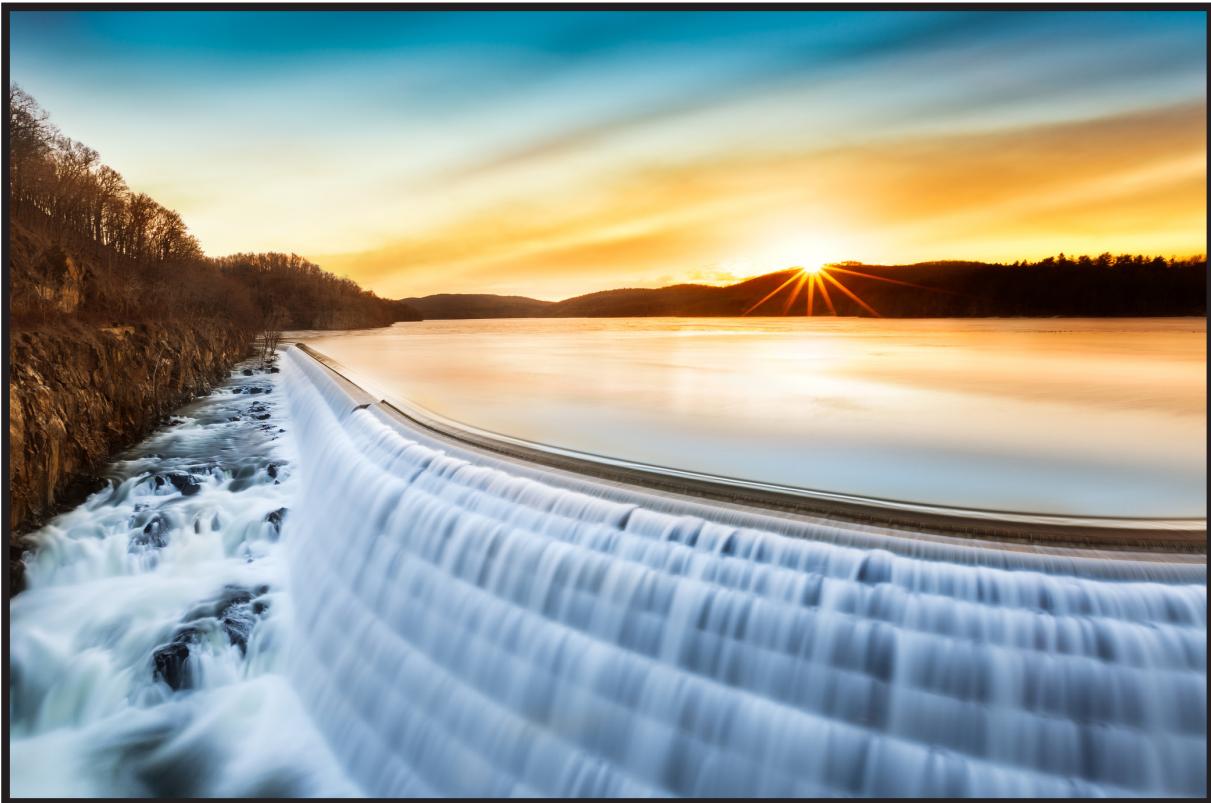




Office of the NEW YORK STATE  
**COMPTROLLER**

## Dam Infrastructure: Understanding and Managing the Risks



New York State Comptroller  
**THOMAS P. DiNAPOLI**

JUNE 2018



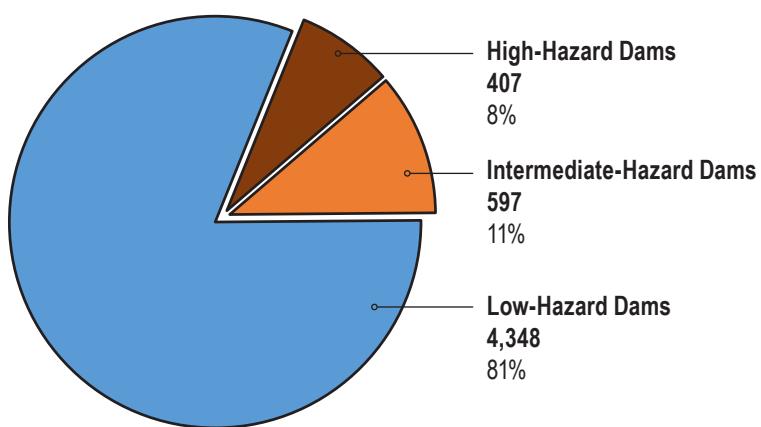
# Dams in New York

New York State has at least 5,352 functioning dams, 861 of which are owned or co-owned by local governments.<sup>1</sup> Dams, which are barriers that hold back flowing water, serve many purposes. Some exist primarily for flood control. Many create ponds or lakes used for recreation, or reservoirs used to manage water supplies. Some generate hydroelectric power. Local officials need to manage this infrastructure effectively, not only to preserve important capital assets, but also because it is a necessary investment in public safety.

The New York State Department of Environmental Conservation (DEC) classifies dams according to the level of risk that a failure would pose to life and property. Under DEC's classifications, there are: 407 high-hazard dams in New York State, more than half of which are owned or co-owned by local governments; 597 intermediate-hazard dams, of which 30 percent are owned or co-owned by local governments; and over 4,300 rated as low-hazard, any failure of which would pose little threat to public safety.<sup>2</sup> (See Figures 1, 2 and 3.) This report focuses on high-hazard and intermediate-hazard dams – those that would pose the greatest risks in case of failure and therefore warrant the most careful monitoring and management. The report also discusses steps local officials and residents can take to manage those risks.

Figure 1

## New York State Has Over a Thousand Intermediate- and High-Hazard Dams



Source: New York State Department of Environmental Conservation (DEC).

