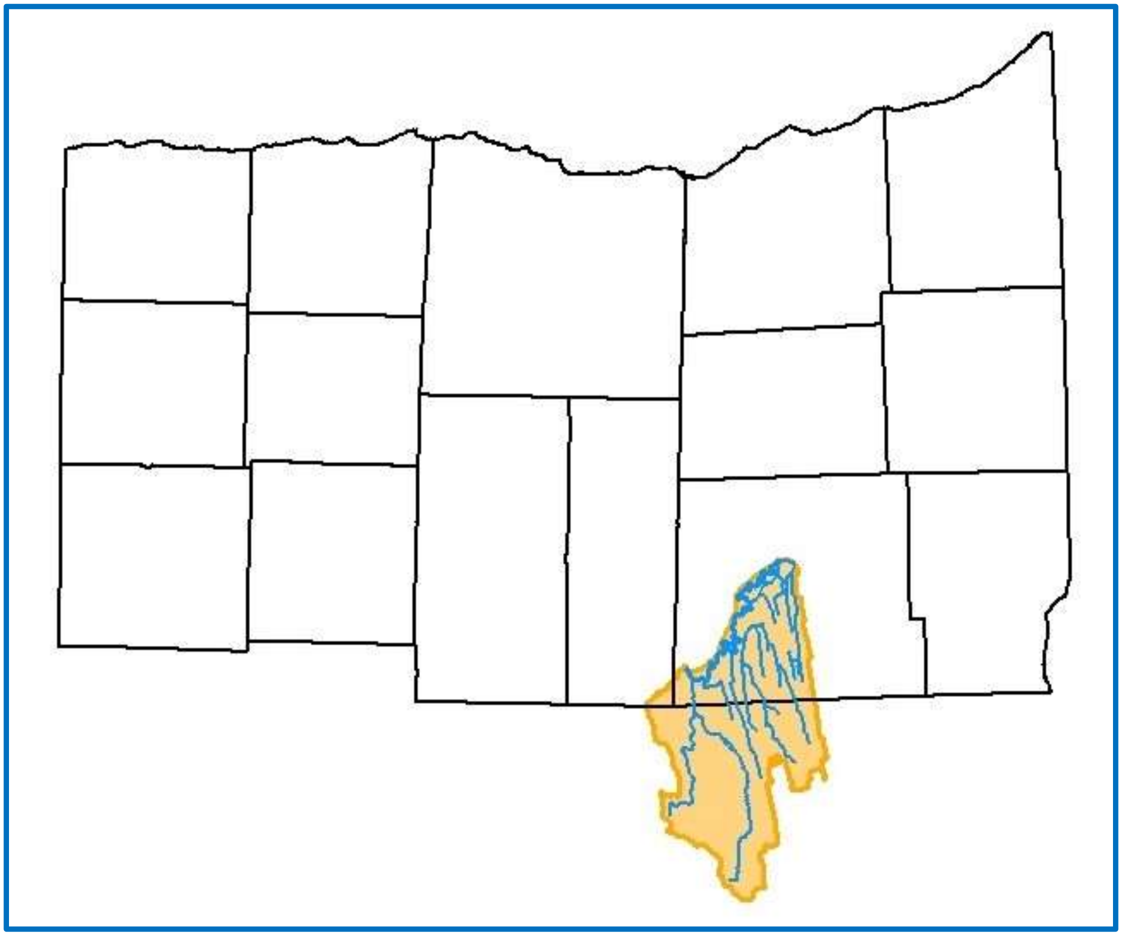

Clyde River Tributaries Watershed Assessment

2019 – 2021

Wayne County Soil & Water Conservation District

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Executive Summary

The Clyde River originally begin at the confluence of Ganargua Creek and the Canandaigua Outlet in the Town of Lyons and meandered east to the Seneca River. A majority of the original channel was altered by the construction of the Erie Canal. Previous classification by NYS DEC categorized the river as 'unassessed' and the tributaries as having water quality impacts but needing more documentation to determine their status. Water quality samples were collected from nine tributary outfalls between 2019 and 2021, and were analyzed for nutrient and sediment concentrations. Phosphorus and organic nitrogen were found to be elevated. In-organic nitrogen was high in two tributaries but low in the remaining tributaries. Suspended solids were low at base flow conditions but elevated during high runoff potential conditions. A majority of the soils in the Clyde River watershed have high infiltration and low runoff potential, but areas in the headwaters and directly adjacent subwatershed have low infiltration and high runoff potential. The landscape of the watershed could be considered rural with the dominant land uses being for agriculture. The large presence of agricultural operations in the watershed makes potential pollution sources associated with livestock and cropland practices a significant focal point. Rural landscapes are often associated with onsite wastewater treatment systems, or septic systems. Rural roads and their adjacent drainage ditches can short-circuit stormwater surface runoff to streams. Roadside ditches in close proximity to agricultural land can create pathways for untreated runoff to connect with streams. Sections of the tributaries appear to have their channels modified for the purpose of drainage improvement. This effects the stream's ability to absorb high flow conditions and the pollutants that are carried. Since the construction of the Erie Canal, the Clyde River has experienced a lack of flow in its main channel, transforming the river into a backwater wetland of the canal

Introduction and Background

A watershed is an area of land that drains water into a specific body of water. Watersheds include networks of rivers, streams, lakes, and the land area surrounding them. They are separated from other watersheds by high elevation geographic features such as ridges, hills, and mountains. We all live in a watershed and our actions affect others in the watershed. It becomes increasingly clear that upstream conditions will ultimately affect the receiving waterbody.

The concept of Watershed Management is to look broadly at the multiple land uses (agriculture, development, etc.) to determine the effects and to find ways to mitigate those impacts to protect the water quality of the receiving waterbodies. Through a combination of field work, resource evaluation and mapping, an assessment of the watershed can help determine and outline upland actions that affect water quality.

This Watershed Assessment then serves as the basis for prioritizing corrective measures and finding appropriate funding opportunities to address upstream sources of pollution within the watershed. The resulting document will serve as a guideline for restoration and improvements within the watershed, which will ultimately improve the water quality and ecology.

Waterbody and Watershed Characteristics

The Clyde River is a main “tributary” that feeds the Seneca River. It originates in the hamlet of Lyons and meanders from west to east, before emptying into the Seneca River in the town of Tyre at Montezuma National Wildlife Refuge. A majority of the original river channel has been channelized to form part of the Erie Canal. Before the Canal was built in 1820-21, the confluence of the Canandaigua Outlet and Ganargua Creek marked the beginning of the Clyde River.

Figure 01. Main Channel of the Clyde River

The portion of the Clyde River that this watershed assessment addresses is from where it exits the NYS Barge Canal System near the intersection of Schwab Road and Lyons-Marengo Road, travelling northeast to where the river re-enters the Canal near Clyde-Marengo Road. This section of the Clyde

Rivers is approximately 10.3 miles in length and lies entirely in the Town of Galen, NY (Figure 01).
Nine contributing outfalls were identified for this assessment (Figure 02). The tributaries for this segment of the River generally all flow from south to north, and includes Pond Brook (0704-0004). The tributary streams are a total of 60.6 miles in length and encompass 21,875.0 acres between all the subwatersheds. Headwaters for the tributaries originate in the towns of Junius and Waterloo in Seneca County. The entire watershed of the section of the Clyde River, including both tributary and direct watersheds, is approximately 23,413 acres. Table 01 and Figure 02 displays the contributing subwatersheds to the Clyde River and the sites where water quality samples were collected.

Table 01. Clyde River contributing watersheds and acreage.

Subwatershed	Sample Site	Acres
Direct Watershed	CR 06 CR 07 CR 09	1,538
Pond Brook	CR 01	11,148
Tributary 1	CR 02	675
Tributary 2	CR 03	1,297
Tributary 3	CR 04 CR 05	5,446
Tributary 4	CR 08	3,309
	TOTAL	23,413

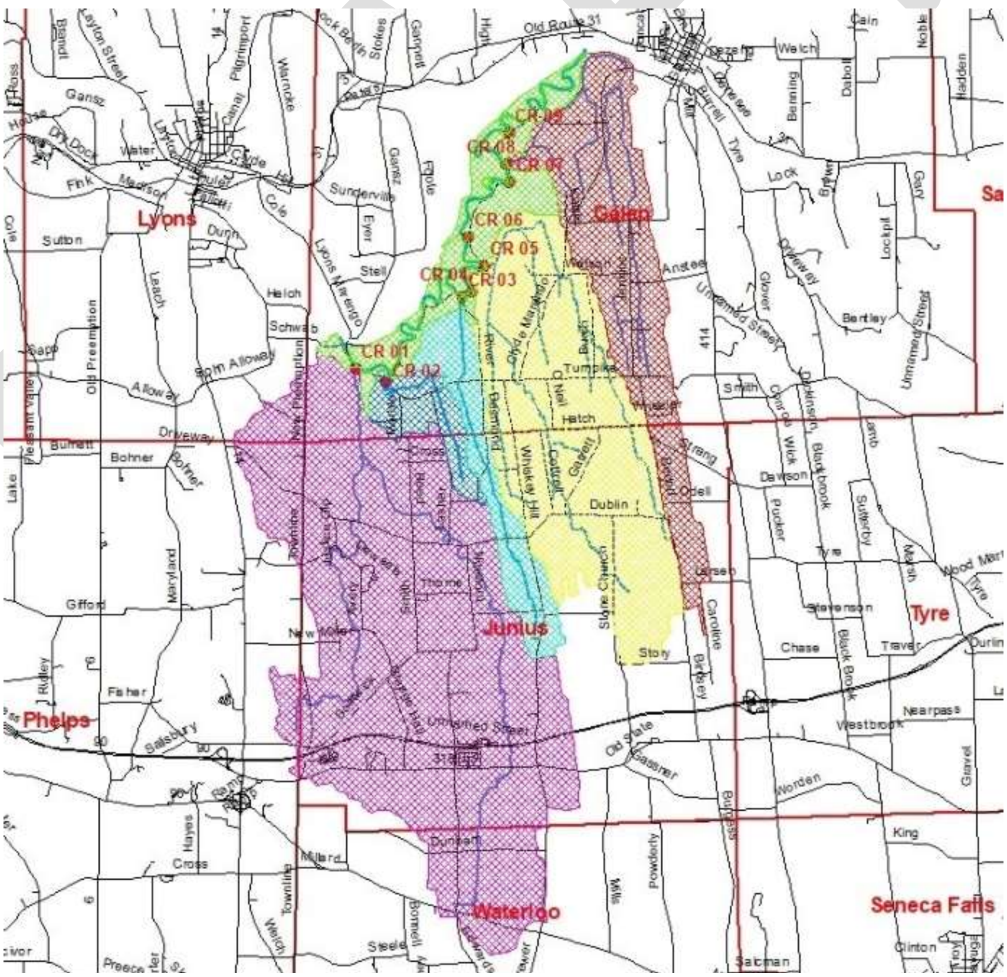


Figure 02. Sampling sites and subwatersheds of the Clyde River

Morphology and Classification

A Backwater is defined as a part of a river not reached by the current, where the water is stagnant; or water backed up in its course by an obstruction, an opposing current, or the tide. In a sense, this section of the Clyde River is a backwater to the Erie Canal. The 'flow' or lack thereof, and water level of the Clyde River is very dependent on that of the NYS Erie Canal System. Water contributions, not including the Canal, is composed of five (5) tributary streams and overland drainage from land directly adjacent to the River. Using USGS StreamStats, the tributaries have the following bankfull statistics:

Table 02. USGS StreamStats Bankfull statistics for Clyde River Tributaries

	Pond Brook	**Tributary 1**	**Tributary 2**	**Tributary 3**	**Tributary 4**
Drainage Area (acres)	11,136.0	678.4	1,292.8	5,452.8	3,308.8
Bankfull Area (ft^2)	77.5 - 104.0	16.5 - 22.2	25.0 -30.1	54.3 - 64.8	41.5 - 46.9
Bankfull Depth (ft)	2.22 - 3.01	1.22 - 1.87	1.4 -2.09	1.9 - 2.66	1.71 - 2.45
Bankfull Width (ft)	32.0 - 40.0	11.1 - 13.8	14.9 - 17.2	24.9 - 28.8	20.9 - 23.6
Bankfull Streamflow (ft^3/s)	330.0	38.8	63.5	191.0	130

The tributary streams are composed of first, second, and third order streams, which would define the Clyde River as a fourth order stream. The following table (Table 03) was constructed using ModelMyWater.org to describe the total length and mean channel slopes of the tributary streams.

