SEDIMENTATION IN THE SCHOHARIE RESERVOIR

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The Schoharie Reservoir is the smallest of the New York City Department of Environmental Protection's West of Hudson Reservoirs, as well as the second oldest in the Catskill System. Based on the small volume of the reservoir relative to its highly productive 314 sq. mi. catchment area, we posit that the Schoharie Reservoir has been subjected to more severe siltation than the other West of Hudson impoundments over the more than eight decades it has been in existence (Fry, 1950). Located 2 miles downstream of the intake chamber of the 18.1 mile long Shandaken Tunnel, the Gilboa Dam functions as a diversion dam to shunt water through the tunnel into the Esopus Creek to the Ashokan Reservoir, and ultimately via the Catskill Aqueduct to the Kensico Reservoir east of the Hudson River. The diminutive Schoharie Reservoir is, in reality, a giant "stilling pool" for seasonally silt laden water, allowing for some detention time before it discharge through the Shandaken Tunnel. However, the turbid water conditions that frequently prevail in times of heavy run-off in the Schoharie Basin are subject to the terms of a SPDES permit (www.catskillstreams.org/pdfs/EKSMP/38_appen_D.pdf). As a result, the Shandaken Tunnel intake chamber is frequently closed and no water is diverted to the Ashokan Reservoir.

Figure 1: Aerial view of sediment below 1065' immediately in front of the Shandaken Tunnel Gatehouse. Photo courtesy D. Wood, c. 1993

On average, sixteen per cent (16%) of the drinking water consumed annually in New York City is supplied from the 314 sq. mi. catchment of the Schoharie Reservoir. Prior to the emplacement of the 220' long x 5.5' deep notch in the spillway of the Gilboa Dam in 2006, when at full pool elevation of 1130', the Schoharie Reservoir had a capacity of 22 billion gallons or 67,515.2 acre-feet of water, with a surface area 1142 acres. Since 2006, the existence of the notch in the spillway has, for much of the year, lowered reservoir water levels behind the Gilboa Dam to 1124.5' or less, with a full pool volume at 1124.5' of 17.5 billion gallons or 53,705.52 acre-feet. Exceptions occur in times of heavy rain and/or snow melt induced run-off, leading to spillage through the notch or over the full length of the 1134' masonry spillway. These conditions are usually accompanied by a reduction or actual cessation of discharge through the Shandaken Tunnel.

As the waters of the Schoharie Creek carry a wide range of particle sizes, in times of high flow, precipitation and deposition of stream burden occurs throughout the full 5-mile length of the Schoharie Reservoir. The fact that the Schoharie Creek can be a very silt laden stream is amply illustrated by the presence of high turbidity in its lower reaches below the dam. The source of this turbidity is frequently spillage or discharge of agitated waters from the Schoharie Reservoir. Turbidity is both observable and persistent downstream of the Gilboa Dam/Schoharie Reservoir long after waters have cleared in the upper reaches of the Schoharie Creek.

Figure 2: Silt and sediment on eastside of original Schoharie Creek channel. Photo courtesy D. Wood, c. 1993

Fry (1950) refers to siltation problems that typically occur behind diversion dams such as the Gilboa Dam: "The amount of silt that is brought to a reservoir on any stream is influenced by the watershed characteristics above the reservoir, such as the geology, types of cover, and the climate that prevails over the area. The amount of sediment that remains in the reservoir is a function of the retention times of the water in the reservoir. The life of a reservoir is dependent on the ratio of the reservoir capacity in acre-feet to the watershed area in square miles. Where this ratio is large, with other conditions being the same, the life of the reservoir will be correspondingly long.

"In the design of many reservoirs, provision is made for dead storage and live storage. The former ordinarily is considered to provide space for the deposition of sediment for a considerable period of years. It is important in the life of a project to determine whether sediment deposits in the dead-storage space or whether it deposits in the live space and thereby encroaches on the purposes for which the reservoir was built.

"The level at which a reservoir is operated is an element of significance in reservoir sedimentation. Some reservoirs, usually single-purpose, are operated with relatively constant levels. Multiple-purpose reservoirs that utilize storage space jointly at different seasons of the year are operated at other than constant levels and with a range in reservoir elevations dictated by the various purposes for which the reservoir was built. This variation in water level in a multiple-purpose reservoir is significant in the deposition of silt in a reservoir and also in the movement of silt through the reservoir. At the higher reservoir elevations the silt is first deposited in the live storage space, but, as the reservoir is drawn down and succeeding storms occur, this sediment is flushed down into the lower elevations of the reservoir and eventually, after a number of cycles, is likely to find its way into the portion of the reservoir originally provided for dead storage."