## Local Government Dams in New York

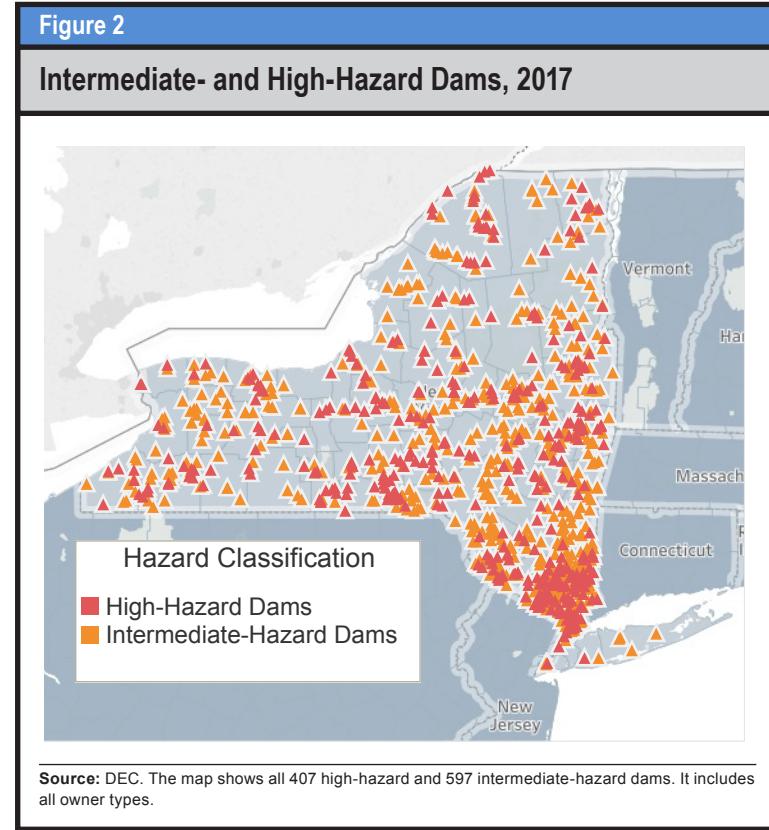
- Local governments own or co-own **213** of New York's 407 high-hazard dams (52 percent).
- **46** high-hazard dams owned by local governments are rated unsound or deficiently maintained.

### **\$360 million:**

The estimated amount needed to repair locally owned high-hazard and intermediate-hazard dams in New York State, according to the Association of State Dam Safety Officials.

- Nearly all local government-owned high-hazard dams have emergency action plans.

New York State has at least 5,352 functioning dams, 861 of which are owned or co-owned by local governments.



**Figure 3**  
**New York Dams by Hazard Classification and Owner Type, 2017**

	Local Government Owner*	Other Owner	Total
<b>High-Hazard Dams</b>			
Number of Dams	213	194	407
Percentage of High-Hazard Dams	52.3%	47.7%	100.0%
<b>Intermediate-Hazard Dams</b>			
Number of Dams	179	418	597
Percentage of Intermediate-Hazard Dams	30.0%	70.0%	100.0%
<b>Low-Hazard Dams</b>			
Number of Dams	469	3,879	4,348
Percentage of Low-Hazard Dams	10.8%	89.2%	100.0%
<b>Total</b>			
Number of Dams	861	4,491	5,352
Percentage of Dams	16%	84%	100%

**Source:** DEC with Office of the New York State Comptroller (OSC) calculations. Many dams have more than one owner. This table excludes 1,297 negligible or no-hazard dams and 522 dams without a hazard classification.

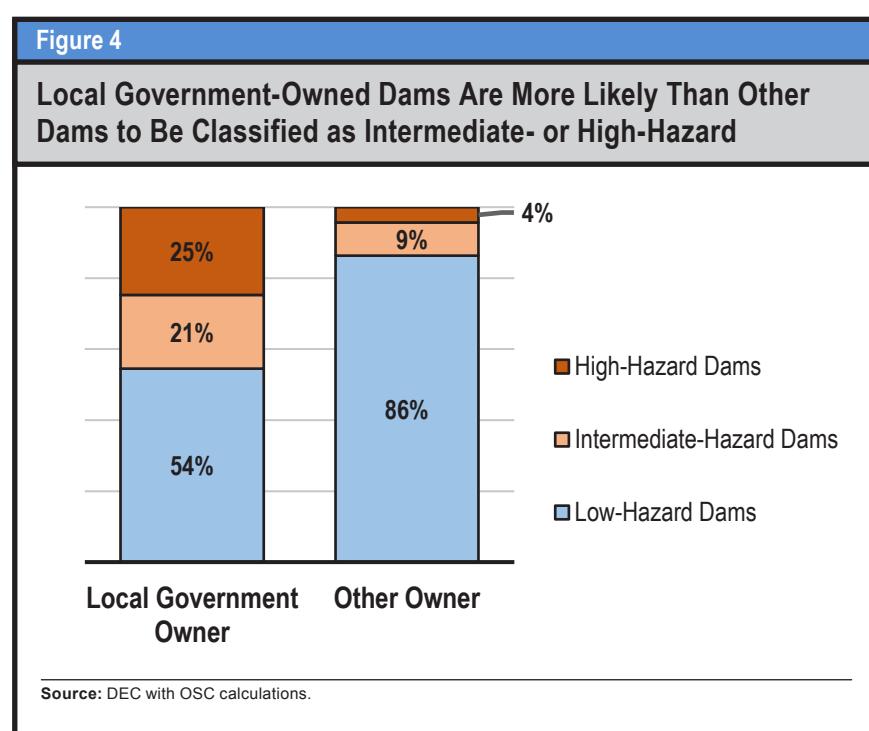
\* Includes joint ownership with other types of entities.

# Dam Safety

The federal government has a limited role in dam safety. Besides being responsible for federal dams, the U.S. government regulates nonfederal dams used to generate hydroelectric power and those used in mining.<sup>3</sup> However, most dams are not subject to federal oversight. States bear most of the responsibility for dam safety regulation in the United States. In New York State, DEC is responsible for regulating most dams.

