

Flood Control

Onondaga Creek Fact Sheet

INTRODUCTION

Flood Hydrology Basics: What is a flood in a freshwater stream?

- A flood occurs when water escapes from the channel cut by the flow of water. Water level at the top edge of the stream bank is “bankfull.” When the water flows above and beyond the bankfull level, it is in flood.
- The flood plain is the land area contacted by water that escaped the stream channel. Flood plains do not have to be flat!
- Natural stream flooding occurs every two to three years, unless limited by control measures to protect human activity.
- Wetlands may be inundated more frequently than the rest of a flood plain.
- Precipitation can be retained by soil and plants, or it can runoff.
- Soil’s retention of water is the first step in “groundwater recharge.”
- Evaporation of water coupled with its release by plants to the atmosphere is termed “evapotranspiration.”
- Floods naturally occur when rain and/or snowmelt exceed the combined retention capacities of the system’s soil, vegetation and stream channels.
- A “100-year flood” is not always a flood. The US Geological Survey computes the probable frequency of peak flows and their volumes. The estimated once-in-a-100-year peak flow is used to calculate the location of a flood plain. For example, the Onondaga Creek channel at Spencer Street has a greater capacity than the computed cubic feet per second of a peak flow that might occur only once in 100 years. The so-called “hundred-year flood,” can occur in the creek at Spencer Street without the creek actually overflowing its constructed banks. This situation is reflected in the very narrow flood plain drawn by the Federal Emergency Management Agency (FEMA) for that location.

See also hydrology fact sheet

FINDINGS

Impairments due to the flood control measures

Human access was lost to urban parts of the creek through channelization, barriers, and related safety features.

Diversity of activity was lost when channelization increased the velocity of water over long stretches. When slower water was lost, that eliminated in-stream fishing and wading areas, boat pull outs, and safety pullouts. Channelization also eliminated the mix of faster and slower water that is desirable for recreational kayaking. The reduction in flood plain through increased channel depth led to water levels unsafe for wading; e.g. creek water depth at Spencer Street typically ranges from 2 to 4 feet (USGS 1993-present). Smoothed channel sides lack boat pull-outs and are largely without handholds.

Continuity of activity along the length of the creek was physically lost at the Dorwin drop structure and the Onondaga Dam, which are barriers to canoes and kayaks.

Approach to the creek sides is blocked by fencing in the city. Fencing has reduced liability and the risk of accidents and drowning fatalities such as had occurred in the past when children fell into the fast water and were not rescued in time (hence the name “Killer Creek”).

Fish habitat was lost. Habitat features needed by fish were eliminated by the smooth sides and bottoms of channels and culverts. Without an accumulation of organic debris in the creek bottom, there were fewer invertebrate creatures

that are fish food. Without patches of gravel and sand, the fish lack spawning “substrate” in which to lay eggs. The channel’s typically higher water velocity means fish experience metabolic stress, as there are fewer places to rest in the channel or the attached culverts. Long stretches occur in the channel without distinct pools and riffles for fish activity.

Water qualities were affected by channels and culverts. The reflective bottom surface of the channel has a thermal effect on water, making it too warm at times for some species. Fewer riffles are present to oxygenate water. With high precipitation or snowmelt, the culverts’ outfalls contribute urban storm water that can be saltier, warmer or colder, and often more contaminated than natural runoff. Some of the storm water outfall pipes also add raw or partially treated human sewage to the creek during high runoff.

Fish migration going upstream is impeded or blocked at one to three locations, depending on conditions:

