Chapter 5: Lower Tonawanda Creek

The Lower Tonawanda Creek Sub-watershed (LT) is located in the northern section of the Niagara River Watershed as seen in Map 5.1. It has an area of 78,802.6 acres, or 123.1 square miles, and includes 216.6 miles of waterways. Located in portions of Erie and Niagara Counties, LT includes the following municipalities: the towns of Cambria, Lockport, Wheatfield, Pendleton, Clarence, Amherst, Lancaster, and Newstead, and the cities of North Tonawanda and Lockport. The sub-watershed is shown in Map 5.1.

Tonawanda Creek is channelized and dredged from the Village of Pendleton to its mouth on the Niagara River to accommodate the Erie Canal. During the months of April to November, a lock diverts water causing the creek to flow backward for approximately 19 miles northeast through the canal to Lockport. This flow reversal and channelization limits habitat connectivity between the Niagara River and Tonawanda Creek and has likely impaired aquatic biodiversity in both systems. Water temperatures are affected by flow reversals and may be responsible for periodic fish die-offs in the creek.

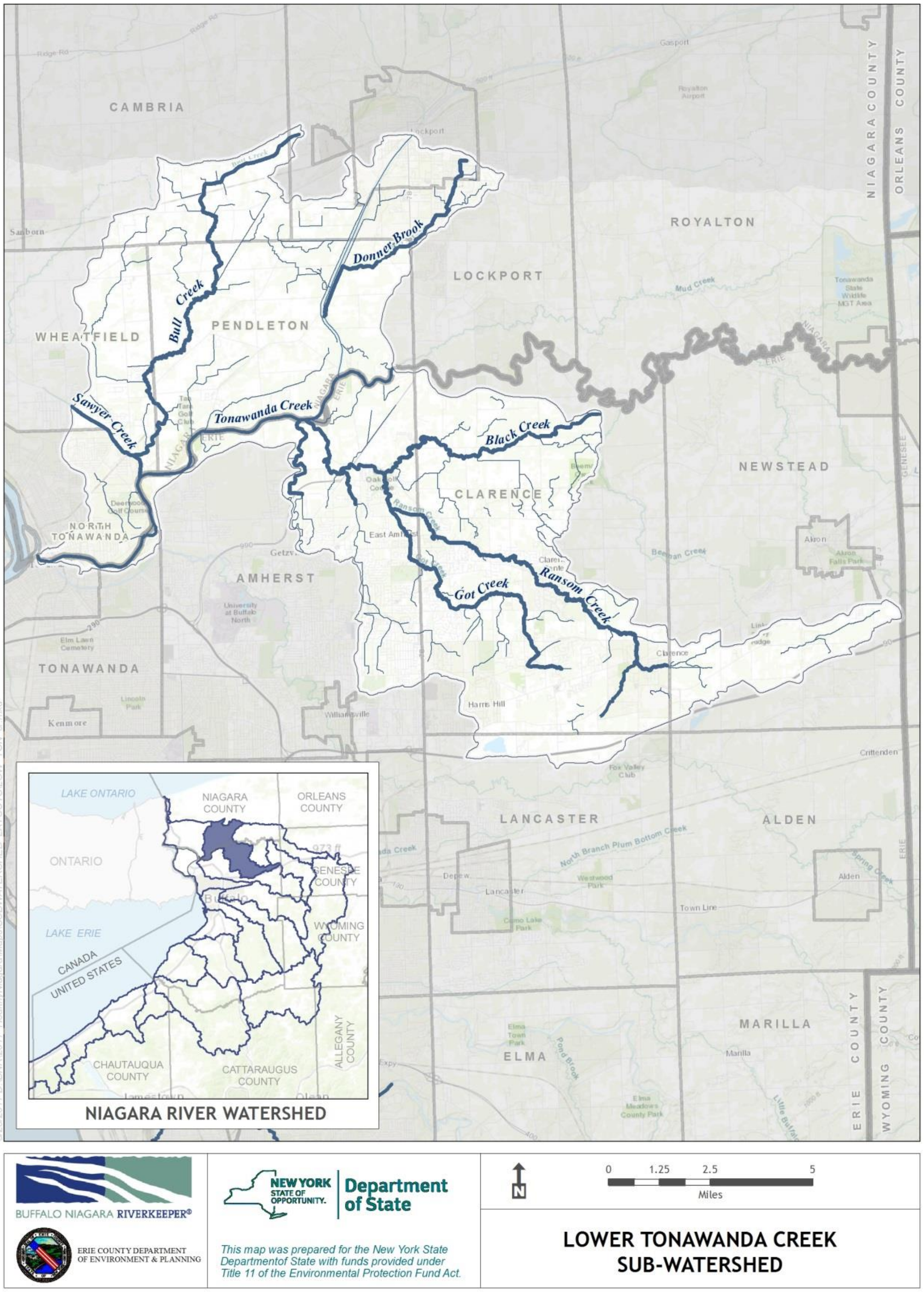
Land Use/Land Cover

Land Use/Land Cover (LULC) classifications for LT were derived from 2010 National Oceanic Atmospheric Administration (NOAA) LULC data, and like classifications were consolidated into groups that reflect the overall LULC classification.[22] The LULC groups can be seen in Table 5.1.

As seen in Map 5.2, large concentrations of agricultural land exist in the northwestern expanse of the sub-watershed, especially in the northwest near Cambria, and Wheatfield Interspersed wetlands exist throughout, but are especially prevalent in the middle of the sub-watershed.

Table 5.1: LULC Groups

LULC Class	% by general LULC
Developed, High Intensity	Developed: 25.41%
Developed, Medium Intensity	
Developed, Low Intensity	
Developed, Open Space	
Cultivated Crops	Agriculture: 36.59%
Pasture/Hay	
Deciduous Forest	Forest: 16.14%
Evergreen Forest	
Mixed Forest	
Palustrine Forested Wetland	Wetland: 17.92%
Palustrine Scrub/Shrub Wetland	
Palustrine Emergent Wetland	
Estuarine Emergent Wetland	
Open Water	Water: 0.74%
Grassland/Herbaceous	
Palustrine Aquatic Bed	
Scrub/Shrub	
Unconsolidated Shore	
Bare Land	Other: 3.21%



Map 5.1: Lower Tonawanda Creek Sub-watershed

Active River Area

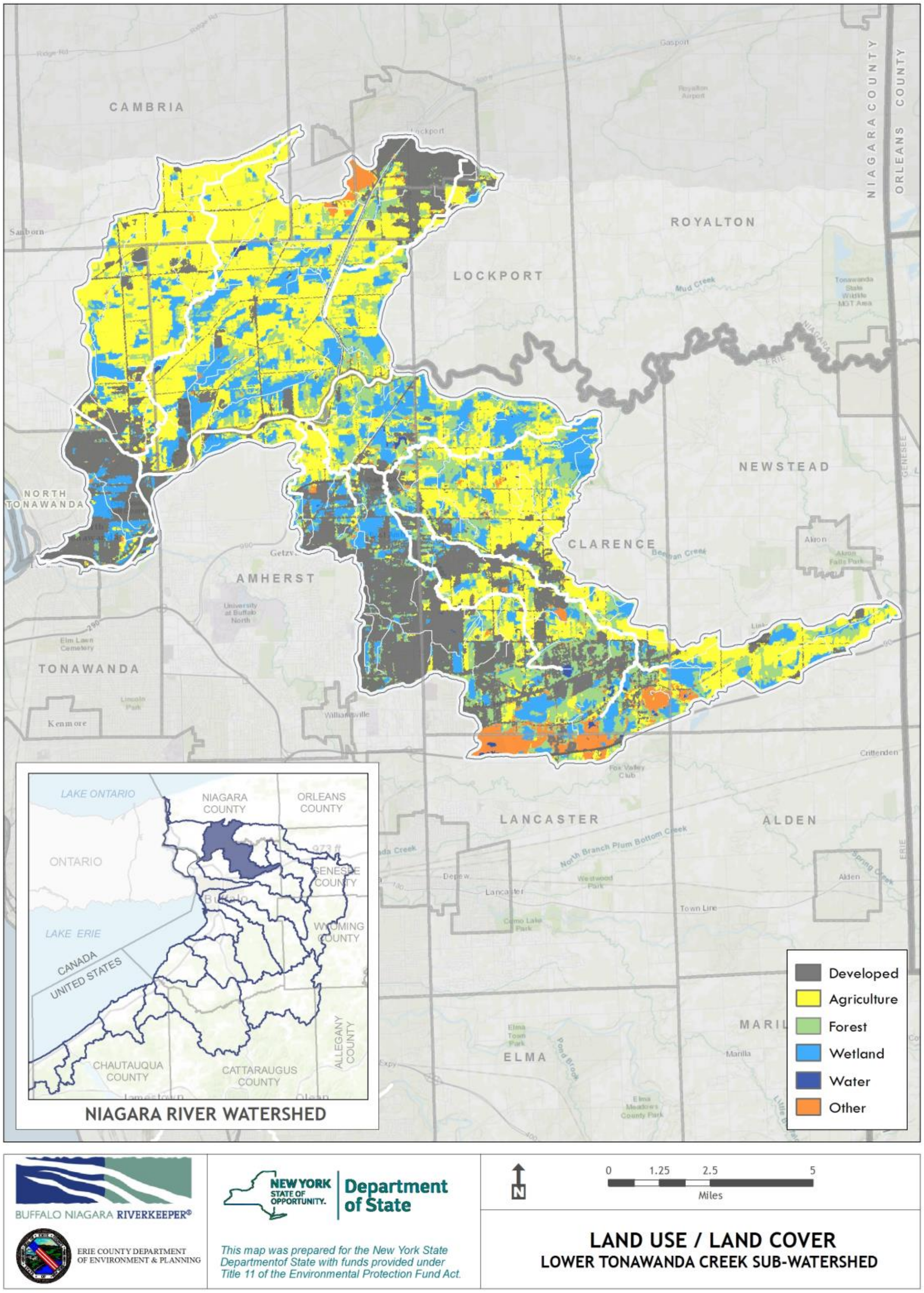
The Active River Area model, as discussed in Chapter 1, was applied to the sub-watershed to determine the extent of the ARA, and focus area for this project. The ARA within the LC is the most expansive of all sub-watersheds in the Niagara River sub-watershed due to flat topography and an abundance of wetlands and hydric soils.