Owners are generally responsible for inspecting and maintaining their dams. However, DEC has the authority to inspect dams out of concern for public safety and to order owners to repair or even remove those posing a threat of personal injury or substantial damage to property or natural resources. DEC aims to inspect most high-hazard dams every two years and the intermediate-hazard ones every four years.<sup>4</sup> Certain State-owned dams are not subject to DEC dam safety regulations. However, DEC's practice is to inspect State-owned dams and monitor their safety programs as if they were subject to DEC regulation.<sup>5</sup>

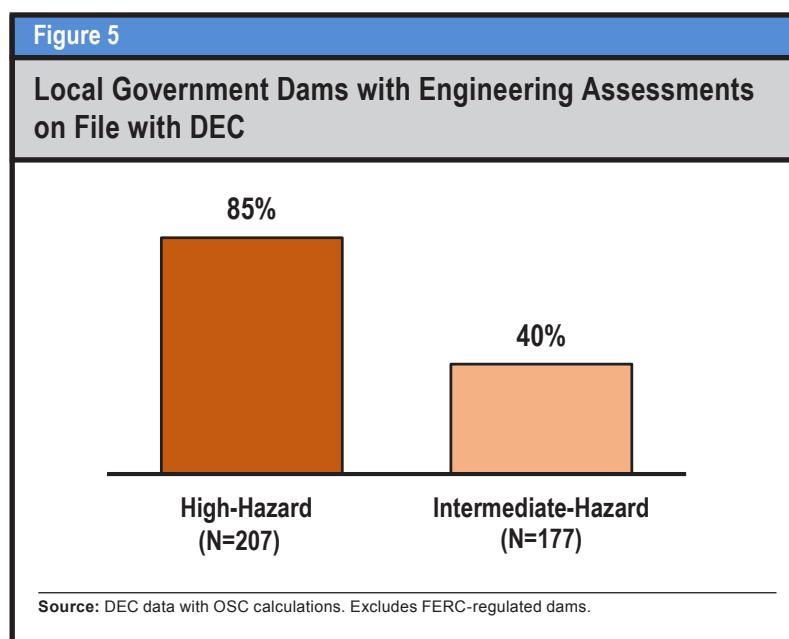
Local governments own more than half of the high-hazard dams and 30 percent of those rated as intermediate-hazard statewide. Additionally, local governments are more likely to own high- or intermediate-hazard dams compared to other types of owners. Forty-six percent of those owned by local governments are either high- or intermediate-hazard, compared to 13 percent for other types of owners. (See Figure 4.)



## Engineering Assessments

In the wake of a 2008 audit of DEC's dam safety program by the Office of the New York State Comptroller (OSC), DEC strengthened its dam safety regulations.<sup>6</sup> The new regulations, which took effect in 2009, include a requirement that most owners of high-hazard and intermediate-hazard dams have an engineering assessment (EA) conducted at least every ten years and submit the report to DEC. These regulations do not apply to certain State-owned and public authority-owned dams. Also, at DEC's discretion, owners of dams regulated by the Federal Energy Regulatory Commission (FERC) may file equivalent EA reports prepared for FERC.<sup>7</sup> Local governments own only six high-hazard and two intermediate-hazard FERC-licensed dams.<sup>8</sup>

For those subject to DEC regulations, the first EA reports were due between 2012 and 2015, depending on the structure's size and hazard classification. However, DEC's data indicates that more than 30 local high-hazard and over 100 local intermediate-hazard dams have no EA report on file. High-hazard dams are much more likely than those rated as intermediate-hazard to have an EA. (See Figure 5.)



### New York Dam Condition Ratings (6 NYCRR 673.16)

**Unsafe:** Dams with deficiencies of such a nature that the failure of the dam is imminent and immediate action is required to eliminate or reduce the danger.

**Unsound:** Dams with deficiencies of such a nature that the safety of the dam cannot be assured. Among the deficiencies which could result in this rating are developing seepage problems, structural stability inadequacies, or seriously inadequate spillway capacity.

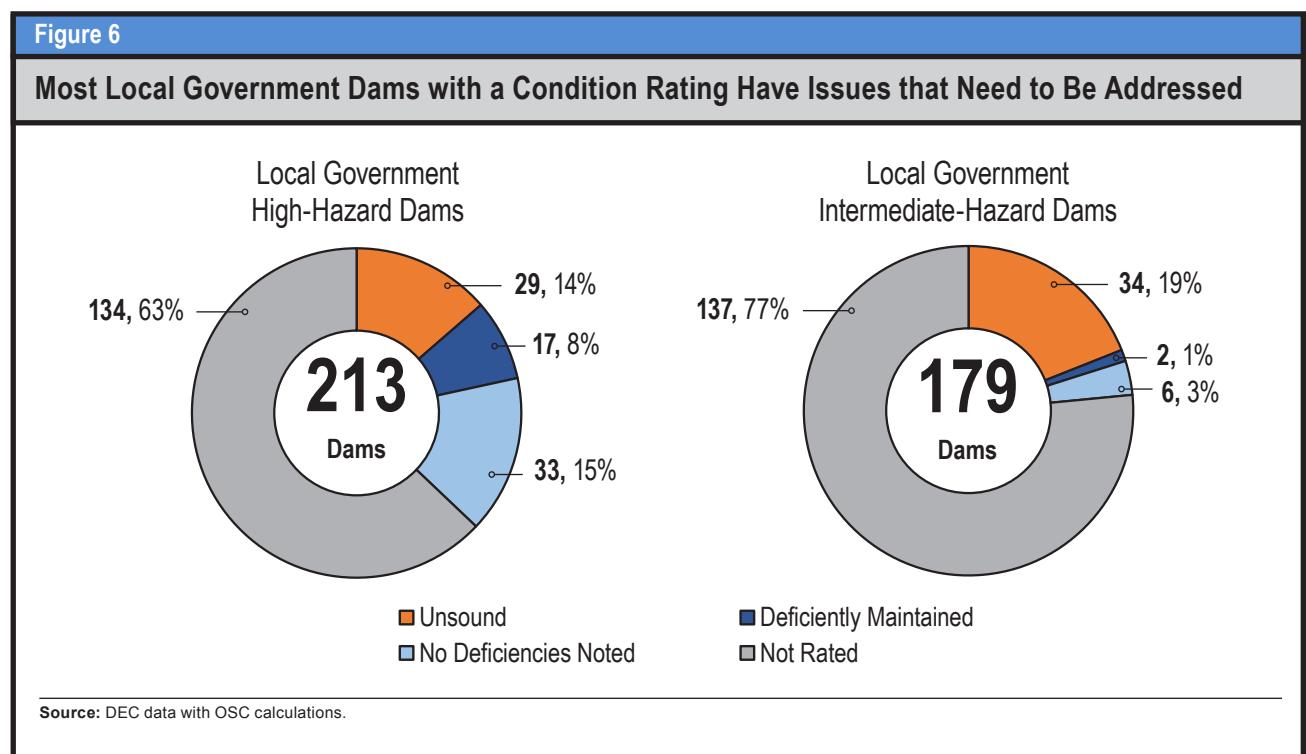
**Deficiently maintained:** Dams with physical or operational deficiencies which do not require further significant engineering analysis. Some corrective action is required, often in the form of increased maintenance, to correct the condition of the dam.

