GREAT SWAMP WATERSHED ASSOCIATION

2018

Water Quality Report Card

Great Swamp Watershed Association

WATERKEEPER® ALLIANCE AFFILIATE

Protecting the waters of the Passaic River region, from source to sea.

Acknowledgements

The 2018 Water Quality Report Card represents a year of hard work and dedication by the GSWA staff and our amazing team of volunteers. The GSWA Stream Team works tirelessly throughout the year to collect the data that is the backbone of all the we do here at the Great Swamp Watershed Association. GSWA was also privileged to host several college and high school interns in 2018 who also assisted in collecting and collating our water quality data. These volunteers and interns go out throughout the year, in all types of weather, to assist in collecting chemical samples for water quality data, macroinvertebrate samples, and to observe, through the NJDEP Visual Assessment protocols, miles of streams and track any changes that may be affecting them. I would like to take this opportunity to thank all of them for without their support and wealth of local knowledge about the watershed this report would not be possible. Special thanks to Roger Edwards for his assistance with data analysis and organization and to Kristina Necovska for her work on our new watershed maps.

Figure 1: Education Associate Adam Palmer, volunteer John Kramer, and WPU Intern Chris Gocklin sampling on the Passaic River

The 2018 water quality program was funded in part by a generous grant from **The Watershed Institute.**

Great Swamp Watershed Association would like to sincerely thank our members, corporations, and foundation supporters whose generous contributions helped fund our water quality monitoring programs in 2018. It is the support of GSWA members that makes the work we do possible. Thank you!

Report Prepared by Sandra LaVigne

Cover Photo – Silver Brook at the GSWA Conservation Management Area – Adam Palmer

Great Swamp Watershed Association

The Passaic River WATERKEEPER® ALLIANCE Affiliate

Table of Contents

Introduction to the Great Swamp Watershed and the Passaic River

The Great Swamp Watershed is a 55-square mile region in Morris and Somerset Counties that includes portions of ten towns (Bernards, Bernardsville, Harding, Chatham Township, Long Hill, Madison, Mendham Township, Mendham Borough, Morris Township, and Morristown). There are approximately 138,000 people living in these towns, with about 38,000 residing in the Great Swamp Watershed.

There are five main streams in the Great Swamp Watershed: Black Brook, Loantaka Brook, Great Brook, Primrose Brook, and the headwaters of the Passaic River. The first four streams flow through the Great Swamp National Wildlife Refuge and then join with the Passaic River before it leaves the watershed through Millington Gorge. Downstream of the Great Swamp Watershed, the Passaic River flows for a further ~70 miles and provides drinking water for over two million people. GSWA, with our expanded mission has begun to monitor this important resource as well as the historic Great Swamp watershed area.

Land uses in the Watershed vary from parks and forested areas to residential neighborhoods and commercial areas. Developed areas typically have the greatest impact on our streams. Large areas of impervious surfaces such as roads, roofs, and parking lots, do not allow rain water to soak into the ground. Instead, precipitation falling on these surfaces "runs off," picking up any pollutants in its path, such as animal waste, trash, motor oil, and more. Stormwater runoff, as it is often called, flows across impervious surfaces directly into the nearest stream, or into a storm drain, which eventually empties to a stream. Mown grassy areas like lawns and golf courses are also relatively impervious and contribute to runoff often adding excess fertilizers (nutrients) to our waters.

Stormwater runoff is the primary way that Watershed streams become impaired. Natural areas such as forests, wetlands, and meadows reduce runoff dramatically and allow precipitation and stormwater runoff to soak into the ground. These areas help to filter and clean the water before it reaches our streams.

The 2018 Water Quality Report Card

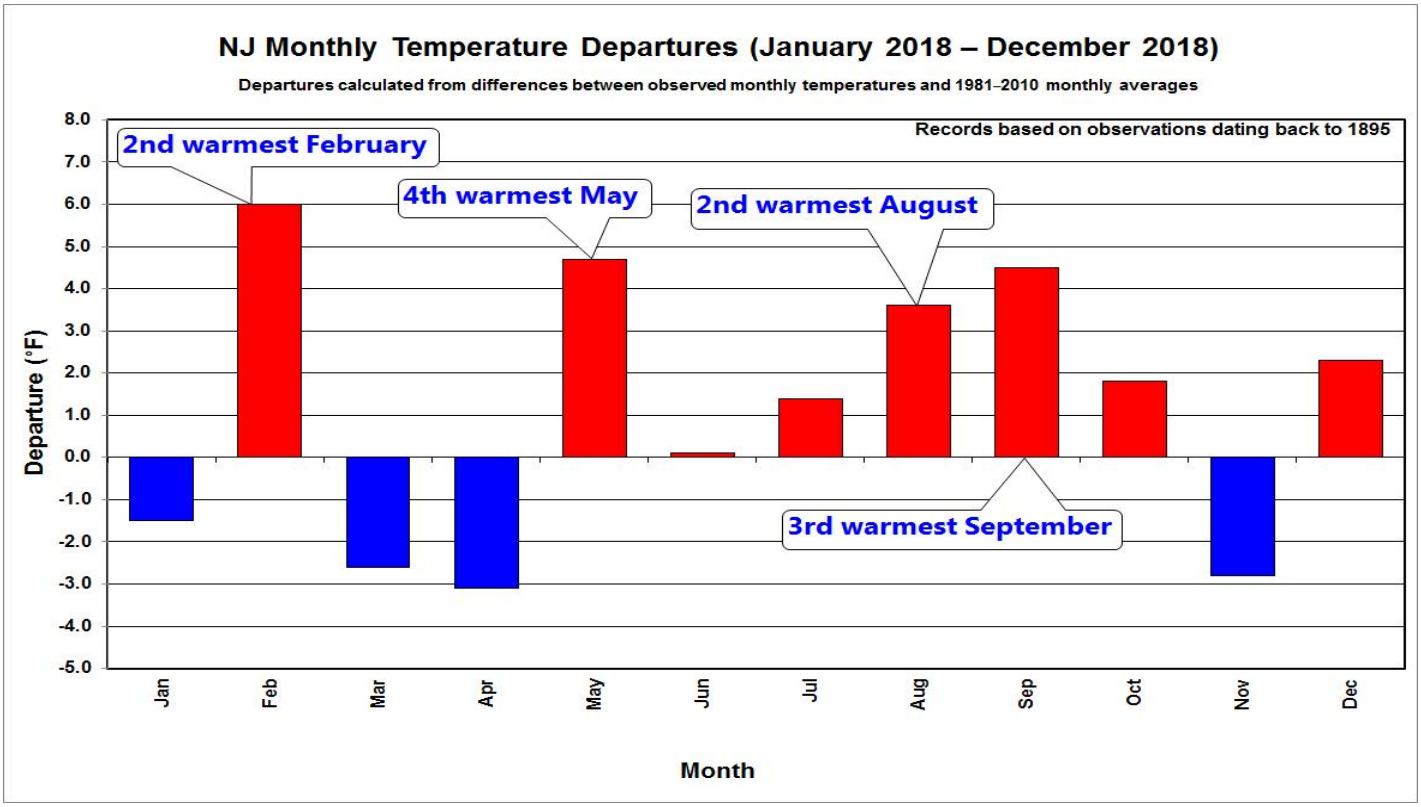
The 2018 Water Quality Report Card reviews all the monitoring data collected by staff and volunteer citizen scientists throughout the year. In 2018, GSWA continued our new expanded Passaic River monitoring program and added a new, downstream site in Livingston, for a total of 5 sites below Millington Gorge. We continued the monitoring of our historic range with a minimum of two chemistry sampling site on each of the four tributaries as well as the headwaters of the Passaic River.

Our sampling expansion, including our newest site, located off Columbia Turnpike in Livingston, was designed to collect baseline data for the region immediately downstream of the Great Swamp Watershed outlet (Millington Gorge). The plan for this project is to sample the same 4 (now 5) sites for three years collecting data to help us better understand the issues impacting the river in this area. With this data we hope to work with the local communities to protect and improve water quality conditions along the upper Passaic River and to build an understanding of how each region of the river differs.

Each of the five Great Swamp Watershed streams is assessed separately in this report card, with each area being referred to as a sub-watershed. Data collected at the Millington Gorge sampling site, the outlet of the Great Swamp Watershed, is also graded separately and is considered to be representative of the quality of the water, with all five streams combined, as it forms the upper Passaic River and heads downstream. Finally, the five new sites will be treated as the Upper Passaic sub watershed. The data from these sites will be broken into three areas within the downstream range with each area graded accordingly. For the 2018 report card we have updated our watershed maps to better show the areas of each sub-watershed and our new expanded region.

