2022
UPPER THAMES RIVER WATERSHED REPORT CARDS

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CONSERVATION AUTHORITY

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Written and published by the Upper Thames River Conservation Authority

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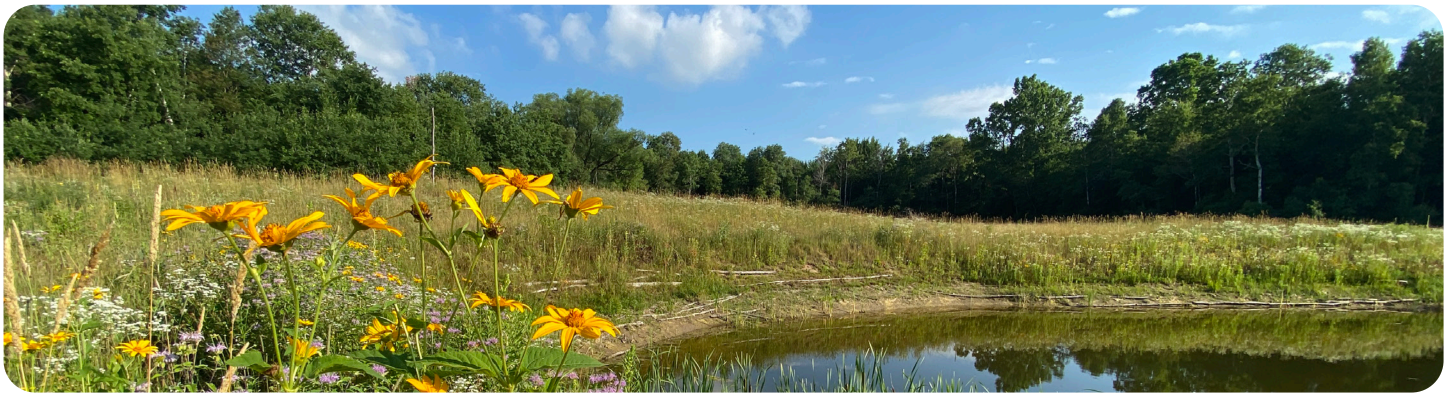

Executive Summary

The Upper Thames River Conservation Authority (UTRCA) produces watershed report cards every five years as a measure of environmental progress in the 28 subwatersheds within the Upper Thames River watershed. Each report card assesses and grades surface water quality and forest conditions in that particular subwatershed, and compares them with previous report card findings.

Each report card also includes a summary of resource information (watershed features), as well as information on groundwater resources and Great Lakes connections, a local action plan, and highlights of progress since 2017.

The UTRCA previously produced report cards in 2001, 2007, 2012, and 2017. Since the last report cards in 2017, much environmental work has been done in these subwatersheds, new stressors have developed, and more data and information have become available. The information in the 2022 Upper Thames River Watershed Report Cards reflects these changes.

While combined efforts in the Upper Thames River watershed have been great over the past two decades, the outcome has shown only small environmental improvement. The report cards and associated environmental monitoring have become key measures in UTRCA's environmental target setting process for the watershed. This initiative sets specific targets for the environment with the goal of measurable improvements in coming decades. Many actions needed to improve water quality, as well as forest and vegetation cover, have multiple benefits including the important role of combatting and adapting to climate change issues locally.

The 2022 report cards use the guidelines and grading system developed by Conservation Ontario in 2011 and updated in 2022 (Guide to Developing Conservation Authority Watershed Report Cards, Conservation Ontario, 2022). The grading system was developed for conditions across Ontario, from highly developed areas with more intensive land use in the south to less developed areas in the eastern portions of the province. As such, this is a stringent grading system and grades in the Upper Thames River watershed and other parts of Southern Ontario tend to be lower. Surface water quality indicators include total phosphorus, benthic invertebrates, and bacteria (*E. coli*). Forest condition indicators include percent forest cover, percent forest interior, and percent riparian zone forested.

Results

- Surface water quality grades (based on 2016 to 2020 data) for the 28 subwatersheds within the Upper Thames River watershed range from a C to a D. Fourteen subwatersheds have C grades and 14 subwatersheds have D grades.
- Since the 2017 report cards, overall water quality scores have improved in five subwatersheds (Dorchester Corridor, Fullarton Corridor, Medway Creek, Mud Creek, and Wye Creek), stayed steady in 21 subwatersheds, and declined in two subwatersheds (Gregory Creek and Reynolds Creek). Overall, the best water quality scores were found in Komoka Creek, followed by Fullarton Corridor, Plover Mills Corridor, and Middle Thames River. The lowest water quality scores were found in Reynolds Creek, followed by Cedar Creek, and River Bend Corridor. The overall surface water quality grade has remained steady since 2012, averaging a D across the watershed.
- Forest conditions grades (based on 2015 aerial photography) range from a C to an F, with five Cs (Dorchester Corridor, Black Creek, Komoka Creek, River Bend Corridor, and Trout Creek), one F (North Mitchell), and the rest (22) have D grades. Two subwatersheds have moved up

a grade (Black Creek and Whirl Creek) due to slight improvements. While there were no other grade changes, 11 subwatersheds showed slight improvements in scores, 13 were steady, and four showed slight declines.

- Overall, the Upper Thames River watershed average is still a D for forest conditions as it was in the 2017 report cards. Since then, there has been a slight increase in forest cover across the Upper Thames River watershed from 11.1% to 11.3% due to a combination of improved mapping and forest succession (i.e., young plantations maturing to forests). This translates to 781 ha across the watershed. Extensive tree planting in the 1970s and 1980s is now reaching maturation.
- Despite the gains, 353 ha of forest were removed and converted to urban or rural land uses between the 2010 and 2015 aerial photography across the watershed. By comparison, 227 ha were cleared from 2006 to 2010, and 571 ha from 2000 to 2006. Overall, the pace of tree planting by the UTRCA, landowners, and other organizations is significant but not keeping up with the loss. A block of planted trees can take 20 to 50 years to mature to the point where it can be called a forest or woodland.