**No deficiencies noted:** A safety inspection or engineering assessment, and/or investigation by DEC, did not reveal deficiencies.

## Dam Condition Ratings

DEC may or may not rate the condition of dams it inspects. Typically, in addition to the results from a visual inspection, DEC also uses information from an EA to determine the condition rating. If the dam has no recent EA or if the information in the EA is incomplete or otherwise insufficient to determine a condition rating, then DEC will either not assign a rating, or assign a condition rating of “unsound” based on lack of information. The ratings range from “unsafe,” meaning that it poses a threat of imminent failure, to “no deficiencies noted.” No New York dams are rated “unsafe.” However, most do not have a condition rating at all.<sup>9</sup> Only 37 percent of high-hazard dams owned by local governments have a condition rating and just 23 percent of intermediate-hazard structures have one.

Out of the 79 high-hazard dams owned by local governments with condition ratings, well over half (58 percent) are rated as either unsound or deficiently maintained. Most of the 42 local government-owned intermediate-hazard dams with condition ratings are classified as unsound (81 percent, or 34 dams). (See Figure 6.)



## Emergency Action Plans

The dam safety regulations implemented in 2009 also require most owners of intermediate- and high-hazard dams to file an Emergency Action Plan (EAP) with DEC and certify annually their compliance with certain safety regulations. These include requirements pertaining to EAP reviews and updates, as well as the development and implementation of maintenance and inspection plans.

DEC's data shows that nearly all high-hazard dams have EAPs on file. However, compliance is much lower for those classified as intermediate hazard: only 61 percent have EAPs on file. Local government intermediate-hazard dams are more likely than others to have EAPs on file: 74 percent compared to 56 percent. (See Figure 7.)

Local governments are also more likely than other types of owners to submit annual certifications of their EAPs and inspection/maintenance plans for high-hazard dams: only 4 percent have no annual certification on file and 82 percent have a recent certification. For the intermediate-hazard locally owned structures, 53 percent have a recent certification on file, and another 35 percent have an older certification. (See Figure 8.)

Figure 7

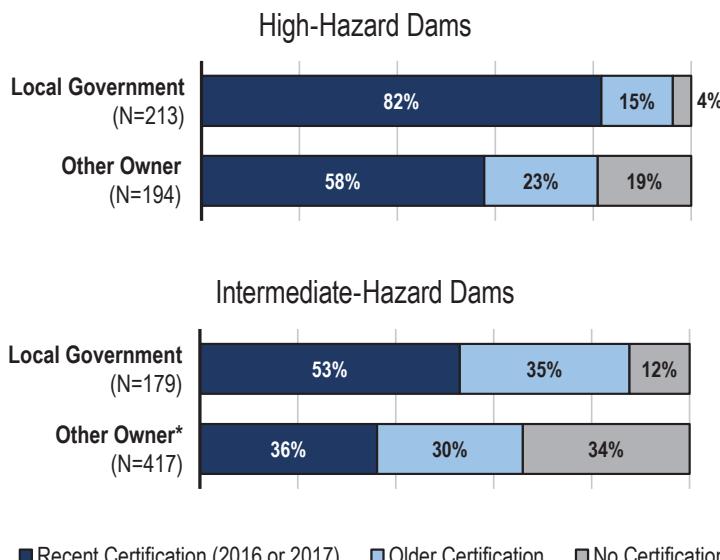
### Nearly All High-Hazard Dams Have an Emergency Action Plan, but Many Intermediate-Hazard Dams Do Not



Source: DEC data with OSC calculations. An EAP is not required for a small number of intermediate- and high-hazard dams.

Figure 8

### Local Governments Tend to Do a Better Job of Meeting the Certification Requirements than Other Dam Owners



Source: DEC with OSC calculations. Figures may not sum to 100 percent due to rounding.

\* Includes dams with unknown owners; excludes one dam with a certification date in 2020.