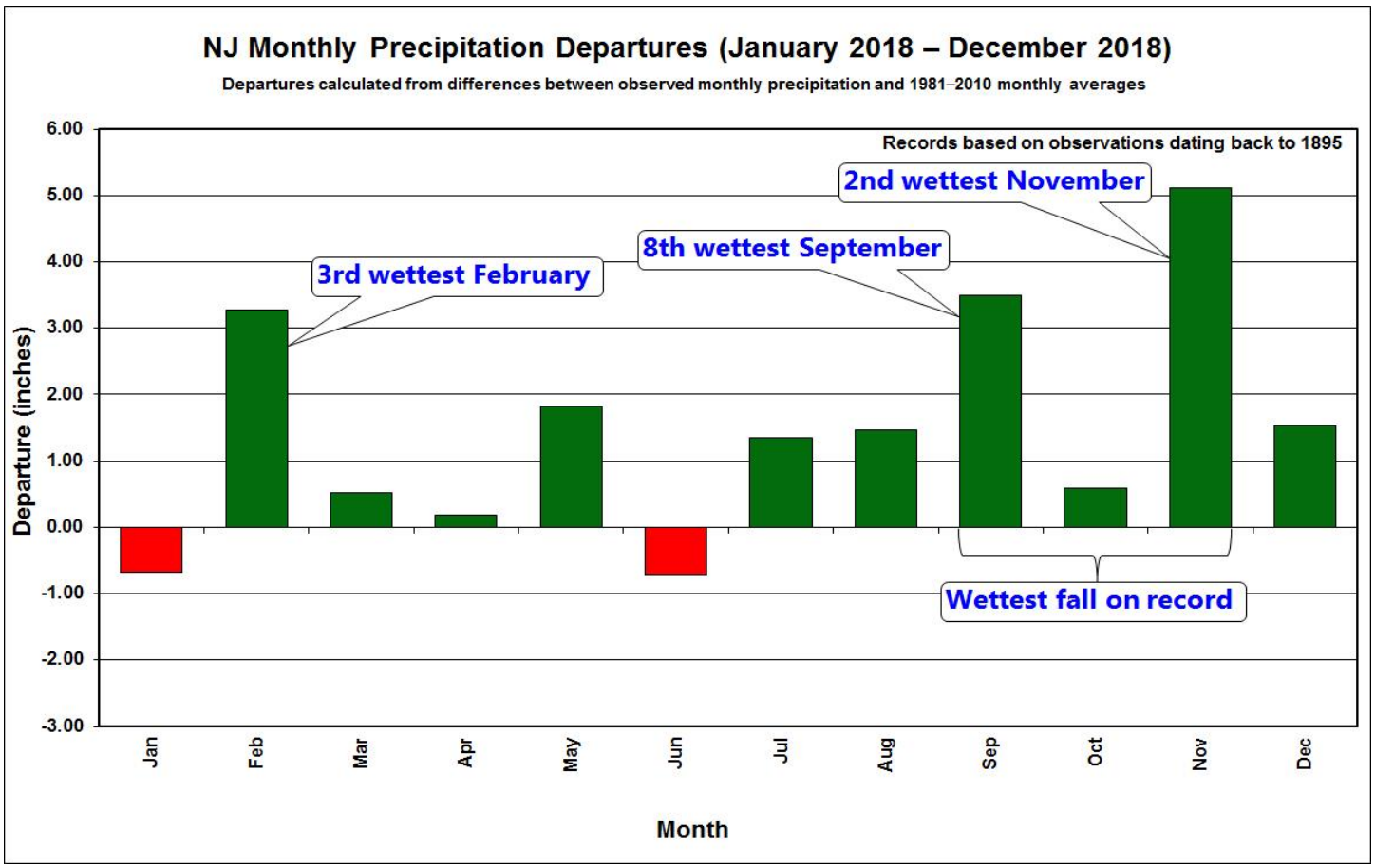
Climate and Water Quality

Overall climate, air temperatures and precipitation, have a significant impact on the water quality throughout the Passaic River region. In 2018, we continued to see warming trends in the area with four months, February, May, August, and September, reaching highs which ranged from the 4th to the 2nd warmest on record in the State of New Jersey for each month (see below). Extended warm temperatures from mid-summer into fall impacted water temperatures and, correspondingly, the amount of dissolved oxygen in the water. Higher temperatures mean less oxygen is available to the aquatic life that live in our streams. Though February was exceptionally warm, March and April were unseasonably cool with heavy, late season snows impacting most of the area in early April. This disparate weather pattern can impact early breeding species as well as spring vegetation along the stream banks.



Precipitation in 2018 was also significantly above the normal levels with ten out of twelve months recorded as above average rainfall. Of note, February and November were the 3rd and 2nd wettest on record respectively. Finally, as noted on the graph

below, 2018 had the wettest fall on record in NJ. Stormwater runoff following many of the rain events caused flooding throughout the area. The runoff also impacted water quality, carrying loose soil and non-point source pollutants into the streams. Many of the rain events throughout the year produced significant rainfall over a short duration. This can cause issues of erosion within the stream channels and can also disrupt sensitive macroinvertebrate habitats. In areas where the buffer zone (the vegetated area surrounding waterways) is impaired or missing the effects of heavy rains is exacerbated. The USGS flow monitoring station at Millington Gorge, the watershed outlet, recorded the average daily flow at the gorge in 2017 as 151 Megaliters. In 2018, the average daily flow was measured at 345 megaliters, more than double the previous year.



How the 2018 Report Card Grades were Created

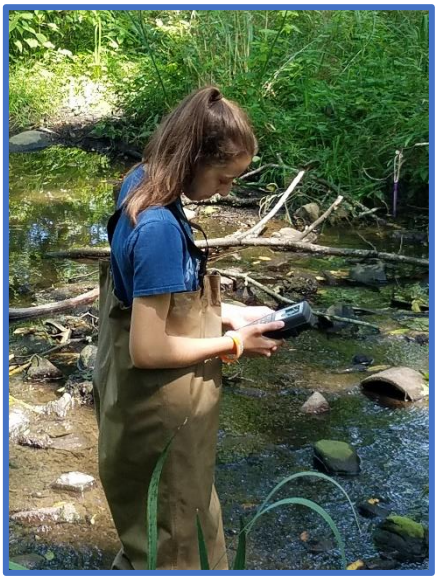
Grading scales are based on New Jersey Department of Environmental Protection (NJDEP) or U.S. Environmental Protection Agency (EPA) standards when applicable. For categories without such standards, grading scales are based on ecological impact and previous GSWA data.

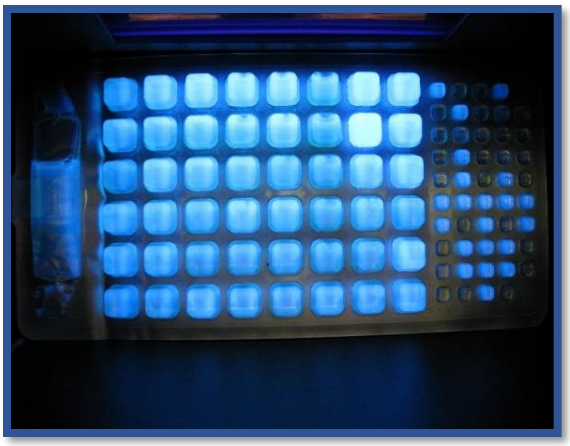
For clarity on the changes happening throughout the watershed, the 2018 report card includes data from 2016 through 2018 on the individual sub-watershed pages for each region. The Upper Passaic River page contains only data from 2017 and 2018 as GSWA sampling of this area only began in 2017.

Water Quality Parameters

The following water quality parameters were considered in grading streams in the Great Swamp Watershed, along with suggestions for reducing their impact.

Dissolved oxygen is just what it says: the amount of oxygen dissolved in the water. Just like humans, aquatic life needs oxygen to survive. Poorly oxygenated water can harm and even kill animals that live in the water. Dissolved oxygen is introduced into streams from contact with the air, aquatic plants, and in places of stream turbulence such as waterfalls and shallow, rocky areas (also known as riffles). Low dissolved oxygen can be caused by algal blooms, high water temperatures, and slow flowing water (for example, due to impoundments). To help keep dissolved oxygen levels high in streams, you can plant trees near stream banks to shade the stream and keep water temperatures cool.





E. coli is a type of bacteria normally found in the intestines of mammals (including humans) and birds. Most strains of *E. coli* are harmless but can indicate the presence of fecal matter, which may contain harmful viruses. No natural body of water will be entirely free of *E. coli* because of the animal life surrounding it, but high levels can indicate fecal contamination which could be due to a failing septic system, broken sewer pipe, wildlife, or stormwater runoff carrying fecal matter deposited by wildlife and pets on land into the water. *E. Coli* data was used to score the bacteria level of each subwatershed. One easy way to reduce *E. coli* levels in local streams is always to pick up after your dog, even in your yard. Remember stormwater runoff flowing from your yard eventually winds up in a water body. If you have a septic system, be sure to perform regular maintenance on it to ensure that it is working properly.