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Komoka Creek
Medway Creek
Middle Thames River
Mud Creek
North Mitchell Corridor
North Woodstock Corridor
Otter Creek
Oxbow Creek
Plover Mills Corridor
Pottersburg Creek
Reynolds Creek
River Bend Corridor
Stoney Creek
Trout Creek
Waubuno Creek
Whirl Creek
Wye Creek

Section 1:
Methods and Results

2022 Watershed Report Cards

1.1 Introduction

The Upper Thames River watershed is situated in a highly developed and highly agricultural part of southern Ontario (see Maps 1 and 2 in Section 2). The water and forests in this region face ongoing pressure from urban and rural land uses. Despite these pressures, the Thames remains one of the most biologically diverse rivers in Canada, and the Upper Thames River watershed is home to 80 species of fish, 30 freshwater mussel species, and many species at risk. The entire Thames River system, including tributaries, is designated a Canadian Heritage River. The Upper Thames River watershed is within the traditional territory of the Attawandaron, Anishinaabeg, Haudenosaunee, and Lunaapeewak peoples, who have long-standing relationships to the land, water, and region of southwestern Ontario.

There has been growing interest from watershed residents, municipalities and agencies in understanding the health of the watersheds in which they live, and the larger Thames River watershed. There is an ongoing need for clear environmental information to support the public's and agencies' understanding of the issues and to assist in decision-making.

Starting in 2001, the Upper Thames River Conservation Authority (UTRCA) has produced Watershed Report Cards every five years as a concise way of reporting on a vast amount of data and information, as well as tracking changes. Feedback found that report cards have been well used by many individuals, groups, municipalities, and agencies involved in the ongoing work of protecting local resources.

The Thames River watershed has received attention for its role in the health of the Great Lakes, specifically the situation of harmful algae blooms. The Thames River has been identified as a priority river in Ontario to reduce nutrients which impact Lake Erie and Lake St. Clair. The 2022 Upper Thames River Watershed Report Cards reflect some of the actions that benefit both local watersheds and the downstream conditions of the Great Lakes.

During the time frame of the 2022 report cards, the worldwide COVID-19 pandemic hit. Locally, nature became more important to society's and people's wellbeing than ever. Through this time, the public has expanded their awareness of and interest in the health of our local rivers, forests, natural areas, and wildlife. Local conservation areas and other public natural areas have seen record numbers of visitors.

Climate change continues to be a prominent issue for our planet and much global and local action is needed. Local concern is increasing, and climate action is now part of planning and action by many local municipalities and industries in an effort to reduce greenhouse gas emissions. Many actions needed to improve water quality and forest and vegetation cover, also play an important role in combatting and adapting to climate change issues locally. The pandemic has demonstrated important societal lessons on what is possible and what will be needed for local action on climate, including: people can make drastic changes to their behavior, governments can work together for a common goal, and nature matters.

Reducing greenhouse gases is a top priority. Nature-based solutions are an important climate action, and all work to increase tree cover, wetlands, and all green cover (including cover crops) will be important actions to take. Locally, climate change impacts are starting to occur and expected to increase in the future. These changes include:

- rising temperatures and changing precipitation patterns,
- more frequent and severe weather with extreme rainfall creating flood and erosion risks,
- threats to water quality and supply,
- degraded wildlife habitats and decreased biodiversity, and
- lowered river flows and warmer surface water temperature (Conservation Ontario, 2022).

Lessening the impacts of climate change on water and forest resources is a current endeavour. There is a need to develop actions on the land that build environmental resiliency to the effects of the changing climate, including extreme wet and dry weather patterns.

A number of these actions are part of a state of the environment report with a focus on actions needed for water quantity and quality. The report, completed in 2019, is called The Thames River (Deshkan Ziibi) Shared Waters Approach to Water Quality and Quantity. This report was completed through the partners in the Thames River watershed who formed the Thames River Clear Water Revival to work together on the protection of water. The partners share the goal of a healthy and vital Thames River, which would also benefit Lake St. Clair and Lake Erie. This partnership brings together Indigenous peoples, three levels of government (municipal, provincial and federal), two conservation authorities (CAs), and the local community.

Through the development of a Strategic Plan (2016) the UTRCA has developed environmental targets for the Upper Thames River watershed. The findings of previous Watershed Report Cards were a driver for these targets. While there have been extensive collective efforts in the watershed, progress in terms of measurable environmental improvements has been slow. The targets will work towards measurable improvements:

- Improve each subwatershed's water quality score by one grade, as measured by UTRCA Watershed Report Cards, by the year 2037.
- Establish and restore 1,500 hectares of natural vegetation cover, windbreaks, and buffers by 2037.
- Reduce flood and erosion risk by updating flood models and hazard mapping for all UTRCA subwatersheds by 2020, then integrating climate change scenarios into the updated models and developing climate change adaptation strategies by 2030.
- Instill conservation values by supporting outreach to one million people annually by 2037 through visits to CA owned and managed lands, as well as hands-on environmental experiences.

Watershed Name Changes: Several watershed names have been updated for the 2017 and the 2022 report cards to better reflect the area represented and, in particular, using 'Corridor' instead of 'Watershed' for sections along the main river corridors. Watersheds with name changes include: Fullarton Corridor (renamed in 2017 from Glengowan), Ingersoll Corridor (renamed in 2017 from South Thames), and Forks Corridor (renamed in 2022 from The Forks).