# Understanding the Risks

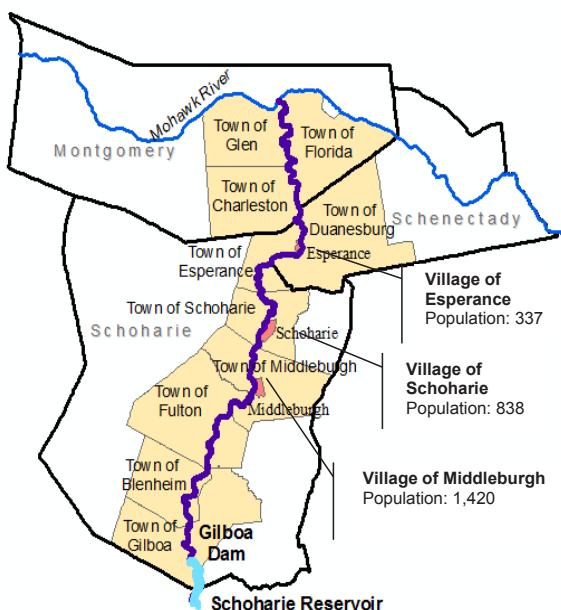
## Dam Failures Have Been Rare, but Consequences Can Be Severe

The deadliest dam failure in U.S. history occurred in 1889 in Johnstown, Pennsylvania, when a breach led to flooding that killed more than 2,200 people.<sup>10</sup> Just last year, in Northern California, authorities issued a mandatory evacuation order for approximately 188,000 residents living downstream from the Oroville Dam after heavy rains increased water levels, and concerns about its spillways led to fears of uncontrolled releases of water. Fortunately, it held and repairs are underway.<sup>11</sup>

A breach in a large dam in New York could cause severe downstream flooding spanning multiple counties. For example, a complete failure of the Gilboa Dam, which can store up to 19.6 billion gallons of water, could devastate downstream communities in Schoharie, Montgomery and Schenectady counties, including the villages of Middleburgh, Schoharie and Esperance. A breach could also cause flooding along the Mohawk River and into the Hudson River.<sup>12</sup> (See Figure 9.)

Figure 9

### Dam Failures Can Cause Far-Reaching Devastation



#### A Breach of the Gilboa Dam Could Cause Flooding Far Downstream

In 2005, a preliminary inspection for a reconstruction of the Gilboa Dam in the Catskills, a structure capable of retaining up to 19.6 billion gallons of water used to provide drinking water for New York City, revealed that the dam could fail under heavy rain or snow melt.

A breach would devastate downstream communities on the Schoharie Creek and could also lead to flooding along portions of the Mohawk and Hudson rivers.<sup>13</sup>

New York City made emergency repairs in 2005 and 2006 as part of a \$138 million reconstruction of the 90-year-old structure. The reconstruction, which was completed in 2014, is part of a larger \$400 million project that will help mitigate flood risks while continuing to ensure a sufficient and safe supply of drinking water to New York City.<sup>14</sup>

Source: Population figures are from the U.S. Census Bureau (2016 American Community Survey estimates).

Even relatively small failures can result in noticeable economic consequences. For example, when water levels need to be lowered for extended periods due to safety concerns, ponds and lakes shrink, recreational activities decline and waterfront property values can suffer. In a small community, this can have a significant fiscal as well as economic impact, as both the property tax base and sales tax collections could decline.

### The Hadlock Pond Dam Failure (Town of Fort Ann, Warren County, 2005)

In 2005, a newly repaired dam on Hadlock Pond, a 220-acre recreational lake in the Town of Fort Ann in Washington County, collapsed. Nearby homeowners had to evacuate as local roads and downstream homes flooded. A new replacement costing \$4.3 million was completed in 2007. In 2011, after years of litigation, a settlement was reached between the Town of Fort Ann and the firm that built the failed structure requiring the firm to pay the Town a total of \$3.48 million. Property owners also pursued legal action against the Town and others to recover damages stemming from the failure.<sup>15</sup>



## Risks Evolve

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Dam safety requires regular attention. Floods can cause serious damage very quickly. More generally, risks can increase over time, not only because structural concerns such as cracking, settling, or “piping” (internal erosion caused by water infiltration through an earthen dam) can develop and worsen, but also because any increase in development downstream means that more people and businesses may be in harm’s way should something go wrong. A dam that once posed little risk to human life, because its failure would result only in flooding of farm fields or vacant land, becomes a greater threat once the land has been developed and people live and/or work there.<sup>16</sup> New York’s high-hazard dams have an average age of 89 years; those classified as intermediate-hazard are 83 years old on average.

Climate change is also likely to increase the risks dams pose. Global warming increases the frequency and severity of storms and accelerates the melting of the winter snow pack in the mountains, potentially subjecting dams to conditions that exceed their design specifications.<sup>17</sup>

A relatively new – and growing – threat is sabotage carried out through cyberattacks. Dams operated by online controls have proven vulnerable to hackers. In 2013, a cyberattacker infiltrated the control systems of a dam in Westchester County. (See textbox.) The federal Environmental Protection Agency (EPA) helps water utilities improve their cybersecurity and manage risks associated with other types of terrorist threats.<sup>18</sup> OSC is also working to increase the number of local government audits of industrial control systems overseeing dams and sewer and water systems in order to protect them from cyberattacks.

### New York Dam Comes Under Cyberattack<sup>19</sup>

In 2016, the U.S. government indicted a foreign citizen for cyberattacks in 2013 targeting the Bowman Avenue Dam, an intermediate-hazard dam in the Village of Rye Brook in Westchester County. Had the dam’s operational controls not been manually disconnected for routine maintenance, the attacker could have gained control of its sluice gate, which controls water levels and flow rates.

In announcing the indictment, then Manhattan U.S. Attorney Preet Bharara said, “The infiltration of the Bowman Avenue Dam represents a frightening new frontier in cybercrime. ... The charges announced today should serve as a wake-up call for everyone responsible for ... guarding our infrastructure.”

## Funding for Dam Safety

Dam safety depends on owners' ability to make needed investments in dam maintenance and repairs. However, repairs and rehabilitation can be very costly, which means that some owners may be unable or unwilling to address deficiencies. Associations of property owners, which own at least 29 intermediate- and high-hazard dams, sometimes fail to assume responsibility for dam repairs, leading residents to appeal to local governments for funding for needed repairs.<sup>20</sup> (See textbox.)

