State of the Saw Kill: Overview of Watershed Health

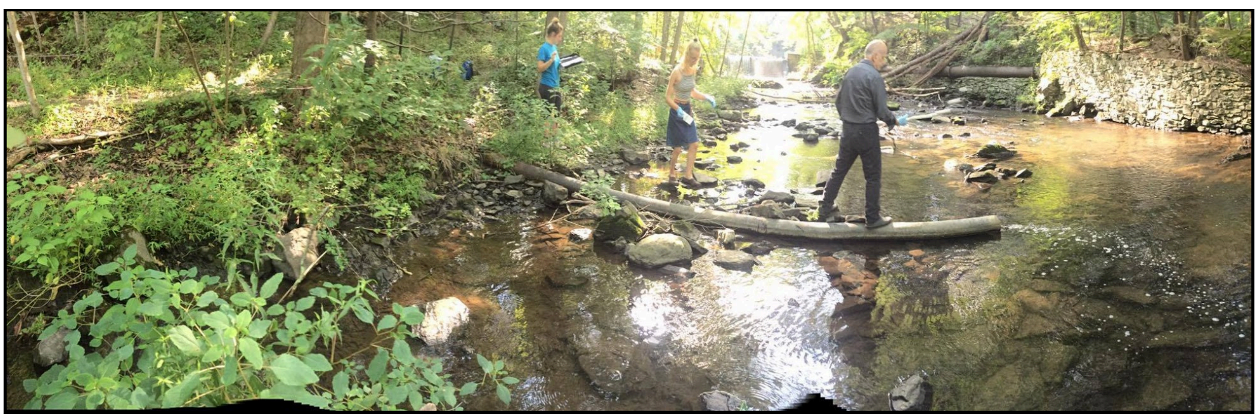
Summary

May, 2018

The Saw Kill's 16.2 mile main channel drains a watershed of approximately 26 square miles. Watersheds cycle, filter, and store water. A watershed's health depends on the condition of its rivers, streams, wetlands lakes, groundwater, and land. We can trace problems like flooding, water supply, and water contamination to the condition of a watershed's features and their role in the movement and storage of water. To protect our water, we need to understand how watershed systems work to

- maintain water supply (for drinking water and for ecosystems)
- improve flood protection
- maintain and improve water quality

Watershed features include buffers, floodplains, wetlands and streams, impervious surfaces, forests, ecosystems (habitat), dams and culverts, groundwater, and water quality.



Buffers

Vegetated buffers along streams, wetlands, and lakes protect water from contaminants carried by stormwater runoff, reduce erosion, moderate water temperature, and provide important habitat. Buffer effectiveness depends on vegetation type and condition; buffer width; length of buffer along a stream, lake, or wetland edge; slope and soil type; and intensity and type of adjacent land use. Buffer characteristics affect the level of protection provided for the adjacent water resource.

The Environmental Law Institute recommends that "land use planners should strive to establish 100 meter wide riparian buffers to enhance water quality and wildlife protection" and that watershed protection efforts should establish continuous buffer strips along streams, and protect stream headwaters as well as broad downstream floodplains.

Initial review of buffers along the Saw Kill includes preparation of a set of 17 maps of the stream channel with 25, 100 and 300 foot buffers indicated. This information will be used to identify areas along the stream that lack sufficient buffers for water quality protection and other benefits. Plans for buffer protection, restoration, and planting will be developed based on maps and other sources including the NYSDEC Statewide Riparian Opportunity Assessment, an online mapping and analysis tool for identifying riparian sites for restoration or protection to improve wildlife habitat, water quality, climate resiliency, and flood protection.

Floodplains

River and stream floodplains slow and absorb floodwaters and surface runoff, and allow it to seep into the soil. Floodplains are best able to provide these services when they are well-vegetated, support minimal structures and impervious surfaces, and are connected to the stream channel. When connections between streams and their floodplains are not obstructed, floodwaters that top the banks spread overland and slow down. Wetlands and streams within floodplains are important to overall watershed flood reduction. Floodplain construction increases risk of property damage and safety; it increases runoff, contributing to the flow and force of floodwater, and leads to downstream property damage.

Wetlands and small streams

A network of wetlands and streams throughout the watershed store, distribute, absorb, and purify water. They often form the headwaters of streams and rivers and provide valuable habitat. Collectively, all wetlands and streams, regardless of size or regulatory jurisdiction, contribute to watershed health.

Wetlands increase the watershed's capacity for absorbing excess stormwater flows and floods, reducing peak stormwater flow in streams. Groups of wetlands work collectively, serving as "sponges" across the landscape; they collect water from precipitation or runoff until they become saturated, and then release it slowly. A one-acre wetland, one foot deep, can hold approximately 330,000 gallons of water.