1.2 The Process

The following is a synopsis of the steps that were undertaken to complete the watershed report cards.

1.2.1 Watershed Scale

For the purposes of the report cards, the Upper Thames River Watershed has been divided into 28 subwatersheds (see Map 4 in Section 2) that are either major tributaries or sections of the main branches of the Thames River. They were deemed as appropriately sized land areas for assessing environmental information, monitoring environmental change, and targeting rehabilitation work. Residents identify with these watersheds in their local communities and a number of community-based watershed groups have formed.

The UTRCA undertakes planning, monitoring, and reporting on a watershed basis, focusing on these 28 subwatersheds. The report cards use the 28 subwatersheds as the scale for reporting.

1.2.2 Grading System

The 2001 Upper Thames River Watershed Report Cards used an indicator and grading system developed by the UTRCA with external peer review. This reporting approach was used as a model for the development of a province-wide watershed report card system for CAs developed in 2003. The 2007 Upper Thames River Watershed Report Cards used the 2003 province-wide CA grading system (Watershed Reporting: Improving Public Access to Information, Conservation Ontario, 2003).

In 2011, a review and update was completed for these guidelines to ensure the most current scientific rationale was incorporated, along with optimizing the grading system to reflect the range of environmental conditions across the province. The 2012 and 2017 Upper Thames River Watershed Report Cards used the 2011 guidelines and updated grading system for Conservation Authority Watershed Report Cards (Guide to Developing Conservation Authority Watershed Report Cards, Conservation Ontario, 2011). These province-wide guidelines have a more stringent grading system and result in generally lower grades in the Upper Thames compared with previous grading systems.

A review of the 2011 guidelines by Conservation Ontario with CAs in 2022 confirmed the 2011 guidelines would be used by all CAs for the 2022 report cards (Conservation Ontario, 2022). The UTRCA re-graded the 2001 and 2007 information using the 2011 grading system to allow accurate comparisons with the 2012, 2017, and 2022 information.

Surface water quality indicators are total phosphorus, benthic invertebrates, and bacteria (*E. coli*). Forest conditions indicators are percent forest cover, percent forest interior, and percent riparian zone forested.

1.2.3 Technical Input

UTRCA staff provided extensive technical input and review to the report cards, bringing experience and expertise in a variety of fields including hydrology, environmental planning and regulations, water quality, land management, hydrogeology, soil conservation, forestry, ecology, fisheries, communications, and GIS (Geographic Information Systems). As well, the City of London and other municipalities provided valuable information and input specific to watersheds in their area.

1.3 Surface Water Quality

1.3.1 Introduction

The water quality of the Thames River has undergone vast changes over the past century as a result of human activity in the watershed. Surface water quality has fluctuated in response to changes in urban wastewater treatment, agricultural practices, industrial waste management, stormwater management, and other land management practices. Weather and climate-related issues also impact water quality.

A great deal of work has been carried out in the agricultural, municipal, and industrial sectors to protect water quality, contributing to general improvement in surface water quality over the past 30 years. However, ongoing stressors, changes in land use, and climate issues continue to put pressure on this resource.

The Upper Thames River Watershed Report Cards were developed to outline current water quality conditions and to document changes over relatively short periods of time (five year increments). Thus, the 2022 report cards show changes in surface water quality since the 2017, 2012, 2007, and 2001 report cards. It is important to note that water quality varies from year to year and the indicators that measure water quality can fluctuate independently of each other in any given year.

The report cards provide a general assessment of surface water quality in the watersheds based on key indicators. A more site-specific monitoring program and assessment of the data would be required for site-specific issues.

The Thames-Sydenham and Region Watershed Characterization Report (UTRCA et al., 2008), completed as part of the Drinking Water Source Protection process, provides a comprehensive assessment of surface water quality at all stations in the Upper and Lower Thames River over the long term (30 to 40 years) in this region. A more recent study also gives a comprehensive assessment of water quality related specifically to nutrient and sediment loadings across the Thames River watershed (Water Quality Assessment in the Thames River Watershed – Nutrient and Sediment Sources, Freshwater Research, 2015).

A recent water report with a focus on actions needed for water quantity and quality was completed in 2019. The Thames River (Deshkan Ziibi) Shared Waters Approach to Water Quality and Quantity was completed by the Thames River Clear Water Revival. The partners in this initiative are working together with the shared goal of a healthy and vital Thames River, which would also benefit Lake St. Clair and Lake Erie.

1.3.2 Indicators and Grading System

The 2022 report cards use the 2022 guidelines and grading system developed by Conservation Ontario (Guide to Developing 2023 Conservation Authority Watershed Report Cards, Conservation Ontario, 2022). The grading system has not changed from the 2011 guidelines (Conservation Ontario, 2011). However, prior to this, a slightly different grading system was used in the 2001 and 2007 report cards. Therefore, the UTRCA re-graded the 2001 and 2007 information using the 2011 grading system to allow accurate comparisons with the 2012, 2017, and 2022 information.

The three indicators used to assess surface water quality for each watershed include:

- total phosphorus,
- bacteria (*E. coli*), and
- benthic invertebrates

These indicators reflect key issues related to surface water across the province, including nutrients, bacteria/waste, and aquatic health. Descriptions and definitions for these indicators are provided in each watershed report card and below.