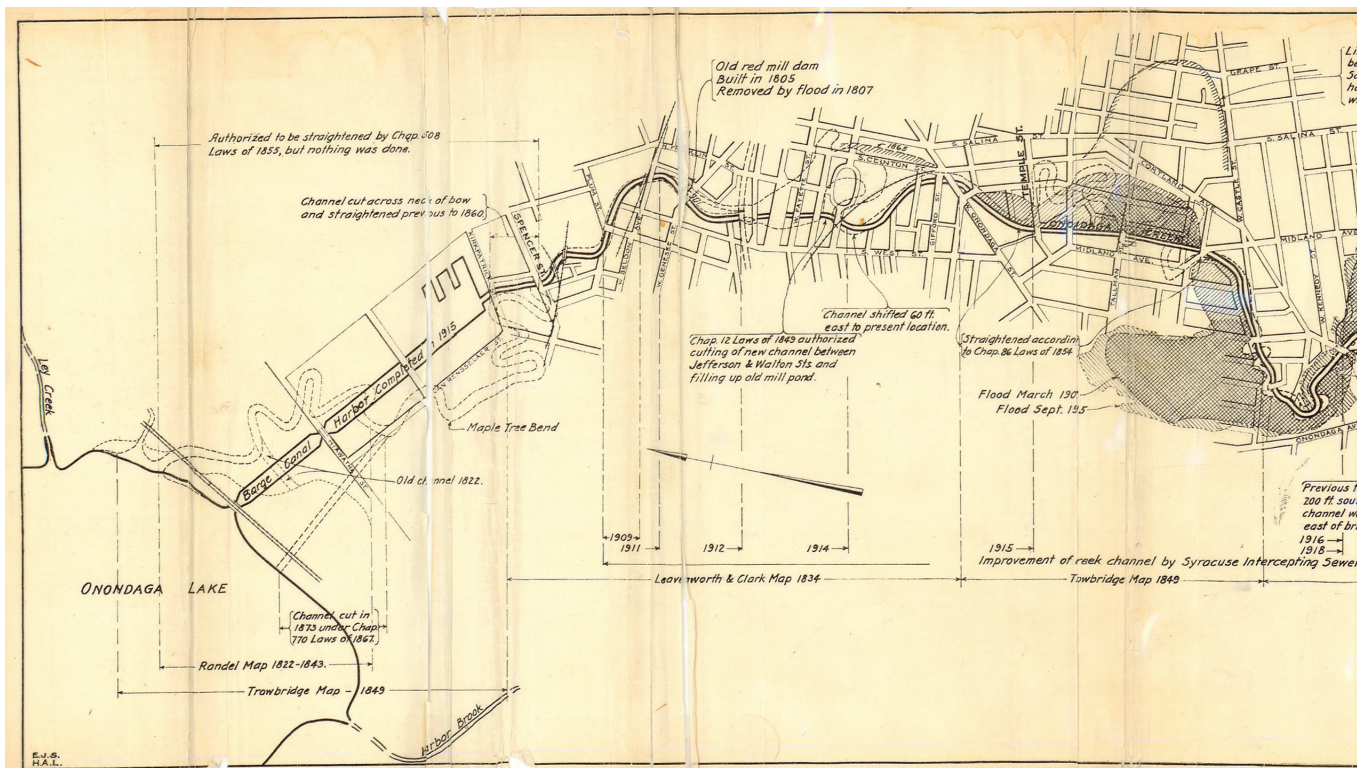
- The Onondaga Flood Control Dam’s conduit is a 200 foot long pipe with a shallow slope of 0.25%¹ as it passes through the base of the dam. Over 31 years of daily monitoring (1967-1998), flow through the conduit ranged from lows around 40 cubic feet per second (cfs) up to about 750 cfs in a peak flow. Around 10% of the days monitored, the conduit was full of water that had backed up behind the dam, causing high velocity in the conduit. The conduit is a smooth pipe that does not have a fish ladder in its 200 foot traverse.
- The Dorwin Avenue drop structure includes a smooth sloped barrier that is approximately 7 feet high and roughly fifty feet in horizontal extent between the downstream and upstream edges,² which is too extended a length for many fish to ascend.
- A concrete sewer pipe crosses Onondaga Creek near Spencer Street. At high lake levels this pipe is covered by water that backs up into the creek, while at low water levels its edge is visible as a riffle or small waterfall, and may be a barrier to fish.

Less vegetation on the stream edges affects fish conditions. Stream bank trees can moderate the temperature of water,

1 USACE, U. S. A. Corps of Engineers, et al. (1949). Definite Project Report on Local Flood Protection, Onondaga Creek, Syracuse, New York. Buffalo, New York: I-II, A-C, 1-? Appendices, maps., Plate 4A. Onondaga Creek Conduit Rating Curve, and page 1.14 text.

