between bars.