The ARA within LC encompasses 79% of LC's total area, as seen in map 5.3

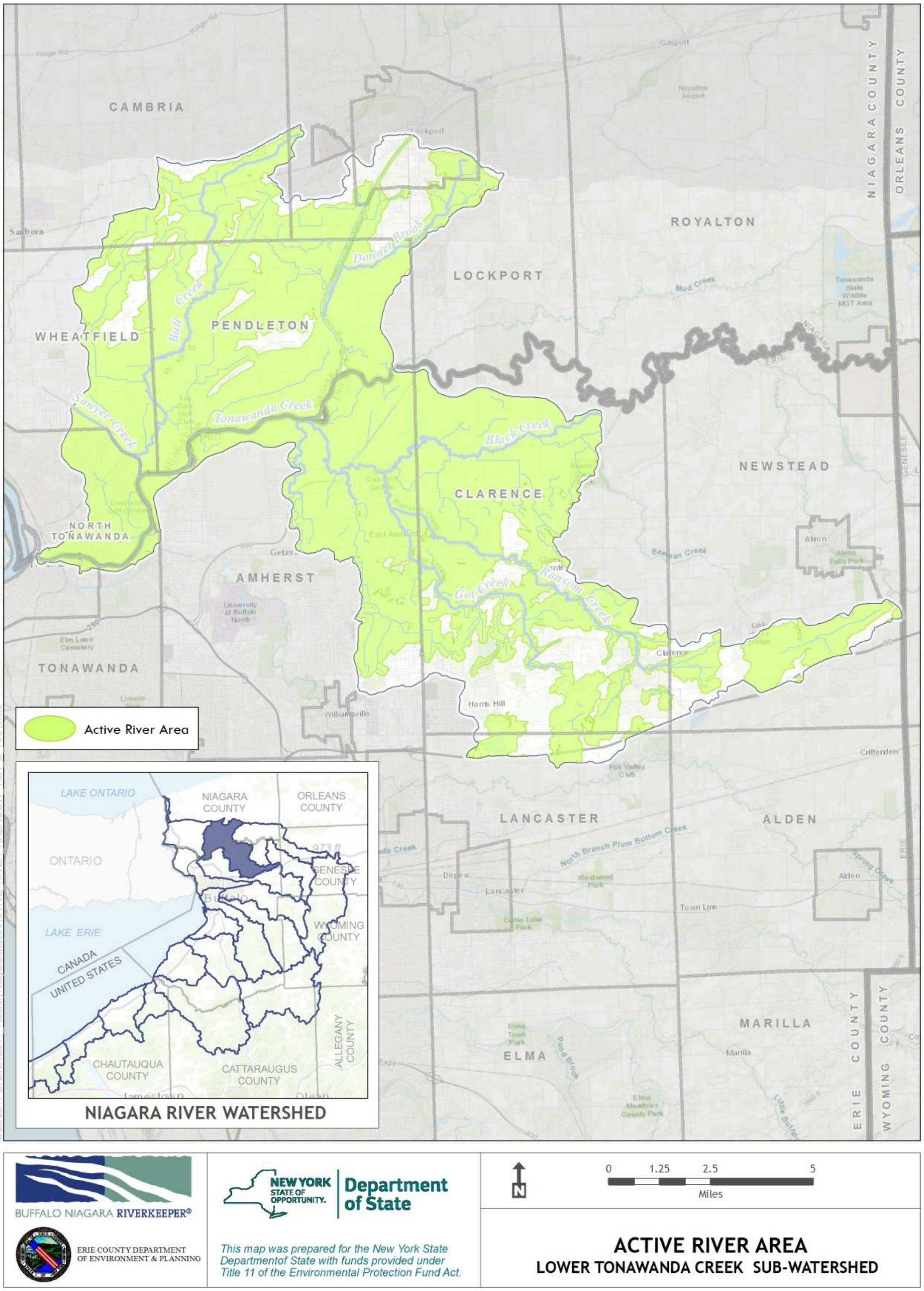
As the ARA in LT is expansive, and covers a majority of the sub-watershed, LULC within the sub-watershed likely has significant effects on overall waterbody health. The ARA in the southwestern headwaters of LT, encompassing the upper reaches of Ransom Creek, Gott Creek, and Black Creek interacts hydrologically with a variety of land uses such as forest, wetland/palustrine aquatic bed, and agriculture. Within the ARA's most expansive area, in the middle sections of the sub-watershed, the land-to-stream interaction becomes increasingly dominated by agricultural land use, suggesting that runoff occurs from these locations. However, this area also contains a large amount of wetland LULC. Additionally, in the lower reaches of LT, Tonawanda Creek and Sawyer Creek flow through lands with heavy urbanized development, where inputs into the creek, such as road runoff and industrial effluent, reflect developed land use and urban environments. Finally, the headwaters of Donner Brook, located in the northeastern reaches of the sub-watershed are also heavily developed in the Village of Lockport, where impervious surfaces contribute urban storm water runoff into streams.

Land Use/Land Cover in the Active River Area

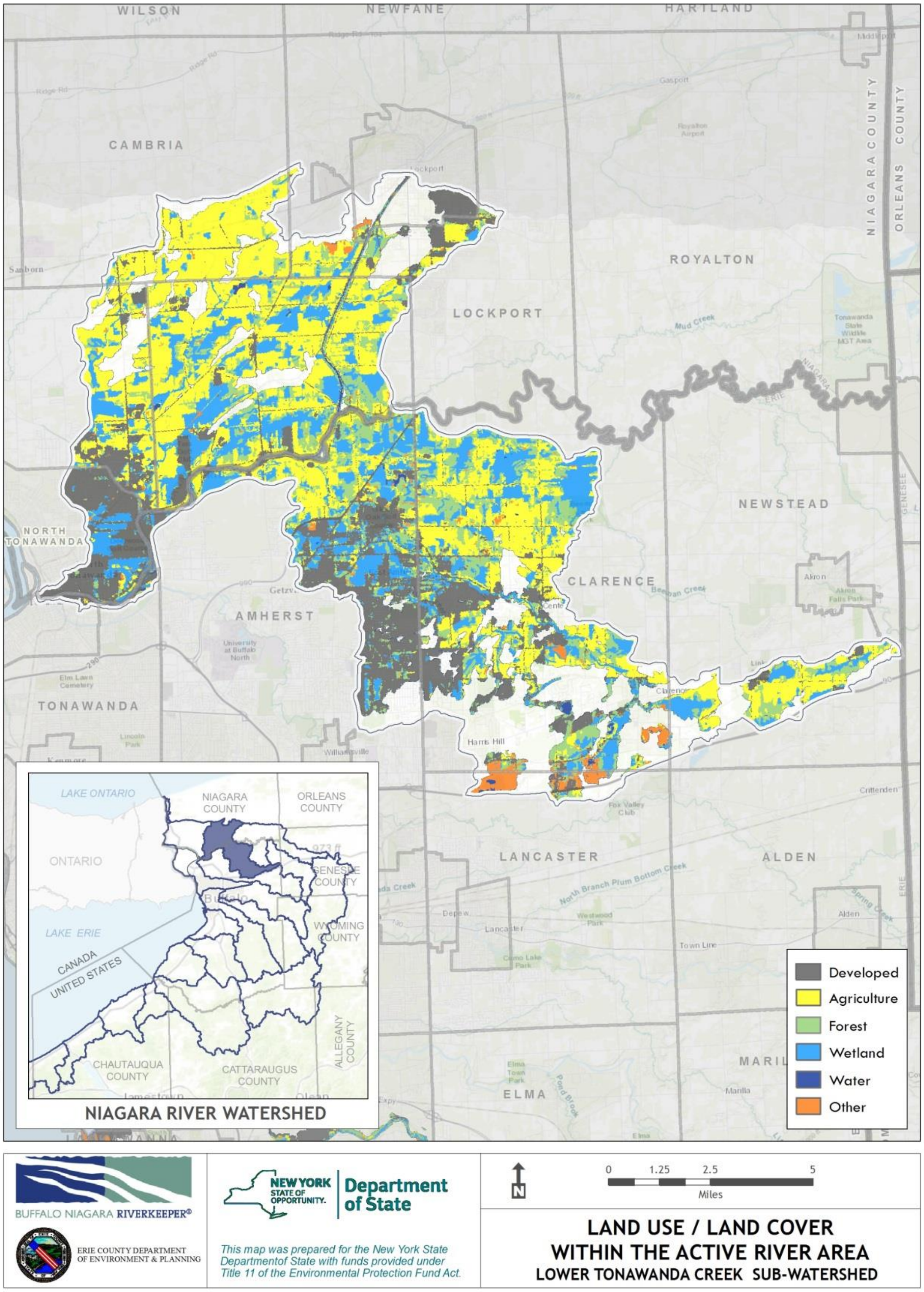
Potential sources of contaminants entering waterways from surrounding lands were identified by overlaying the ARA model on LULC data, to plot where specific land uses interact with streams through natural hydrologic mechanisms. Map 5.4 displays LULC limited to the bounds of the ARA, indicating where contaminants on land may have direct interaction with stream waters.