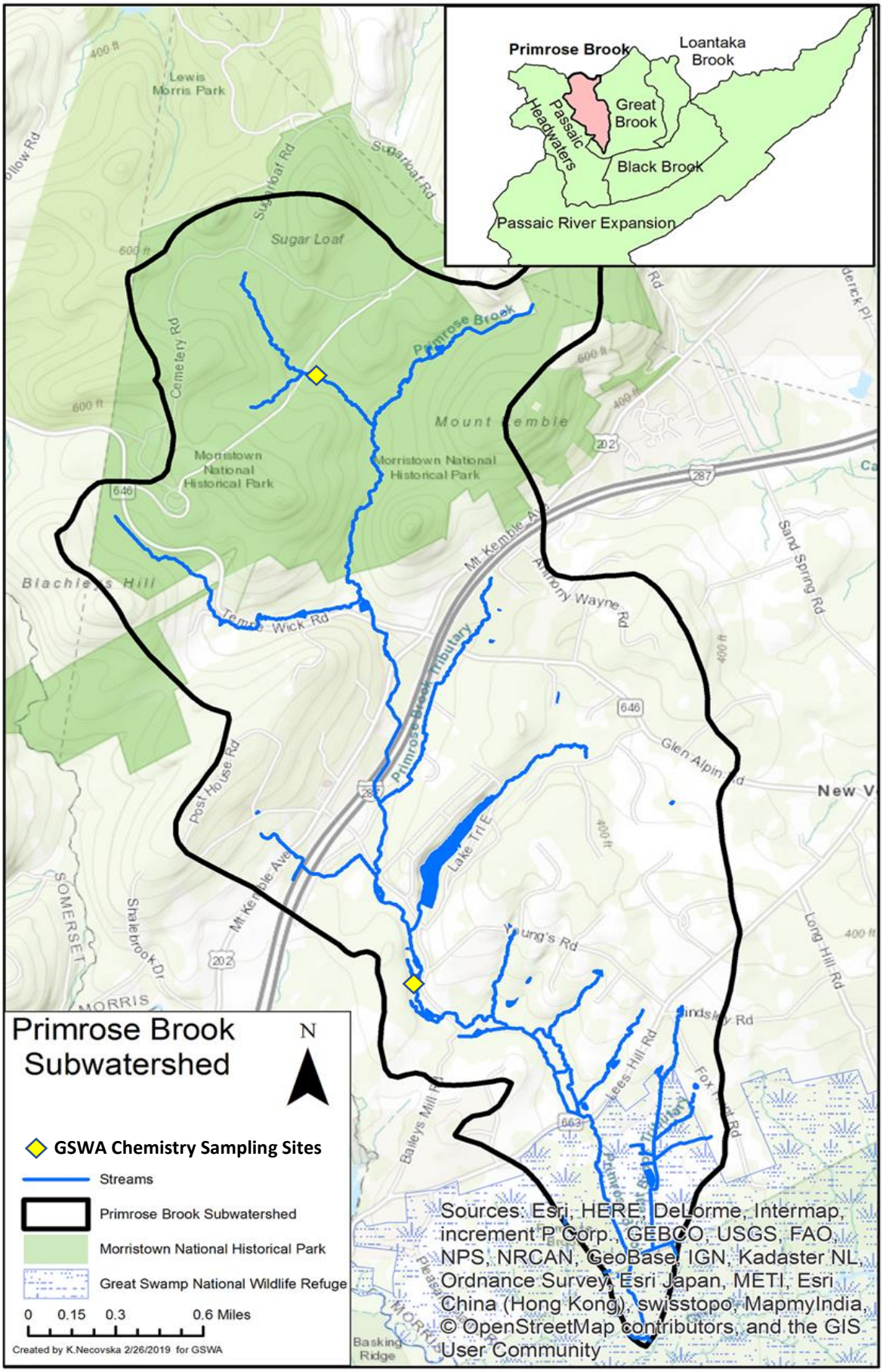
Macroinvertebrates are small animals without backbones that live in the water, such as crayfish, insect larvae, and worms. These creatures can be used as a marker of water quality since some types of macroinvertebrates need high quality water and others can tolerate different levels of water pollution. The macroinvertebrates have life spans of anywhere from a few weeks to a few years, so the presence (or absence) of different types of macroinvertebrates tells the recent history of the water quality in the stream. While we think of the chemical data as a snapshot of what is happening in the stream at the moment of collection, macroinvertebrate data helps us see long term effects of water quality. Some of the factors that influence the variety and quantity of macroinvertebrates in streams include water temperature, dissolved oxygen, nitrogen, phosphorus, road salt, and aquatic habitats. Macroinvertebrates are a food source for fish, birds, and other wildlife. *Water Quality Parameters continued on page…27.*

Primrose Brook

The Primrose Brook sub-watershed is the second smallest at just over 5 square miles. It is comprised of primarily forested land (58%), with an additional 30% of its area developed. The upper reaches of the stream begin in and near the Jockey Hollow section of Morristown National Historical Park, and the stream traverses a relatively rural and suburban landscape to its outlet in the Great Swamp National Wildlife Refuge. An unnamed tributary, referred to by GSWA as the Mount Kemble Lake tributary, begins upstream of Mount Kemble Lake, flows into the Lake and then into the main stem of Primrose Brook. Primrose Brook is considered the healthiest stream in the Great Swamp Watershed, and two segments are classified as Category 1 by NJDEP, one of the highest stream classifications given by the State of New Jersey.

Category	Primrose Brook (Main Stem)		
	2016	2017	2018
Macro-invertebrates	Good ↑	Good ↓	Good ↑
Visual Stream Assessment	Good ↓	Good ↓	Good ↑
Bacteria	Poor ↓	Poor	Poor
Dissolved Oxygen	Excellent ↑	Excellent ↑	Excellent ↑
Water Temperature	Excellent ↑	Excellent ↑	Excellent
pH	Excellent	Excellent	Excellent
Road Salt	Excellent ↑	Excellent ↑	Excellent
Water Clarity	Excellent ↑	Excellent ↑	Excellent
Nitrogen	Excellent	Excellent ↓	Excellent
Phosphorus	Excellent	Excellent ↑	Excellent

Comments – In 2018, data collected showed increasing sedimentation in the upper reaches of Primrose Brook. This area saw a decrease in water clarity and lower overall visual assessment scores than in previous year. Though the stream remains a excellent example of a pristine habitat with minimal changes in the macroinvertebrate population, continued heavy rain with no improvement of the buffer zone could cause…*continued on page:* 26

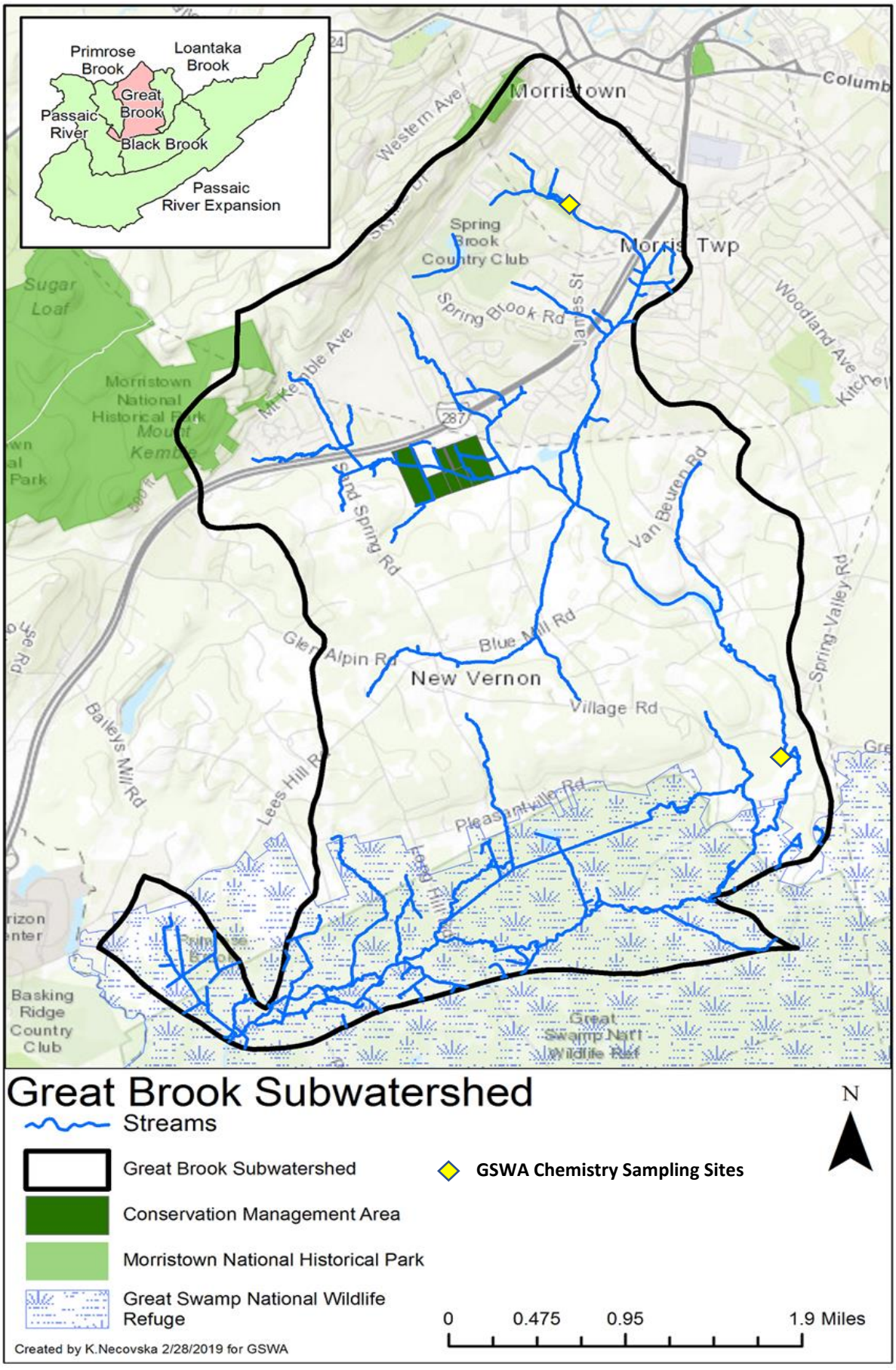

Primrose Brook
Loantaka Brook
Great Brook
Passaic Headwaters
Black Brook
Passaic River Expansion
Primrose Brook Subwatershed
N
GSWA Chemistry Sampling Sites
Streams
Primrose Brook Subwatershed
Morristown National Historical Park
Great Swamp National Wildlife Refuge
0 0.15 0.3 0.6 Miles
Created by K.Necovska 2/26/2019 for GSWA
Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
Lewis Morris Park
Sugar Loaf
Primrose Brook
Cemetery Rd
Mount Kemble
Morristown National Historical Park
Blachleys Hill
Temple Wick Rd
Mt Kemble Ave
Anthony Wayne Rd
Primrose Brook Tributary
Post House Rd
Lake Tri E
Young's Rd
Glen Alpin Rd
Sand Spring Rd
Long Hill Rd
Lees Hill Rd
Baileys Mill Rd
Basking Ridge
SOMERSET
MORRIS
Shalebrook Dr