The Saw Kill Watershed water resources map includes wetlands mapped by the NYS DEC and the National Wetlands Inventory. Because these represent approximate wetland locations, we've added ‘hydric’ and ‘poorly drained’ soils to create a map that presents a more complete overview of likely wetland locations within the watershed.

The Saw Kill is a perennial stream, classified by the DEC as B(t). Its watershed contains a system of smaller streams that may be perennial or intermittent. Approximately 55 percent of the streams that supply drinking water to NY state residents are small intermittent, ephemeral, or headwater streams. A network of small streams distributes floodwaters from heavy rainfall across the landscape and channels it into other streams, wetlands, lakes and ponds. During periods of low flow in river channels, small tributary streams, especially those with cool clean water provide refuges for fish and other aquatic life.

Impervious surfaces

The extent of impervious surfaces (roads, buildings, pavement) as a percent of land cover in the watershed is directly related to water quality. Impervious surfaces increase runoff and flooding; they carry water contaminants and reduce groundwater recharge.

Relationships between impervious cover and water quality can guide the evaluation of land use activities. Extensive research indicates that at 10 percent impervious cover, stream health is impaired; by 25 percent, streams are degraded and can no longer support aquatic organisms that were originally present. This relationship between impervious surfaces and water condition underscores the importance of using stormwater management methods based on “best practices” to keep impervious cover percentages as low as possible. According to USGS Streamstats data, approximately 12 % of the Saw Kill watershed is developed land, and 2.8% is impervious surface. Percentages may vary depending on the source of the data and the methods used for calculation.

Forests

Wooded areas contribute to overall watershed health by reducing stormwater runoff, flooding, and erosion; improving water quality; and providing habitat. A high percentage of wooded areas in a watershed can lower drinking water treatment costs and improve groundwater recharge. Forest cover is important both within buffers and throughout a watershed; it can be measured as a percent of total watershed area, or linear riparian buffer.

Good stream health is correlated with a higher percent (45-65% or more) of stream length in forested buffer (at least 100 feet wide). The Trust for Public Land and the American Water Works Association have found that the more forest cover in a watershed (at least 60%), the lower the cost for clean drinking water. In the Saw Kill Watershed, according to USGS Streamstats, approximately 68% of the watershed is covered by forest.

Ecosystems

Watershed health depends upon healthy aquatic, terrestrial, and wetland ecosystems. These communities of plants and animals interact with each other and with their physical and chemical environment, affecting water quality, flooding, aquifer recharge, and biodiversity. Habitats mapped in the northeast section of the Saw Kill watershed include stream, springs and seeps, upland meadows, vernal pools, upland mixed forest, crest ledge talus, marsh, orchard, constructed ponds, upland conifer forest, hardwood swamp, red cedar wetland, upland hardwood forest, and wet meadow. Additional habitats are likely to be found in other portions of the watershed.

Both common and rare plants and animals are important for sustaining local ecosystems. Many of our threatened and endangered species are at risk because of habitat loss and invasive species that out-compete, displace, and prey on native species. New York State's Wildlife Action Plan (2015) lists wildlife species of greatest conservation need (SGCN). The Saw Kill Watershed provides habitat used by at least 38 of these species (8 bats, 20 birds, 2 fish, 8 reptiles and amphibians).

Dams and culverts

Stream connectivity enables aquatic organism passage and facilitates stream flow, especially during high water or flood stages. Dams and culverts impede passage and flow and can increase flooding potential. Maps that identify problematic dams and culverts within the watershed (including biologically important barriers) have been produced by DEC as the first stage in a process for eventual barrier removal.

Groundwater

Residents in Red Hook obtain their water from the Saw Kill itself (Bard College), from two municipal well systems (Village and Town of Red Hook), and from numerous individual wells throughout the rest of the watershed. These individual wells serve about 89% of the town's population. The aquifer that underlies the Village of Red Hook is its main source of drinking water. All of these water sources are affected by watershed conditions.

Under natural conditions, groundwater moves along flow paths from areas of recharge to areas of discharge at springs, streams, lakes, and wetlands. Groundwater and surface water are connected; groundwater contributes to the water in small and medium-sized streams— up to 100 percent in some streams during dry weather. Water withdrawal changes the local groundwater-flow system. Pumping from multiple wells can cumulatively affect groundwater supply, water distribution, and water levels in streams and wetlands especially during periods of low rainfall. Excessive pumping of groundwater may affect a large area because of the interconnections between groundwater and surface streams, wetlands, and lakes.