Indicator: Phosphorus
- What it measures: The concentration (mg/L) of phosphorus in the water.
- How it is calculated: The 75th percentile was calculated for all data from 2016-2020 for the site closest to the outlet of each creek/ watershed. The 75th percentile (means 75% of the data fall below this value) is used to reflect the tendency for this sampling data to be dry weather biased and, therefore, more accurately reflects pollution levels.
- Why it is important: Phosphorus tends to bind to soil particles and thus is an indicator of soil delivery to streams (as well as other contaminants that are carried to the stream on soil particles). Phosphorus is found in soaps, detergents, fertilizers, and waste, and contributes to algae blooms in streams and lakes.

Indicator: Bacteria
- What it measures: The amount of fecal bacteria (*E. coli*) in the water.
- How it is calculated: A 5-year geometric mean for data from 2016-2020 measured in number of Colony Forming Units (CFU) *E. coli* bacteria per 100 ml of water. The geometric mean is a measure of the central tendency of data and minimizes the effect of extreme values.
- Why it is important: *E. coli* bacteria are found in human and animal waste and its presence in water indicates fecal contamination. *E. coli* is also a strong indicator of the potential to have other disease-causing organisms in a stream.
- Note: In 2019 the Provincial Recreational Guideline for *E. coli* changed from 100 CFU *E.coli*/100 ml to 200 CFU *E.coli*/100 ml, but the grade ranges did not change.

Indicator: Benthic
- What it measures: Benthic invertebrates (organisms without a backbone that live in the sediment of a water body).
- How it is calculated: The Family Biotic Index (FBI) is used to assess water quality based on the number and type of invertebrates found in a sample. Each invertebrate species is given a score from 0 to 10 that indicates its pollution tolerance. Low scores indicate sensitivity to pollution while organisms with high scores are pollution tolerant. The average benthic value was calculated for samples taken from 2016-2020 at the outlet of each watershed.
- Why it is important: Benthic organisms are an excellent indicator of the quality of the water and the habitat where they live. Since they are relatively immobile and spend all or most of their lives in water, the presence or absence of certain species gives good information on water conditions over time. These organisms are at the bottom of the food chain and they reflect the health of the aquatic ecosystem.

Each indicator is given equal weight in determining the overall surface water quality score for each watershed. Point scores for each indicator were calculated, added together, and divided by three to determine the overall letter grade for water quality in each watershed (see Table 1, Section 3).

Change Status

There is not yet an established or standardized method for evaluating changes in water quality and forest conditions since previous editions of the watershed report cards (Guide to Developing Conservation Authority Watershed Report Cards, Conservation Ontario, 2022). The UTRCA used the same approach to determine change as was used in previous upper Thames River watershed report cards, which involved assessing change based on knowledge of local conditions over time.

The terms Improved, Steady, and Declined are used to describe changes in water quality since the 2017 report card.

- For phosphorus, a change in status resulted when there was an overall increase or decrease of at least 0.03 mg/l for the 5 year data blocks used in the 2017 and 2022 report cards.
- For bacteria, a change in status resulted when there was an increase or decrease of 50 Colony Forming Units (CFU) E. coli/100 ml from the 2017 to 2022 report cards.
- For benthic invertebrates, if the difference in average FBI score between the 2022 report card and the 2017 report card was more than 0.25, then the status changed (improved or declined). If change was less than 0.25, the status is steady.

Determining the change status for each

subwatershed's overall water quality grade was done by assessing change (Improved, Steady, or Declined) in the final point score from 2017 to 2022, in combination with any change in grade.

1.3.3 Data Sources

There are several water quality monitoring programs operating in the Upper Thames River watershed. Data from the following programs was used to evaluate the watersheds for these report cards:

- Provincial Water Quality Monitoring Network,
- Other water quality data sources, and
- Benthic Monitoring Program.

Data from 2016 to 2020 was used in this 2022 report card. Data from previous report cards is shown for comparison.

Provincial Water Quality Monitoring Network (PWQMN)

Water quality has been monitored in the Upper Thames River watershed since the 1960s under the PWQMN. The network is a cooperative program of the Ministry of the Environment, Conservation, and Parks (MECP) and CAs.

Currently, surface water chemistry is monitored at 24 sites within the Upper Thames River watershed as part of the PWQMN. Map 6 in Section 2 shows the surface water quality monitoring sites. Some of the sites are part of the original PWQMN program that was initiated in the 1960s, while others have been added more recently.

Table S1 summarizes the history of the UTRCA's surface water quality monitoring program.

From the 1960s to 1995, data was collected from 23 sites in the Upper Thames River watershed. In 1996, the number of sites was reduced to 15 due to provincial funding cutbacks.

In 2001, as part of a strategic planning process by the UTRCA, a new subwatershed approach was adopted for watershed management. The Upper Thames River watershed was divided into 28 subwatersheds which were deemed to be appropriately sized land areas for assessing environmental information, monitoring environmental change, and targeting rehabilitation work. They are also a scale where the subwatershed (creek or river) is recognizable to the local pubic and municipalities, and information is meaningful and provides motivation for local action. The 28 subwatersheds are either major tributaries or sections of the main branches of the Thames River.

In 2002, the UTRCA worked with the MECP on a new strategic approach to monitoring, which involved relocating and adding some additional PWQMN monitoring stations to maximize coverage of the 28 subwatersheds. Also, it was a priority to maintain long-term monitoring sites, some of which had been monitored since the 1960s. The goal was to have a monitoring station at or near the outlet of each subwatershed.

In 2002, the UTRCA and MECP redesigned the monitoring program for the Upper Thames River watershed, bringing the number of sites up to 24 to better reflect the UTRCA's approach of monitoring, reporting, and implementing work on the 28 subwatershed units. The redesign included 10 new PWQMN sites added in 2003 in locations where surface water monitoring was not occurring previously. In 2005, one site that was dropped in 2003 was added back to the PWQMN.