Great Brook

The Great Brook subwatershed encompasses almost 13 square miles of predominantly developed land (40%), with a mix of forest (26%), wetlands (24%), and agriculture (9%). Great Brook originates in four locations, with the main stem beginning in Morris Township at Spring Brook Country Club. Silver Brook, a tributary, begins in Morris Township and flows through Harding, including GSWA's Conservation Management Area. Bayne Brook, another tributary, flows through Harding's Bayne Park. The two tributaries meet east of James St. in Harding, and flow shortly thereafter into the main stem of Great Brook. After its urban and suburban origins, Great Brook passes through protected lands scattered among suburban and rural landscapes until it enters the Great Swamp National Wildlife Refuge.

Category	Great Brook (Main Stem)			Silver Brook		
	2016	2017	2018	2016	2017	2018
Macro-invertebrates	Poor ↑	Good ↑	Poor ↓			
Visual Stream Assessment	Good ↓	Good ↓	Good ↑	Poor ↑	Poor ↑	Poor
Bacteria	Very Poor ↓	Very Poor ↑	Very Poor ↑	Very Poor ↓	Very Poor ↓	Poor ↑
Dissolved Oxygen	Excellent ↑	Excellent ↑	Excellent		Good	Good
Water Temperature	Excellent ↓	Excellent ↓	Excellent	Excellent	Excellent	Excellent ↓
pH	Excellent	Excellent	Excellent		Good	Good
Road Salt	Good ↑	Good ↑	Poor ↓			
Water Clarity	Good ↓	Good ↓	Poor ↓			
Nitrogen	Good	Poor ↓	Very Poor ↓			
Phosphorus	Good	Good	Good			

Comments – Great Brook saw an increase in nitrogen levels in 2018 near Foots Pond in the upper reach of the stream. Foots Pond is a very shallow basin near the headwaters of Great Brook, heavy rain fall can cause flushing of the sediment from such ponds increasing nutrient levels downstream. Increased sedimentation was noted at the downstream sampling site likely due to erosion from increased flow volumes. Both the increased *continued on page*: 26

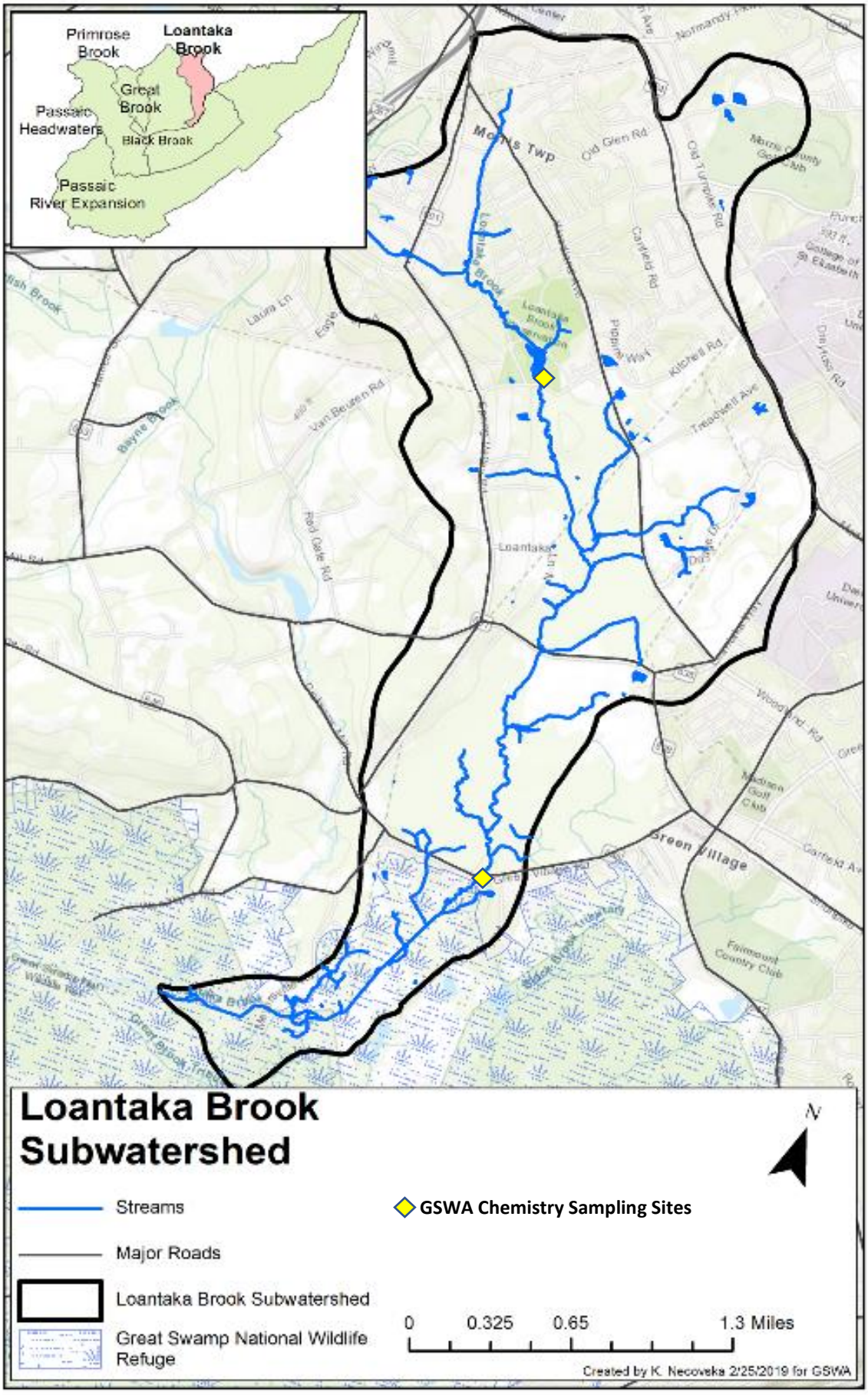

Primrose Brook
Loantaka Brook
Great Brook
Passaic River
Black Brook
Passaic River Expansion
Morristown
Morris Twp
Spring Brook Country Club
Spring Brook Rd
James St
Western Ave
Woodland Ave
Sugar Loaf
Morristown National Historical Park
Mount Kemble
Mt Kemble Ave
287
Sand Spring Rd
Van Beuren Rd
Spring Valley Rd
Glen Alpin Rd
Blue Mill Rd
New Vernon
Village Rd
Baileys Mill Rd
Lees Hill Rd
Pleasantville Rd
Basking Ridge Country Club
Great Swamp Natl Wildlife Ref
Great Brook Subwatershed
Streams
Great Brook Subwatershed
GSWA Chemistry Sampling Sites
Conservation Management Area
Morristown National Historical Park
Great Swamp National Wildlife Refuge
N
0
0.475
0.95
1.9 Miles
Created by K.Necovska 2/28/2019 for GSWA

Loantaka Brook

At just over 5 square miles, Loantaka Brook is the smallest subwatershed. With its headwaters in Morristown and Morris Township, most of the land in the subwatershed is developed (53%), which tends to have a negative impact on the stream. There are however, significant areas of wetlands (21%) and forest (19%). Shortly downstream from its origins, Loantaka Brook flows past mown fields, Morris Township's Ginty Pool, Seaton Hackney Stables (where GSWA completed a 3-year remediation project), and the Woodland Water Pollution Control Utility (wastewater treatment plant). Any of these sites may contribute to stream impairment through potential input of nutrients, bacteria, and chemicals. Below the headwaters region, Loantaka Brook continues into Morris County Park Commission's Loantaka Brook Reservation. Within the park, the stream is dammed at Kitchell Pond, and then continues downstream through Green Village and into the Great Swamp National Wildlife Refuge. Over the last few years GSWA volunteers and staff have worked with Morris County Park Commission to improve the buffer zone around Kitchell Pond and to remove invasive aquatic plants from the pond itself to help improve water quality in this area.