2 Ibid. Plate, Onondaga Channel Improvement Details.

Figure 1. Syracuse Intersecting Sewer Board Map of Onondaga Creek (Holmes 1926). Peck Brook is now known as Cold Brook, and part of Atlantic Ave. is now known as Ballantyne Ave.



keeping stream water cooler in summer and acting as wind barrier in winter. When present, vegetation can shape shallows and wetlands in patterns that allow spawning and contribute organic material for the fishes' 'food chain.' However, vegetative debris can dam up the creek, so fallen trees are routinely removed from the urban sections of creek channel to avoid flooding in the city.

Human health and safety are affected both positively and negatively

The city center of Syracuse is protected from flooding, although it is located on the former natural flood plain of Onondaga Creek and several of its tributaries. The flood control measures accommodated more rapid transit of sewage overflows from the city through the main creek channel to the lake. Channelization contributed to the danger of deep fast flows with no hand holds; it proved difficult to retrieve children who fell in, earning the creek nickname, "Killer Creek."

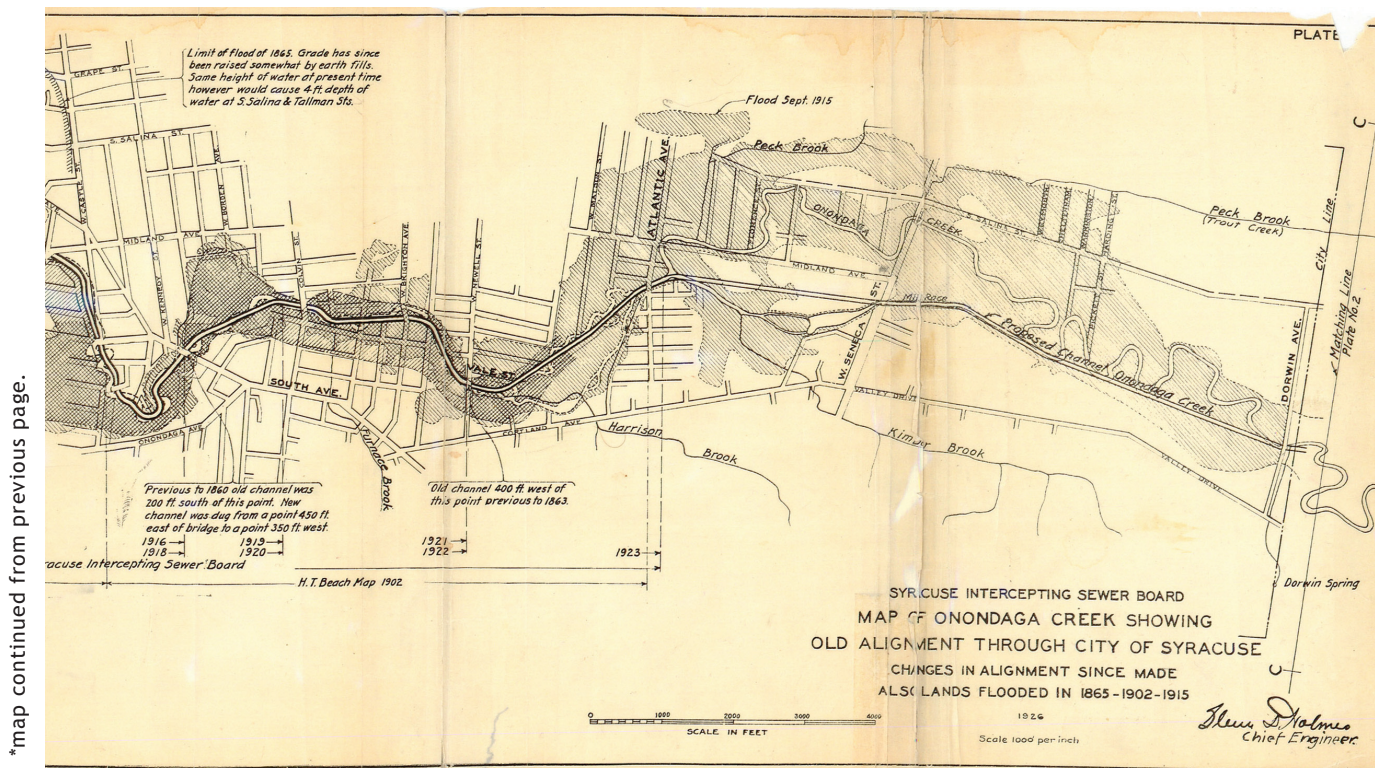
Flood control planning: The closest thing to a plan