From 2002 to 2018, nine of the 24 PWQMN sites were monitored eight times a year. Water samples were collected at these stations on a monthly basis, generally from March to November, and analyzed for metals, nutrients, and bacteria. The other 15 PWQMN stations were monitored four times a year through the PWQMN program from March to November (this was changed in 2018, see below). Since 2006, samples from these 15 stations have not been analyzed for metals as MECP deemed this analysis unnecessary due to low levels. For PWQMN total phosphorus data, there was a change in analytical lab methods used for 2013-2015 samples, using a different lab method than previous years. However, based on MECP and UTRCA evaluation, the data is comparable for the purposes of watershed report card reporting.

Other Water Quality Data Sources

2010 – New Stations Added: In 2010, the UTRCA added three new long-term UTRCA water quality monitoring stations to complete monitoring of each of the 28 subwatersheds for report cards. Funding came from the UTRCA as part of recommendations in the UTRCA Strategic

Table S1. History of UTRCA Water Quality Sampling Programs

Years	Number of Sites	Program	Sampling Frequency	Analysis	Notes
1960s - 1995	23	PWQMN	Some sites 4x/yr and some 8x/yr	MECP Lab - metals, nutrients, and bacteria	PWQMN began in cooperation with CAs across Ontario.
1996 - 2001	15	PWQMN	12x/yr	MECP Lab – metals and nutrients (bacteria discontinued)	In 1996, the number of sites was reduced to 15 due to provincial funding cutbacks.
2002 - 2018	9 sites added for a total of 24	PWQMN	9 sites sampled 8x/yr 15 sites sampled 4x/yr (Mar - Nov)	MECP Lab – metals (9 sites only) and nutrients Health units – bacteria	UTRCA worked with MECP on a new strategic approach to monitoring using 28 subwatersheds. Some PWQMN sites were relocated and others were added. In 2001, the UTRCA formed a partnership with local health units to continue monitoring bacteria at PWQMN locations. The 15 sites sampled 4x/yr ceased testing for metals due to low levels.
2002 - Present	4 sites added* for a total of 28	City of London Thames River Monitoring	12x/yr	Greenway Lab	UTRCA utilizes data from the City of London Thames River Monitoring in four of the subwatersheds that are not included in the PWQMN (Pottersburg Creek, Medway Creek, Forks Corridor, and Dorchester Corridor).
2010 - Present	3 sites added for a total of 31	UTRCA Targets Funding	8x/yr	Min. of Health Lab – *E.coli*. ALS Lab - total phosphorus (2010 - 2018) ALS Lab – *E.coli*, nutrients, and metals (2020-present)	In 2010, the UTRCA added three new long-term UTRCA water quality monitoring stations to complete monitoring of the 28 subwatersheds for watershed report cards. Funding through UTRCA's Targets Funding. Stations: Fullarton Corridor, Whirl Creek, and Mud Creek.
2018 - Present	15 sites	PWQMN/ UTRCA	15 sites previously sampled 4x/yr are now sampled 8x/yr	Extra samples analyzed at ALS Lab – E. coli, nutrients, metals	In 2018, the UTRCA increased sampling frequency of the 15 sites that previously were at 4x/yr. Now all 24 sites are sampled 8x/yr.
Present	24-PWQMN 3-UTRCA 4-London, 31 Total	PWQMN, UTRCA, London	8x/yr	MECP Lab (PWQMN), ALS Lab (UTRCA), Greenway Lab (London)	

Plan Environmental Targets (2016). These stations are in the Fullarton Corridor (formerly called Glengowan), Whirl Creek, and Mud Creek subwatersheds. From 2010 to 2018, these three sites were monitored eight times per year for *E. coli* (analyzed at the Ministry of Health and Long-Term Care laboratory in London) and total phosphorus (analyzed at ALS). Since 2018, these sites have been analyzed at ALS laboratories for *E. coli* (starting in 2020) and the full range of parameters similar to PWQMN.

2018 – Extra Monitoring Frequency Added: In 2018, the UTRCA expanded long-term monitoring as part of recommendations in the UTRCA Strategic Plan Environmental Targets (2016) to ensure all 28 subwatersheds have equal monthly monitoring. No new sites were added but 15 of the 24 PWQMN sites that were monitored only four times per year were now monitored eight times, ensuring all long-term sites used for report cards are monitored equally. These samples are analysed at ALS laboraties for the full range of parameters similar to the PWQMN.

Winter Sampling: In recent years, winter sampling started through the PWQMN at select sites across the province. For the UTRCA, this is currently done at five stations (Ingersoll, Avon, North Woodstock/Innerkip, North Mitchell, and Middle Thames). However, this winter data is not used for watershed report cards in order to ensure comparable information/time frames for all subwatersheds since 2001.

Bacteria Testing: Bacteria (fecal coliform or *E. coli*) were monitored in river samples as part of the PWQMN until 1996, at which time the Province discontinued this part of the program. In 2001, the UTRCA formed a partnership with the local health units to continue monitoring bacteria at the PWQMN locations. Samples were analyzed at the Ministry of Health and Long-Term Care laboratory in London. Since the spring of 2020, as a result of public health lab restrictions due to the pandemic, all *E. coli* samples for the Upper Thames PWQMN sites and UTRCA sites have been analysed through a private lab (ALS in London). The partnership with the Ministry of Health and Long-Term Care laboratory in London to analyze *E. coli* samples could be restarted in coming years.

City of London Data: Starting in 2002, data from the City of London's Thames River monitoring program was used in four of the subwatersheds that are not included in the PWQMN. The City has 16 long-term monitoring sites and this data was used in the Pottersburg Creek, Medway Creek, Forks, and Dorchester report cards.