Category	2016	2017	2018
Macro-invertebrates	Poor ↑	Poor ↑	Poor
Visual Stream Assessment	Good ↓	Good ↓	Good ↑
Bacteria	Very Poor ↓	Very Poor	Very Poor ↑
Dissolved Oxygen	Excellent ↑	Excellent ↑	Excellent
Water Temperature	Excellent ↓	Excellent ↓	Excellent
pH	Excellent	Excellent	Excellent ↓
Road Salt	Poor ↑	Poor ↑	Poor
Water Clarity	Good	Good	Good
Nitrogen	Very Poor	Very Poor ↓	Very Poor ↑
Phosphorus	Poor ↑	Poor ↑	Poor

Comments – In 2018, Loantaka Brook saw significant changes in the stream channel below Kitchell Pond. High water levels and flooding in February caused a large tree trunk, which had previously transected the stream bed just below the outflow of the pond, to shift downstream and parallel to the bank. This released a significant amount of sediment, that had built up behind the trunk, further down into the main stream bed. Then in April, during the heavy snow, *continued on page:* 27

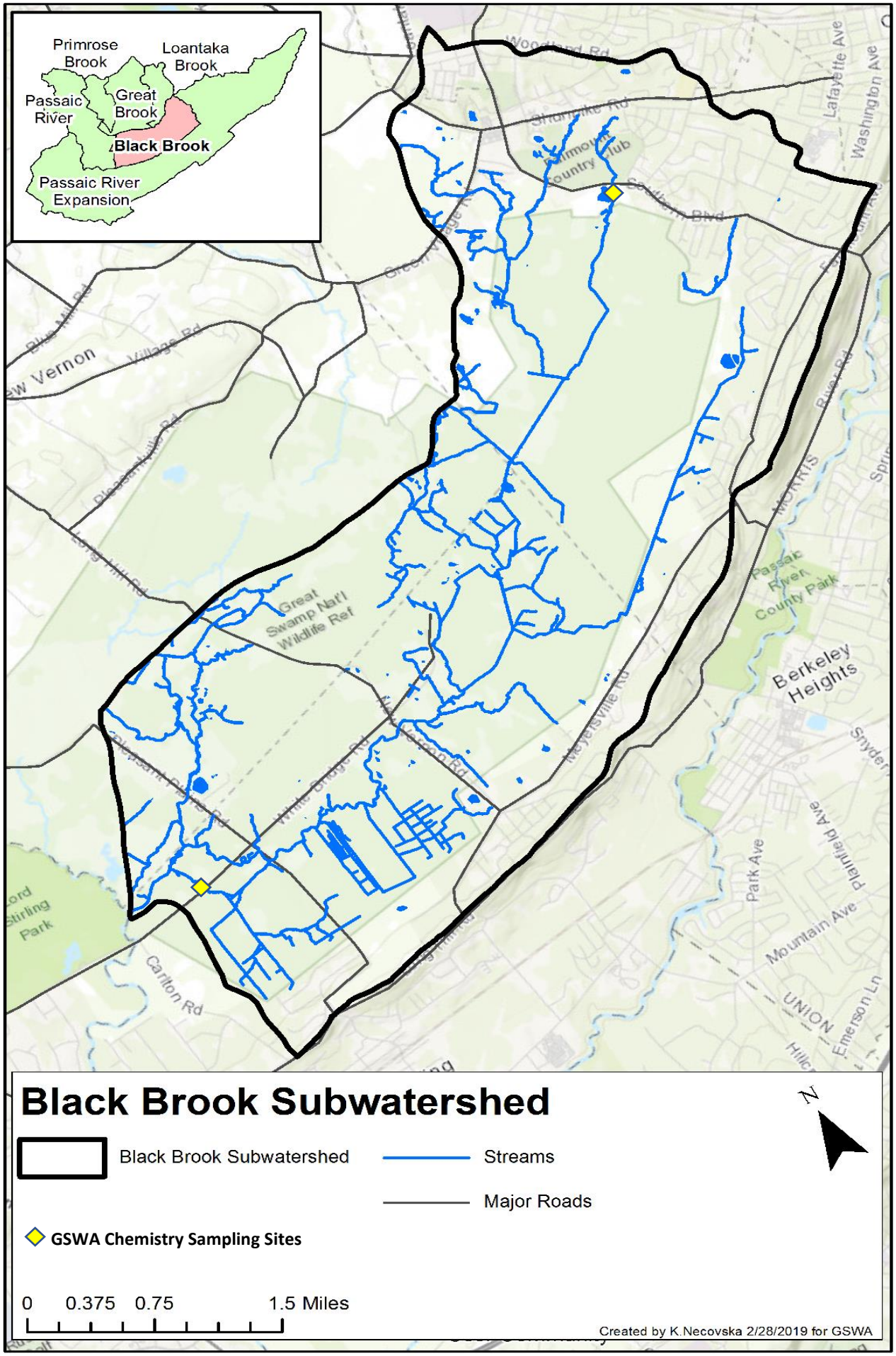

Primrose Brook
Loantaka Brook
Great Brook
Passaic Headwaters
Black Brook
Passaic River Expansion
Morris Twp
Old Glen Rd
Carfield Rd
Kitchell Rd
Van Beuren Rd
Loantaka Brook
Green Village
Fairmount Country Club
Madison Golf Club
Loantaka Brook Subwatershed
N
Streams
GSWA Chemistry Sampling Sites
Major Roads
Loantaka Brook Subwatershed
Great Swamp National Wildlife Refuge
0
0.325
0.65
1.3 Miles
Created by K. Necoveka 2/25/2019 for GSWA

Black Brook

Black Brook, the second largest subwatershed in the Great Swamp Watershed with over 14 square miles, lies primarily within the Great Swamp National Wildlife Refuge. Reflective of this, wetlands are the predominant land cover (59%). Outside of the Refuge, much of the subwatershed is developed (27% total). The headwaters of Black Brook include several branches which begin in the developed areas of Chatham Township, with two originating in the Fairmount Country Club. After entering the Refuge, the branches converge and continue their course until entering the Passaic River. At sites near White Bridge Road within the Refuge, the stream has taken on a darker "tea colored" appearance due to the decomposition of organic matter in the stream. Black Brook is a low gradient stream, meaning the elevation difference between the headwaters and the stream's outlet is relatively low. This causes the stream to generally have a slow flow.

Category	2016	2017	2018
Macro-invertebrates	Poor ↑	Poor	Poor ↑
Visual Stream Assessment	Good	Good	Good ↑
Bacteria	Very Poor ↑	Very Poor ↑	
Dissolved Oxygen	Good ↑	Good ↑	Good
Water Temperature	Excellent ↑	Excellent ↓	Excellent
pH	Good ↓	Good ↓	Excellent ↑
Road Salt	Good ↑	Good ↑	Good ↑
Water Clarity	Excellent	Excellent	Poor ↓
Nitrogen	Poor ↑	Good ↑	Good ↓
Phosphorus	Poor ↑	Poor ↑	Poor

Comments – Macroinvertebrate sampling in Black Brook showed a significant improvement in the diversity and density of the population at the downstream location. Visual assessments in that area also indicated improvement in the vegetated buffer zone along the brook. However, upstream clarity decreased likely due to erosion from heavy runoff from storms. Non-point pollution from stormwater runoff is also the likely source of the increased nitrogen levels. Black brook is one of.. *continued on page*: 28


Primrose Brook
Loantaka Brook
Passaic River
Great Brook
Black Brook
Passaic River Expansion
Great Swamp Nat'l Wildlife Ref
Berkeley Heights
New Vernon
Passaic River County Park
Carlton Rd
Mountain Ave
Park Ave
Meyersville Rd
White Bridge Rd
Lafayette Ave
Washington Ave
Woodland Rd
Shunpike Rd
Green Village Rd
Blue Mill Rd
Village Rd
Pleasantville Rd
River Rd
Plainfield Ave
Emerson Ln
Black Brook Subwatershed
Black Brook Subwatershed
Streams
Major Roads
GSWA Chemistry Sampling Sites
N
0 0.375 0.75 1.5 Miles
Created by K.Necovska 2/28/2019 for GSWA

Great Swamp Watershed

Stream		Macro-invertebrates	Visual Stream Assessment	Bacteria	Dissolved Oxygen
Black Brook		Poor ↑	Good ↑		Good
Great Brook (main stem)		Poor ↓	Good ↑	Very Poor ↑	Excellent
	Bayne Brook			Excellent ↑	
	Silver Brook		Poor	Poor ↑	Good
Loantaka Brook		Poor	Good ↑	Very Poor ↑	Excellent
Primrose Brook (main stem)		Good ↑	Good ↑	Poor	Excellent ↑
Passaic River (Headwaters)		Good ↑	Good		Excellent ↓
	Indian Grave Brook	Excellent ↑	Excellent		
Passaic River Watershed Outlet		Poor ↑	Good	Very Poor ↑	Excellent
Passaic River (Upper Passaic)					
	Millington (below outlet)	Good	Poor ↑	Very Poor ↑	Excellent ↑
	Berkley Hts (below Dead River)		Very Poor	Very Poor	Excellent
	Summit through Livingston		Poor	Very Poor ↑	Excellent ↓

	KEY				
	correspond with the grade not the measurement				
	Excellent	Good	Poor	Very Poo	NO Data