### When Private Owners Neglect Dams, Stakeholders May Turn to Local Governments for Assistance

The Westchester Lake Dam, an intermediate-hazard dam located in the Town of Cortlandt and rated as unsound by DEC, is owned by the Westchester Lake Home Association, according to DEC's records. However, the Association has dissolved. With no owner to assume responsibility, local residents have petitioned the Town for funding for dam repairs. The Town, in turn, has requested assistance from Westchester County.<sup>25</sup>

The Association of State Dam Safety Officials – a group whose members include State officials, engineering consultants, contractors, and others – estimates that it would take \$360 million to repair the locally owned high- and intermediate-hazard dams in New York.<sup>21</sup> This estimate could be low: the recent reconstruction of the Gilboa Dam, completed in 2014, cost \$138 million for just that single project. (See Figure 9.)

The United States Department of Agriculture (USDA) has watershed protection programs that may be used for dam projects (as well as many other types of projects). For example, the federal Emergency Watershed Protection (EWP) Program funds a variety of projects that mitigate hazards due to floods, fires, drought and other natural occurrences. Both public and private landowners are eligible for assistance, but the project sponsor must be a local or tribal government.<sup>22</sup>

A new federal program that could help dams – the High Hazard Potential Dam Rehabilitation Program, authorized under the Water Infrastructure Improvements for the Nation (WIIN) Act of 2016 – would provide federal grants for the rehabilitation, repair or removal of nonfederal high-hazard potential dams. However, that program has not yet been funded.<sup>23</sup>

Dam projects are generally not eligible for funding through the EPA's Drinking Water State Revolving Fund Program, even though many dams are used to create and manage reservoirs that supply drinking water.<sup>24</sup>

## New York City's Drinking Water Supply Relies on Dams in the Catskills and Croton Watershed<sup>26</sup>

New York City relies primarily on two separate systems—the Catskill/Delaware and the Croton—for its drinking water. Nearly 10 million people get their water from these systems, which supply over a billion gallons of water a day. Some of the City's water travels as far as 125 miles before reaching consumers. The systems include 19 reservoirs, three controlled lakes and roughly two dozen dams. An extensive network of tunnels and aqueducts carry the water to the City. Water from the Catskill/Delaware watershed supplies most of the City's drinking water.

In managing the water systems, the City's main concern is to provide a safe and adequate drinking water supply, but it also works with local communities on flood control projects. In addition, it is party to an agreement with the states of Delaware, Pennsylvania, New Jersey and New York requiring the City to use its reservoirs on tributaries of the Delaware River to support the ecological health of that river system. Among other things, under certain conditions, the City is required to release large amounts of water from those reservoirs to reduce salt water intrusion into the Delaware River.



# Managing the Risks

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As the main regulatory authority overseeing dams (and as an owner of intermediate- and high-hazard dams), the State plays a key role in promoting dam safety. Inspections, education and outreach as well as enforcement of applicable laws and regulations are all important tools the State must use appropriately to help manage the risks dams pose. However, local officials and residents also have roles to play.

## What Local Officials Can Do

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As they prioritize spending in the face of scarce resources, local officials need to ensure that they provide enough funding and oversight to manage dams effectively. Since failures have been rare, there may be a tendency to underinvest in dam safety.

- **Comply with Applicable Laws and Dam Safety Regulations**

Local officials should be proactive in following applicable dam safety laws and regulations. EAPs and annual certifications should be adequate and up to date, as required. Officials should take corrective actions promptly as needed to address deficiencies identified through inspections and engineering assessments. Flood events and development downstream from dams should spur reviews and revisions to EAPs.

- **Include Dams in Capital Asset Planning**

To help ensure funds are available for dams, local governments should include them in capital asset management planning. Plans should include long-term financial forecasting for dam maintenance and, if necessary, rehabilitation. Some municipalities have created special districts under certain circumstances to create a funding stream for related capital improvements. When authorized by law, using a special district to fund a dam helps local governments ensure that the residents benefiting from the infrastructure pay the associated costs.

- **Raise Awareness about Other Dams that Could Affect Residents**

In addition to their own dams, local officials also need to know about other intermediate- and high-hazard dams that could affect their residents and businesses. They should verify the EAP status of these structures to ensure that local governments, State agencies and other affected parties understand their respective roles in the event of an emergency.

When DEC produces a field inspection report for an intermediate- or high-hazard dam, both the owner and the municipality where the structure is located receive a copy of the report.<sup>27</sup> DEC will also provide, upon request, copies of field inspection reports for these dams to other municipalities (in the same county or an adjoining county) that lie within the inundation area of the dam. Requesting and reviewing these reports will help local officials understand any risks posed by dams owned by others.

Some very old dams do not have clearly defined ownership. Consequently, no one assumes responsibility for these “orphan dams.” Local officials should be aware of the risks such structures may pose to their communities and contact DEC to identify any safety concerns.

## What Residents Can Do

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- **Understand the Risks Dams Pose to Life and Property and Know What to Do in an Emergency**

Residents – especially those downstream from a dam – should be aware of related threats to their safety, homes and livelihoods. Local emergency management agencies can help residents determine whether they live in a dam inundation zone. FEMA publishes Flood Insurance Rate Maps that can help residents understand the risks they may face, and the United States Geological Survey has online streamflow maps showing where flooding is occurring, based on real-time data on water levels.<sup>28</sup> People living in a dam failure inundation area should consider purchasing flood insurance, if they do not already have it.<sup>29</sup>

Residents should also sign up for emergency alert notifications with local governments, if they are available. People who live or work near a river or dam should be familiar with any warning systems in place (sirens, reverse 911 notifications, text messages, etc.) and know what to do and where to go in the event of an evacuation or other emergency.

Individuals purchasing real property should make sure they understand any dam-related liability they could incur as property owners, as well as the risks dams could pose to their use and enjoyment of the property.