Contaminants including septic system effluents can move between surface and groundwater. The Dutchess County Aquifer Recharge and Sustainable Rural Density Analysis recommends optimal parcel sizes for Red Hook based on septic system density and soil hydrologic groups.

Water Quality

Water contaminants fall into two broad categories depending on their source. Point-source pollution originates at an identifiable location. Nonpoint source pollution, carried by stormwater runoff, is comprised of contaminants that are washed from land surfaces into the water. Soluble pollutants like chlorides (salts), nitrate, copper, and dissolved solids can migrate into groundwater. Stormwater can carry chemicals that directly harm aquatic organisms and human health. “Hotspots” are areas that produce higher concentrations of harmful chemicals including hydrocarbons and trace metals, which can be carried into water via runoff.

Since 2015, the SKWC has collected water samples from 14 sites along the Saw Kill on a monthly basis. The Bard Water Lab tests them for turbidity, temperature, phosphorus, nitrogen, sewage-indicating bacteria, and conductivity as an indicator for heavy metals and salt. In some areas, conductivity, nitrogen, phosphorus, and bacteria levels indicate potential water quality concerns. Stream biomonitoring assesses water quality by analyzing samples of insects and other invertebrates that live on the stream bottom. The need for additional future testing to detect specific chemicals and other contaminants will depend on local conditions.

The following section provides additional details about water quality in the Saw Kill.

Water Quality at a Glance

Water quality affects human and ecological health. Pollutants reach drinking water via surface water, air, groundwater, or soil, and from a variety of sources including: stormwater runoff (urban and agricultural), contaminant discharges, chemical spills, landfill seepage, wastewater discharges, septic system effluents, and eroded banks. We can assess basic water quality condition by testing for a variety of parameters and contaminants.

Water quality monitoring on the Saw Kill

Historic sampling from 1976-1982 included monitoring for water temperature, dissolved oxygen, pH, phosphates, nitrates, and coliform bacteria. Red Hook middle school students collected several years' information about macroinvertebrates in the Saw Kill. Today, the Water Lab at Bard College works with the citizen samplers from the Saw Kill Watershed Community, Bard College students and faculty to sample water quality at 14 sites along the Saw Kill. Samples are collected monthly and processed at the Water Lab for salts and heavy metals (measuring conductivity), turbidity, and total coliform bacteria (*Enterococci*, total coliforms, and *E. coli*). Comparison of monthly temperature data collected at various points along the Saw Kill from 1976-1982 and from 2014-2017 indicates that the Saw Kill is now warmer in the late summer and autumn months than it has been historically.

This water quality information is dynamic, continually adding to knowledge about our communities' water. Additional information and results from monitoring programs can be viewed online at http://sawkillwatershed.wordpress.com. The Bard Water Lab also maintains a data archive for the Saw Kill Watershed Community that houses historic water quality data and maps of sub-basins, riparian buffers, wetlands, impervious surfaces, and dams in the Saw Kill Watershed.

What we measure

The table below displays nine commonly measured water quality parameters, their sources and effects: salt, turbidity, bacteria, pH, nitrogen, phosphorus, dissolved oxygen, temperature, and heavy metals. Macroinvertebrate information follows the table.

Water Quality Characteristic	Source or Causes of Change	Examples of Impacts
Temperature	Water temperature increased by removing trees and shrubs along banks; soil erosion increases turbidity which increases water temperature; stormwater runoff warmed by impervious surfaces flows into surface waters; industrial effluents.	Aquatic organisms thrive at optimum temperatures according to species. Warmer water holds less oxygen, increases metabolism of aquatic organisms, increases sensitivity to other contaminants.
pH (alkalinity/ acidity)	Sulfur dioxide, nitrogen oxides and carbon dioxide in the air may contaminate water (“acid rain”); chemical contaminants.	Aquatic organisms (fish, eggs, plankton, bacteria) are sensitive to pH changes; pH affects the toxicity of some chemicals like ammonia and heavy metals. High pH leaves deposits in pipes; low pH corrodes metals.
Dissolved oxygen (DO)	DO is reduced by increased water temperature, salinity, sewage, decaying organic matter (yard waste), dense algal growth; addition of chemicals; stagnant non-aerated water.	Lower DO reduces the water’s ability to support plants and animals; temperature, salinity and level of pollution affect DO; few fish survive below DO of 3.0 ppm (6.0 is healthy for most fish). Cold aerated water holds more DO.
Chlorides (salt) (conductivity is a measure of salts and minerals dissolved in water)	Flooding, evaporation; stormwater runoff with high salt or mineral content (from road salt used for de-icing); agricultural runoff (irrigation return flows); airborne gases and dust transported into water via rain; discharges from wastewater treatment plants, industrial effluents, water softeners, leaky sewers and septic systems.	Changes in water’s salt content can be an early indicator of changes in water quality. High salt content harms freshwater aquatic organisms, damages freshwater ecosystems; changes water chemistry; contaminates drinking water wells; corrodes plumbing fixtures, damages agricultural crops.
Turbidity Suspended particles in water (e.g., silt and clay, plankton, algae, fine organic debris)	Stormwater runoff from eroded areas; removal of streambank vegetation, dredging and other instream activity, waste discharges, algae, decaying organic materials, particles from water treatment processes.	High turbidity increases water temperature, reduces light and DO; interferes with photosynthesis and foraging; clogs gills and affects respiration of some aquatic organisms. Prolonged high turbidity can kill fish and other aquatic organisms; suspended soil particles provide surfaces for attachment of disease-causing organisms and heavy metals.
Phosphorus	Agricultural fertilizers, manure, and organic wastes in sewage and industrial effluent; detergent; stream bank erosion (attaches to soil particles).	Even small amounts in freshwater systems can cause algal blooms, decrease DO as algae die, and change type of plants present; can migrate into groundwater