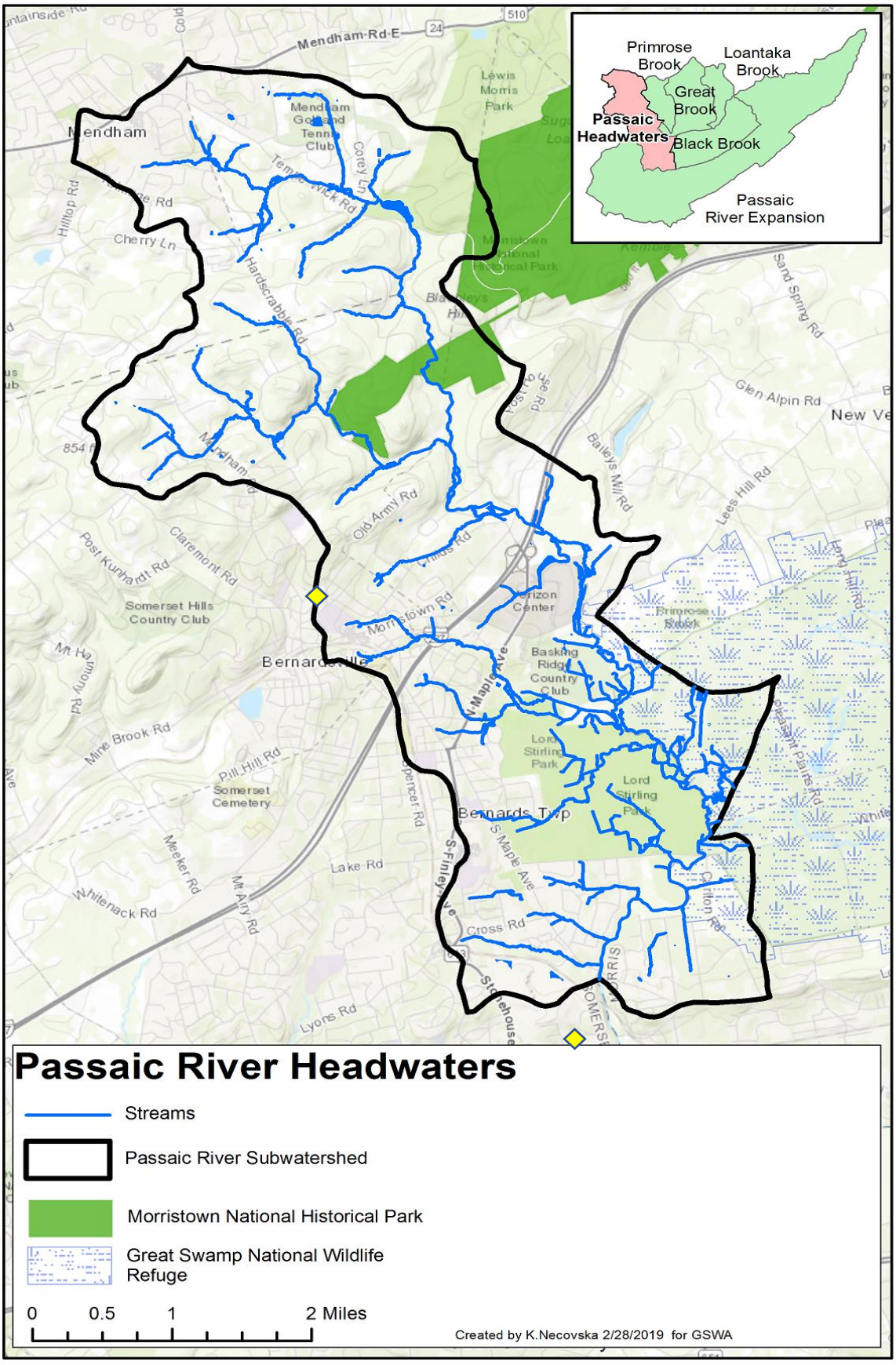
Water Quality Report Card

Water Temperature	pH	Road Salt	Water Clarity	Nitrogen	Phosphorus
Excellent	Excellent ↑	Good ↑	Poor ↓	Good ↓	Poor
Excellent	Excellent	Poor ↓	Good ↓	Very Poor ↓	Good
Excellent					
Excellent ↓	Good				
Excellent	Excellent ↓	Poor	Good	Very Poor ↑	Poor
Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Excellent ↑	Excellent ↓	Excellent ↑	Good ↓	Poor ↓	Excellent
Excellent	Excellent	Excellent ↑	Good ↓	Excellent ↑	Excellent ↑
Excellent ↑	Excellent	Excellent ↑	Poor ↓	Excellent ↑	Good ↓
Excellent	Excellent	Good	Very Poor	Very Poor	Poor
Excellent	Excellent	Poor	Poor	Good ↑	Poor

Passaic River Headwaters

At almost 17 square miles, the Passaic River headwaters subwatershed is the largest within the Great Swamp Watershed. The headwaters of the Passaic River begin in downtown Mendham Borough and Mendham Township, and the river then flows through a heavily forested area before reaching more dense development along Route 202 and I-287. In total, 43% of the headwaters region is developed while 33% is forested. Like Primrose Brook, a segment of the Passaic River (above Osborne Pond) is classified by NJDEP as Category 1, one of the highest stream classifications given by the State of New Jersey. The Passaic River within the Great Swamp Watershed is considered, with Primrose Brook, to be one of the healthiest Watershed streams. Branta Pond, located within the Somerset County Environmental Education Center, flows into the Passaic River downstream of Lord Stirling Road.

Category	Passaic River		
	2016	2017	2018
Macro-invertebrates	Good ↑	Good ↓	Good ↑
Visual Stream Assessment	Good ↑	Good ↑	Good
Bacteria			
Dissolved Oxygen	Excellent ↑	Excellent ↑	Excellent ↓
Water Temperature	Excellent ↑	Good ↓	Excellent ↑
pH	Excellent	Excellent	Excellent ↓
Road Salt	Excellent ↑	Excellent	Excellent ↑
Water Clarity	Excellent ↑	Excellent ↑	Good ↓
Nitrogen	Excellent	Good ↓	Poor ↓
Phosphorus	Excellent	Excellent	Excellent



Comm ch of
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levels f from
roads a

Passaic River – Great Swamp Watershed Outlet

The outlet of the Great Swamp Watershed at Millington Gorge gives a snapshot of the combined water quality of all upstream sites. The results are directly impacting our downstream neighbors, and those whose drinking water comes from the Passaic River. Through 2017, this was the farthest site downstream on the Passaic River that was sampled by the GSWA. Note that some data was collected upstream from Millington Gorge at the Fishermen's Parking Lot on the Passaic River. This site was considered to be a Watershed outlet site since it is below where all major tributaries empty into the main stem of the Passaic River, and data taken there also serves as an indicator of the quality of water leaving the Great Swamp Watershed.

Category	2016	2017	2018
Macro-invertebrates		Poor	Poor ↑
Visual Stream Assessment			Good
Bacteria	Very Poor ↓	Very Poor ↓	Very Poor ↑
Dissolved Oxygen	Excellent	Excellent	Excellent
Water Temperature	Excellent	Excellent	Excellent
pH	Excellent	Excellent	Excellent
Road Salt	Good	Good	Excellent ↑
Water Clarity	Excellent ↑	Excellent ↑	Good ↓
Nitrogen	Excellent	Excellent ↓	Excellent ↑
Phosphorus	Good ↓	Good ↑	Excellent ↑

Comments – In 2018, we collected our initial visual assessment data at this site with the result falling in the good range statistically. Issues in this area include an impaired buffer zone with little shrub and non-woody plants present. This allows runoff to enter the stream from the steep banks at a high velocity with very little filtering. However, the substrate in the area remains good for macroinvertebrate habitat and the low nutrients allow for a healthy population indicating overall good water quality. Bacteria samples, *continued on page 23*

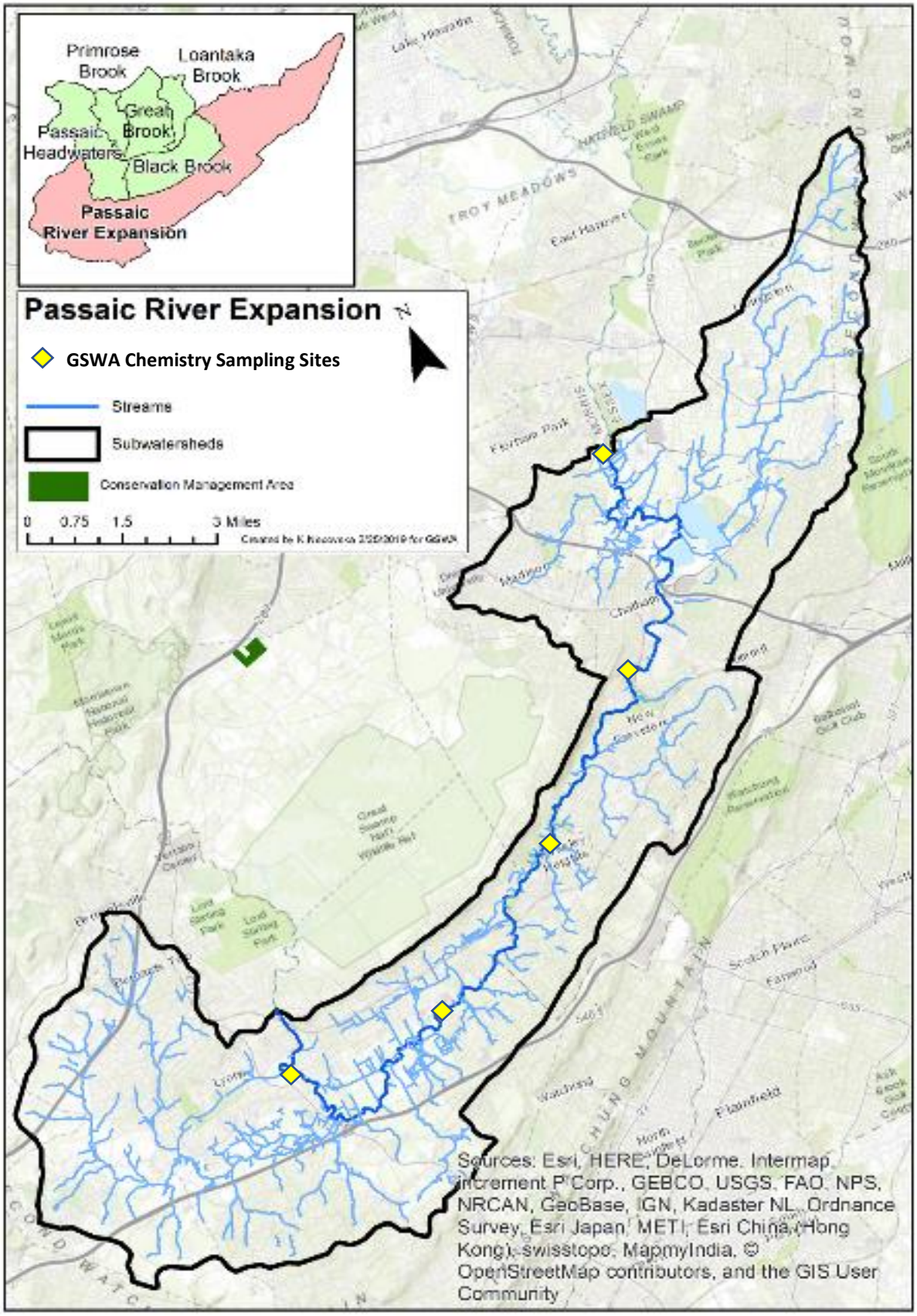
which are collected just upstream from the gorge at the Fisherman's parking lot, improved in 2018. Though the numbers were higher than the NJ State standard, this is not unusual for waters coming through a wetland area where water often moves very slowly, and bacteria break down the vegetative materials. The dumber of bacteria in each sample decreased through the sampling period. As in other areas of the watershed, this is likely due to the high volume of flow through the system due to frequent storms. Dissolved oxygen at the outlet was low for through the fall sampling likely due to the higher than usual temperatures and the exposed, slow moving conditions as the water traverses the Great Swamp area.