Map 6 (see Section 2) shows all of the surface water quality monitoring sites used for the report cards.

Benthic Monitoring Program
Benthic invertebrate data has been collected at various sites throughout the Upper Thames River watershed since 1994. The UTRCA Benthic Monitoring Program was developed with the Biology Department of Western University and incorporates aspects of the Ontario Benthic Biomonitoring Network and Canadian Aquatic Biomonitoring Network sampling protocols.

UTRCA staff collects samples from approximately 100 sites across the watershed annually. Sampling is conducted in the spring and fall with spring samples utilized for calculating report card scores. The samples are analyzed by the UTRCA. The data used for these report cards is from a site close to the outlet of each watershed (see Map 5 in Section 2).

Other UTRCA Sampling Data
In addition to water quality sampling and benthic monitoring, fish monitoring is also carried out by the UTRCA, as resources permit. Water quantity or flow information is important to understanding and evaluating water quality data, and many of the subwatersheds have a UTRCA flow station at, or in proximity to, the water quality station.

1.3.4 Surface Water Quality Results

Table 2 (in Section 3) lists the final grades and point scores for each of the 28 watersheds. Table 3 summarizes the watershed grades, sorted by ranking. Map 7 (in Section 2) shows the distribution of grades by watershed.

Surface water quality grades for the 28 subwatersheds within the Upper Thames River watershed range from a C to a D. It should be noted that the province-wide guidelines (2011) for watershed report cards have a stringent grading system and higher grades tend to be in areas of the province where there is less development or intensive land use.

The average grade for surface water quality remains steady at a D, similar to the grade achieved in previous report cards dating back to 2012.

Fourteen watersheds have C grades and 14 watersheds have D grades. This shows some improvement from the 2017 report cards. Since the 2017 report cards, overall water quality scores have improved in five watersheds (Dorchester Corridor, Fullarton Corridor, Medway Creek, Mud Creek, and Wye Creek), stayed steady in 21 watersheds, and declined in two watersheds (Gregory Creek and Reynolds Creek). Overall, the best water quality scores were found in Komoka Creek, followed by Fullarton Corridor, Plover Mills Corridor, and Middle Thames River. The lowest water quality scores were found in Reynolds Creek, followed by Cedar Creek and River Bend Corridor.

As seen in Table 2, there are a number of instances where different indicators show different trends for a watershed. Many variables, including weather (e.g., rainfall, temperature) and pollution can impact indicators differently. Tracking a range of indicators including nutrients (i.e., phosphorus), pollutants (i.e., *E. coli*), and aquatic life (i.e., benthic invertebrates), helps identify the impacts of landuse and natural processes on water quality.

1.4 Forest Conditions

1.4.1 Introduction

Forests, wetlands, thickets, meadows, and prairies covered the Upper Thames River watershed prior to European settlement. Species diversity was very high in this region due to the long growing season and deep, glaciated soils. However, these same factors also made the area attractive for farming and urban development. Today, forest cover is highly fragmented, existing as small woodlots separated by agricultural fields, urban development, and other land uses.

Forests and other natural habitats fulfil many functions, including:

- protecting and building the soil (humus layer),
- producing oxygen and taking up nutrients and pollutants,
- moderating the climate and taking up carbon,
- protecting groundwater,
- providing fuel, timber, seeds, and berries,
- providing opportunities for recreation and education,
- providing habitat for wildlife, and
- contributing to our heritage.

Ecologists and biologists have been studying the health of southern Ontario's natural landscapes for decades. They are concerned about the dwindling amount of natural vegetation and the ability of these habitats to support a healthy diversity of native plants and animals:

"Deforestation is often seen as just a net loss of forest cover. But deforestation can also refer to the loss of the quality of the remaining forests. The size and shape of a woodlot affect its quality, as do its proximity and linkage to other landscape features" (Federation of Ontario Naturalists, Woodland Facts).

To evaluate the health and status of the terrestrial (land) environment, key indicators are used to grade the forest conditions in each of the 28 watersheds.

1.4.2 Indicators and Grading System

As it is impossible to study or inventory every woodlot/forest in a watershed, landscape-scale parameters are used as a means of measuring overall forest conditions. The 2007 Upper Thames River Watershed Report Cards used two indicators (percent forest cover and percent forest interior), based on the 2003 Conservation Ontario guidelines. In 2011, the guidelines were updated to incorporate the newest science and to better reflect conditions across the province. Environment Canada's 2013 How Much Habitat is Enough? report, and its earlier editions, was heavily relied upon in the creation of the indicators and the grading system. The Environment Canada report synthesizes and translates a large amount of scientific literature that deals with habitat and species conservation. The Conservation Ontario guidelines were reviewed in 2017 and again in 2022 with no changes to the forest conditions grading system.

There are now three indicators: percent forest cover, percent forest interior, and percent riparian zone forested. All indicators relay a great deal of information about the sustainability of the natural heritage system. They can be calculated relatively quickly and uniformly across the watersheds using GIS technology.

The text below describes the indicators, how they were calculated, and their importance (more details can be found in the Guide to Developing Conservation Authority Watershed Report Cards, Conservation Ontario, 2022). Table 4 (see Section 3) shows the grading system used in the 2022 Upper Thames River Watershed Report Cards and follows the province-wide guidelines (Conservation Ontario 2022).

Indicator: Percent Forest Cover

- What it measures: The percentage of the watershed that is forested or wooded (these terms are used interchangeably). Forest cover includes upland and wetland forest types.
- How it is calculated: Divide the area of forested land by the area of the watershed.
- Why it is important: It is believed there should be about 30% forest or natural cover in southern Ontario's landscape to sustain native plants and animals.