Table 03. Linear miles and mean channel slope of the Clyde River and tributaries

Stream Order	**Total Length (mi)**	**Mean Channel Slope (%)**
1st	21.07	0.31%
2nd	13.38	0.14%
3rd	8.26	0.04%
Other[1]	15.14	No Data

[1]Contains canals, artificial pathways, and flowlines without a flow directions

New York State Department of Environmental Conservation (NYSDEC) identifies this section of the Clyde River as the waterbody segment NYS Barge Canal/Clyde River, Portion 6 (0704-0014) and is categorized as UnAssessed through the water quality monitoring program. The NYSDEC *2008 Oswego River/Finger Lakes Basin Waterbody Inventory/Priority Waterbodies List* Report (WI/PWL) classifies the tributaries to the Clyde River into two (2) separate waterbody segments: Pond Brook and tribs (0704-0004) and Minor Tribs to Clyde River (0704-0008). Both segments are classified as C streams with impacts that NEED VERIFICATION to determine the extent of possible stress on AQUATIC LIFE and RECREATION (Appendix XX). For class C waters, the best usage is fishing. "These waters shall be suitable for fish, shellfish, and wildlife propagation and survival. The water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes" (Chapter X – Division of Water, Section 701.8). Waterbodies with impacts that *NEED VERIFICATION* are "waterbodies that are thought to have water quality problems or impact, but for which there is not sufficient or definitive documentation. "Such waterbodies require additional monitoring to determine whether uses are restricted or threatened." The Waterbody Inventory Data Sheets for both of the waterbody segments state that the pollutant are suspected to be *D.O./OXYGEN DEMAND*, while the Minor Tribs also suspect Nutrients pollution versus possible Nutrients pollution in Pond Brook. The Data Sheets state that the major, suspected source of the pollutants is AGRICULTURE. The WI/PWL Data Sheets indicate that the resolvability of the impairment requires the evaluation of possible solutions and/or the development of management action (*NEEDS VERIFICATION/STUDY*). The Resolution Potential noted is *MEDIUM*, meaning the resources necessary to address the problem are beyond what are currently available. The 'Further Details' section of both Data Sheets contains similar information regarding minor impacts to aquatic life support and recreational uses due to agricultural activities in the watersheds. In both segments, previous assessments noted that barnyard runoff, silage leakage, and the dumping of excess milk in the streams had impact of the fishery as well as the aesthetics of the streams.

Water Quality

This watershed assessment was designed to evaluate and further identify potential sources of pollution that impact the Clyde River and its tributaries. The nine (9) sampling locations were selected based on location to the tributary stream's outfall into the river, and safety/ease of access (Figure 02 and Table 01). Grab samples were collected at the 9 locations from May and June of 2019; April, May, and October of 2020; and April, May, June, and July of 2021. Water sampling was limited in 2019 and 2020 due drought conditions and below-baseline stream flows. A total of 10 sampling efforts were completed for the previous dates. Sampling was completed to reflect random seasonal variations in water quality. Samples were collected during what could be classified as 'Event' conditions (i.e. noticeable precipitation runoff). Water samples were not collected during winter months. Samples were transported, on ice, to the water chemistry laboratory at Upstate Freshwater Institute in Syracuse, NY, for water chemistry analysis of total phosphorus (TP), nitrate + nitrite (NO_x), total nitrogen (TN), and total suspended solids (TSS). Total Kjeldahl Nitrogen (TKN) was determined by finding the difference between TN and NO_X. Variability existed in the concentrations of nutrients from the 11 sampling sites. This is due to the differences in land uses as well as point and nonpoint sources present in the watershed.

Table 03a. Mean, Non-event concentrations for Tributaries to the Clyde River, 2019 to 2021 and Mean, Non-event concentrations from various Wayne County tributaries.

TRIBS TO CLYDE RIVER 19-21 NON-EVENT					
SITE ID	TP (µg/L)	TN (mg/L)	NOx (mg/L)	TKN (µg/L)	TSS (mg/L)
CR 01 (Pond Brook)	120.1	2.517	1.940	576.3	13.0
CR 02	146.6	1.149	0.229	920.0	5.3
CR 03	50.1	2.017	1.646	370.0	6.9
CR 04	39.4	0.663	0.113	528.2	6.5
CR 05	57.9	1.105	0.046	1059.0	16.4
CR 06	71.8	0.715	0.054	610.0	5.4
CR 07	72.0	0.596	0.008	565.0	2.1
CR 08	79.7	0.516	0.017	442.1	5.0
CR 09	95.5	0.757	0.034	727.7	6.2
WAYNE COUNTY TRIBUTARIES NON-EVENT					
Waterbody	TP (µg/L)	TN (mg/L)	NOx (mg/L)	TKN (µg/L)	TSS (mg/L)
Canandaigua Outlet 09-10	47.8	N/A	1.032	590.2	3.0
Glenmark Creek 09-10	39.2	N/A	0.774	535.9	3.2
Crusoe Creek 09-10	103.5	N/A	0.110	1201.9	3.4
Black Brook 09-10	55.3	N/A	0.464	848.7	11.0
Red Creek East 09-10	127.7	N/A	0.282	939.9	4.4
Red Creek West 09-10	98.5	N/A	0.238	710.4	3.2
Salmon Creek West 10	N/A	N/A	N/A	N/A	N/A
Maxwell Creek 10	252.3	N/A	0.340	754.0	2.0
Ganargua Creek Lower 12-13	61.4	N/A	0.790	448.2	11.2
Red Creek West 16-17	70.0	1.198	0.222	976.4	9.4
Red Creek East 17-18	269.5	1.018	0.161	856.4	5.1
Ganargua Creek Upper 18-19	188.1	2.608	1.993	615.0	45.5

Table 03b. Mean, Event concentrations for Tributaries to the Clyde River, 2019 to 2021 and Mean, Non-event concentrations from various Wayne County tributaries.

TRIBS TO CLYDE RIVER 19-21 EVENT					
SITE ID	TP (µg/L)	TN (mg/L)	NOx (mg/L)	TKN (µg/L)	TSS (mg/L)
CR 01 (Pond Brook)	83.1	3.332	2.295	1036.6	22.5
CR 02	63.8	2.417	0.950	1467.2	10.5
CR 03	58.7	2.803	2.549	513.0	11.4
CR 04	101.8	0.965	0.093	871.7	27.8
CR 05	57.5	1.413	0.095	1260.5	14.2
CR 06	109.6	0.948	0.079	881.0	10.8
CR 07	131.0	0.780	0.022	810.7	6.2
CR 08	216.5	0.859	0.223	634.6	11.8
CR 09	111.6	2.603	0.988	2769.8	13.9
WAYNE COUNTY TRIBUTARIES EVENT					
Waterbody	TP (µg/L)	TN (mg/L)	Nitrate (mg/L)	TKN (µg/L)	TSS (mg/L)
Canandaigua Outlet 09-10	72.3	N/A	1.795	1449.0	13.6
Glenmark Creek 09-10	91.4	N/A	0.793	800.8	20.5
Crusoe Creek 09-10	138.5	N/A	0.170	1067.9	7.5
Black Brook 09-10	70.3	N/A	0.828	968.6	17.7
Red Creek East 09-10	132.6	N/A	0.489	842.4	9.8
Red Creek West 09-10	110.5	N/A	0.348	743.0	7.1
Salmon Creek West 10	162.2	N/A	2.130	990.0	4.6
Maxwell Creek 10	222.4	N/A	1.260	802.0	8.4
Ganargua Creek Lower 12-13	106.3	N/A	0.907	430.0	33.9
Red Creek East 17-18	181.9	1.1	0.311	667.7	15.4
Ganargua Creek Upper 18-19	104.5	2.015	0.941	1073.8	39.0

Total Phosphorus (TP)

Phosphorus as phosphate is one of the major nutrients required for plant growth and is often considered the 'limiting' nutrient in New York's freshwaters. Sources of phosphorus include animal wastes, sewage, detergent, fertilizer and disturbed land.

U.S. Environmental Protection Agency recommended water quality standard for flowing waters entering a lake is 50 µg/L and 100 µg/L for all other streams (USEPA, 2012). Wisconsin Department of Natural Resources established a phosphorus water quality standard for flowing waters entering lakes at 75 µg/L and 100 µg/L for all other streams and rivers (Wisconsin, 2010). The NYS DEC Stream Biomonitoring Team, in conjunction with the University of Albany - Department of Biological Sciences, suggests a phosphorus threshold limit of 65 µg/L between mesotrophic and eutrophic conditions in flowing streams (Smith et al., 2006).

During non-precipitation event conditions, 6 of the 9 tributary sampling sites had mean concentrations of TP exceeding 65 µg/L. Sites CR 02 and CR 01 had the highest observed mean concentration at 146.6 µg/L and 120.1 µg/L, respectively (Table 03a). Compared to other streams assessed in Wayne County, the TP results for tributaries to Clyde River observed were found to be elevated but not as high as other results observed. Based on the results observed, there appears to be significant sources of phosphorus that are entering the tributaries associated with sample sites CR 01 and CR 02. The subwatershed Tributary 1 (CR 02) is the smallest of all the tributaries to the Clyde River, making the abundance of phosphorus more noticeable. Pond Brook's watershed is the largest of contributing streams, therefore offering more possible sources of phosphorus to the Clyde River. A segment analysis of Pond Brook would assist in identifying these sources.

During precipitation event conditions, 6 of 9 sampling sites exceeded 65 µg TP/L. Site CR 08 had the highest observed mean TP concentration at 216.5 µg/L (Table 03b). This site had a one-time result on 6/9/2021 of 535.0 µg/L. The event concentrations observed in Clyde River tributaries were fairly similar to those of other tributaries in Wayne County. Under precipitation event conditions, sample sites CR 04, CR 06, CR 07, and CR 08 had significant increases from what was observed during non-event conditions. This strongly suggest that there are significant sources of phosphorus in these subwatershed are lost during high runoff situations. Stressed stream analysis is a water sampling technique that divides a watershed into smaller geographical units to locate individual sources of pollution (Makarewicz, 1993). By systematically monitoring the water quality in the watershed, the nutrients and sediment can be traced to their source. Once the sources are identified/located, corrective actions can be taken using Best Management Practices (BMPs).