Map 5.2: Upper Tonawanda Creek Sub-watershed Land Use/Land Cover



Map 5.3: Lower Tonawanda Creek Sub-watershed Active River Area



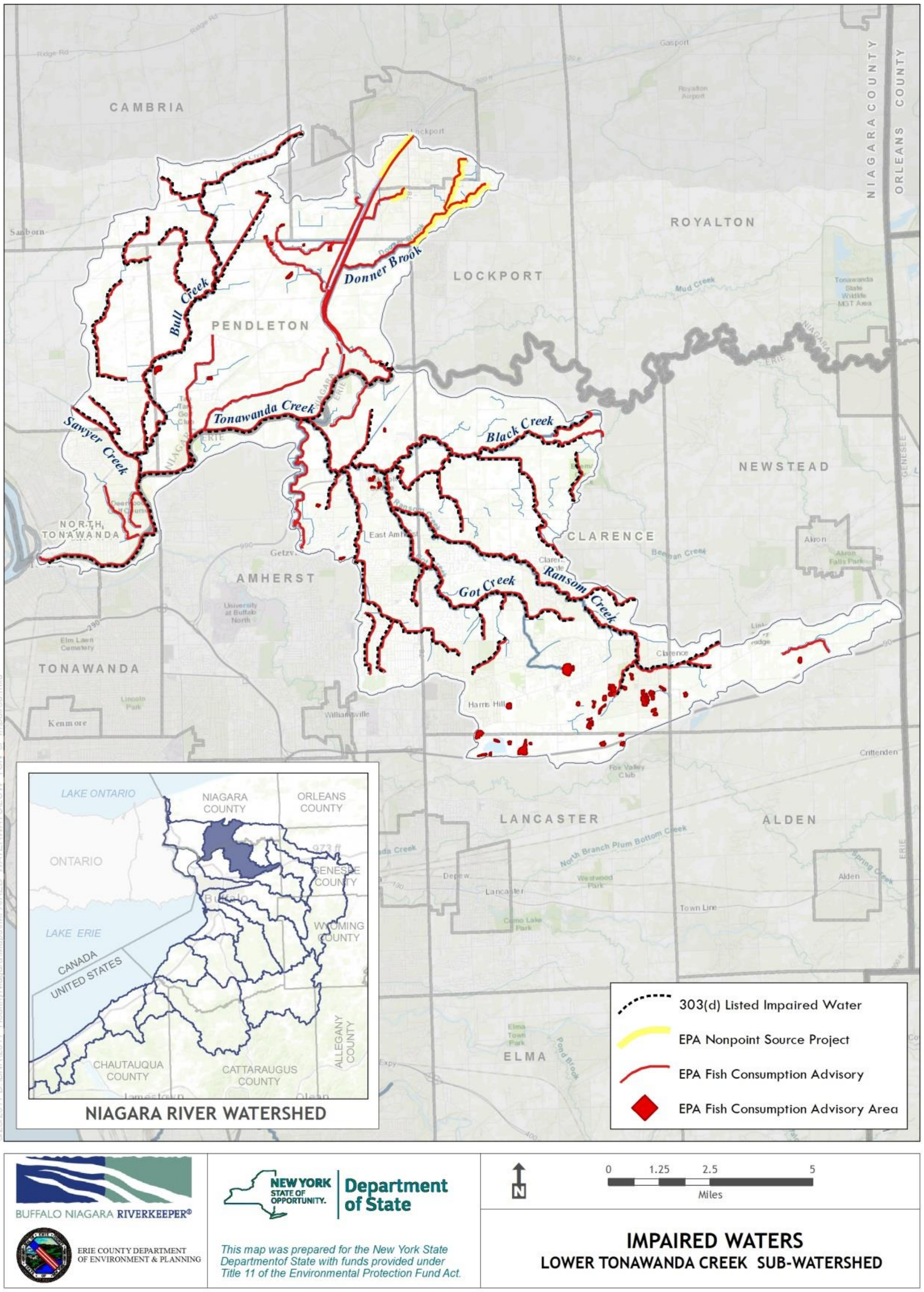
Map 5.4: LULC and ARA Interaction

Impaired Waters

The NYSDEC WI/PWL catalogs several waterbody segments within LT, encompassing 154.2 miles, or 71.2% as impaired. Impaired segments include the Lower Main Stem of the Niagara River, Bull Creek and its tributaries, and both Upper and Lower Ransom Creek and its tributaries. The minor tributaries to Lower Tonawanda Creek remain unassessed.

As depicted in Map 5.5, much of the sub-watershed's main streams, including Tonawanda Creek, Sawyer Creek, Bull Creek, Black Creek, Ransom Creek and Black Creek, are listed on the 303(d) list indicating impaired waterways, with a majority of streams are listed as being under EPA Fish Advisories. Portions of the northern reaches of the sub-watershed, including Donner Brook are listed as EPA Nonpoint Source Projects, a program established under Section 319 of the Clean Water Act, and administered by the NYSDEC to "control pollution from nonpoint sources to the waters of the state and to protect, maintain and restore waters of the state that are vulnerable to, or are impaired by nonpoint source pollution".[9]

NYSDEC classifies waterways according to a class system related to uses.[12] Stream classifications for waterways assessed in this project are listed below in Table 5.2. Streams with AA or A classifications are suitable for drinking water sources, while streams classified as B, C, or D support descending numbers of uses. The addition of a (T) to a stream classification indicates that the stream may support trout populations, while a (TS) waterway may support trout spawning.



Map 5.5: Lower Tonawanda Creek Sub-watershed Impaired Waterways

Table 5.2: NYSDEC Priority Waterbody Classifications

		Designated Use(s) Not Supported by the Waterbody			Pollutant(s) of Concern		Source(s) of Pollution	
Priority Waterbody	Stream Class	Use(s) Impacted	Severity of Impact	Documentation	Type of Pollutant	Documentation	Source	Documentation
Tonawanda Creek, Lower, Main Stem	C	Fish consumption Aquatic Life Recreation	Impaired Stressed Stressed	Known Suspected Suspected	Priority Organics - PCBs Nutrients Silt/Sediment	Known Suspected Suspected	Toxic/Contaminated Sediment Urban Runoff Other Sanitary Discharge Streambank Erosion Landfill/Land Disposal Municipal	Known Known Suspected Suspected Possible Possible
Bull Creek and tributaries	C	Aquatic Life	Impaired	Known	Unknown Toxicity Dissolved Oxygen/Oxygen Demand Nutrients	Suspected Suspected Suspected	Unknown Source Municipal Urban Runoff Industrial	Suspected Suspected Suspected Possible
Ransom Creek, Lower, and tributaries (includes Black Creek)	C	Aquatic Life Recreation Aesthetics	Impaired Impaired Stressed	Suspected Suspected Known	Dissolved Oxygen/Oxgyen Demand Pathogens Aesthetics (odors) Nutrients Silt/Sediment Ammonia	Known Known Known Suspected Suspected Possible	On-site Septic Systems Private/Community/Industrial (various residential) Urban Runoff	Known Known Suspected
Ransom Creek, Upper, and tributaries (includes Gott Creek)	C(T)	Aquatic Life Recreation Aesthetics	Impaired Impaired Stressed	Suspected Suspected Known	Dissolved Oxygen/Oxgyen Demand Pathogens Aesthetics (odors) Nutrients Silt/Sediment Ammonia	Known Known Known Suspected Suspected Possible	On-site Septic Systems Private/Community/Industrial (various residential) Urban Runoff	Known Known Suspected

Stream Visual Assessment & Water Quality Data Collection

In order to supplement existing data and fill in data gaps, Buffalo Niagara Riverkeeper (BNR) conducted water sampling and stream assessments throughout the sub-watershed. Sampling took place in eight stream bodies in LT during the 2016 field season.

Waterways within LT were assessed from June 20, 2016 to August 8, 2016. Within eight stream bodies, 825 reaches were assessed. Reaches refer to a length of stream 200 feet in length. The streams assessed were Sawyer Creek, Black Creek, Bull Creek, Ransom Creek, Gott Creek, a tributary of Ransom Creek, a tributary of Tonawanda Creek, and another minor tributary to Tonawanda Creek. Each stream was broken up into segments and assigned a unique identifier based on location (SAW, BLK, BUL, RSM, GOT, RT, TOND, EC).

Figure 5.1: Stream visual assessment in Bull Creek (BNR)

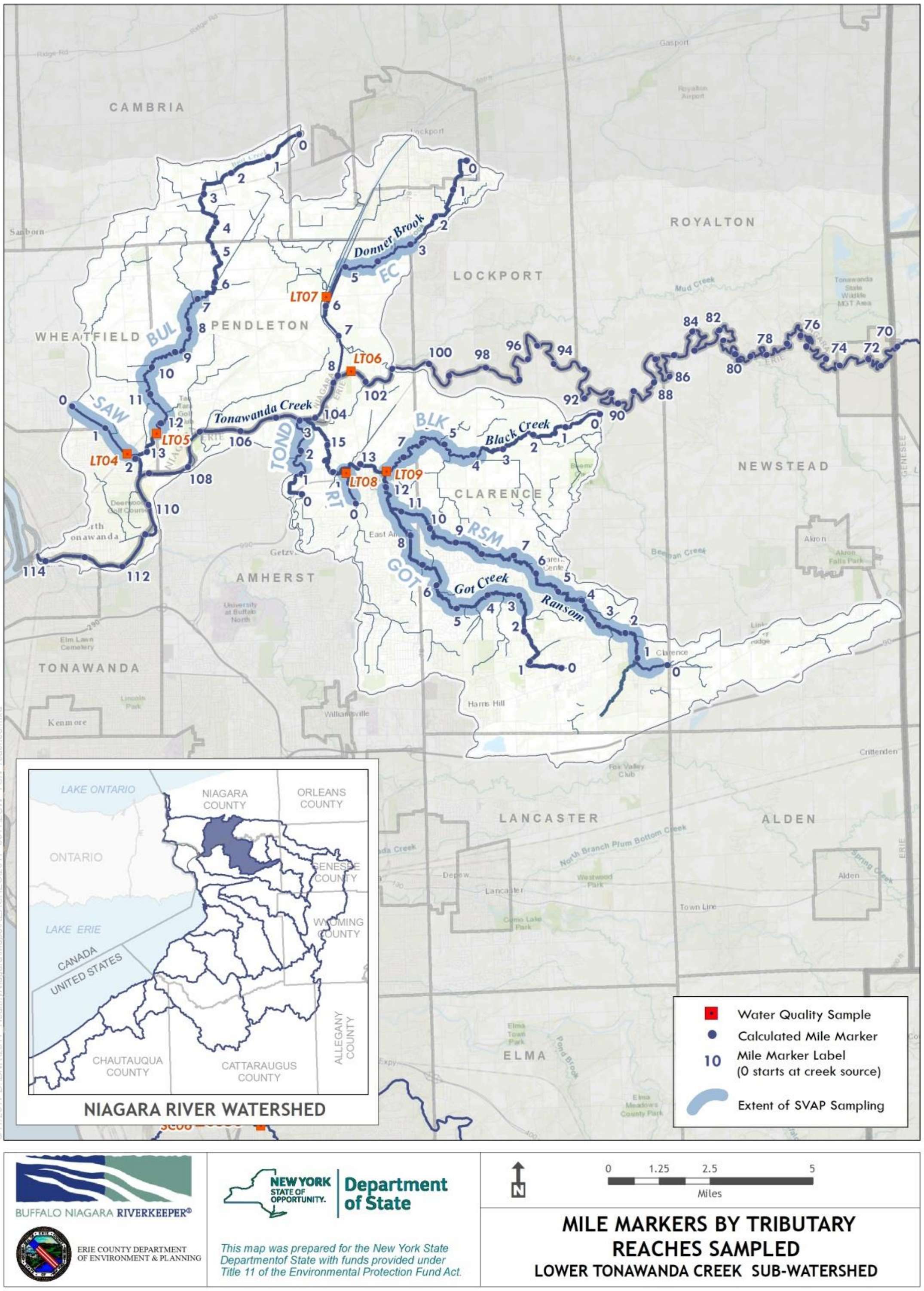
Within LT, 31 of the total 216 miles (14%) of waterways were assessed using a modified version of the Stream Visual Assessment Protocol (SVAP).[21] Field teams encountered numerous streams where water depth was too high or where drought conditions resulted in dry stream beds. In these locations, assessment was not possible.