The City of Syracuse's 1927 report on flood-control was used throughout the 20th century by the City of Syracuse, State of New York and the Army Corps of Engineers to guide their policies and construction (Holmes 1927).

As the Chief City Engineer who coordinated the 1927 report, Holmes drew a map (see Figure 1) of three notable floods, with the occurrences spread over fifty-one years (1865, 1902, 1915), along with proposals to expand channelization and construct a flood control dam or dams, to be located upstream of the city.

The three floods emphasized by Holmes and the Intercepting Sewer Board had all occurred during a period of deforestation in the county. A major flood in the city in 1920 was not mapped by Holmes, but the public sentiment that resulted from that flood had favored immediate measures to protect from further floods. The 1927 designs for channels and a dam or dams were implemented over twenty years later in post World War II projects by U.S. Army Corps of Engineers, under an Act of Congress passed before the war.

The 1927 report had dismissed reforestation as a control measure at a time when the watershed was largely devoted



to agriculture. In 1930, only 8% of Onondaga County had been forested (Nyland, Zipperer et al. 1986). That era was followed by decades of reforestation efforts in the county and across New York State (NYSDEC 2006). By 1997, the Onondaga Creek sub-watershed was 53% forested, the highest percentage of forest cover among the sub-watersheds of Onondaga Lake (Coyle 2002). The Onondaga Flood Control Dam, completed in 1949, has yet to be exposed to the maximum water volumes for which it was designed.

Flooding has occurred, though more rarely, since the 1927 designs were implemented by the dam construction in 1949 and the last channelization in 1963.

Types of flood control measures in place

Engineering objectives

- *Water removal*
 - Channelization design controlled the main channel's volume capacity, by widening the channel, smoothing an artificial creek bottom, incising the channel deeper than its natural elevation, and armoring the lining of the channel with rock. These measures while intended primarily to increase volume, also served to fix the location of the creek channel relative to valuable properties.
 - Similarly, tributaries were merged into the urban drainage system either by complete co-option into the sewer system or by partially covered stretches, such as Furnace Brook and Cold Brook (Peck Brook).
 - Greater speed of removal was approached by straightening of channel sections to reduced transit time, and by grading the channel's bottom to a more consistent slope. The Dorwin Drop Structure is a junction between a shallower upper channel and a deeper stream bed elevation. A more consistent grade (slope) of creek bottom shunted potentially catastrophic flood events more quickly through the city, as there was typically little time to prepare for evacuation when flooding was imminent.
- *Water retention or delay* The Onondaga Dam is the largest constructed retention area in the main channel. The flume at Ballantyne is also a form of retention.
- *Shunting of some runoff to the lake via Metro* Combined storm and sanitary sewers (CSOs) route some of the urban storm water to Metro Sewage Treatment Plant, and in heavy rain, release storm water to Onondaga Creek along with sanitary waste

Reduced flood plain area - Storm sewers routinely drain city locations, and their outfall drops into the lowered channel of the creek.