Total Kjeldahl Nitrogen (TKN)

Total Kjeldahl Nitrogen is the combination of organically bound nitrogen and ammonia. Natural sources of TKN include decaying plant debris and wildlife. Human-caused sources include fertilizers, failing septic systems, waste water treatment plant discharges, pet waste, and livestock/farm animals. Organic nitrogen is typically higher than nitrate in landscapes dominated by more natural conditions, such as forests and grassland areas.

U.S. Environmental Protection Agency water quality criteria recommendations for New York State region provided data that un-impacted waterbodies have a TKN concentration of 200.0 µg/L (USEPA, 2000). For this report, TKN was calculated by finding the difference between the concentrations of Total Nitrogen (TN) and Nitrate + Nitrite (NO_x).

All 9 sample sites exceeded 200.0 µg/L for non-event conditions, although some of the concentrations observed could be considered low for waterbodies with some level of land use impact (less than 560 µg/L). Concentrations ranged from 370.0 µg/L at CR 03 and 1059.0 µg/L at CR 05 (Table 03a). The tributaries' TKN non-event concentrations for this report were diverse and fairly similar to that of other streams in Wayne County.

During event conditions, all 9 sampling sites exceeded 200.0 µg/L. The results for site CR 03 (513.0 µg/L) are considered low for having some level of impact in its drainage basin. Site CR 09 was considerably higher than the other Clyde River tributaries (2769.8 µg/L). The mean, event concentrations of TKN for the tribs were observed to fairly similar to other Wayne County stream under alike conditions, with the exception of CR 09.

Nitrate + Nitrite (NO_x)

Nitrate is the form of nitrogen that is most readily available for plant uptake. It is more easily detected as Nitrate + Nitrite, or NO_X (Nitrite is not commonly found in surface waters but is created as nitrate converts to nitrogen gas during denitrification). Natural sources of nitrate include leaves and woody debris, decaying plants and animals, and animal wastes. Human-caused sources include fertilizers, failing waste treatment systems, waste water treatment plant discharges, pet waste, livestock and farm animals, and industrial discharges. Where streams originate in areas of agricultural production, nitrogen as nitrate is usually substantially higher than organic nitrogen. Nitrate is very soluble in water and is negatively charged, therefore it moves easily through the soil profile, and reaches streams through subsurface pathways. Nitrate is the dominant form of nitrogen in groundwater and, where total nitrogen is elevated, in streams and rivers.

The NYSDEC water quality standard for nitrate in drinking water is 10 mg/L. The United States Geological Survey (USGS) states that background nitrate concentrations for undeveloped watersheds is 0.6 mg/L (USGS, 1999).

Two, CR 01 and 03, of the 9 sites sampled during non-event conditions surpassed 0.6 mg/L. The mean, non-event NO_X concentrations ranged from 0.008 to 1.940 mg/L. Compared to other Wayne County streams during non-event conditions, the Clyde River tributaries NO_X results were high for site CR 01 and 03, but slightly lower at the other outfalls.

Mean NO_X concentrations observed under precipitation-event conditions were relatively low, except for sites CR 01 and 03, 2.295 mg/L and 2.549 mg/L respectively. Four of the sample sites were less than 0.1 mg/L. Compared to other Wayne County streams under event conditions, CR 01 and 03 were the highest NO_X observed thus far, while sites CR 04 through 07 were the lowest observed.

Total Suspended Solids (TSS)

Total suspended solids is a measure of soil particles and other materials suspended in water. Water-borne sediments act as an indicator, facilitator and agent of pollution (Makerawicz et al. 2011). As an indicator, TSS adds hue to water. As a facilitator, sediments transport other pollutants such as nutrients and toxic substances. As an agent, sediments smother organisms and cover habitats used by some species for spawning (Makerawicz et al. 2011).

Mean non-event concentration of TSS ranged from 2.1 mg/L at site CR 07 to 16.4 mg/L at CR 05. A total suspended solids concentration below 20 mg/L will appear clear, while levels exceeding 40 mg/L may begin to appear cloudy. Seven of the 9 sample sites had concentrations less than 7 mg/L. With the exception of a few outliners, TSS concentrations observed were slight higher than other streams observed in Wayne County.

Mean event concentrations of TSS in Upper Ganargua Creek ranged from 6.2 mg/L at CR 07 to 27.8 mg/L at CR 04. Compared to other Wayne County streams, the Clyde River tributary concentrations during precipitation events fell between the higher and lower ends of the other streams.

HYDROLOGIC SOIL GROUPS

Hydrologic soil group (HSG) is a group of soils having similar runoff potential under similar storm and cover conditions. Soil properties that influence runoff potential are those that influence the minimum rate of infiltration for a bare soil after prolonged wetting, and when not frozen. Wetness characteristics, water transmission after prolonged wetting, and depth to slowly permeable layers are properties that influence runoff potential. Changes in soil properties caused by land management or climate changes also cause the HSG to change. Hydrologic soil groups are important in the planning watershed-protection and flood-prevention projects as well as for planning or designing structures for the use, control, and disposal of water.

The HSGs are described as:

Group A—Soils in this group have low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission (greater than 0.30 in/hour).

Group B—Soils in this group have moderately low runoff potential and moderate infiltration rates when thoroughly wetted. They consist of 10 – 20 percent clay and 50 – 90 percent sand. These soils have a moderate rate of water transmission (0.15-0.30 in/hour).

Group C—Soils in this group have moderately high runoff potential and low infiltration rates when thoroughly wetted. These soils have a low rate of water transmission (0.05-0.15 in/hour).

Group D—Soils in this group have high runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, a permanent high water table, a claypan or clay layer at or near the surface and shallow soils over nearly impervious material. These soils have a very low rate of water transmission (0-0.05 in/hour).

Dual hydrologic soil groups—Certain wet soils are placed in group D based solely on the presence of a water table within 24 inches of the surface even though the ease with which pores of a saturated soil permit water movement may be favorable for water transmission. If these soils can be adequately drained, then they are assigned to dual hydrologic soil groups (A/D, B/D and C/D) based on their ability to allow water movement and the water table depth when drained. The first letter applies to the drained condition and the second to the undrained condition.

Table 04. Acres of each Hydrologic Soil groups and acres for the Clyde River. Note: Includes the direct watershed and tributary watersheds

Hydrologic Soil Groups		Acres	%
	HSG A	2234	10%
	HSG B	8267	35%
	HSG C	2646	11%
	HSG D	4457	19%
	HSG A/D	1190	5%
	HSG B/D	954	4%
	HSG C/D	3264	14%
	No HSG	402	2%
	TOTAL	23414	

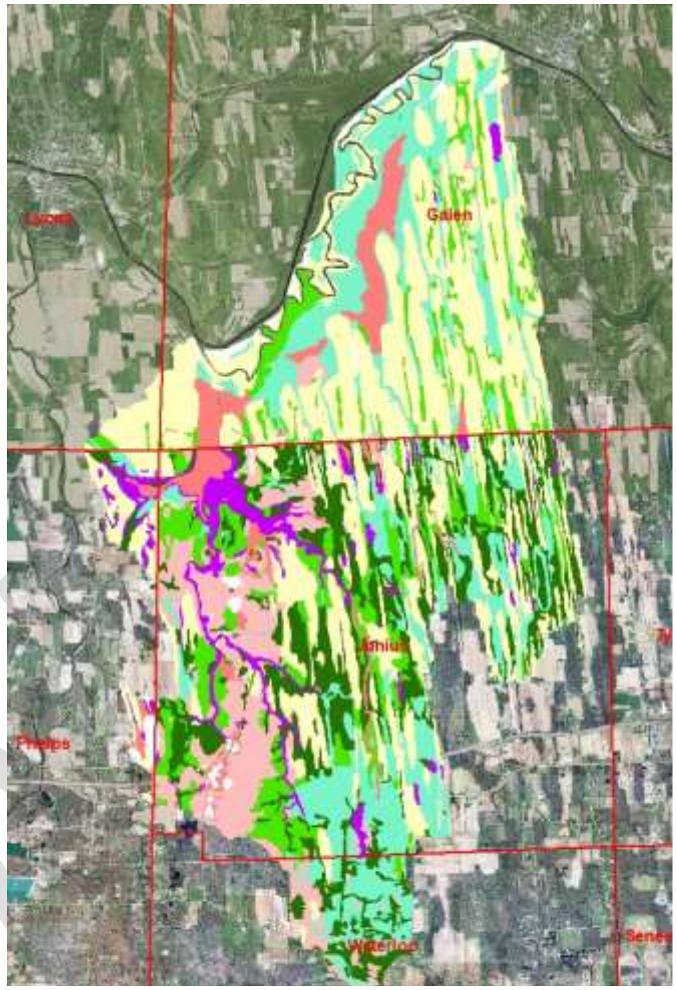


Figure 03. Hydrologic soil groups for the Clyde River.

For locations with "No HSG", these are areas denoted as waterbodies (ponds), gravel pits, or cut-and-fill land.

It is important to note that in Figure 03 the drastic visual difference in HSGs along the boundary between Wayne and Seneca County. This can most likely be attributed to two different soil scientists' interpretation of the soil type and classification when producing each County's Soil Survey. Alas, the information is still valuable to this watershed assessment.

Figure 03 displays that the Pond Brook subwatershed is significantly composed soils with high to moderately high infiltration and low to moderately low runoff potential. The headwaters of the tributaries and the direct drainage to the Clyde River show low infiltration and high runoff potential. In these locations, any alteration in land use should consider that there increased concern for pollution runoff. Lack of or removal of vegetative ground covers could prove detrimental to water quality.

High infiltration rates can pose an increased risk for groundwater and surface water contamination. Soil filtration usually removes suspended solids and particulate phosphorus, but dissolved phosphorus (as phosphates) can remain untreated. Fine- to medium-textured soils have a larger capacity to hold phosphate, while coarse-textured soils do not (Busman et al, 2002). The same can be stated for nitrate-N. Water-soluble nitrate leaches below root zones with excess water. This form of nitrogen has the potential to enter ground and surface water in areas of coarse-textured soils (Lamb et al, 2014). Fertilizer and manure spreading on land with high infiltration rates (HSG A soils) can be cost ineffective and have a negative impact on water quality.

LAND USE

The land use and land cover patterns (permeability) in a watershed have a significant effect on the overall quality of the receiving waterbody. Knowing the extent of development in a watershed and where the development is located can play a key role in the contaminant loading to a waterbody. In general, as land uses occur, stream systems and overall waterbody health can become diminished through changes in runoff and other human impacts.

The National Land Cover Database (NLCD) was used to provide spatially explicit and reliable information on land cover and land cover changes

Land use categories observed in the Clyde River watershed are categorized as:

Open Water: Areas of open water, generally with less than 25% cover of vegetation or soil.

Developed, Open Space: areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly include large-lot single-family housing units, parks, golf course, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.

Developed, Low Intensity: Areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20% to 49% of total cover. These areas most commonly include single-family housing units.

Developed, Medium Intensity: Areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50% to 79% of the total cover. These areas most commonly include single-family housing units.

Developed, High Intensity: Highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses, and commercial/industrial. Impervious surfaces account for 80% to 100% of the total cover.

Barren Land (Rock/Sand/Clay): Areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.