As seen below in Table 5.3, segments assessed through SVAP were within the following streams: Sawyer Creek, Black Creek, Bull Creek, Ransom Creek and tributaries, Gott Creek, and two unnamed tributaries of Tonawanda Creek.

Table 5.3: Streams Assessed in Lower Tonawanda Creek Sub-watershed

Stream Assessed	Stream Class	Miles Assessed
Sawyer Creek	C	1.7
Black Creek	C	3.2
Bull Creek	C	5.5
Ransom Creek and tributaries	C, C(T)	11.86
Gott Creek	C(T)	5.8
Tributary of Tonawanda Creek		1.33
Minor Tributary to Tonawanda Creek		1.93

Stream miles were calculated using ArcGIS software so that stream segments and sample sites could be assigned a unique "mile marker" within the waterways for reference. Mapped segments with mile markers can be seen in Map 5.6.



Map 5.5 Stream Segments Assessed

Physical Properties

As seen in Table 5.4, LT recorded an average depth of 9.9 inches for the eight streams assessed. The sub-watershed recorded an average bankfull width of 23.7 feet and an average baseflow width of 13.4 feet.

Table 5.4: Lower Tonawanda Creek Sub-watershed Physical Properties

Stream	Average Depth (in.)	Average Bankfull Width (ft.)	Average Baseflow Width (ft.)
Sawyer Creek	13.2	29.4	21.9
Black Creek	6.5	25.5	11.0
Bull Creek	8.8	24.2	12.4
Ransom Creek	8.8	24.1	13.8
Gott Creek	9.5	22.9	14.4
Ransom Creek Tributary	12.9	17.4	8.2
TOND (Tonawanda Creek Tributary)	15	28.9	17.9
EC (Minor Tributary to Tonawanda Creek)	4.3	17.1	7.8
Sub-watershed Average	**9.9**	**23.7**	**13.4**

Stream Visual Assessment and Water Quality Findings

During the Phase 1 process, LT was chosen based on its impairment of water quality and habitat conditions. Throughout the fieldwork process, it became apparent that stream conditions varied greatly by individual reach. Overall SVAP findings from the eight assessed waterbodies within the sub-watershed resulted in a score of 'poor' (5.7).

Within the sub-watershed, the EC stream segment had the highest average SVAP score, 'fair' (6.9). The lowest score recorded in the EC stream segment was 'poor' (5.6) and the highest score was 'good' (7.9). The stream segment with the lowest average SVAP score was the SAW segment in Sawyer Creek, which recorded an average of 'poor' (3.1). The lowest SVAP score in the segment was 'poor' (2.1) and the highest score was also 'poor' (5.0).

Overall SVAP scores draw attention to Sawyer Creek, which recorded the lowest average score in LT. Sawyer Creek recorded an average score of 'poor' (3.1). Sawyer Creek runs closely parallel to Niagara Falls Boulevard in the city of North Tonawanda before the confluence at Tonawanda Creek, primarily a developed landscape. Characterized by a severely altered channel, the creek recorded an average score of 'poor' (1.0) for channel conditions. The creek is highly channelized. Straightening channels is often implemented for navigational purposes, or in the attempt to reduce flooding in a specific area. However, these drastic alterations create many ecological consequences. The straightening of stream channels can result in faster flow and deeper water which can lead to increased soil erosion.[19] In addition, the removal of riparian vegetation results in decreased bank stability and increased water temperatures due to reduction of shading.

Table 5.5 presents an SVAP score summary for LT, and a full SVAP summary is available in Appendix D.

Table 5.5: Lower Tonawanda Creek Sub-watershed SVAP Element Summary

	Channel Conditions	Riparian Zone Left Bank	Riparian Zone Right Bank	Bank Stability Left Bank	Bank Stability Right Bank	Water Appearance	Nutrient Enrichment
# of scores average	825 7.3	825 7.4	825 7.2	825 6.8	825 8.6	825 4.8	825 4.3
	Instream Fish Cover	**Pools**	**Invertebrate Habitat**	**Canopy Cover**	**Manure Presence**	**Riffle Embeddedness**	
# of scores average	825 3.5	825 2.7	825 5.5	823 6.5	83 5.0	104 4.3	

Substrate in LT is predominantly silt/clay, with 66% of assessed reaches having a silt/clay substrate. Cobble comprised 17% of the sub-watershed's assessed substrate. Gravel comprised 13%, with sand, boulders, and bedrock making up only 4% of the substrate of assessed reaches, cumulatively.

Hydrilla was observed in 15% of stream reaches assessed in the sub-watershed. Phragmites, or common reed was observed in 11%, Purple Loosestrife in 8%, and Japanese Knotweed in 3% of all assessed reaches.

These conditions impacted the extent of stream assessments and water quality sampling within Ransom, Bull, and Black Creeks. The upper reaches of Bull and Black were dry and water flow was intermittent. Flow at select mid-reaches within Ransom Creek was also dry and intermittent. During community presentations and outreach events, local landowners also anecdotally noted that water levels within Ransom Creek were unusually low. One unnamed tributary of Tonawanda Creek completely dried up from the time of reconnaissance in April 2016 to mid-July. It should be noted that assessments preformed in abnormal weather conditions may not be representative of a stream's typical conditions.

Additional water quality sampling was performed at six sites within LT from June 2015 to November 2015. Of those six sites, three were sampled again from April 2016 to November 2016. It must be noted however, that as discussed above, 2016 sampling took place during drought conditions, and fewer storm events would have contributed to runoff brining nutrients into waterways.

Table 5.6 displays water quality parameters measured, including the number of measurements performed, high and low values measured and the average value recorded for each parameter. Full water quality parameter results can be found in Appendix C and D.

Table 5.6: Lower Tonawanda Creek Sub-watershed Water Quality Element Summary

	Temperature ºC	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%)	Conductivity (uS/cm)	Total Dissolved Solids (mg/L)
# of scores	194	172	172	194	194
low value	12.6	2.8	30	336.5	225.6
high value	29.2	15.1	178	1982	1670.5
average	20.77	7.37	83.32	1160.41	828.09
	pH	**Turbidity (NTU)**	**Phosphorus (µg/L)**	**Nitrate (µg/L)**	
# of scores	194	193	193	181	
low value	7.19	1.09	3.3	0	
high value	8.27	820	848.1	30,400	
average	7.72	52.35	128.7	6,310	

Baseline Indicators

Through the fieldwork portion of this project, parameters that either indicated pervasive impairments throughout the sub-watershed, or had high numbers of water quality parameters exceeding relevant standards or guidance values were isolated for further discussion. These baseline indicators are representative of the impairments that were identified through the field and analysis. Identifying and understanding the baseline indication and their sources is a crucial step for developing goals and actions to address stream impairments or act on conservation opportunities.

Baseline Indicators for the Lower Tonawanda Sub-watershed are identified as:

- Land Use/Land Cover
    - LULC in LT directly affects water quality throughout the sub-watershed, and stormwater and agricultural runoff is a major vector transporting contaminants from surrounding land into waterways. LULC also affects suggested management actions, as those actions that are able to be performed on agricultural or forested land may not be appropriate for more developed land.
- Turbidity
    - Turbidity as measured throughout the sub-watershed is consistently high. 69.8% of water quality samples performed during stream assessments had levels over the NYS DEC standard of 5 NTU.
- Riparian Zone and Bank Stability
    - The riparian zone, which measures the expanse of a natural vegetated strip, was rated as 'fair', but many waterbody segments recorded 'poor' scores. A 'poor' riparian zone allows stream banks to erode more readily, and for contaminants in runoff to flow uninterrupted into a waterbody. Bank stability is grouped with riparian zone, as a poor riparian zone generally coincides with poor bank stability. While some reaches scored very high, erosion issues were prevalent throughout the sub-watershed, and 'poor' bank stability scores were recorded in every stream segment SVAP assessments occurred in.
- *E. coli*
    - *E. coli* measurements performed in the sub-watershed had levels greatly exceeding recommended levels for recreational use.
- Nutrient Load
    - Phosphorus and Nitrate within the sub-watershed are consistently high, indicating that elevated levels of these constituents are entering waterways.
- Dissolved Oxygen
    - Dissolved Oxygen levels throughout the sub-watershed were very low, promoting excessive algae growth attributed to nutrient-laden stormwater runoff. Low dissolved oxygen directly affects stream health, as insufficient levels can lead to fish and aquatic die-offs.

Baseline Indicators Discussion

Land Use/Land Cover

As discussed previously, high levels of developed LULC in Lower Tonawanda Creek Sub-watershed, especially the southern portion, result in contributing urban runoff and industrial effluent into area waterways through direct inputs (runoff, industrial SPDES discharges), or overflow events (CSO/SSO events). Because some areas in the northern portion are heavily agricultural, impairments caused by runoff from fields and other operations is also prevalent.

Turbidity

High turbidity levels were common throughout LT in the 2016 field season. Of the samples collected, 70% read over the NYSDEC standard. Turbidity can be used an in indirect indicator of the concentration of suspended matter.