The overall amount of forest cover is generally of greatest importance in terms of maintaining bird populations (Environment Canada, 2013). Forest birds are a good indicator of habitat quality and the ability of habitats to sustain native animals and plants. In fragmented landscapes with less than 30% forest cover, forest interior plays a major role in determining breeding bird success.

Indicator: Percent Forest Interior

- What it measures: The percentage of the watershed that is forest interior. Forest interior is the protected core area 100 m inside a woodlot that some bird species require to nest successfully. The outer 100 m is considered "edge" habitat and is prone to high predation, wind damage, and alien species invasion.
- How it is calculated: Divide the area of forest interior by the area of the watershed.
- Why it is important: Many bird species require large forests that contain a more protected core area to breed successfully. Many forest bird species are declining, a reflection of disappearing habitat. Forest birds are a good indicator of habitat quality and the ability of habitats to sustain native animals and plants.

Forest interior includes the core of the woodlot, minus the outer 100 metres along the edge. Environment Canada (2013) recommends forest interior should be greater than 10% of a major watershed to maintain breeding birds, especially area-sensitive birds. Area-sensitive forest birds are species requiring a relatively large forest patch within which to reproduce successfully. Many of Ontario's forest birds, including many migratory raptors and songbirds, are fully or somewhat area-sensitive, being drawn to large forest patches to fulfil breeding needs and seek protection from nest parasites and other disturbances. Forest interior is a measure of forest fragmentation and habitat quality and size.

The edge of a forest is more likely to possess non-native plants, the trees are exposed to sun scald and wind throw, and predators (e.g., raccoons) are more abundant. Brown-headed cowbirds are the main nest parasites of forest breeding birds. They are more likely to lay their eggs in host bird nests within approximately 100 m of the forest edge (Environment Canada/CWS Fact Sheet).

Indicator: Percent Riparian Zone Forested

- What it measures: The amount of forest cover within a 30 m riparian/buffer zone adjacent to all open watercourses.
- How it is calculated: Divide the area of forest cover within the riparian zone by the area of the riparian zone.
- Why it is important: Riparian habitats support high numbers of wildlife species and provide an array of ecological functions. Forest cover along waterways also protects aquatic life.

Percent riparian zone forested is a measure of the amount of forest cover within a 30 m riparian zone adjacent to all open watercourses and lakes. Environment Canada (2004) recommends 75% of stream length be naturally vegetated and that "streams should have a minimum 30 m wide naturally vegetated adjacent-lands area on both sides, greater depending on site-specific conditions." Only forest cover is used in the report card calculation because most CAs do not have the mapping detail to include non-forested permanent cover types such as meadow, thicket, or marsh.

Riparian areas are regional hot spots that support a disproportionately high number of wildlife species and provide a wide array of ecological functions and values (Naiman et al. 1993, Fischer and Fischenich 2000, National Research Council

2002). Carolinian Canada's The Big Picture project (Jalava et al. 2000) proposes using river corridors to connect natural areas and to expand the natural heritage system. Many CAs are promoting the establishment of riparian buffers to protect water quality and to serve as a corridor for wildlife movement.

1.4.3 Mapping Data

Through the use of GIS technology and digital aerial photography (ortho-imagery), the UTRCA has made significant progress in mapping natural heritage features across the watershed. With each iteration of the watershed report cards (2001, 2007, 2012, 2017, and 2022), a new mapping version has been used, each with greater accuracy and detail. The 2022 report cards use 2015 imagery as there is always a lag between the flight year and when the data is available and processed.

The Southern Ontario Landuse Resource Information System (SOLRIS) mapping rules, which provided the original basis to collect certain natural features, were expanded to include more detailed wetlands and meadows (especially riparian meadows). These features were mapped by digitizing features recognizable in orthoimagery using air photo interpretation skills and other GIS mapping layers to determine habitat types.

Considerable effort was made to ensure that borders around woodlots and natural features are correct. A drawback to the addition of habitat types in the SOLRIS layer is that in woodlots with a creek, meadow, or hydro corridor running through them, the border for that woodlot went around these features, essentially dissecting the patch and altering its size and interior calculations. Woodlots are not homogenous and almost always contain small patches of other habitat types within them. Wildlife does not face insurmountable barriers in crossing meadows, wetlands, or hydro corridors, and so these were left inside the woodlot patch. The UTRCA corrected these boundary errors.

Recently, the UTRCA refined the watershed boundaries using the 2017 Digital Terrain Model on 2015 ortho-imagery. Some of the 28 watersheds increased or decreased in size by a few square kilometres. The largest change was in the Ingersoll Corridor (9 sq. km smaller) and Reynolds Creek (17 sq. km larger). This change in watershed size was taken into consideration when comparing the forest conditions results from the 2017 to the 2022 watershed report cards.

Improved Mapping vs. Real Habitat Loss/Gain
As stated above, it is challenging to compare percent forest cover values over the years since mapping improvements mean it is not an apples-to-apples comparison. It has been difficult to determine whether a slight change in forest cover was the result of actual loss or gain on the landscape, or a result of mapping improvement.

Air Photo Interpretation: The 2015 air photography provided excellent clarity and improved resolution that allowed further refinement in defining forest boundaries and habitat type as compared to the 2010 photography. Also, watercourses within woodlots were mapped more clearly for the first time. By comparing the two images (2010 to 2015), polygon to polygon, GIS technicians corrected the vegetation layer. In some cases, the type of habitat (thicket vs. meadow) was corrected, and in other cases, the boundary of the feature was corrected. For instance, woodlots were seen as slightly larger since shadows were not as much of a factor.