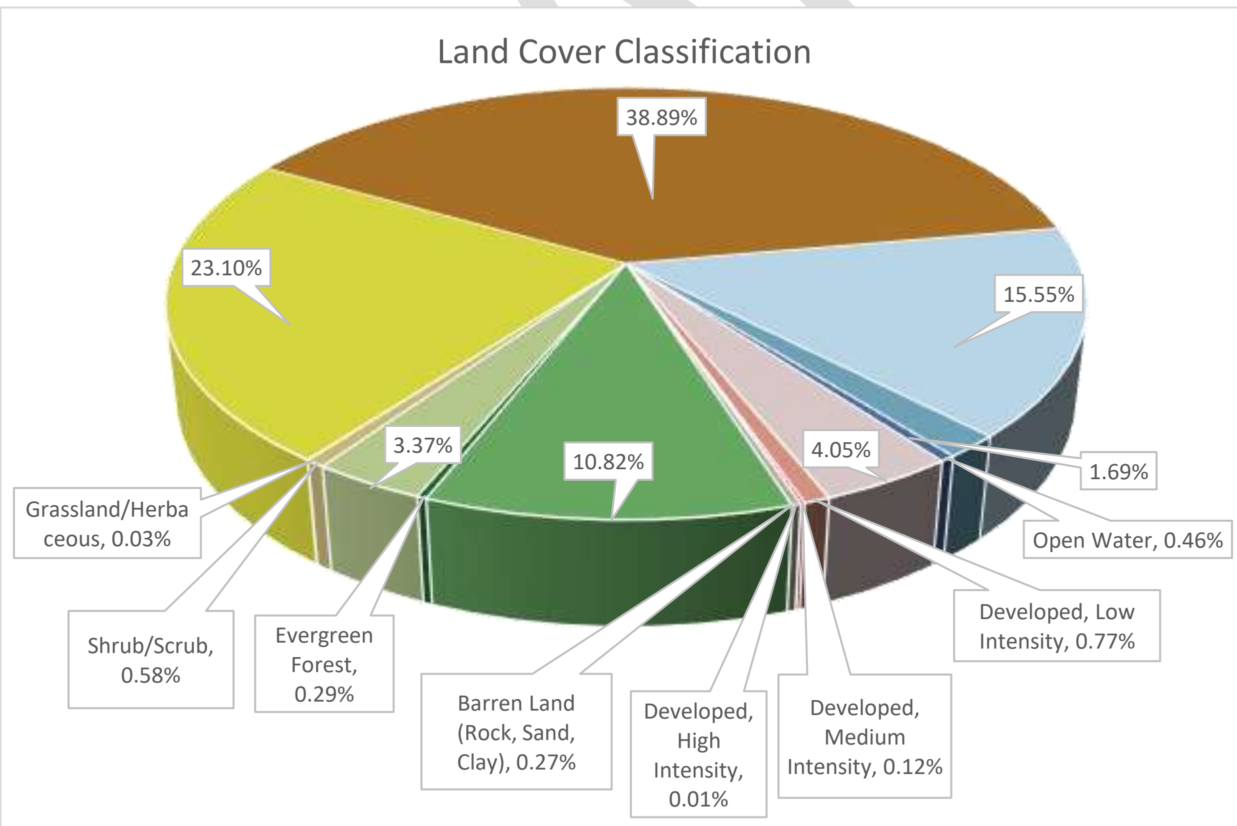
Deciduous Forest: Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species shed foliage simultaneously in response to seasonal change.

Evergreen Forest: Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species maintain their leaves all year. Canopy is never without green foliage.
Mixed Forest: Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75% of total tree cover.
Shrub/Scrub: Areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.
Grassland/Herbaceous: Areas dominated by grasses or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.
Pasture/Hay: Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20% of total vegetation.
Cultivated Crops: Areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation account for greater than 20% of total vegetation. This class also includes all land being actively tilled.
Woody Wetlands: Areas where forest or shrub land vegetation accounts for greater than 20% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.
Emergent Herbaceous Wetlands: Areas where perennial herbaceous vegetation accounts for greater than 80% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

Figure 04 displays the distribution of land uses throughout the Clyde River watershed and tributary subwatersheds. As evident by the map, percentage graph, and data table, the watershed is composed of approximately 62% agricultural land uses (Cultivated Crops and Pasture/Hay). Of the assessment area, 30% is considered forest (various Forests and Woody Wetlands), with the majority being consider woody wetlands. Upland forests are more isolated wood lots averaging approximately 4.1 acres in size, and ranging from 0.002 to 92.8 acres. Only 5% of the watershed is considered Developed, including roads. The most intense development is along the NYS Thruway (I-90) and State Route 318 in the southern portion of the Pond Brook watershed. Therefore, development in the Clyde River watershed could be considered rural. According to the NLCD, the Clyde River watershed has 17% wetlands, with a significant majority located in the downstream areas of the tributary subwatersheds and the direct drainage. Based on analysis using ArcMap, there is a noticeable difference between wetlands identified within the NLCD and NYS DEC State Regulated Wetlands.

Table 05. Acres and percentage of land use classification of Clyde River subwatersheds.

Land Cover Classification		Direct	Pond Brook (CR 01)	Trib 1 (CR 02)	Trib 2 (CR 03)	Trib 3 (CR 04-05)	Trib 4 (CR 07-09)	Acres per Class.	%
		Acrage							
11	Open Water	---	96.8	1.390	---	7.07	1.56	106.8	0.46%
21	Developed, Open Space	47.1	518.3	33.0	54.0	178.8	117.4	948.5	4.05%
22	Developed, Low Intensity	3.4	149.8	0.6	5.0	15.5	5.7	180.0	0.77%
23	Developed, Medium Intensity	0.3	26.7	---	0.5	0.2	---	27.8	0.12%
24	Developed, High Intensity	---	3.1	---	---	---	---	3.1	0.01%
31	Barren Land (Rock, Sand, Clay)	---	62.8	---	---	---	---	62.8	0.27%
41	Deciduous Forest	141.0	1120.1	87.3	122.9	580.2	479.4	2530.9	10.82%
42	Evergreen Forest	---	53.4	---	2.9	6.9	4.7	67.9	0.29%
43	Mixed Forest	191.3	257.7	44.8	40.5	106.6	147.8	788.6	3.37%
52	Shrub/Scrub	6.8	67.8	0.6	10.5	30.3	19.1	135.2	0.58%
71	Grassland/Herbaceous	---	5.9	---	---	---	---	5.9	0.03%
81	Pasture/Hay	72.1	2754.5	134.2	141.6	1310.0	993.1	5405.4	23.10%
82	Cultivated Crops	415.2	4655.4	282.6	673.2	2296.1	777.5	9100.0	38.89%
90	Woody Wetlands	596.5	1247.5	88.8	213.4	838.1	654.3	3638.6	15.55%
95	Emergent Herbaceous Wetland	52.0	119.2	2.2	32.0	81.1	108.6	395.1	1.69%



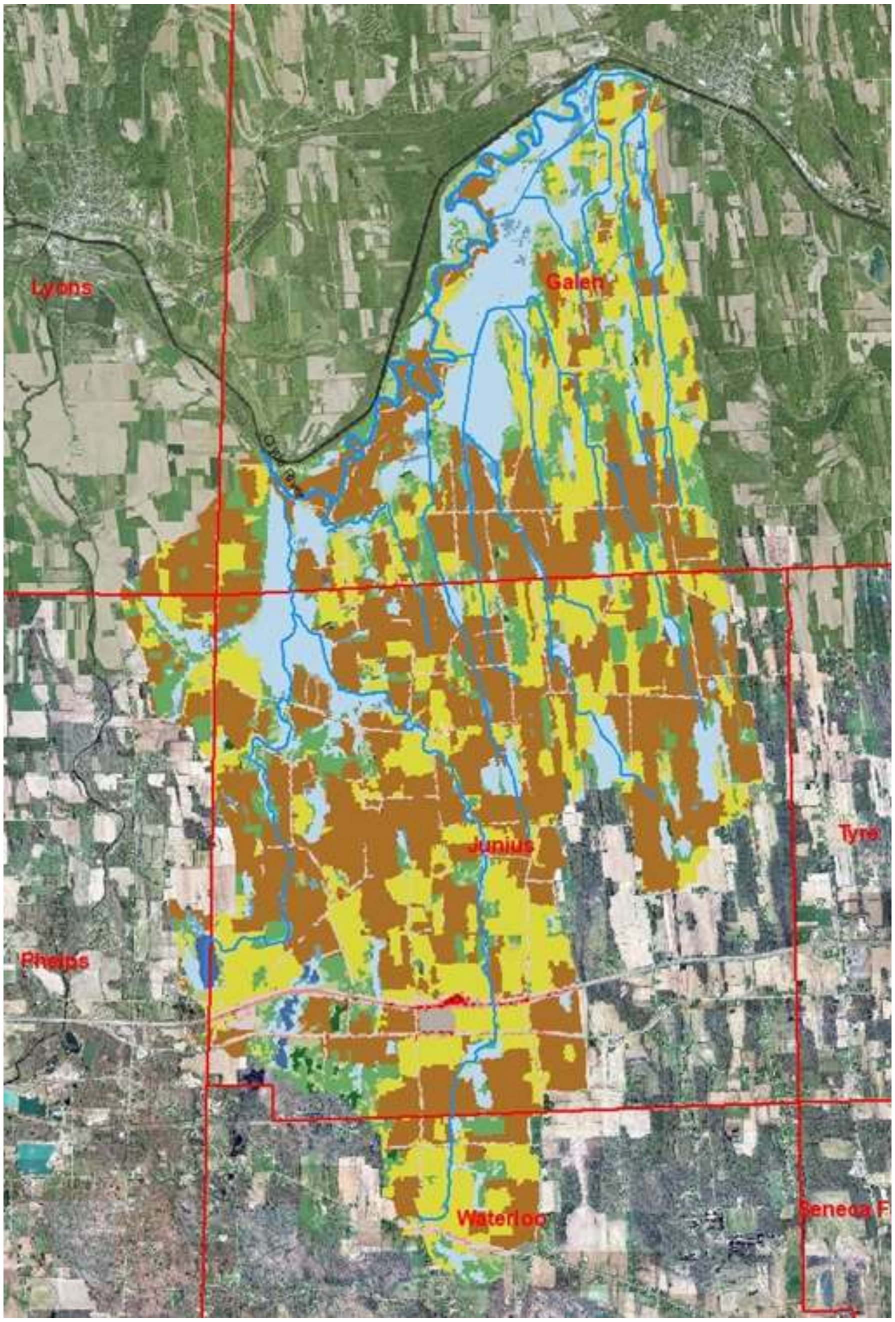


Figure 04. Clyde River watershed land use distribution

WETLANDS

Wetlands are defined as "areas saturated by surface or ground water sufficient to support distinctive vegetation adapted for life in saturated soil conditions." Wetlands provide flood- and stormwater control by absorbing, storing, and slowing the movement of runoff. Wetlands provide erosion control by slowing water velocity, filtering sediment and by buffering streambanks and shorelines. Wetlands treat pollution and cycle nutrients back into the

environment by filtering out natural and manmade pollutant. Wetlands provide important habitat for feeding, nesting and spawning fish and wildlife including rare and endangered species. Lastly, wetlands give humans areas for recreation, education and research opportunities.
Wetlands may act as a sink for nutrients and sediment, meaning they act as filters. The biological and chemical process of the nitrogen cycle in wetlands causes up to 90% to be removed.
Phosphorus enters wetlands as dissolved phosphorus or attached to suspended solids. Its removal occurs through uptake by plants, and chemical reactions with soil and soil components. However, wetlands can become saturated with phosphorus and may release it from the system. This loss of phosphorus from wetlands occurs in late summer, early fall and winter as organic matter decomposes causing low oxygen conditions.

Wetlands filter suspended solids from water that comes into contact with wetland vegetation. The plants also create friction on water flow, slowing movement, thus allowing suspended material to settle.