During monthly sampling, turbidity was measured in 2015 as an average of 42.9ntu throughout the six, with a high value of 222ntu recorded at Bull Creek in October 2015, and a low value of 1.8ntu recorded at Sawyer Creek in August 2015. In 2016, turbidity recorded an average of 62.2 NTU, with a low value of 13.2 NTU in May. A low value of 374 NTU was recorded in August at a tributary of Ransom Creek. Average Turbidity within the sub-watershed in 2015 and 2016 averaged above the NYSDEC standard value of 5 NTU, indicating that turbidity and sedimentation within the sub-watershed is prevailing concern.

Riparian Zone

The riparian zone, or area of natural vegetation bordering waterbodies, along assessed stretches of Sawyer Creek recorded an average score of 'poor' (3.0), the lowest of all waterbody segments assessed within LT. Poor scores indicate a lack of riparian zone or a narrow riparian zone in comparison to the streams active channel. This zone is vital component to a healthy waterbody, as the roots of riparian vegetation naturally stabilize banks and control erosion. This zone of vegetation also functions as a surface water filter, slowing and absorbing storm water

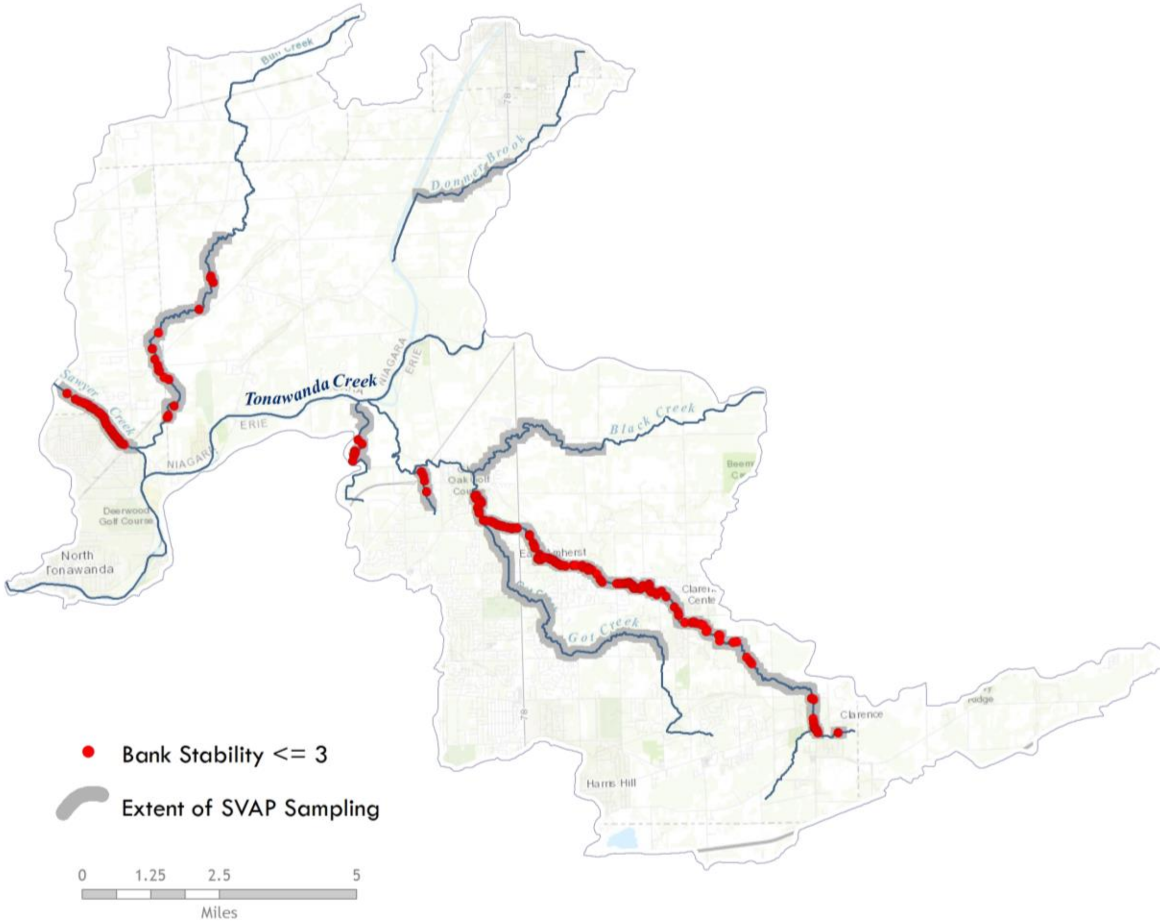
Figure 5.2: Lack of Riparian Vegetation along Sawyer Creek (BNR)

runoff and the various pollutants it transports. Due to the extent of development along Sawyer creek, the natural vegetation has been severely depleted as seen in Figure 5.2. Excellent scores (9.0+) refer to a riparian zone extending at least two times the width of the streams active channel.

Figure 5.3: Riparian Vegetation along Bull Creek (BNR)

In contrast, Bull Creek recorded a 'good' (8.8) score in regards to riparian zone. Bull Creek flows in a less developed area, primarily agricultural land, and its riparian vegetation has been less modified which can be seen in Figure 5.3.

Bank stability within the sub-watershed recorded an average score of 'fair' (6.8). Bank stability scores can be impacted by the height of stream banks, current evidence or lack of erosion, and presence or absence of rip-rap. Sawyer Creek recorded the lowest average bank stability score in the sub-watershed of 'poor' (4.0) due to its lack of natural riparian vegetation, which provides natural bank stabilization. Black Creek recorded the highest average bank stability score of 'good' (8.1). Bank stability scores under 3 for the sub-watershed are shown in Map 5.7 below. A score of 3 indicates that "banks are moderately unstable, typically high, actively eroding at bends; ~50% rip-rap; excessive erosion" while a score of 1 represents "Unstable high banks, actively eroding at bends throughout; dominated by rip-rap."



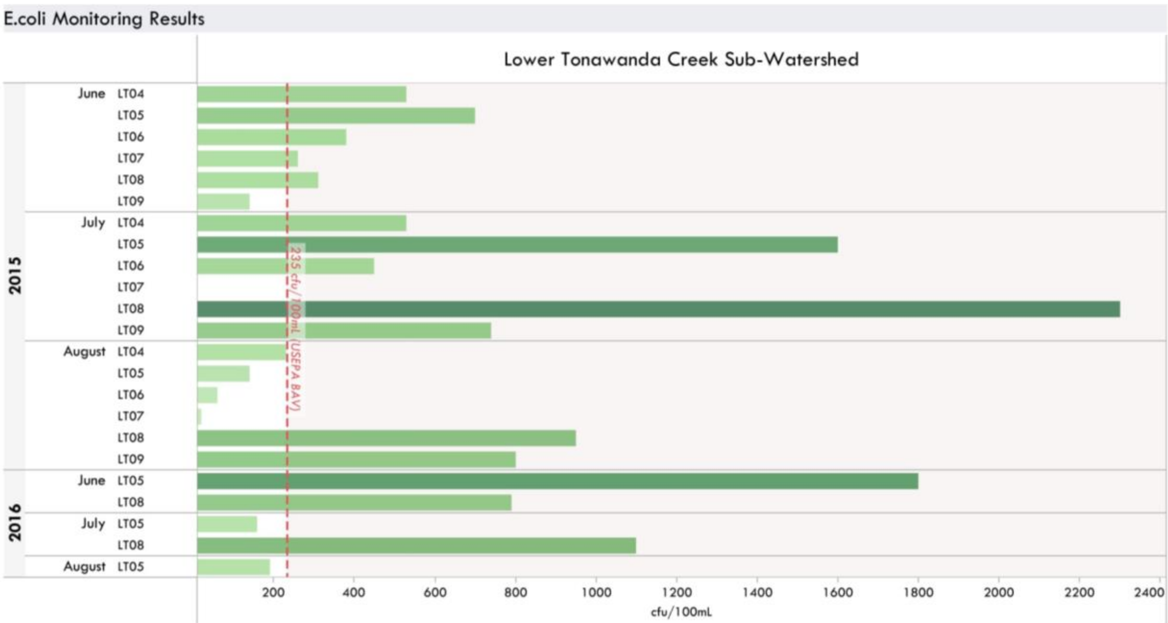
Map 5.7: Bank Stability Scores 1-3

E. coli

Manure presence was observed at 10% of the assessed stream reaches, with Ransom Creek accounting for the majority. A high amount of deer activity along the stream banks was observed.

Escherichia coli (*E. coli*) samples were collected within LT at six sites during 2015 and two sites during 2016. Results were frequently above the USEPA Beach Action Value (BAV) of 235 cfu/100mL as seen in Figure 5.4. The BAV is a tool often used to assist in making beach notifications and closures.[29] Overall higher levels of *E. coli* measured in 2015 can be partially explained by more precipitation during the sampling season than 2016, although the LT08 site in 2016 was also well above the recommended value, indicating input during non-storm event conditions.