Passaic River – Upper Passaic

In 2017 GSWA began collecting data below Millington gorge. Our first year of sampling included four sites along approximately 14.5 miles of the river ending at Stanley Ave in Chatham. In 2018, we further expanded our range along the Passaic River another ~7 miles to Livingston, downstream of Canoe Brook. This expansion was added following elevated nutrient and bacteria levels found during a monitoring trip with a local school. This subwatershed encompasses the inputs from the Dead River, the first major tributary on the Passaic River below the Great Swamp Watershed. The area includes parts of Long Hill, Gillette, Berkeley Heights, New Providence, Chatham, Summit, and now Livingston. It captures the effluent from multiple WWTPs and flows through both industrial areas as well as small areas of protected park lands.

Category	Millington (Below the Gorge)		Berkley Hts (below Dead River)		Stanley to Livingston (downstream of Canoe Brook and Spring Garden Brook)	
	2017	2018	2017	2018	2017	2018
Macro-invertebrates	Good	Good				
Visual Stream Assessment	Poor	Poor ↑	Very Poor	Poor ↑		Poor
Bacteria	Very Poor	Very Poor ↑	Very Poor	Very Poor ↑	Very Poor	Very Poor ↑
Dissolved Oxygen	Excellent	Excellent ↑	Excellent	Excellent		Excellent ↓
Water Temperature	Excellent	Excellent ↑	Excellent	Excellent ↑		Excellent
pH	Excellent	Excellent	Excellent	Excellent		Excellent
Road Salt	Good	Excellent ↑	Good	Excellent ↑		Excellent ↑
Water Clarity	Poor	Poor ↓	Very Poor	Poor ↑		Poor
Nitrogen	Excellent	Excellent ↑	Very Poor	Poor ↑		Good ↑
Phosphorus	Good	Good ↓	Poor	Poor		Poor

Comments – This is the second set of data for the Upper Passaic expansion area. Many of the categories along this stretch of the river improved from the 2017 data. Weather conditions are likely the cause for this overall change. With a significant increase in the amount of flow through the area dilution begins to have an impact, specifically on nutrient levels. Much of the nutrient input in this area comes from point source pollutants like waste water treatment plant discharge. In a year with lower than average… *continued on page* : 28.


Primrose Brook
Loantaka Brook
Great Brook
Passaic Headwaters
Black Brook
Passaic River Expansion
Passaic River Expansion
GSWA Chemistry Sampling Sites
Streams
Subwatersheds
Conservation Management Area
0 0.75 1.5 3 Miles
Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Continued Comments

Primrose Brook Continued - further impacts in this area. Downstream in Primrose Brook, macroinvertebrate sampling showed a significant increase in both diversity and density indicating improved water quality conditions in this area. Dissolved oxygen levels in this area were also slightly better than in 2017. With higher flow volumes the velocity of the water over the cobble in the stream bed helps to increase the amount of available oxygen.

Great Brook Continued - sedimentation as well as an increase in nitrogen levels likely impacted the macroinvertebrate population. In 2017, Silver Brook, the tributary of Great Brook that runs through GSWA's conservation management area, was studied for elevated levels of bacteria. In 2018, GSWA continued to follow up on this issue monitoring a further four sites within the impacted area. The samples collected in 2018 all fell within NJ State limits with the exception of one. With the heavy rainfall during the bacteria sampling season it is possible that the bacteria were diluted by the stormwater. We will continue to monitor this area in 2019 to be sure the issue has been resolved.

Loantaka Brook Continued - a second tree fell across the stream in the same area. Finally, the flooding in September pushed this second tree out of the main flow of the channel as well. The macroinvertebrate habitat in this area was highly impacted by the changes cause by the flooding, first with increased sedimentation and then by a clearing of the loose sediment as flows continued to carry it further downstream. Though not noticeably impacted this year, this may cause changes in the macroinvertebrate population and GSWA will continue to monitor this area to see if the restored flow helps to improve the conditions. Further downstream, we were unable to sample for macroinvertebrates due to high water levels during the sampling period. Bacteria in Loantaka Brook in 2018 was elevated below Kitchell Pond, likely due to the flushing of the shallow pond caused by heavy rains. However, it decreased significantly downstream, after the stream flowed through the more protected reservation area showing that the natural stream processes in this area are functioning.

Black Brook Continued - the slower moving streams in the watershed, as such, the high temperatures in the late summer and early fall impacted both the water temperature and the dissolved oxygen in the stream. Decreased dissolved oxygen levels for prolonged periods of time can impact the aquatic life in the stream.

Passaic River headwaters Continued - region are collected at two ponds within the subwatershed, Branta and Cat Swamp Pond. Both of these water bodies saw a significant decrease in the overall bacteria counts with decreasing quantities through the sampling period of five weeks. This is likely due to flushing of the ponds from the storm events that happened during the sampling period.

Passaic River – Upper Passaic - rainfall, like 2017, the nutrient levels are more concentrated and have a higher impact on the river. In 2018, with much higher than average rainfall the nutrients are diluted by the volume of flow from both upstream and from runoff. Turbidity was similar or slightly worse in many areas due to erosion and sediment carried by stormwater. Finally, due to the high flow volumes, we were only able to collect macroinvertebrate data at one site, our furthest upstream site in Millington. The data collected was very similar to the 2017 data indicating healthy conditions for macroinvertebrate populations.

Water Quality Parameters Continued

Nitrogen is an essential nutrient for plants and animals, so there is naturally some nitrogen in streams. Because it is necessary for plant growth, nitrogen is also found in fertilizer. Too much nitrogen in streams, lakes, and ponds can work like fertilizer for aquatic plants, dramatically increasing plant growth and algal blooms. Algal blooms can compete with other aquatic plants for resources, such as nutrients and sunlight. When algae die off, it can lead to decreases in dissolved oxygen, which can suffocate aquatic animals. Nitrogen can come from many sources and often gets into local water bodies via stormwater runoff. In addition to fertilizer, animal waste (including from humans), and organic material such as leaves also contain nitrogen. You can reduce your impact on nitrogen in streams by picking up after your dog, reducing fertilizer use on your property, and ensuring that your septic system is functioning properly.

pH is a measure of how acidic or alkaline (basic) water is. The pH scale ranges from 0 to 14. Water with a low pH is considered acidic, while a high pH is considered alkaline or basic. Although 7 is considered neutral, streams in our area have an expected pH between 6.5 and 8.5. If the water in a stream is too acidic or basic, fish, plants, and other life forms cannot survive. People at home can reduce the human effect on the pH of streams by conserving energy. Power plants release chemicals into the air which can cause acid rain (which then falls into our streams), so reducing the amount of energy you use in your home reduces the pollution output of the power plants.

Phosphorus, like nitrogen, is an essential nutrient for plants and animals, so it is naturally occurring in streams. Too much phosphorus, like too much nitrogen, can lead to algal blooms. Algal blooms compete with aquatic plants for resources and can kill off those plants and decrease dissolved oxygen in the stream, leaving the water uninhabitable for aquatic life. Phosphorus can come from animal waste, specialized fertilizers, organic matter, and household products such as dish detergent and laundry detergent. To reduce the impact of phosphorus in streams, use household cleaning products that are labeled *phosphate free.* If you use a

service for lawn maintenance, ask them to reduce the amount of fertilizer used on your lawn and to use fertilizers without phosphorus. Though the fertilizers sold to homeowners no longer contain phosphorus, professional landscaping companies are still able to purchase and apply them.