Water Quality Characteristic	Source or Causes of Change	Examples of Impacts
Nitrogen (nitrates and nitrites)	Fertilizers applied to agricultural lands, landscaping, lawns; animal waste; yard waste; stream bank erosion; fossil fuel combustion (cars, power plants), poorly maintained septic systems, high septic system density that exceeds soils' natural processing capacity	Increased aquatic plant growth, algal blooms (and resulting toxic conditions), depletion of oxygen in water, increase in decomposers (bacteria), decline of fish and other aquatic animals. High nitrate levels can reduce capacity of blood to carry oxygen; higher levels of nitrite and ammonium are toxic to aquatic life.
Bacteria (fecal coliform bacteria: *Escherichia coli and Enterococci*)	Animal (including livestock, pets) and human wastes, improperly functioning sewer or septic systems, sewage; runoff from roads and other impervious surfaces including rooftops; feedlots, pastures.	Effects on human and ecosystem health; presence of these bacteria indicates fecal matter (human and/ or animal) in the water, increasing the likelihood that other disease-causing organisms (bacteria, viruses and protozoa) are also present. Fecal coliform and strep are correlated with gastrointestinal illness.
Heavy metals (e.g., arsenic, cadmium, copper, lead, mercury)	Used in many industrial, agricultural, and technological products, including automobiles and heavy equipment; paints; road salts; galvanized pipes; runoff from waste batteries and paints, corrosion of household plumbing systems. May attach to soil particles.	Many heavy metals are toxic in certain concentrations. They accumulate in sediment, can be taken up into the food chain and accumulate in fish, and are toxic to aquatic life; widespread contamination poses increasing threat to human and ecological health.

Macroinvertebrates

Macroinvertebrates are aquatic insect larvae and other invertebrates typically found beneath rocks in streams. They are essential components of aquatic ecosystems, and often an important food source for fish and other aquatic organisms. These organisms are sensitive to environmental impacts and can accumulate contaminants in their bodies, indicating toxic contaminants in the food chain. Some species occur only in healthy streams while others can survive in contaminated waters.

Macroinvertebrate indicators of good water quality:

Mayfly nymphs. Often numerous in clean streams; sensitive to most types of pollution .
Stonefly nymphs. Limited to cool, well-oxygenated streams; sensitive to most pollutants.
Caddisfly larvae. Build a portable case of sand, stones, sticks, or other debris; most species are sensitive to pollution, some are tolerant.
Riffle beetles and water pennies. Require a swift current and an adequate supply of oxygen.

Indicators of poor water quality:

Midges. Common aquatic flies; larvae found in almost any aquatic environment; many species tolerate pollution.

Black fly larvae. Filter plankton and bacteria from the water, require a strong current. Some species tolerate contaminants, others don't.

Segmented worms. Burrow in the substrate and feed on bacteria; they thrive in severe pollution and low oxygen levels; valuable pollution indicators.

Leeches. Tolerate poor water quality.

The presence of each species depends on aquatic habitat conditions, food source, flow regime, and the presence or absence of contaminants in the water. We can evaluate water quality and stream condition by analyzing the relative abundance of the different species in a stream. A "biological assessment profile" based on that data describes water quality (i.e., whether a stream is severely impacted to non-impacted) on a scale of 0 to 10.