Figure 5.4 *Escherichia coli* Monitoring Results



Nutrient Load

During stream assessment, scores for nutrient enrichment were recorded. LT recorded an average 'poor' (4.5) score indicating high levels of nutrients throughout the assessed waterbodies. Abundant macrophyte and algal growth was observed (Figure 5.5) in addition to abundant lawn debris in the streams or on the stream banks (Figure 5.6). This lawn debris contributes nutrients, including phosphorus, promoting the growth of algae and other aquatic vegetation. Samples to assess nutrient levels (phosphorus and nitrate) were also collected and processed. Phosphorus levels recorded an average of 129.7 µg/L, well above the NYSDEC guidance value of 10 µg/L for Lake Erie Eastern basins.[8] Sawyer Creek recorded the highest average phosphorus reading of 305.5 µg/L. All waterbody segments sampled recorded average nitrate readings below the NYSDEC standard value of 10,000 µg/L.[6]

Figure 5.5: Mowed Lawn Adjacent to Stream with Extensive Algal Growth (BNR)

Nitrogen and phosphorus are natural constituents of the environment, but can also be introduced into the system via fertilizers and sewage inputs. Most traditional fertilizers, used both for agricultural or residential purposes, contain nitrogen, phosphorus, and potassium (or potash). Animal manure and commercial fertilizer, used as a crop fertilizer, are primary sources of nitrogen and phosphorus to surface and groundwater via runoff or infiltration.[26]

Figure 5.6: Grass Clippings along Ransom Creek (BNR)

While nitrogen and phosphorus are vital for a healthy stream, the correct balance is critical to sustain aquatic life.[18] High nutrient levels can fuel growth of aquatic vegetation and algae which can congest streams, restricting water flow and fish movement as seen in Figure 5.7. With elevated plant respiration and decomposition, dissolved oxygen levels become depleted. These oxygen-depleted environments can stress and have detrimental impacts on aquatic life. At times, algae will grow in large, expansive colonies often referred to as an algal bloom. Under the right conditions, some algal blooms will produce toxins that can be dangerous to wildlife and human health.[14]

Figure 5.7: Abundant Growth of Aquatic Vegetation in Sawyer Creek (BNR)

Dissolved Oxygen

Average dissolved oxygen for the sub-watershed was measured at 7.37 mg/L and 83.3%. Dissolved oxygen levels over 100% can be a function of photosynthesis, rapid aeration, water temperature, or a lack of aquatic respiration. Organisms producing oxygen through photosynthesis contribute to a stream's dissolved oxygen level. In addition, cold water has the ability to hold more dissolved oxygen than warm water, and as water temperatures rise throughout the day, a stream may not quickly equalize its dissolved oxygen content with the atmosphere, resulting in a saturation level over 100%. The highest values recorded were 15.1 mg/L and 178%, while the lowest values recorded were 2.8 mg/L and 30%. Lower dissolved oxygen levels often correlate to areas with elevated plant respiration and decomposition, as previously discussed. These areas are more likely to succumb to algal blooms, creating harmful conditions for wildlife and potentially humans.

Dissolved oxygen during monthly water quality sampling was measured in 2015 to be highest in October, with an average sub-watershed wide measurement of 71.6%. 2016 however, had much higher levels, with the highest levels by sub-watershed average in April and May, with nearly identical measurements of 125.7% and 125.5% respectively. The highest individual reading in 2016 was recorded at the LT08 site in May.

Lower Tonawanda Critical Source Areas

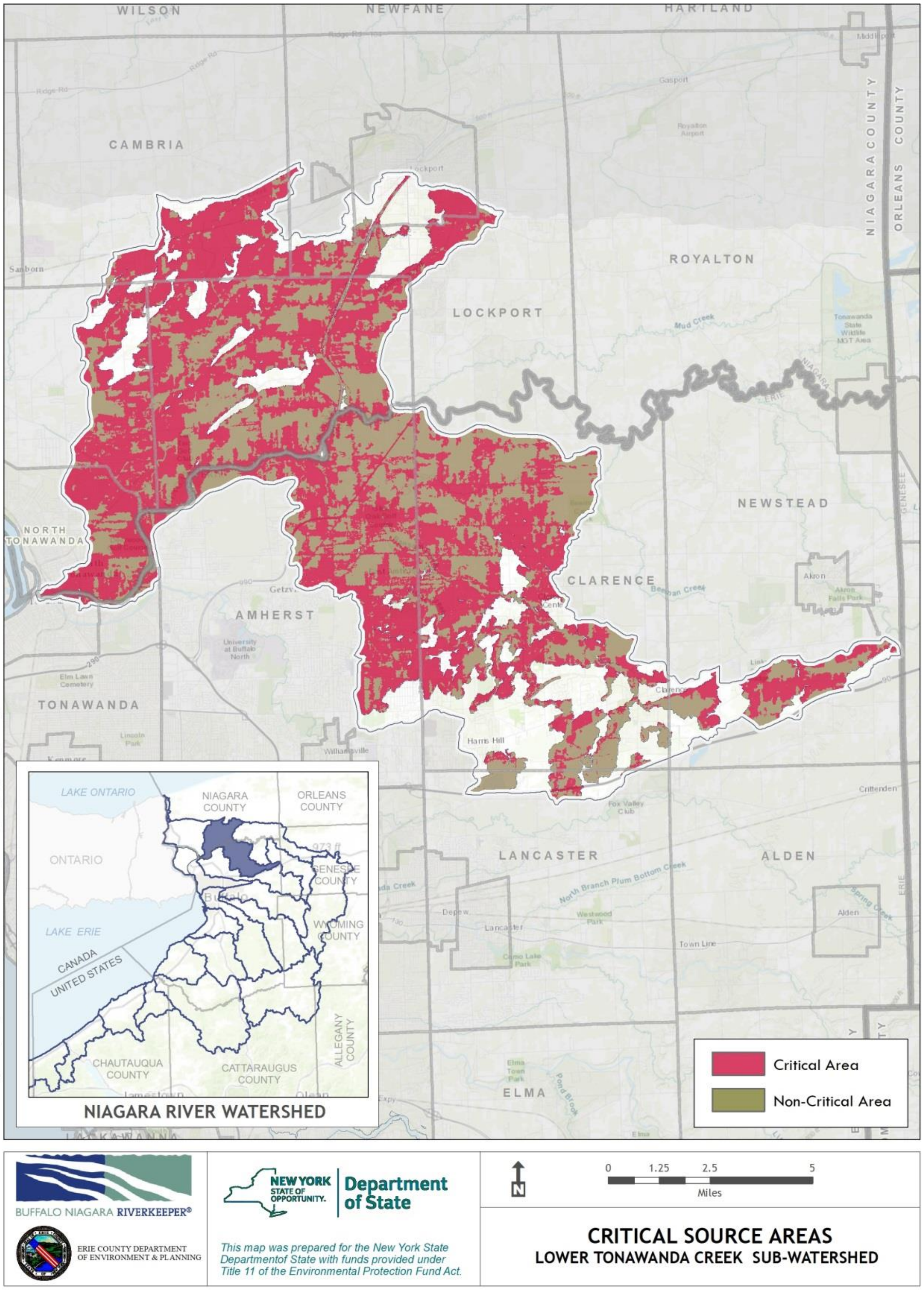
CSAs in LT are depicted in Map 5.8, and displays CSA using the methodology described on page 1-9.

The CSAs in LT are those areas which are thought to be actively contributing to impairments found through assessments. In LT, these "critical" or "contributing" areas are those agricultural, and developed land uses within the ARA. These critical areas represent the priority areas for intervention in the sub-watershed. Undeveloped, forested, or wetlands within the ARA are shown to be "Non-Critical Areas", meaning that they are not actively contributing impairments, but and are priority areas for conservation and protection. These Non-Critical areas can generally be described as a large area which contains important riparian forest tracts, critical for preventing future pollutants from entering surrounding waterways.

CSA Conservation Priorities

LT is dominated by critical source areas throughout and it is predicted that impervious cover in LT will rise from 8.4% to 35% in the near future. One of the most prominent features in the sub-watershed, the Erie Canal corridor, remains a priority for riparian buffer protection and restoration. Several critical headwater forests occur throughout the sub-watershed including multiple locations in Pendleton, Clarence, and Newstead. The headwaters of Ransom Creek, just north of Interstate 90, are identified as important riparian woodland to be protected in order to prevent further decline and future contribution as a source area. Large amounts of developed land generate a high percentage of impervious cover, making protection of remaining natural habitats even more vital. Sand and gravel quarries are frequent throughout the heart of sub-watershed and serve as good opportunities for long-term restoration and protection of groundwater.

Several projects have been identified through Buffalo Niagara Riverkeeper's Niagara River Habitat Conservation Strategy, which are seen as priority projects for conservation lands that may directly address impairments in the sub-watershed. These projects are included as Appendix H.



Map 5.7: Critical Source Areas

Target Goals for Baseline Indicators

As specific management actions are carried out, baseline indicators can be used for comparison or to determine the effectiveness of implementation efforts. Suggested management actions are also developed to address baseline indicators, as these indicators can vary regionally and can be tuned to address a sub-watershed's unique characteristics.

Land Cover: Land cover can provide valuable information related to water quality and overall watershed health. With increased development and urbanization, areas with impervious cover will also increase. According to the Center for Watershed Protection, water quality can begin to degrade at 10% impervious cover.[1,3]

> **Future Goal:** Reduce the amount of impervious cover within the sub-watershed.
>
> **Target:** In data compiled in 2005, LT contains 8.4% Impervious Cover. A target plant to reduce impervious cover to below 5% should be developed.
>
> **Future Goal:** Conserve and protect undeveloped land in the sub-watershed.
>
> **Target:** Engage communities in the sub-watershed to develop a cross-municipal land conservation strategy.

Turbidity: Erosion of shorelines contributes to turbidity and sedimentation of waterways. High turbidity levels were common throughout LT in the 2016 field season. Of the samples collected, 70% read over the NYSDEC standard. Turbidity can be used an in indirect indicator of the concentration of suspended matter.

> **Future Goal:** Restore steep and actively eroding shorelines to decrease erosion and sedimentation in streams.
>
> **Target:** Meet NYSDEC water quality standard or set a higher reachable level <25 NTU throughout the sub-watershed.

Riparian Zone and Bank Stability: Vegetation bordering waterways naturally stabilizes banks, controls erosion, functions as a natural filter for water runoff, and cools water temperatures via shading. The natural riparian zone has been removed or severely altered within this sub-watershed.

> **Future Goal:** To increase the length and width of riparian vegetation along streams within the sub-watershed, and incentivize and encourage riparian buffer ordinances.
>
> **Target:** Increase the width of riparian vegetation to two times the active channel or 300ft, whichever is greater.

Future Goal: Work with communities, agencies, and municipalities to implement stream bank stabilization programs at actively eroding sites.

Target: Stream stabilization at reaches scoring 3 and below in SVAP Bank Stability (Map 5.7).

***E. coli*:** As a bacterial indicator, *E. coli* is used to monitor the presence of human/animal waste in waterbodies. Sources may include fertilizer, livestock, sanitary discharges or compromised septic systems.

Future Goal: Reduce access of livestock to streams and stream banks thereby limiting bacterial inputs.

Future Goal: Provide resources to communities to upgrade outdated and deteriorated septic systems.

Future Goal: Municipalities continue to prevent sanitary sewers from overflowing into waterways.

Target: Samples at or below USEPA BAV throughout the sub-watershed or reduce 30-day geometric mean value to meet USEPA recommended value of 126 cfu/100mL.