- **Help Identify Neglected or Orphan Dams**

Residents aware of neglected or orphan dams should bring them to the attention of appropriate government officials, who can help identify owners and work to ensure that the dams are appropriately managed and adequately maintained.

# Notes

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- <sup>1</sup> Data are from the New York State Department of Environmental Conservation (DEC), which maintains data on dams in New York State. The figures, which are as of December 28, 2017, include only man-made dams that are functioning (i.e., they impound water) and therefore pose some risk should a breach occur. The figures exclude an additional 1,297 dams that do not materially impound water, either because they have been removed, are breached or were planned but never built. The figures also exclude 522 dams that have not been assigned a hazard code.
- <sup>2</sup> The dam ownership information presented in this report is as reported in DEC's data on New York's dams and does not imply that all dam owners hold title to dams or the property where they are located or are parties to formal partnerships with other dam owners. Under DEC's dam safety regulations, dam ownership is defined as "any person or local public corporation who owns, erects, constructs, reconstructs, repairs, breaches, removes, maintains, operates, or uses a dam." Person is defined as, "any individual, firm, co-partnership, association or corporation, other than the State and a public corporation, as is set forth in ECL article 1, section 0303, subdivision 18." (Title 6 of the New York Code of Rules and Regulations [NYCRR], Part 673, Section 2.) The definitions of the dam hazard classifications are set forth in State regulations. High-hazard dams are those for which a dam failure may result in widespread or serious damage to infrastructure or the environment, such that the loss of human life or widespread substantial economic loss is likely. Intermediate-hazard dams are those for which a dam failure may result in the threat of personal injury and/or substantial economic loss or environmental damage. Loss of human life is not expected. Low-hazard dams are those for which a dam failure is unlikely to result in damage to anything more than isolated or unoccupied buildings, undeveloped lands, or minor roads. Low-hazard dams are unlikely to pose the threat of personal injury, substantial economic loss or environmental damage. (For the precise definitions, see 6 NYCRR, Part 673, Section 5.)
- <sup>3</sup> Federal Emergency Management Agency (FEMA), *Living with Dams: Know Your Risk* (FEMA P-956), February 2013, p. 22. The Federal Energy Regulatory Commission (FERC) regulates hydroelectric dams and the Mine Safety and Health Administration regulates dams involved in mining.
- <sup>4</sup> See Office of the New York State Comptroller (OSC), *Selected Aspects of the Dam Safety Program* Follow up (Report 2013-F-4, June 2013), p.3. DEC does not include dams licensed by FERC in its usual inspection schedule, since those dams are subject to federal regulatory oversight that supersedes DEC's regulatory authority.
- <sup>5</sup> Article 15 of the New York State Environmental Conservation Law, which governs water resources, does not include the State in its definitions of dam owners. Information on DEC's practices for monitoring State-owned dams are based on conversations with DEC staff.
- <sup>6</sup> See OSC, *Department of Environmental Conservation: Selected Aspects of the Dam Safety Program* (Report 2006-S-61, issued in March 2008). A follow-up report to DEC in 2013 (Report 2013-F-4, issued June 4, 2013) noted that the agency had implemented Section 673.7 of its dam safety regulations, which established many of the requirements regarding engineering assessments and emergency action plans discussed in this report (6 NYCRR 673.7).
- <sup>7</sup> New York has 225 FERC-regulated dams, including 11 with pending FERC license applications.
- <sup>8</sup> Three other local high-hazard dams have pending FERC license applications.
- <sup>9</sup> Not all dams are inspected and an inspection alone does not provide enough information to determine a dam's condition. Additional information from an engineering assessment is needed. If a dam owner has not submitted an engineering assessment to DEC, that could prevent DEC from assigning a condition rating. Even when there is an engineering assessment, DEC may not assign a condition rating if it has questions about the assessment. (Conversation with DEC staff on March 8, 2018.)
- <sup>10</sup> FEMA, *Living with Dams*, op.cit; and David Curran, "Biggest Dam Failures in U.S. History," *SFGate* (February 13, 2017). Available at: [www.sfgate.com/news/article/Biggest-dam-failures-in-U-S-history-10928774.php](http://www.sfgate.com/news/article/Biggest-dam-failures-in-U-S-history-10928774.php).
- <sup>11</sup> *Independent Forensic Team Report: Oroville Dam Spillway Incident* (January 2018), p. 26; and the Associated Press, "Oroville Dam: State Official Says New Spillway Already Has Cracks" (November 29, 2017), published in *The Mercury News* (online). Available at: [www.mercurynews.com/2017/11/28/state-official-new-oroville-spillway-already-has-cracks/](http://www.mercurynews.com/2017/11/28/state-official-new-oroville-spillway-already-has-cracks/).
- <sup>12</sup> See New York City Department of Environmental Protection (NYC DEP), press release, "DEP Starts Next Phase of Construction for Release Works at Schoharie Reservoir" (May 9, 2017); Bryan Fitzgerald, "A Plan for the Unthinkable," *Times Union* (January 9, 2012). Dam break inundation maps from 2001 for the Gilboa dam are posted on NYC DEP's website. See, "Gilboa Dam Stabilization Project;" available at: [www.nyc.gov/html/dep/html/dep\\_projects/gilboa.shtml](http://www.nyc.gov/html/dep/html/dep_projects/gilboa.shtml). Accessed on March 30, 2018.
- <sup>13</sup> Bryan Fitzgerald, "A Plan for the Unthinkable Deluge," *Times Union* (January 9, 2012).

# Notes

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<sup>14</sup> NYC DEP, “Gilboa Dam Stabilization Project,” available at: [www.nyc.gov/html/dep/html/dep\\_projects/gilboa.shtml](http://www.nyc.gov/html/dep/html/dep_projects/gilboa.shtml); and NYC DEP, press release, “DEP Starts Next Phase of Construction for Release Works at Schoharie Reservoir” (May 9, 2017).