WATER QUALITY ISSUES AND RECOMMENDATIONS

Livestock

Livestock production is an important component of the agricultural economy of Wayne County, comprising 24% of the county's 179,000 acres of farmland. Using aerial imagery, 67 locations were identified as having livestock units with varying numbers of animal units. Four (4) the locations could be identified as dairy operations due to the presence of liquid manure storage. Depending on management, livestock operations can either degrade or contribute to the quality of natural resources. Livestock operations that can contribute nutrients and sediment to a waterbody include grazing, animal feeding operation and animal waste.

Overgrazing describes what happens when livestock feeds on pasture to the point where there is no vegetation left. It exposes soils, increases erosion, encourages invasive species colonization, destroys aquatic habitat, and destroys streambank and floodplain vegetation. Over-used grazing lots can be devoid of vegetation are saturated with animal waste. These areas are susceptible to causing contaminated runoff of nutrients and sediment. Unfenced pastures give livestock direct access to streams which can degrade water quality by excreting manure directly into the stream, and by disturbing streambank stability. Vegetation along a stream corridor is necessary for wildlife habitat and water quality filtration. To reduce the negative impacts of overgrazing on water quality, farmers can adjust grazing intensity (rotational grazing), exclude livestock from sensitive areas (fencing), provide alternative sources of water and shade, and promote the revegetation of damaged areas.

Managing livestock grazing land to protect water quality and aquatic and riparian habitat should include the following measures:

- Improving and/or maintaining the health of a stable and desired forage plant community that, at the same time, stabilizes soil and improves water quality;
- Ensure adequate residual vegetative cover (Pasture picture);
- Provide adequate regrowth time and rest for plants;
- Excluding livestock from riparian zones and wetlands using fencing and, where necessary, providing stable stream crossings;
- Determining a grazing system for each individual farm;
- Providing water facilities away from streams;
- Stabilizing heavily used areas (Access Road/Heavy Use Area); and
- Planting vegetative buffers along pasture edges, especially for fields bordering waterbodies.

Confined animal systems for beef and dairy cattle, swine, and poultry have greatly increased farm production efficiency. But this concentration of animals can bring about water resource concerns. Contaminated runoff from these operations can contain excessive amounts of nutrients, pathogens, and sediment. Such operations have to manage manure in the confinement areas and utilize/dispose of manure in an appropriate way. Pollution of surface waters is not the only concern associated with livestock manure. Manure applied to agricultural land can be beneficial because of its nutrients and soil building characteristics, but improper management may lead to groundwater contamination, especially nitrate and fecal coliform bacteria. As previously state nitrate-N is highly mobile in water. This is a significant concern to rural areas where residential drinking water comes from wells.

Animal feeding operations (AFOs) should be managed to minimize impacts on water quality and public health. To meet this goal, management of AFOs should address the following:

- Divert clean water away from feedlots and holding pens, animal manure, and manure storage systems;
- Prevent leaching of contaminated runoff into ground and surface water;
- Provide adequate, safe storage of animal manure (Manure Storage);
- Applying nutrients (fertilizer and manure) in the right amount, at the right time of year, with the right method and with the right placement;
- Land receiving manure should be managed to minimize the movement of nutrients and organic material, and buffer/treat runoff;
- Operators should document the quantity of waste produced and its utilization/disposal; and
- Deceased animals should be managed so to not adversely affect ground and surface waters.

Although livestock operations observed during this watershed assessment exhibited varying degrees of water resource concerns, many the farms in this watershed have already implemented a variety of BMPs to protect water quality.

NYS Department of Agriculture and Market's *Agricultural Environmental Management* (AEM) program is a specific program that addresses nonpoint source pollution associated with agriculture. AEM is a voluntary, incentive-based program that provides farmers with technical assistance to help plan and implement conservation practices to meet business objectives and that address natural resource concerns. Wayne County SWCD, the local AEM resource professional, has over 300 agricultural operations enrolled in the program since 2005. Eight (8) farms within the Upper Ganargua Creek watershed are enrolled in the AEM 5-tier approach. By participating in AEM, agricultural operations can document environmental stewardship and further improve contributions to the community, economy, and environment.

More detailed information regarding AEM can be found at:

http://www.agriculture.ny.gov/SoilWater/aem/index.html

Cropland

Cultivated cropland in the Clyde River watershed consist of approximately 39% (9,100 acres) of the land use, and includes both row crops and some horticultural cropland (see description above). The National Water Quality Assessment shows that agricultural runoff is the leading cause of water quality impacts to rivers and streams.

Cropland operations can have significant impacts on water quality due to the amount of land involved, and the soil-disturbing nature of those activities. Application of commercial fertilizer to cropland can introduce surplus nitrogen and phosphorous to surface or groundwater. When excess nutrients are introduced to natural waterbodies through runoff, they can potentially increase the "productivity" of the receiving waterbody. This is referred to as eutrophication. Eutrophication sets off a chain reaction in the ecosystem, starting with an overabundance of algae and plants. The excess algae and plant matter eventually decompose, producing large amounts of carbon dioxide. Harmful algal blooms, dead zones, and fish kills are the results of a process called eutrophication

Pesticides and herbicides can be transported to surface and groundwater through runoff and/or soil infiltration. Chemicals that are resistant to degradation can persist in natural waterbodies and can bioaccumulate in aquatic organisms. This can result in chemicals biomagnifying through the food chain. The water quality sampling regime of this report did not analyze for this contaminants.

The tilling of croplands destabilizes soils making them susceptible to stormwater runoff which can lead to excess soil erosion and sedimentation in a waterbody. Soils eroded from cropland often contain nutrients which further impact water quality in the receiving waterbodies. Salts produced from natural weathering of soil can also be transported in runoff, which can negatively affect water quality.

Where fertilizer and manure are applied to cropland, there is a possibility of excessive concentrations of pathogens and nutrients entering adjacent waterbodies through surface or ground water. Soil characteristics, soil types, type of crop grown, amount of manure applied, rate of application and seasonal timing of application determine the potential for adverse impacts to water quality.

Best Management Practices (BMPs) for cropland can be designed to either prevent runoff or to treat polluted runoff before it reaches a waterbody. The simplest BMP to use for cropland activities is sound farm administration and planning. Whole-farm planning is the holistic approach to farm management, used to identify and prioritize issues on a farm without compromising the farm business. Often for administrative BMPs to be successful, they require the implementation of structural BMPs.

Structural BMPs for cropland have the goal of improving water quality in waterbodies adjacent to cropland by preventing excessive erosion and intercepting and filtering possibly contaminated runoff. Cropland BMPs that can be used to meet this goal includes:

- Nutrient management planning;
- Crop rotation;
- Strip cropping;
- Contour farming;
- Cover cropping;
- Inter-seeding cover cropping;
- Residue management;
- Vegetated filter strips;
- Grassed swales (picture);
- Riparian buffers;
- Diversions;
- Conservation drainage practices
- No-till/conservation tillage;
- Water and sediment control basin; and
- Grade stabilization structures.

In many situations, the use of multiple BMPs may be needed to reduce nonpoint source pollution on agricultural operations. The appropriate BMP(s) to implement can be dependent on numerous onsite factors (climate, topography, installation costs, etc.) and may require management from a natural resource professional. Management and conservation plans should contain BMPs that are most applicable to the farm location, with each practice functioning with all others to achieve the operation's goals.

NYS Department of Agriculture and Markets and the NYS Soil and Water Conservation Committee offers programs that can assist farming operations with soil and water resource concerns. The Agricultural Non-point Source Abatement and Control Program (https://agriculture.ny.gov/soil-and-water/agricultural-non-point-source-abatement-and-control) is a cost-share grant program that provides funding to address and prevent potential water quality issues that stem from farming activities. Financial and technical assistance supports the planning and implementation of on-farm projects with the goal of improving water quality in NY's waterways.

The Climate Resilient Farming Program (https://agriculture.ny.gov/soil-and-water/climate-resilient-farming) is designed to mitigate the impact of agriculture on climate change for greenhouse gas emissions reduction and carbon sequestration, in addition to enhancing the on-farm adaptation and resiliency to projected climate conditions due to heavy storm events, rainfall, and drought.

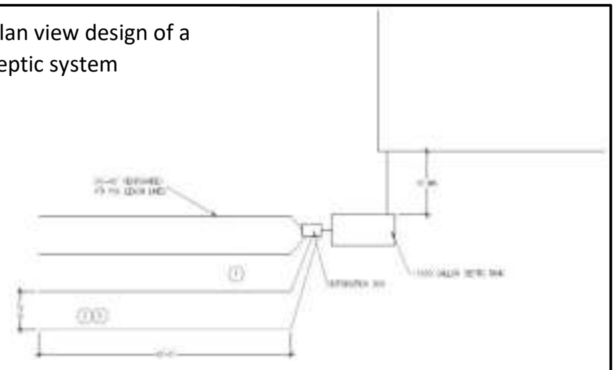
Onsite Wastewater Systems (Septic)

Based on the Land Use section of this report, 95% of the watershed is considered developed. This characterizes the area as rural countryside. This may depict that the household residences of the area have onsite wastewater treatment systems, or septic systems. Elevated nitrogen-forms observed in the stream may be attributed to improper treatment of sewage, consequently the importance of septic management should not be overlooked.

Septic systems are designed for collection, treatment, and dispersal of wastewater from individual residence, clusters of homes, isolated communities, industries, or institutional facilities. Wastewater undergoes primary treatment to remove suspended solids and some nutrients and pathogens. The effluent is then leached into subsurface soil where final treatment occurs before returning to the hydrologic cycle. Unless systems are properly designed, sited, installed, maintained, and used, the dispersed effluent may adversely affect surface and groundwater quality. Even properly functioning systems contribute a certain nutrient load (nitrogen and phosphorus) to ground- and surface waters.

Septic system failure can be attributed to a number of causes including:

- Poor design and installation;
- Improper location
- Damaged distribution pipes;
- Inadequate sizing; and
- Lack of routine maintenance.



Plan view design of a septic system

A typical septic system consists of a septic tank and a drainfield, or soil absorption field. The following are signs that a septic system is failing:

- Wastewater backing up into household drains;
- Bright green, spongy grass on the drainfield, even during dry weather;
- Pooling water or muddy soil around your septic system or in your basement; and
- A strong odor around the septic tank and drainfield.

Successful upkeep of a septic system should include:

- Inspect and pump frequently: The average household septic system should be inspected at least every three years by a septic service professional and is typically pumped every three to five years.
- Water efficiency: Efficient water use can improve the operation of a septic system and reduce the risk of failure.
- Proper waste disposal: Septic systems are designed to process only human waste and bath tissue. Disposing of chemicals and/or pharmaceuticals via toilets or drains can damage the living organisms that digest and treat septic system waste.
- Drainfield maintenance: Avoid driving across or parking on the drainfield. Avoid planting trees near the leach lines. Keep roof drains, sump pumps, and other rainwater drainage systems away from the drainfield area.

Perfecting designed and functioning septic systems systems will still contribute a low concentration of nutrients to ground- and surface waters. This makes it very important to make certain that a system is operating as well as possible.

Local Roads

Roadside ditch networks are ever-present in rural landscapes and are designed to convey stormwater runoff from the road surface. Roadside ditches are a critical part to a roadway's safety and proper maintenance is important. A properly managed ditch is relatively shallow and only drains a small area. They only need to be deep enough to carry the surface flows, and possibly drain the base of the roadway. Ditches are also utilized by adjacent landowners to carry water away from properties. If done properly, this can work adequately, but it needs to be done in coordination with both the landowner and the local highway department. If done improperly, pollutants and sediment can get into, and clog the ditch and structures (culverts) associated with it.