Nutrient load: Resulting from stormwater runoff, wastewater treatment plants, septic systems, fertilizers, and improper lawn debris disposal, high nutrient levels are common throughout the sub-watershed.

Future Goal: Reduce loadings of nutrients, specifically phosphorus

Target: Meet NYSDEC guidance values

- Phosphorus NYSDEC guidance value for Lake Erie Eastern basins of 10 µg/L
- Nitrate NYSDEC standard value of 10,000 µg/L

Dissolved Oxygen: Dissolved oxygen levels can be influenced by water temperature, flow rates, the presence of aquatic plants and animals, and inputs from stormwater and wastewater. Low dissolved oxygen levels can create harmful conditions for wildlife and potentially humans.

Future Goal: Increase shading along streams, to help lower water temperatures thereby increasing the potential to hold higher levels of dissolved oxygen.

Target: Meet NYSDEC standard value of no less than 4.0 mg/L

Suggested Management Actions

The work performed during this project, along with the compilation of preceding data collection and inventory of watershed characteristics is intended to support the development of an action plan consisting of suggested management actions. Actions suggested below are intended to be part of an ongoing, dynamic process, in which management actions are periodically revisited to address changing conditions and management goals with the Niagara River/Lake Erie Watershed.

By implementing the general strategies and recommendations detailed here, the sub-watershed will be on track to meet the previously listed targets for various baseline indicators. These recommendations focus on key issues facing the sub-watershed that were identified through this effort and are not intended to act as a comprehensive list of everything that could be implemented.

These suggested management actions apply to: homeowners, municipalities, volunteer groups, agricultural landowners, organizations and agencies working within the sub-watershed.

Land Use

Goal: Reduce the amount of impervious cover within the Lower Tonawanda sub-watershed from 8.4% to <5%

Benefit: According to the Center for Watershed Protection, water quality begins to degrade at 10% impervious cover, because of the loss of groundwater recharge through percolation, and the surge in runoff entering waterways, altering natural flow regimes and overwhelming sewer systems.[3] Lower Tonawanda sub-watershed population has steadily increased (by over 9,000 people between 2000-2010), and consequently so has the impervious surface coverage which negatively impacts water quality. Currently, the Lower Tonawanda sub-watershed has an estimated 8.4% impervious cover, which is approaching the 10% threshold. Ideally, the sub-watershed impervious coverage should be decreased to <5%.

Best Management Practices

The actions outlined in the table below are organized into three broad categories: green and living infrastructure, land use policy changes and community engagement.

Implement Green Infrastructure | Living Infrastructure

By incorporating simple living infrastructure practices such as bioswales or rain gardens into small-scale development plans or implementing broader techniques across a larger scale, the resulting effect will be to help to collect rain water before it is able to flow over impervious surfaces, collect pollution and enter bodies of water. In addition, the use of porous material in constructing roadways and parking lots beyond what is required by the NYS Stormwater Manual, rain barrels to disconnect rooftop runoff and incorporation of strategically preserved or placed green and living spaces into landscaping plans will reduce runoff from impervious surfaces directly into waterways and lessen the negative impacts of combined sewer overflows and stormwater discharges. As noted in the NYSDEC Stormwater Management Design Manual, a one-acre parking lot can produce 16 times more stormwater runoff than a one-acre meadow each year".[10]

Land Use Policy

Recommended changes in land use policies include actions like updating a municipality's Comprehensive Plan or amending zoning codes. A Comprehensive Plan allows the municipality to clearly state its long-term goals and priorities for a community. While this document is not law, it does inform the law as a municipality would write zoning codes and ordinances that enable it to meet the goals outlined in the Comprehensive Plan. Conservation updates that can be made to code include: conservation overlay districts, steep slope requirements to limit erosion, minimum setback requirements from waterbodies (sometimes called a "waterfront yard" or "buffer" requirement) on new development, or requirements and standards for vegetated buffers along waterways on all lands.

Community Education and Engagement

While regulation through zoning codes forces those living in a municipality to abide by a certain set of laws, some practices are better implemented through landowner cooperation and collaboration. For example, almost 40% of the EC sub-watershed is classified as agricultural land and data analysis suggests that agricultural lands may be contributing to water quality impairments in places across the EC sub-watershed. Here, encouraging landowners to voluntarily participate in conservation initiatives can greatly benefit a community. These initiatives include landowner stewardship like utilizing a vegetated riparian buffer along a shoreline or installing a rain barrel to disconnect gutters and collect rainwater for reuse. Similarly, hosting town clean-ups or invasive species removal days can help people feel more connected to their environment, thereby fostering a greater sense of community ownership and stewardship. Invasive species, such as Japanese knotweed, were observed in the sub-watershed. Japanese knotweed requires a multi-step removal process in order to eradicate it and it will overtake as a nuisance weed without control.

Recommended Actions to reduce impervious land cover:

Short Term	• Encourage municipalities to utilize pervious surfaces or living infrastructure in new developments and redevelop traditional grey infrastructure beyond the percentage requirements of the New York State Stormwater Management Design Manual for impervious cover.
	  ○ Cost: Medium
	• Reclaim and develop unused or underutilized impervious surfaces into "green spaces"
	  ○ Cost: Low to Medium
	• Host sustainable development workshops targeted at municipalities and agricultural operations
	  ○ Cost: Low
	• Create educations programs for green and living infrastructure solutions
	  ○ Cost: Low to Medium
	• Develop and implement educational outreach materials for waterfront landowners that address better yard management practices, riparian buffer design and erosion control and Living Shoreline implementation
	  ○ Cost: Low to Medium
	• Promote recreational use of natural areas to increase land protection and awareness through placemaking
	  ○ Cost: Low
	• Implement vegetated riparian buffers along stream corridors and on agricultural land
	  ○ Cost: Low (no mow) to Medium (erosion control structures)

Long Term	• Improve/incorporate stormwater management on paved and unpaved roads/parking lots
	  ○ Cost: Medium
	• Reduce new parking lot sizes in urban areas
	  ○ Cost: Medium
	• Use pervious surfaces and materials when constructing new parking lots or updating existing parking lots beyond the percentage required by the New York State Stormwater Management Design Manual
	  ○ Cost: Medium

Turbidity

Goal: Restore steep and actively eroding shorelines to decrease erosion and sedimentation in streams such that stream quality, at a minimum, meets the NYSDEC water quality standard for turbidity

Benefit: Levels of high turbidity were prevalent in the waters surveyed and tested throughout the Upper Tonawanda sub-watershed. High turbidity in waterways can be an indicator of concentrations of suspended matter. Cloudy or turbid water affects light penetration through increasing light scattering, which typically leads to warmer water temperatures (with lower dissolved oxygen capacity). The effects of turbidity on light penetration also directly affect plant growth, further lowering the dissolved oxygen in water. Typically, lowering turbidity can improve plant growth and benthic communities, which are the basis for the aquatic food chain.

Best Management Practices

High turbidity levels were common throughout the Lower Tonawanda sub-watershed. High water velocity rates have a higher carrying capacity for sediment increasing the travel distance before the particles fall out of suspension. This process is exacerbated by high levels of erosion which causes more sediment to go into waterways and creates excessively turbid water. Combating erosion and offsetting elevated velocity and water levels from runoff is one good way to reduce turbidity.

Land Use

Any number of actions that limit erosion and lessen sediment loading into waterways will help to combat turbidity. For example, instituting steep slope ordinances, where appropriate, into zoning codes can limit the amount of sediment that enters into waterways from highly erodible banks. Specifically, in the Upper Tonawanda Sub-watershed, this would be useful tool for Town of Orangeville. The town of Cortlandt, downstate in Westchester County, provides a good example of a steep slope ordinance. The ordinance states the following as one of the reasons for the protection of steep slopes:

> "The Town's experience with past development has shown that the improperly managed disturbance of steep slopes can aggravate erosion and sedimentation beyond rates experienced in natural geomorphological processes. Erosion and sedimentation often include the loss of topsoil, a valuable natural resource, and can result in the disturbance of habitats, degradation of the quality of surface water, the silting of wetlands, alteration of drainage patterns…"

Similarly requiring setbacks and requiring or encouraging vegetated buffers can help to anchor soil to the banks. Installing a Living Shoreline or vegetated buffer of either shrubs and grasses or tall trees can all help sediment remain in place.

Recommended Actions to combat turbidity:

Short Term	• Landowners should replant and reshape failing streambanks with stabilizing vegetation to reduce erosion and sediment deposition
	  o Cost: Low to High
	• Development of restoration plans for severely altered waterways
	  o Cost: Medium

Long Term	• Develop vegetated buffer standards for all waterfront development that ensure a protected, stabilized shoreline.
	  o Cost: Low
	• Identify and mitigate or replace improperly installed road/stream crossings and stream barriers
	  o Cost: Medium to High
	• Cost: Medium to High Implement Living Shoreline restoration projects to remove hardened shorelines and naturalize shorelines and slopes
	  o Cost: Medium to High

Riparian Zone and Bank Stability

Goal: Increase the length and width of riparian vegetated buffers along stream banks within the sub-watershed

Benefit: Vegetation bordering waterways naturally stabilizes banks, controls erosion, functions as a natural filter for pollutants and cools water temperature by providing a shade over the water. The natural riparian zones in the lower portions of BR have been affected by development and upstream, are subject to agricultural stressors. Increasing the width of vegetated riparian zones to twice the width of the stream channel or 300 feet, whichever is greater, would provide the greatest improvement to the health of the waterway.

Best Management Practices

Stream Stabilization

Stabilization of actively eroding shorelines using living and natural infrastructure is recommended where appropriate. Other engineered stabilization techniques should be used only in extreme cases

Add Vegetation

Hosting community tree planting days in a municipality can provide great benefit to the riparian corridor and improve waterway health with limited costs borne by the municipality. Trees can even be obtained at no cost through the NYSDEC “Trees for Tribs” Program.[5] Similarly installing appropriately sized vegetated buffers in the more open and agricultural areas on the sub-watershed would be very beneficial.