Policy

- Debris removal from the urban creek channel avoids damming up of water.
- Rural Best Management Practices (BMP)

STRUCTURE:	Onondaga Flood Control Structure (Dam) [1949]	Nedrow Channel [1963]	Dorwin Drop Structure [1950]	Channel from Dorwin Ave. to Ballantyne Rd. [1950]	Channel Sections from Ballantyne to Onondaga Lake
DESIGN	City of Syracuse, Chief Engineer Glenn D Holmes, and US Army Corps of Engineers (USACE)				City of Syracuse
CONSTRUCT	Subcontractors				City of Syracuse
WATER LEVEL MONITOR	USGS, NYS DEC		USGS		USGS
MAINTAIN	NYS DEC	NYS DEC	NYS DEC		City of Syracuse
JURISDICTION	Onondaga Nation	New York	New York	Syracuse	Syracuse

Table 1. Management history of the flood control structures

Current effectiveness of flood control measures

Specific flood control structures built by 1963 are presumed structurally sound at this time although an engineer's report of the whole has not been found to date. The effectiveness of each component is related to the hydrology of the whole system.

Valley Area and Nedrow Floods in the 1950s occurred after some of the structures were in place. The Onondaga Creek Dam (1949) followed by the Dorwin drop structure (1950) and the straightened channel from Dorwin Ave. to Ballantyne Rd. (1950) were built to reduce floods in the more densely populated sections of city of Syracuse, further downstream. The Dorwin Avenue drop structure connected a shallower natural section of the creek upstream to the deeper dredged-out channel from Dorwin Avenue to Ballantyne Road (Pollard, 1960). The Dorwin section can carry water at 6000 cubic feet per second, an increased in-channel flow capacity, while it reduces the storage of water in the flood plain. Ironically, the channel's presence combined with the dam to prompt homebuyers and developers in the 1950s to feel safe to occupy the flood plain. Between 1950 and 1960, eighteen floods occurred in the recently-built residential areas near the creek in Nedrow and Syracuse's Valley section (Pollard, 1960). In 1963, the construction of a newer Nedrow section of channel upstream of Dorwin Ave. to the border of the Onondaga Nation further reduced flood plain holding capacity, while increasing in-channel flow capacity. Data on more recent flooding in the Nedrow and Valley areas has not been located to date.

Syracuse Neighborhood Flood in 1974. Heavy thunderstorms fell on the region in early July 1974; the creek channel near Kirk Park overflowed into a residential neighborhood. Factors involved were rapid urban runoff and very heavy rain that combined to be in excess of the design capacity. Urban rain runoff typically reaches the creek quickly (as shown in flashy hydrograph patterns). Although the dam upstream delays flow from the upper watershed, it had no effect on rain that fell directly on the city. The 1970s were a period of heavier precipitation and saturated soil conditions in the region. Those factors combined with a heavy multi-day rainfall to produce localized flooding, even though control measures were in place.

Tributary Floods in 1996. In 1996, also after heavy rain, sections of the creek's two main branches, both upstream of the dam, overflowed into occupied areas previously identified as flood plain. This is a further indication that population has spread into more flood-prone areas, in ways that were not fully anticipated in 1927 plans or the latest 1963 construction.

Current policies affect flood control. The City of Syracuse conducts debris removal from the urban channel, and has been proceeding with construction of catchment areas, including Kimber Brook and Valley Drive area. Two other policies positively affect flood control, but are not specifically identified for this purpose. The Onondaga County Soil and Water Conservation District promotes agricultural Best Management Practices (BMP) upstream of the dam, including management of runoff. The New York State Department of Environmental Conservation (NYSDEC) has a multi-decade reforestation policy which has supported the great recovery of the Onondaga Creek watershed from a mere 8% forest cover in 1930 to 53% forest cover in 1997.

Whole system effectiveness Few episodes of flooding have occurred in the past four decades that followed the last channelization construction in 1963. An unpublished thesis on the hydrology of the dam has shown that the dam is essential to flood control in the current hydrologic system, although alternate measures could be developed to maintain effectiveness if the dam were to be removed (Higgins, 2005).

IMPLICATIONS

Shifting factors are a consideration in looking to the future

- Heavy precipitation pattern occurred in the 1970s and may occur again.
- Population spread, or "suburbanization," continues to occur in flood-prone areas above and below the dam.
- The constructed components in the system are ageing.
- Forest protection is voluntary at this time so the conservation of a forested watershed is uncertain.

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This fact sheet and additional information about the Onondaga Creek Revitalization Plan project can be found on the World Wide Web at www.esf.edu/onondagacreek/.