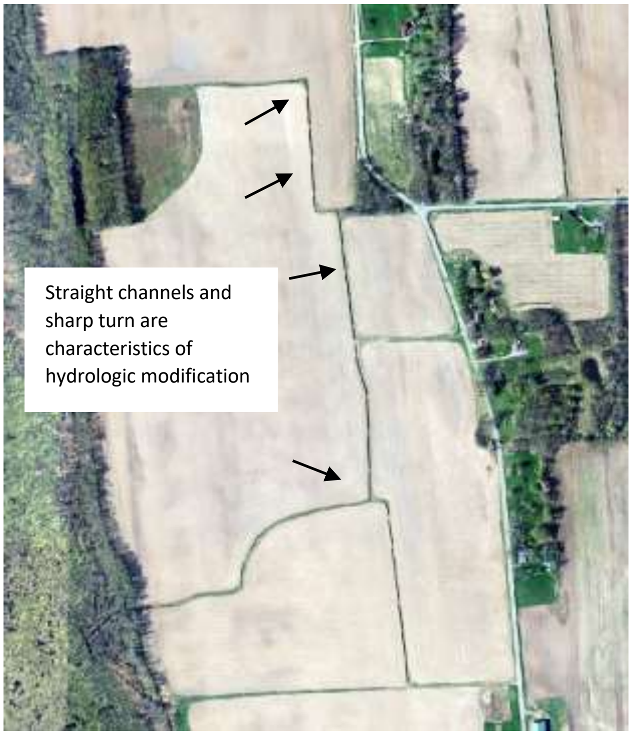
Roadside ditches transport collected surface water to natural streams, making the ditch an extension of a first order stream. Ditch networks alter watershed hydrology by rerouting and concentrating surface runoff, and by converting shallow subsurface flows to a rapid channel flow (Buchanan et al, 2013). By concentrating stormwater flow, ditches may collectively contributes to increased downstream flooding. They also act as conduits that short circuit sediments, nutrients, bacteria, and other pollutants from the surrounding land.

Ditches in a rural landscapes are often connected to adjacent agriculture land, and receive surface and subsurface drainage directly from agricultural fields (Buchanan et al, 2013). In some case, there is little to no buffer between the agricultural land and the drainage network.

Maintenance of roadside ditches can be a major source of sediment when ditches are cleaned, scrapped, or reshaped and not protected from erosion during storms (Schneider et al, 2019). Establishing vegetation and/or installing filtering structures reduces the transport of pollutants downstream. Another management strategy could be to redirect ditch outlets away from streams to rentention/infiltration basins, and design the ditch to act as a stormwater treatment device.

Hydrologic Modification

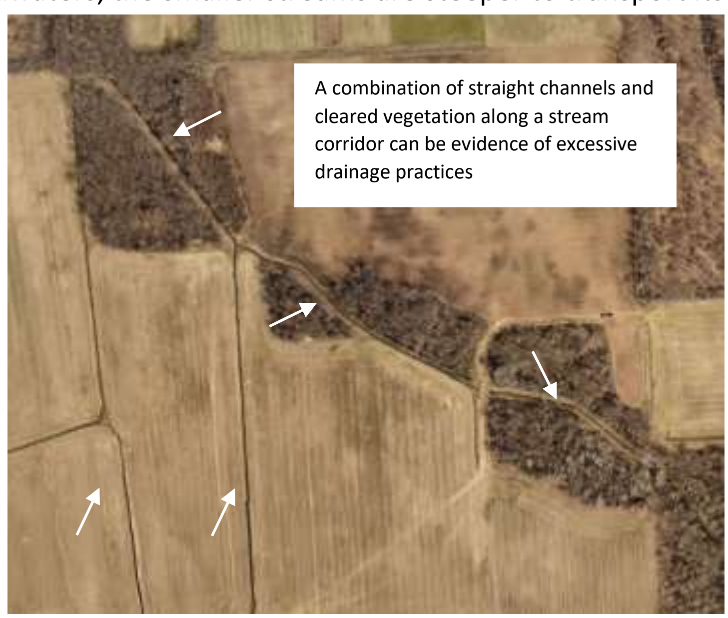
Hydrologic Modification is the alteration of natural flow of water through a landscape. Although not stated on the NYS DEC WI/PWL data sheet related to the Clyde River, hydrologic modification was observed in the watershed in the form of channel modification.



Channel modification, sometime referred to as channelization, is stream channel engineering done for the purpose of flood control, navigation, drainage improvement, and reduction of channel migration potential (EPA, 2007). This includes activities such as straightening, widening, deepening, or relocating stream channels, clearing, or snagging operations. These types of hydrologic modification typically result in a more uniform channel cross sections, steeper stream gradients, and reduced average pool depths (EPA, 1993). Hydrologic modification also reduces groundwater recharge (EPA, 2007).

Channel modification changes the ability of a natural systems to both absorb hydraulic energy and filter pollutants from surface waters (EPA, 2007). It also alters the rate and pathway of sediment erosion, transport and deposition (EPA, 1993). Channel modification often results in diminished instream and riparian habitat for fish and wildlife. Channelization accelerates the movement of NPS pollutants to the receiving waterbody.

A typical longitudinal profile of a stream is curved with steep slopes near the headwaters and a gentle slope near the mouth. In the headwaters, the smaller streams are steeper to transport its naturally eroding sediment. As often observed in the headwater and intermediate streams of Wayne County, the slope is altered by drainage practices to make the land meet the needs of the landowner. The velocity of the stream then changes, causing significant changes in erosion and sedimentation throughout the stream.



Physical and chemical characteristics of surface waters that may be influenced by channel modification include sedimentation, turbidity, temperature, nutrients, dissolved oxygen, oxygen demand, and contaminants. Channelization observed in the Clyde River watershed were mostly associated with agricultural drainage practices with little to no buffer filter strip between the crop and the waterbody. Certain sections of the tributary streams have been straightened and take sharp turns along property lines or field edges. If such activities take place on navigable streams or within protected wetlands, they are required to have state or federal permit coverage. A Protection of Waters Permit is required for: Excavating or placing fill in navigable waters of the state, below the mean high water level, including adjacent and contiguous marshes and wetlands.

The River's Flow

The Clyde River's flow, or lack thereof, was either greatly diverted or completely taken over by the construction of the Erie Canal (built 1817 – 1825), and even further by the NYS Barge Canal (built 1903 – 1918). The Canal was built to create a navigable water system from the Hudson River to Lake Erie, thus connecting the Atlantic Ocean to the Great Lakes Basin. Today, the Clyde River runs either parallel or concurrent with the Canal. The water level of the Clyde River is very dependent on that of the Canal, especially during the winter when transit on the Canal is closed.

The Canal influences the water level of the River at three location: the inlet on Lyons-Marango and Schwab Road, an old culvert pipe at the end of Gansz Road East, and the outlet near the village of Clyde, NY. All vectors become ineffective when the Canal's level is seasonally lowered.

Pond Brook has the largest contributing watershed to the Clyde River. Sediment has deposited where Pond Brook meets the Clyde River, creating a delta. The lack of flow of the River, especially during Canal-influenced low water periods, prevents the sediment from being transported downstream. The buildup of sediment has created an in-channel block that cuts off stream flow to the east. Thus, Pond Brook's flow is diverted west toward the Canal. When the Canal's water level is restored for transportation in the spring, the River's water level rises over the delta. This floods into the east portion of the River but does not provide enough velocity to remove the sediment buildup.

Pond Brook outlet, Lyons-Marango Rd. Left: Facing west. Right: Facing east with sedimentation

Left: Looking west from the Pond Brook outlet toward the Canal. Right: Looking east from the Pond Brook outlet toward downstream Clyde River. April 29, 2020

Pond Brook outlet looking west (left) and east (right) after over an inch of precipitation. May 1, 2020

The severely corroded and damaged culvert located at the end of Gansz Road East only provides a conduit for the Canal to overflow into the Clyde River during the Canal's open season. The canal flows through the culvert until the river's inlet and outlet are equal with the water level equilibrium of the Canal. It does not contribute to the flow regime of the Clyde River, but uses the river as a backwater wetland. During the Canal's low water times, the River actually drains into the Canal.

Gansz Road East culvert between the River (left) and the Canal (right)

The outlet continually flows due to the contributions of the tributary streams (with the exception of Pond Brook at base flow conditions), although at a lower level. When the Canal's water level is restored for the spring, the outlet backfills until it reaches equilibrium with the Canal.

Restoration of flow to this section of the Clyde River would prove to be difficult due to all the influencing factors. The lack of continuous flow has caused an extensive amount of sedimentation throughout the River.

Conclusion

We all live in a watershed and our actions on the land have an effect on the receiving waterbody. Looking holistically at the multiple land uses can determine the origin and extent of the effects, and aid in finding ways to mitigate those impacts. Water is one of our most precious natural resources and protecting its quality is imperative to support a healthy ecosystem.

The Clyde River tributary watershed assessed in this document is significantly composed of agricultural land use, making the management of agricultural nonpoint sources of pollution a top priority. Agricultural operations within the watershed are not likely to end in the near future. Therefore it is extremely important to manage the land uses in the best interest of the stream. Managing runoff from grazing land, animal feeding lots, and cultivated cropland would prove beneficial to the ecology of the river and its tributaries. Irresponsible management of lands can further degrade the water quality and aquatic ecosystem of Clyde River and its tributaries. Channel modification of the stream for drainage purposes can accelerate the rates of erosion and sedimentation in the stream system. Protection of water resources is dependent on not just a single entity but an entire watershed community. This assessment is intended to summarize water resource issues within the watershed and to improve awareness of them. It is the duty of landowners within the watershed to be stewards of this stream so that future generations may enjoy it.