<u>Develop Ordinances</u>

As noted above, including vegetated buffer or setback requirements into a municipality's zoning code is one regulatory mechanism to ensure measures are taken to protect water health. Not all land can be regulated through laws so in some instances encouraging best management practices or utilizing incentive programs may be a more effective approach. Towns of Amherst and Pendleton both include language in their zoning codes for vegetated buffers. For example, Goal 4-4 of The Bicentennial Comprehensive Plan for the Town of Amherst (amended Feb 2011) sets a goal, "To establish buffer/setback standards for new development to help protect streams of significance." This goal is then applied in the town's zoning code in Chap. 204, Part 3 §3-5-6, "Lots abutting a watercourse." This sections requires that lots abutting a watercourse install a 50-foot-wide riparian buffer on either side of a watercourse and further, any building be an additional 10 feet from the buffer.

Recommended Actions to increase the length and width of riparian zones:

Short Term	• Host tree plantings with volunteers
	  ○ Cost: Low
	• Develop programs to encourage the installation of riparian buffer and cover crops
	  ○ Cost: Low to Medium
	• Implement stream and bank stability projects to stop erosion
	  ○ Cost: High

Long Term	• Develop vegetated buffer requirements for development in riparian areas
	  ○ Cost: Low
	• Develop setback ordinances for new development in riparian areas
	  ○ Cost: Medium
	• Encourage collaboration amongst municipalities and agencies to develop zoning codes to encourage conservation and best management practices across waterways that span municipalities
	  ○ Cost: Low

E. coli

Goal: Reduce bacterial inputs into streams throughout the sub-watershed

<u>Benefit:</u> *E. coli* is a fecal indicator bacteria used to monitor the presence of human/animal waste in waterbodies. Because few strains of *E. coli* naturalize in the environment, the presence of *E. coli* almost certainly suggests that fecal matter is contaminating a body of water. Sources may include fertilizer, livestock, sanitary sewer discharges, or compromised septic systems. Waterbodies with high levels of *E.coli* are not suitable for consumption or recreating and can result in a chain-reaction of negative human health and economic effects. Reducing *E. coli* levels to meet USEPA's recommended value of 126 cfu/100ml (30 day geometric mean) would greatly improve water quality. Combating *E. coli* requires that the sources inputting the bacteria into waterways be mitigated, such as CSO/SSO outfall mitigation and livestock exclusion.

Best Management Practices

Livestock

When livestock is able to freely roam in and across streams, they can produce a number of undesirable effects such as trampling banks, increasing erosion, and directly inputting sources of bacteria such as *E. coli* into water bodies through excrement. In addition, livestock fecal contamination releases a large amount of antibiotics into waterways, contributing to widespread naturalized antibiotic resistance. If livestock cannot be completely excluded from streams, then at a minimum, limit access by creating a designated crossing. Similarly, some lands have seen success by placing water troughs near the water body so that the cows can easily get to the stream water they may use for drinking but are not directly standing in the stream.

Update and Upgrade Septic Systems

Leaking septic systems are a direct input of bacteria into groundwater which can pollute drinking water and contaminate streams. It is important to recall that the presence of *E. coli* is not the only indicator species of biological pollution—it is just the simplest and most widely tested for. *E.coli* often occurs in tandem with other pathogenic bacteria, viruses and protozoans, such as those that cause cholera, dysentery, and Giardia. Upgrading septic systems with denitrification systems and fixing leaking systems is a necessary solution to mitigate this input.

Green and Living Infrastructure

In more populous areas, CSOs can be a large source of contaminants (particularly bacteria). CSOs occur where a municipality has combined storm and sanitary pipes and where rainfall inundates the system, resulting in more water than the pipes can handle. This results in an overflow situation where the pipes discharge excess untreated water directly into waterbodies. Implementing green and living infrastructure in both urban and suburban areas can drastically mitigate CSO events. By utilizing green and living infrastructure elements like rain barrels, raingardens, wetlands, and other installations meant to trap rainwater and runoff, less water goes into the sewer system resulting in fewer overflow events. In agricultural or suburban areas with larger swaths of open land, utilizing living infrastructure such as woodlands, meadows, and riparian buffers, and living shorelines to intercept stormwater and overland runoff can also help reduce runoff. In agricultural or suburban areas which larger swaths of open land, natural or constructed wetlands and bio-filtration systems can also be beneficial.

Recommended Actions to reduce bacterial inputs into streams:

Short Term	• Utilize livestock exclusion fencing to limit livestock access to and crossing of streams
	  ○ Cost: Medium
	• Install alternative watering facilities for livestock away from streams
	  ○ Cost: Medium
	• Install riparian buffers and covers crops to reduce stormwater runoff which can wash animal byproduct directly into waterways
	  ○ Cost: Medium
	• Install liquid manure retention and targeted spreading systems to prevent manure runoff from crop fields.
	  ○ Cost: Medium

Long Term	• Encourage the installation of wetland treatment systems or other living infrastructure to replace grey systems
	  ○ Cost: Low to Medium
	• Install vegetated bio-filtration systems such as bioswales and rain gardens
	  ○ Cost: Low
	• Install Living Shorelines along riparian land
	  ○ Cost: Low to High
	• Replace aging infrastructure and remove CSO/SSO outfalls from municipal sewer systems
	  ○ Cost: High

Nutrient Load

Goal: Reduce loadings of nutrients, specifically phosphorous

Benefit: Limiting phosphorus limits algae growth (including nuisance blue-green algae such as *Microcystis spp.)* and allows for more dissolved oxygen in a waterbody. In turn, this results in better aquatic species health and overall cleaner water.

Best Management Practices

High levels of nutrients such as phosphorous and nitrates were found in the waterbodies tested within the sub-watershed. As stated above, all the waterbody segments sampled within the Buffalo River Sub-watershed recorded average phosphorus readings above the NYSDEC guidance value for Lake Erie Eastern basins of 10 µg/L with Sprague Brook recording the highest average phosphorus Interestingly, as the map shows there is agricultural activity in the upper reaches of Sprague Brook. Although this may suggest correlation, it does not show causation. Similarly, nitrate measurements were also found to be above NYSDEC standard value of 10,000 µg/L. The prevalence of high nutrient levels is likely due to the number of sources or inputs including: storm water runoff, wastewater treatment plants, CSOs, septic systems, fertilizers, and improper disposal of lawn debris. Two of the best ways to combat nutrient inputs are through improving land use practices and education.

Land Use

Making minor to moderate changes to the way in which a person interacts with their land can have significant benefits to waterbody health. The actions outlined below provide examples of tactics both private homeowners and agricultural landowners can implement.

Education

Many of the changes that could result in the greatest improvement on the overall health of water bodies are behavioral. Encouraging changes in actions or promoting different protocols can be beneficial to combatting nutrient loadings along waterways. For instance, while in the field, the data collection team observed a number of piles of grass clippings abutting the stream and getting blown into the water. Inputs of grass clippings and yard waste into a waterway cause a direct increase in nutrients. Similar minor changes in farming practices or utilizing well known best practices can have significant impacts to the health of a waterbody. Suburban communities can benefit from individual small changes like using phosphorous-free fertilizer and consulting local town or village officials on lawn debris pick-up policies.

Recommended Actions to reduce nutrient loadings:

Short Term	○ Agricultural landowners should coordinate with Erie County Soil and Water Conservation District to enact best management practices which reduce nutrient and sediment loading from entering local waterways. • Cost: Low ○ Municipalities should host educational workshops for riparian landowners pertaining to funding opportunities and financial assistance for implementing best management practices for runoff mitigation • Cost: Low ○ Encourage no till farming practices • Cost: Low ○ Utilize cover crops to keep fertilizer laden soil in place • Cost varies by crop planted and need to be addressed. For example, planting clover can be inexpensive and eliminate some nitrogen from the soil ○ Provide educational stormwater trainings for designers and highway officials to ensure stormwater law compliance • Cost: Low ○ Implement “no mow” zones • Cost: Low ○ Appropriately dispose of lawn debris • Cost: Low ○ Use phosphorous-free fertilizer • Cost: Low
Long Term	• Development and implement direct-application fertilizer techniques and educational programs ○ Cost: High • Develop and implement educational trainings for homeowners about lawn care techniques, debris disposal, native plant species ○ Cost: Low • Promote rotation grazing for livestock ○ Cost: Low • Implement and enforce pesticide and fertilizer use standards and regulations. ○ Cost: Low • Increase watershed stewardship by installing markers and signage for storm drains. ○ Cost: Medium

Dissolved Oxygen

Goal: Meet NYSDEC standard value of no less than 4.0mg/L

Benefit: Proper levels of dissolved oxygen create healthier aquatic environments to prevent adverse impacts to fish and wildlife.

Best Management Practices

Since dissolved oxygen levels can be influenced by water temperature, flow rates, the presence of aquatic plants and animals, and inputs from stormwater and wastewater, all of the best management practices outlined above would also have positive effects on dissolved oxygen levels. The Lower Tonawanda sub-watershed had the lowest average levels of dissolved oxygen out of the five priority sub watersheds studied. Moreover, 2015 data collected by Riverkeeper through monthly sampling also showed low levels of dissolved oxygen. As noted above, the Lower Tonawanda sub-watershed is nearing the 10% threshold for impervious cover. This can have drastic effects on water temperature. For instance, data suggests that changes in the level of impervious cover in drainage areas can increase stream temperature by between five to twelve degrees Fahrenheit.

Limiting nutrient inputs, such as from lawn fertilizer, can help address low dissolved oxygen. Efforts to decrease fertilizer inputs are particularly important in the Lower Tonawanda sub-watershed as the team observed grass cuttings and animal access directly abutting the stream.

Recommended Actions to increase dissolved oxygen:

Short Term	○ Plant riparian trees and riparian buffers for shade canopy and to prevent nutrient-laden stormwater runoff from entering waterbodies.
	    • Cost: Low to Medium
	○ Limit streambank erosion that carries excess solids into waterbodies.
	    • Cost: Medium to High
	○ Limit and educate landowners on proper lawn clipping disposal.
	    • Cost: Low

Long Term	• Install Living Shorelines along riparian lands, especially near recreational uses such as golf courses
	    ○ Cost: Low to High
	• Reduce fertilizer runoff from lawns by using phosphorus-free fertilizers
	    ○ Cost: Low
	• Reduce stormwater inputs into waterways that bring warm water into streams, and raise temperatures, allowing for algal growth.
	    ○ Medium to High
	• Naturalize stream channels that have been channelized or heavy modified to restore stream flow.
	    ○ High