Road salt is the primary pollutant in Great Swamp Watershed streams. Winter use of road salt easily contaminates streams (through runoff from impervious roads, driveways, parking lots, and sidewalks). It can be deadly to aquatic life and plants on stream banks. Fish, insects, and macroinvertebrates often cannot tolerate high levels of road salt and may die when the levels are too high. Non-aquatic animals can also be negatively affected by road salt. As a homeowner, you can help to decrease road salt in the environment by using less or no road salt on driveways and walkways in the wintertime. If you must use salt, apply according to package directions and choose a product that is more environmentally benign. Sodium chloride has the highest environmental impact and should be avoided, while calcium magnesium acetate has the lowest environmental impact. Additionally, support municipal efforts to utilize lower salt alternatives such as brining.

Visual stream assessments are a way of assessing the condition of a stream segment that cannot be easily measured quantitatively. These assessments cover a range of topics, such as tree canopy cover over the stream, the presence of suitable habitats for aquatic life, and nearby land uses which might impact water quality. To learn more about visual assessments and see exactly what data is collected on the data sheet, visit www.GreatSwamp.org.

Water Clarity should be high to allow the plants living in the stream to thrive. Underwater plants serve many purposes in a stream ecosystem, from providing food for animals to oxygenating the water. However, plants need sunlight in order to thrive, and muddy, opaque water does not let light in. Additionally, poor water clarity frequently is a sign of excess sediment which can impact aquatic life by

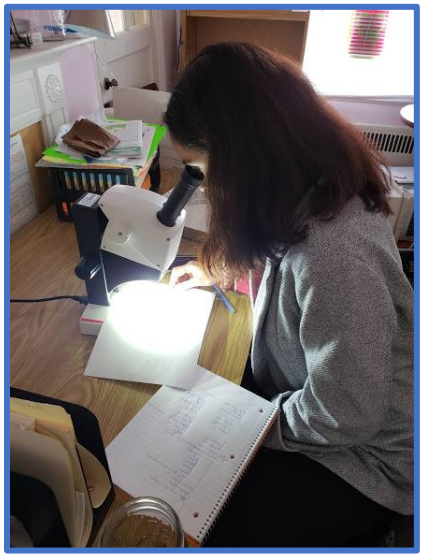
burying stream bottom habitat and making it harder for aquatic life to survive. To help improve water clarity, you can allow natural vegetation to grow along stream banks by planting trees and shrubs or simply reducing or eliminating mowing there. Taller vegetation acts as a filter, catching sediment before it enters the stream. If you have large areas of exposed soil due to construction, use silt fencing to keep it in place.

Water Temperature is critical because the fish, amphibians, and invertebrates that live in streams are cold-blooded, and the temperature of the stream can dictate whether they can survive and thrive. Different species of fish live best in different temperatures of water, and water that is consistently too hot or too cold for the native fauna will not support an ecosystem well. For example, trout are very sensitive to water temperature and cannot live in streams that are too warm. High water temperatures can also decrease dissolved oxygen levels, further negatively impacting aquatic life. To decrease water temperatures, trees and shrubs should be planted along streams to provide shade.

Microplastics

The issue of microplastics is not a new one but it has been more prevalent in the media lately raising public awareness about the problem. Concerns over the amount of plastics in our waters has influenced local communities and business to begin to reduce the amount of single use plastics regularly used. Local businesses have begun to phase out plasticware with their takeout, they have stopped handing out plastics straws automatically, they have begun to switch to tap water instead of bottled water for their customers. Research has begun to be conducted to quantify the amount of plastics in our waters. This research has mostly focused on marine systems but in 2018 GSWA began a pilot study to determine the extent of microplastics in the waters of the Great Swamp Watershed and the Upper Passaic River.

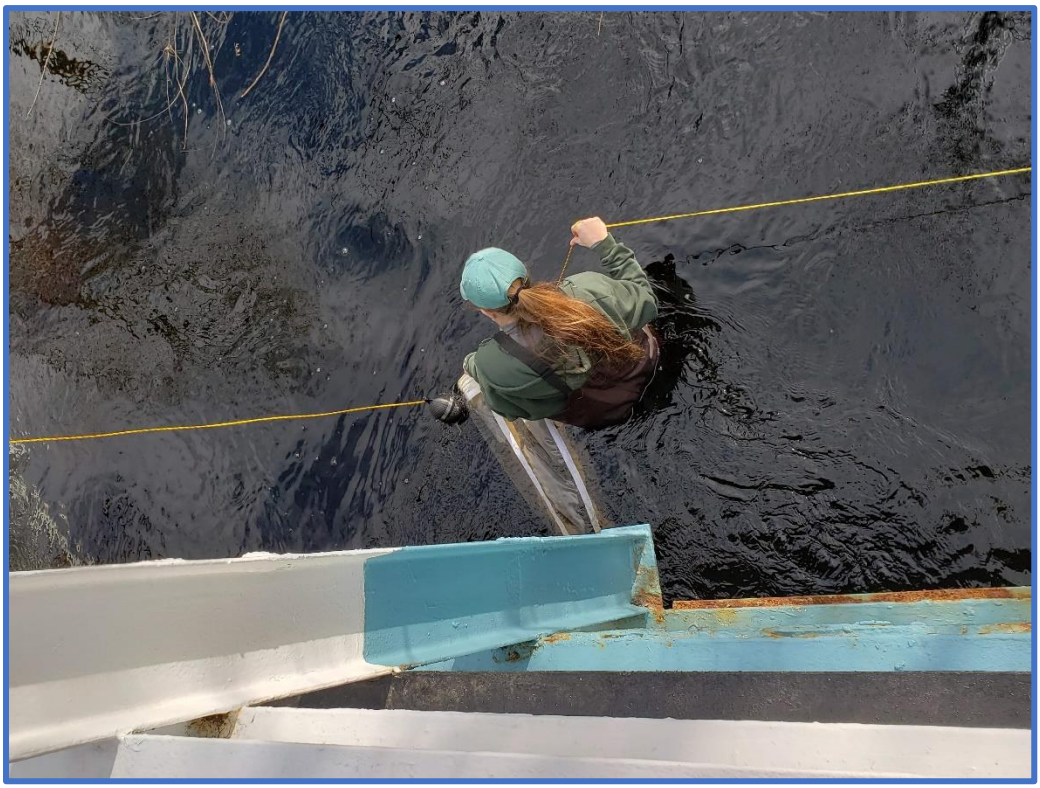
In November and early December, GSWA staff and volunteers collected 10 samples throughout the region. Sampling locations were selected to cover all four of the Great Swamp Watershed tributaries, the Passaic headwaters and the new expanded Upper Passaic region. The samples were returned to the GSWA office and processed using a filter system. The samples were then examined under a microscope to quantify the microplastics in each sample. Our goal is to begin to understand the extent of microplastics pollution in our local waters. This first round of sampling was designed to help us pinpoint hotspots for microplastics so that we can conduct a more indepth study in 2019.



Of the four Great Swamp Watershed tributaries, Great Brook, Black Brook, Loantaka Brook, and Primrose Brook, Great Brook contained the highest quantity of microplastics with 26 fibers observed and 12 pieces of film likely from broken up plastic bags or bottles. Along the Passaic River, the highest concentration observed was just

below Route 202 in Basking Ridge, with 56 individual fibers observed (though a further 12 clumps containing multiple fibers were also noted) and 16 pieces of plastic film. Below Millington gorge, the numbers increased with the distance downstream, with the highest observed quantities seen at Shepard Kollock Park in Livingston.

Further studies will be conducted in 2019 with sampling sites chosen based on the data gathered in this preliminary study. The 2019 study will partner with Rutgers University to allow us to better process the samples and determine the source materials found. We hope that this data will allow us to work with our local communities to target possible sources of microplastics in our waters and address this growing issue.



Conclusions and Recommendations

The 2018 water quality throughout most of the Great Swamp continued to meet the stringent standards set forth by the NJDEP and GSWA for healthy streams. The above average rainfall throughout the year had a visible impact on a number of areas within the system. Many of our streams had increased turbidity and sedimentation and within the watershed we saw increases in nitrates as well. The Passaic River expansion region data is beginning to indicate the influence of runoff on the nutrient levels and correspondingly the impact of waste water effluent inputs have as well. Elevated temperatures continued for the second year in the region and again impacted dissolved oxygen levels and temperatures in our streams. It is more important every year that communities work to protect our water as an important resource.

Below are some recommendations that everyone can help with:

- Elevated water temperatures, notably in our two NJDEP high classification streams –
  - Develop strategies with towns to increase tree and shrub buffers adjacent to streams
- Increasingly elevated levels of nutrients moving downstream along the Passaic River –
  - Reduce fertilizer use, plant native shrubs and trees, break up large lawns with gardens
- Decreasing buffer zone quality at select sites –
  - Work with communities to build and preserve wider stream buffer areas and educate homeowners about the importance of buffers
- Microplastics in the waters
  - Use reusable water bottles
  - Carry reusable cutlery and straws
  - Utilize reusable bags
  - Be aware of packaging and try to purchase items not over packaged in plastics.

Great Swamp Watershed Association is dedicated to protecting and improving the water resources of the Passaic River region, from the Great Swamp headwaters to Newark Bay, for present and future generations. Through education, advocacy, science, land preservation and stewardship, in collaboration with partners, we work to instill our communities with an awareness of water's effect on health and the beauty of the environment, from source to sea.

Great Swamp Watershed Association

Protecting the waters of the Passaic River region, from source to sea.

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