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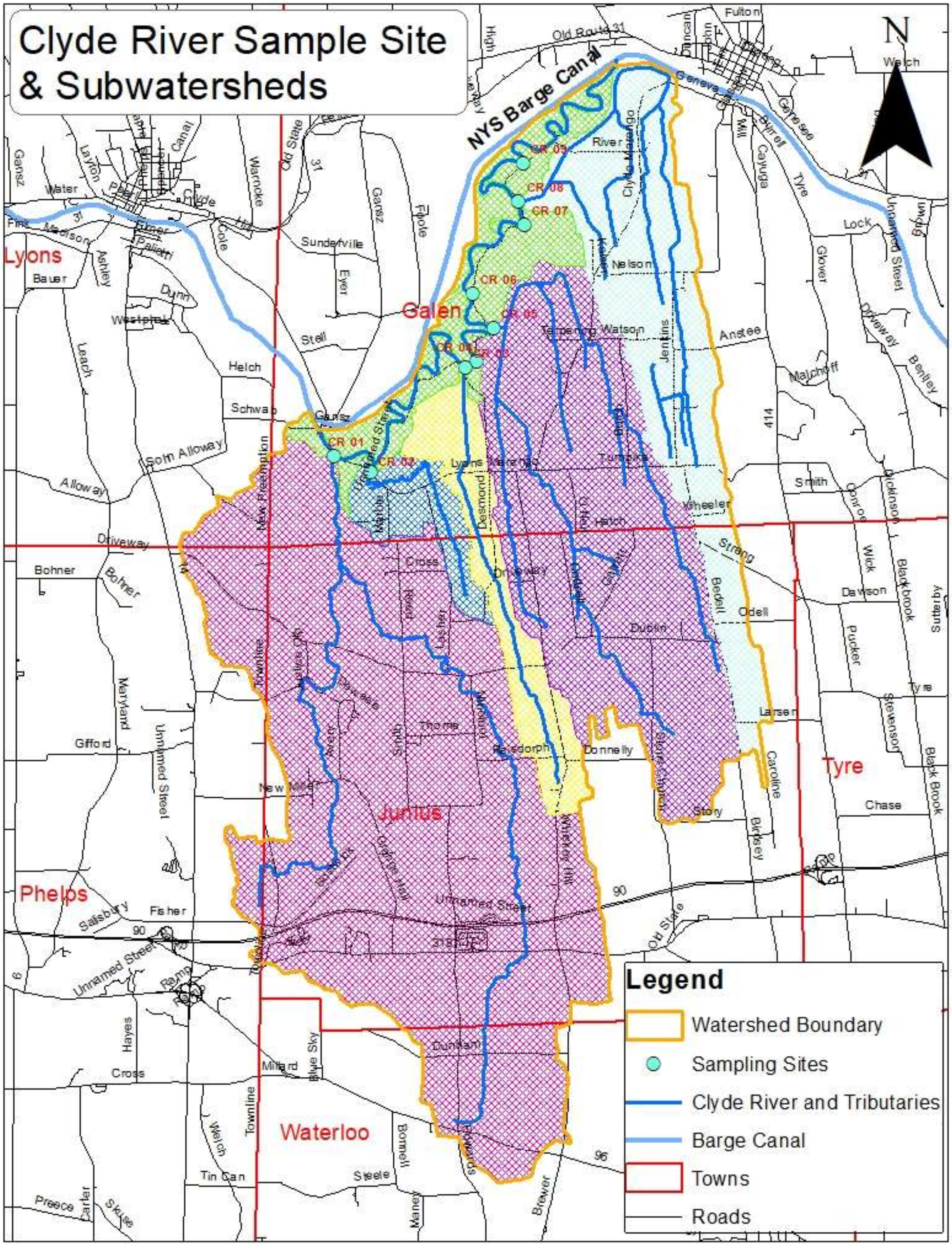
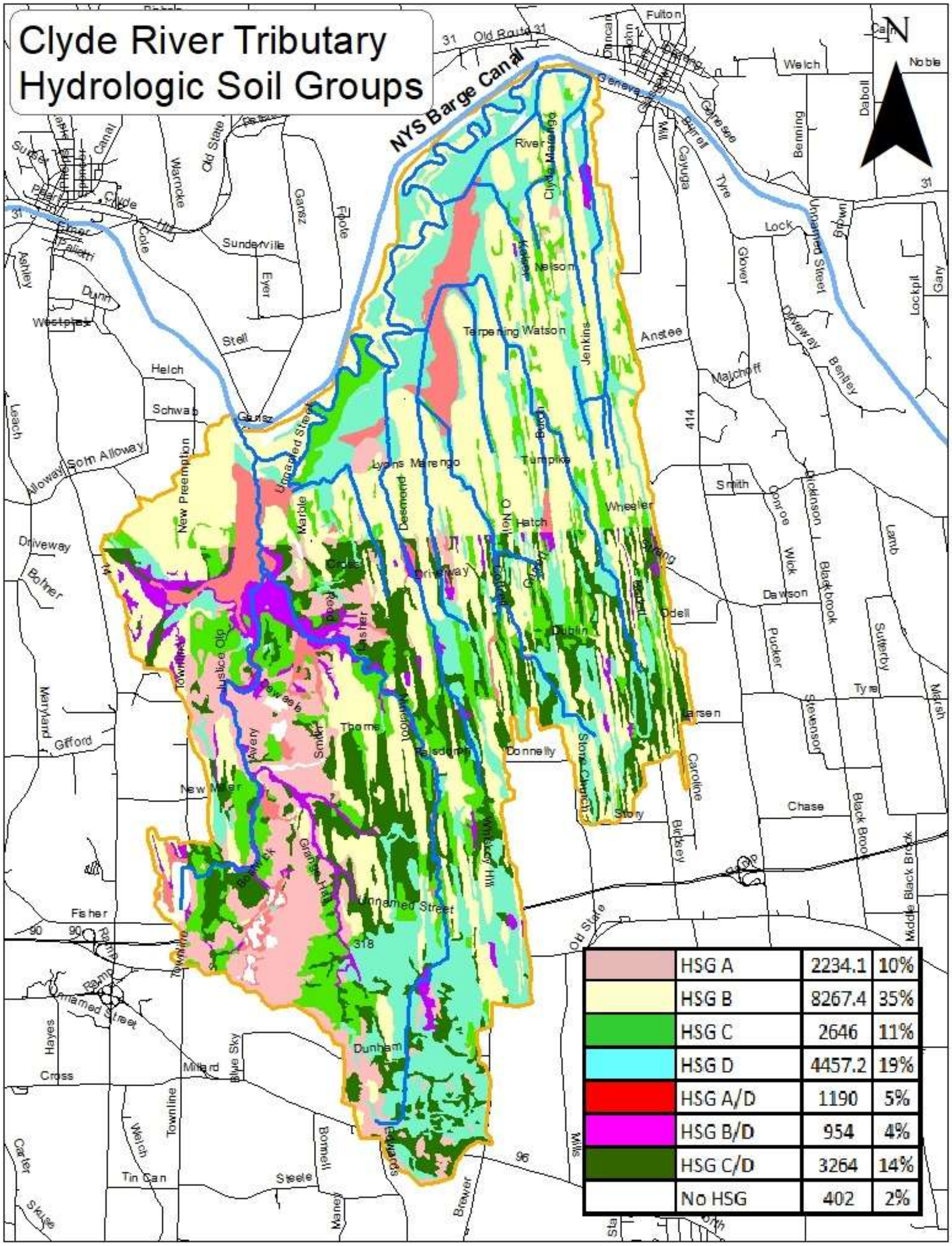
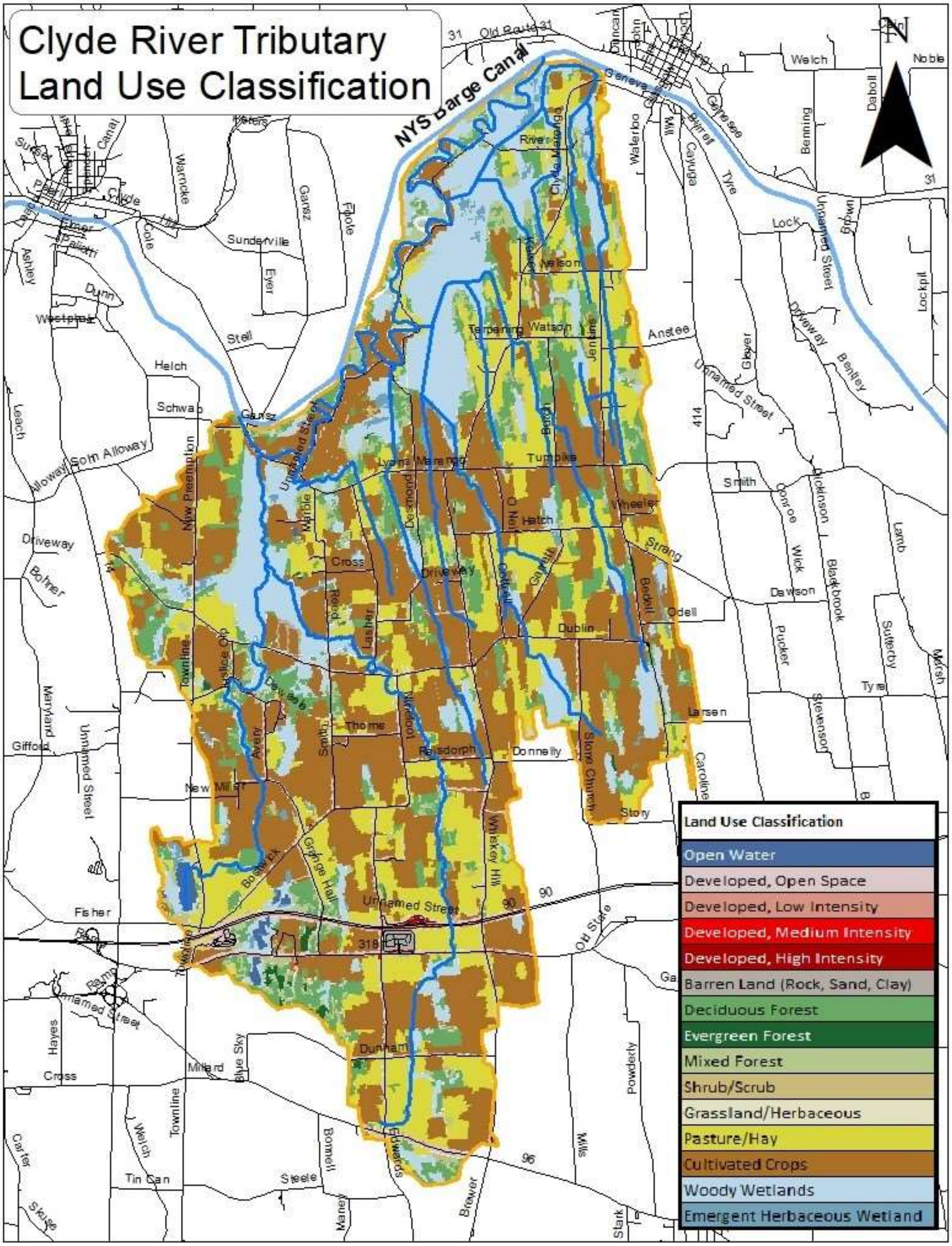
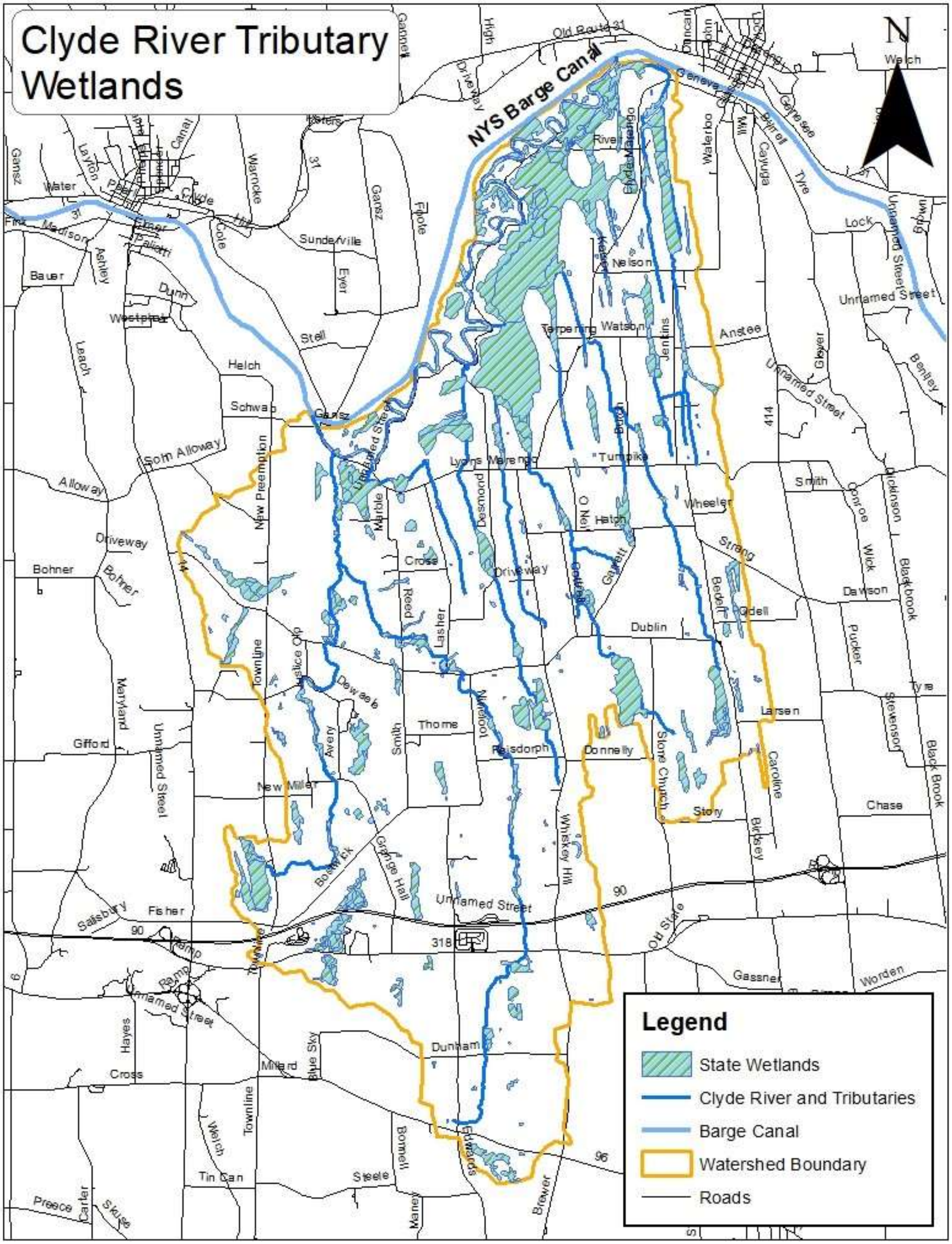
Appendix I. – Detailed Maps