The ratio of the acre-feet storage capacity of the 6 West of Hudson reservoirs, relative to their respective catchment areas, is shown in Table 1. It is evident that the Schoharie Reservoir has the smallest ratio of capacity to catchment area, a factor further exacerbated by the presence of the spillway notch since 2006. Taking this into account, it is highly likely that the processes described above have occurred within the Schoharie Reservoir. The removal of silt from an area 50' x 300' at the mouth of the intake chamber of the Shandken Tunnel further supports this assertion.

This excavation was for the purpose of clearing a channel for water to pass into the gatehouse and intake chamber. The picture below shows the Schoharie Reservoir, in a "dewatered" condition, as it appeared in the early 1990's. The base elevation of water in the Schoharie Reservoir's "live storage" area is 1065' above seal level. Pictures taken in front of the Gate House show a pool level several feet lower than the intake base level of 1065'. In order to dewater the Schoharie Reservoir to the extent shown in the pictures, the two 30" blow-off valves under the western end of the 1324' long spillway were opened. These aged and woefully under fit release works have not been used since these pictures were taken, nearly 20 years ago. The intake of these drains is now buried under many feet of sediment. This, coupled with the fact that they are 85 years old and obsolete, renders them unusable. These old "blow-off" valves are to be replaced by a new Low Level Outlet when the rehabilitation of the Gilboa Dam/Schoharie Reservoir is completed.

Figure 3: Water in fig. 1-3 constitutes "dead storage" of Schoharie Reservoir. Photo courtesy D. Wood, c. 1993

Building from the information presented above, it is possible to make the following conclusions/recommendations:

1. Extensive siltation has occurred in the Schoharie Reservoir since it was first filled in 1927.
2. The "dead storage" area of the reservoir above the intake chamber of the Shandaken Tunnel has been greatly reduced.

3. The original watercourse of the Schoharie Creek, prior to the construction of the Gilboa Dam is visible in the pictures and shows that there has been very heavy siltation on the stream's western side.

4. On September 30, 2010 the Schoharie Reservoir was at el. 1096.57'. As the reservoir water level rose by more than 33' in 24 hours, the four-month period of high turbidity in the Schoharie Creek downstream of the Gilboa Dam following the flood of October 1, 2010 was most likely due to the presence of the vast quantities of silt entrained by floodwaters entering the reservoir. This rapid influx of run-off into the reservoir incised the silt beds and elevated its fine particles in a long-term state of suspension.

5. Since the adoption of the Upper Esopus Creek Management Plan in January of 2007, the main recipient of reservoir-induced turbidity has been the Schoharie Creek downstream of the Gilboa Dam. This turbid water reaches downstream of the dam via the route of the 4 siphons surmounting the spillway as well as spillage through the notch.

6. It would seem prudent to periodically remove sediment from the Schoharie Reservoir on a routine basis. The large delta of sediment at the upstream extremity of the reservoir obstructs water flow to the intake chamber and contributes greatly to turbidity in times of high run-off. The benefits that would occur in both economic and environmental terms would off set the cost of removal. The vast quantity of silt in the reservoir constitutes a nuisance in its present state, but is of a valuable agricultural resource whose natural course of downstream deposition has been interrupted by the presence of the Gilboa Dam.

Bibliography

Fry, A.S., 1950, Sedimentation In Reservoirs *in*: "Applied Sedimentation", Trask, P. ed. John Wiley & Sons, Inc., NYC, NY, 347-363.

Table 1: Ratio of acre-feet storage capacity for six reservoirs west of the Hudson River.

RESERVOIR	DRAINAGE AREA mi^2	CAPACITY In Billion Gallons/Acre feet	RATIO Reservoir capacity /Catchment Area
Delaware System			
Pepacton	376	140.2/609,740.00	1621.75/1
Cannonsville	450	97.5/450,000.00	1000.00/1
Rondout	95	49.6/202,800.00	2134.75/1
Neversink	92	34.9/112,000.00	1217.39/1
Catskill System			
Ashkoan	256	122.9/577,166.25	1473.30/1
Schoharie	314	22.0/67,515.52	215.01/1 (pre-notch) 171.03/1 (post-notch)