<sup>15</sup> Rebecca Dravis and Lisa Bramen, “Hadlock Pond Breaks, Flooding Area,” *The Post Star* (July 3, 2005); Paul Post, “Hadlock Pond Property Owners Await Compensation, Four Years After Flood,” *Saratogian* (June 23, 2009); and Lee Coleman, “Kubricky Ordered to Pay \$3.48 million in '05 Fort Ann Dam Collapse,” *The Daily Gazette* (January 2, 2012).

<sup>16</sup> For a discussion of dam risk exposure, see, FEMA, *Risk Exposure and Residual Risk Related to Dams* (Technical Advisory 2 – North and South Carolina, DR-4285-NC and DR-4286-SC) (December 2017).

<sup>17</sup> Haregewoin H. Chernet et al., “Safety of Hydropower Dams in a Changing Climate,” *Journal of Hydrologic Engineering* 19 (3) (March 2014), pp. 569-582.

<sup>18</sup> Environmental Protection Agency, “Water System Security and Resilience in Homeland Security Research.” Available at: [www.epa.gov/homeland-security-research/water-system-security-and-resilience-homeland-security-research](http://www.epa.gov/homeland-security-research/water-system-security-and-resilience-homeland-security-research). Accessed on May 29, 2018. The EPA also helps water utilities manage risks of other types of terrorist threats. See also OSC, *Protecting Sensitive Data and Other Local Government Assets: A Non-Technical Cybersecurity Guide for Local Leaders* (June 2016), available at: [www.osc.state.ny.us/localgov/ligli/pdf/cybersecurityguide.pdf](http://www.osc.state.ny.us/localgov/ligli/pdf/cybersecurityguide.pdf).

<sup>19</sup> U.S. Department of Justice, U.S. Attorney’s Office, Southern District of New York, “Manhattan U.S. Attorney Announces Charges Against Seven Iranians for Conducting Coordinated Campaign of Cyber Attacks Against U.S. Financial Sector on Behalf of Islamic Revolutionary Guard Corps-Sponsored Entities” (press release) (March 24, 2016); and Max Kutner, “Alleged Dam Hacking Raises Fears of Cyber Threats to Infrastructure,” *Newsweek* (March 30, 2016). The City of Rye owns and operates the Bowman Avenue Dam.

<sup>20</sup> The estimate of the number of intermediate- and high-hazard dams owned by property owner associations is based on a review of the dam owner names. As such, it likely underestimates the number of dams owned by homeowners associations and other groups of property owners.

<sup>21</sup> Unpublished estimate provided by the Association of State Dam Safety Officials (ASDSO), based on data from the 2016 National Dam Inventory and ASDSO’s cost estimate methodology. The cost estimate is not based on costs associated with actual or planned dam repair or rehabilitation projects. Instead, the dams are grouped according to height and estimates are made of the percentage in each group in need of certain “treatments,” such as addressing deferred maintenance, engineering assessments, and remedial actions. Costs are associated with each of these treatment scenarios and the results are aggregated to obtain an overall cost estimate. The model, which was created in 2002, has been updated several times since then, most recently in 2016. See ASDSO, *The Cost of Rehabilitating Our Nation’s Dams* (December 2002, Updated: 2009, 2012, and 2016).

<sup>22</sup> USDA, “Emergency Watershed Protection Program.”

Available at: [www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/ewp/](http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/ewp/). Accessed on May 29, 2018.

<sup>23</sup> Natalie Mamerow, American Society of Civil Engineers, “Advocating on the Hill for Funding of Critical Dam Programs” (July 31, 2017).

Available at: [www.infrastructurereportcard.org/advocating-on-the-hill-for-funding-of-critical-dam-programs/](http://www.infrastructurereportcard.org/advocating-on-the-hill-for-funding-of-critical-dam-programs/).

<sup>24</sup> Code of Federal Regulations, Title 40, Section 35.3520 (e) (1).

<sup>25</sup> Correspondence dated June 15, 2016 from Catherine Borgia, Westchester County Board of Legislators, to Micheal Kaplowitz, Chair of the Westchester County Board of Legislators, regarding a letter and petition from residents regarding the Westchester Lake Dam, including attachments.

Available at: [www.westchestercountyny.iqm2.com/Citizens/FileOpen.aspx?Type=4&ID=15622&MeetingID=4448](http://www.westchestercountyny.iqm2.com/Citizens/FileOpen.aspx?Type=4&ID=15622&MeetingID=4448).

<sup>26</sup> NYC DEP, *New York City 2017 Drinking Water Supply and Quality Report*.

<sup>27</sup> 6 NYCRR 673.14.

<sup>28</sup> FEMA flood maps are available at: <https://msc.fema.gov/portal>. United States Geological Survey “WaterWatch” streamflow maps are available at: [www.waterwatch.usgs.gov/new/index.php](http://www.waterwatch.usgs.gov/new/index.php).

<sup>29</sup> See FEMA’s National Flood Insurance Program website: [www.fema.gov/national-flood-insurance-program](http://www.fema.gov/national-flood-insurance-program). A list of participating communities in New York State is available at: [www.fema.gov/cis/NY.html](http://www.fema.gov/cis/NY.html). Both sites accessed on May 29, 2018.

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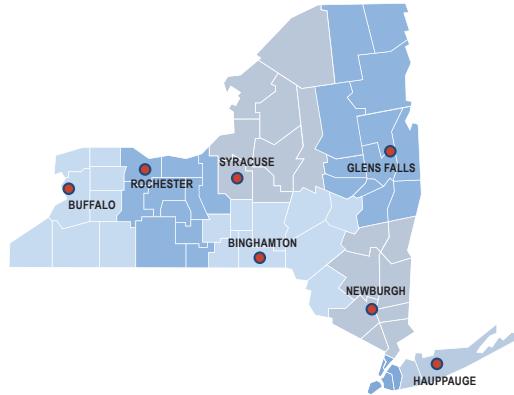
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