Clyde River Tributary
Hydrologic Soil Groups
NYS Barge Canal
N
HSG A 2234.1 10%
HSG B 8267.4 35%
HSG C 2646 11%
HSG D 4457.2 19%
HSG A/D 1190 5%
HSG B/D 954 4%
HSG C/D 3264 14%
No HSG 402 2%


Clyde River Tributary
Land Use Classification
NYS Barge Canal
Land Use Classification
Open Water
Developed, Open Space
Developed, Low Intensity
Developed, Medium Intensity
Developed, High Intensity
Barren Land (Rock, Sand, Clay)
Deciduous Forest
Evergreen Forest
Mixed Forest
Shrub/Scrub
Grassland/Herbaceous
Pasture/Hay
Cultivated Crops
Woody Wetlands
Emergent Herbaceous Wetland


Clyde River Tributary Wetlands
N
NYS Barge Canal
Legend
State Wetlands
Clyde River and Tributaries
Barge Canal
Watershed Boundary
Roads

Appendix II. – Water Quality Data

Non-Event Concentrations

CR 01					
Date	TP (µg P/L)	TN (µg N/L)	NOx (µg N/L)	TKN (µg P/L)	TSS (mg/L)
5/7/2019	50.8	2380.0	1750	630	19.1
5/19/2019	66.0	2980.0	2020	960	11.5
10/22/2020	351.0	2780.0	2040	740	9.2
4/2/2021	32.1	2083.0	1762	321	2.1
5/18/2021	100.6	2359.4	2128.9	230.5	22.9

CR 02					
Date	TP (µg P/L)	TN (µg N/L)	NOx (µg N/L)	TKN (µg P/L)	TSS (mg/L)
5/7/2019	124	1210.0	318	892	4.4
5/19/2019	149.4	1060.0	227	833	4.1
10/22/2020	-----	-----	-----	-----	-----
4/2/2021	-----	-----	-----	-----	-----
5/18/2021	166.5	1178	143	1035	7.3

CR 03					
Date	TP (µg P/L)	TN (µg N/L)	NOx (µg N/L)	TKN (µg P/L)	TSS (mg/L)
5/7/2019	47.6	1850.0	1420	430	8.6
5/19/2019	60.0	2360.0	1870	490	13.3
10/22/2020	44.5	1260.0	765	495	6.9
4/2/2021	24.7	2090.0	1770	320	2.1
5/18/2021	73.7	2522.4	2407.2	115.2	3.5

CR 04					
Date	TP (µg P/L)	TN (µg N/L)	NOx (µg N/L)	TKN (µg P/L)	TSS (mg/L)
5/7/2019	29.8	482.0	10	472	6.5
5/19/2019	34.3	634.0	29.3	604.7	8.1
10/22/2020	-----	-----	-----	-----	-----
4/2/2021	14.5	808.0	300	508	<LOD
5/18/2021	79.1	727.5	<LOD		4.8

CR 05					
Date	TP (µg P/L)	TN (µg N/L)	NOx (µg N/L)	TKN (µg P/L)	TSS (mg/L)
5/7/2019	52.1	1190.0	31	1159	11
5/19/2019	77.2	968.0	23.9	944.1	3.1
10/22/2020	-----	-----	-----	-----	-----
4/2/2021	18.9	959.0	90	869	<LOD
5/18/2021	83.3	1303	39.3	1263.7	35

CR 06					
Date	TP (µg P/L)	TN (µg N/L)	NOx (µg N/L)	TKN (µg P/L)	TSS (mg/L)
5/7/2019	101	781.0	96	685	12.2
5/19/2019	105.2	648.0	<LOD	-----	2.2
10/22/2020	-----	-----	-----	-----	-----
4/2/2021	27.2	547.0	12	535	<LOD
5/18/2021	53.9	882.4	<LOD	-----	1.8

CR 07					
Date	TP (µg P/L)	TN (µg N/L)	NOx (µg N/L)	TKN (µg P/L)	TSS (mg/L)
5/7/2019	84.4	490.0	5	485	0.8
5/19/2019	97.3	656.0	11	645	4.5
10/22/2020	-----	-----	-----	-----	-----
4/2/2021	55	528.0	<LOD	-----	1.3
5/18/2021	51.4	708.8	<LOD	-----	1.6

CR 08					
Date	TP (µg P/L)	TN (µg N/L)	NOx (µg N/L)	TKN (µg P/L)	TSS (mg/L)
5/7/2019	59.8	448.0	5	443	0.9
5/19/2019	78.8	438.0	33.6	404.4	<LOD
10/22/2020	-----	-----	-----	-----	-----
4/2/2021	33.5	490.0	11	479	<LOD
5/18/2021	146.5	689.1	<LOD	-----	9.1

CR 09					
Date	TP (µg P/L)	TN (µg N/L)	NOx (µg N/L)	TKN (µg P/L)	TSS (mg/L)
5/7/2019	127	808.0	5	803	5.7
5/19/2019	131.4	737.0	73	664	4.1
10/22/2020	-----	-----	-----	-----	-----
4/2/2021	38.1	739.0	23	716	1.4
5/18/2021	85.3	745.1	<LOD	-----	13.7

Event Concentrations

CR 01					
Date	TP (µg P/L)	TN (µg N/L)	Nitrate (µg N/L)	TKN (µg P/L)	TSS (mg/L)
6/11/2019	8.3	3550.0	2360	1190	47
4/28/2020	130.7	2600.0	1950	650	25.7
4/16/2021	41.9	2198.0	1680.9	517.1	4.3
6/9/2021	146.2	2022.0	1468.4	553.6	22.5
7/22/2021	88.2	6288.5	4016.1	2272.4	12.8

CR 02					
Date	TP (µg P/L)	TN (µg N/L)	Nitrate (µg N/L)	TKN (µg P/L)	TSS (mg/L)
6/11/2019	7.8	1140.0	56	1084	11
4/28/2020	50.4	969.0	354	615	13.9
4/16/2021	76.6	1060.0	82.1	933.9	9.8
6/9/2021	-----	-----	-----	-----	-----
7/22/2021	120.2	6542.3	3306.5	3235.8	7.1

CR 03					
Date	TP (µg P/L)	TN (µg N/L)	Nitrate (µg N/L)	TKN (µg P/L)	TSS (mg/L)
6/11/2019	10.2	3730.0	3210	520	15
4/28/2020	62.5	2110.0	1750	360	13.9
4/16/2021	36.1	1932.0	1363.4	568.6	5.2
6/9/2021	106.4	2463.0	1859.6	603.4	17.5
7/22/2021	78.3	3780	4541.4	-----	5.5

CR 04					
Date	TP (µg P/L)	TN (µg N/L)	Nitrate (µg N/L)	TKN (µg P/L)	TSS (mg/L)
6/11/2019	14.5	1080.0	20	1060	40
4/28/2020	31.3	559.0	82.6	476.4	6
4/16/2021	41.4	764.0	66.4	697.6	7
6/9/2021	351.1	1500.0	46.3	1453.7	64.4
7/22/2021	70.9	921.2	250.2	671	21.5

CR 05					
Date	TP (µg P/L)	TN (µg N/L)	Nitrate (µg N/L)	TKN (µg P/L)	TSS (mg/L)
6/11/2019	15.7	1640.0	41	1599	26
4/28/2020	40.2	992.0	20.2	971.8	3.2
4/16/2021	38.0	1297.0	80.2	1216.8	13.9
6/9/2021	135.4	1641.0	<LOD		24.5
7/22/2021	58.2	1493	2.8.6	1254.4	3.4

CR 06					
Date	TP (µg P/L)	TN (µg N/L)	Nitrate (µg N/L)	TKN (µg P/L)	TSS (mg/L)
6/11/2019	7.7	978.0	9	834	13
4/28/2020	60.6	507.0	<LOD	-----	1.3
4/16/2021	50.8	863.0	13.2	688.3	4.4
6/9/2021	243.2	1353.0	<LOD	-----	20.2
7/22/2021	185.8	1083	49.7	909.9	15

CR 07					
Date	TP (µg P/L)	TN (µg N/L)	Nitrate (µg N/L)	TKN (µg P/L)	TSS (mg/L)
6/11/2019	7.3	838.0	4	834	10
4/28/2020	70.2	552.0	<LOD	-----	2.3
4/16/2021	46.2	699.0	10.7	688.3	1.8
6/9/2021	315.1	852.2	<LOD	-----	13.6
7/22/2021	216.1	959.6	49.7	909.9	3.2

CR 08					
Date	TP (µg P/L)	TN (µg N/L)	Nitrate (µg N/L)	TKN (µg P/L)	TSS (mg/L)
6/11/2019	6.5	853.0	5	848	17
4/28/2020	39.2	470.0	25.1	444.9	<LOD
4/16/2021	280.3	763.0	60.4	702.6	12.6
6/9/2021	535	863.0	<LOD	-----	13.7
7/22/2021	221.6	1346	803.1	542.9	3.9

CR 09					
Date	TP (µg P/L)	TN (µg N/L)	Nitrate (µg N/L)	TKN (µg P/L)	TSS (mg/L)
6/11/2019	25.3	1910.0	209	1701	24
4/28/2020	45.0	472.0	<LOD	-----	1.2
4/16/2021	257.5	1267.0	<LOD	-----	33.4
6/9/2021	95.8	1096.0	25.1	1070.9	3.2
7/22/2021	134.6	8267.5	2730	5537.5	7.8