Rule Changes: Mapping rule changes were made in the 2017 watershed report cards to follow protocols used in natural heritage systems studies undertaken by the UTRCA. For example, treed areas less than 0.5 ha in size or less than 30 m wide no longer met the definition of woodland/forest. GIS technicians categorized and tallied each change. No further changes were made in the 2022 report cards.

Real Forest Loss: Any forested/wooded area present on the 2010 ortho-imagery that was gone on the 2015 image (e.g., cleared for urban development, agriculture, aggregates, etc.) was categorized as removed/real loss.

Forest Gain: Between the 2010 and 2015 photography, several tree plantations succeeded (matured) from the young plantation category to the woodland/forest category. This resulted in a gain of forest cover overall across the watershed. A great deal of reforestation work occurred in the 1970s to 1980s, especially on CA lands, and these are now maturing to the point that they can be added to the forest category. This is good news. In addition, some natural thickets also succeeded to the forest category.

1.4.4 Forest Conditions Results

Table 5 in Section 3 lists the data and final grades for each of the 28 watersheds, and Table 6 sorts the watersheds by grade and ranking. Map 8 illustrates the distribution of watershed grades in map form.

Grades: The average grade for forest conditions remains a D which is the same overall grade achieved in the 2001, 2007, 2012, and 2017 report cards. This low grade is not surprising considering the Upper Thames River basin is located in a highly developed part of southern Ontario where only 11% forest cover remains. The Environment Canada guideline to sustain species in southern Ontario is 30%, or a B grade.

Forest conditions grades for the subwatersheds range from C to F, with five Cs (Dorchester, Black, Komoka, River Bend, and Trout), and one F (North Mitchell). The remaining 22 subwatersheds scored a D. The average grades for each indicator are: D for percent forest cover, F for percent forest interior, and C for percent riparian zone forested. Forest conditions are best in watersheds that contain large wetlands such as the Dorchester Swamp and Ellice Swamp.

Two subwatersheds have moved up a grade (Black Creek and Whirl Creek) due to slight improvements. While there were no other grade changes, 11 watersheds showed slight improvements in scores, 13 were steady, and four showed slight declines. Urbanizing watersheds were more likely to see declines.

Gains: Since the 2017 report cards, there has been a slight increase in forest cover across the Upper Thames River watershed from 11.1% to 11.3% due to a combination of improved mapping and forest succession. This translates to 781 ha more forest cover. Large areas planted to trees in the 1970s and 1980s are now reaching maturation. Note, this does not mean a gain in vegetation cover, but just a shift in vegetation type (e.g., thicket to forest). Overall, the pace of tree planting by the UTRCA, landowners, and other organizations is significant but not keeping up with the loss. A block of planted trees can take 20 to 50 years to mature to the point where it can be called a forest or woodland.

Losses: Despite the gains, there were 353 ha of forest removed and converted to urban or rural land uses between the 2010 and 2015 aerial photography across the watershed. By comparison, 227 ha were cleared from 2006-2010, and 571 ha from 2000-2006. Forest loss usually happens incrementally with edges of woodlots being cleared for agriculture or urban development, etc.

Indicators

The percent forest cover is generally low in the Upper Thames River watershed with an average of 11.1% (D grade) which is well below the guideline of 30% (B grade). Percent forest cover ranges from a low of 4.7% in North Mitchell to 20.0% in River Bend. Much of the remaining forest cover is along watercourses, at the back of farms, and as wetlands.

The percent forest interior is generally quite low throughout the watershed and, at an average of 1.5% (F grade), is much lower than the target of 10% (B grade) due to the fact that most woodlots are small and narrow. Woodlots must be over 4 ha in area or 200 m wide (assuming a square shape) to contain forest interior. Percent forest interior ranges from a low of 0.1% in the Forks watershed to a high of 6.1% in Black Creek. Ellice Swamp in the Black Creek watershed is the largest tract of forest in the Upper Thames Basin.

Percent riparian zone forested ranges from a low of 12.0% in North Mitchell to 55.3% in River Bend. The main channels of the Thames tend to have larger forested buffers than headwater streams and drains, due to the increased natural hazards (i.e., flood risk and steeper slopes) near larger waterways. The overall Upper Thames River watershed average is 35.7%, which is lower than the target of 50% (B grade). The riparian cover has increased since the last report cards due to the fact that many watercourses within woodlots were mapped for the first time.

Change Status

While two watersheds had a grade change from the 2017 to 2022 report cards, the grade is a fairly coarse measure by which to see subtle changes on the landscape. To provide an indication of whether a watershed's forest conditions have changed since the previous report cards, the UTRCA uses the terms Slight Improvement, Steady, and Slight Decline.

Determining this change status is somewhat subjective and reflects the balance of forest gains (through succession and/or mapping improvements) and real forest losses (clearcutting). Forest conditions in 10 of the 28 subwatersheds showed a slight improvement, 13 were steady, and five showed a slight decline. Overall, the Upper Thames River watershed has seen a small increase in forest area since 2017.

1.5 Groundwater

The 2022 report cards include a section on groundwater (see Map 9) that describes drinking water supplies (municipal water supply and private wells) and local sources of groundwater information. Much of this information has been developed through the Drinking Water Source Protection program. For each report card, a map is included showing:

- Municipal well locations
- Significant Groundwater Recharge Areas (SGRA): Areas where a relatively large volume of water makes its way from the ground's surface to recharge or replenish an aquifer. Much of the natural recharge of an aquifer comes from rain and melting snow. A recharge area is considered significant when it helps maintain the water level in an aquifer that supplies a community with drinking water. Under the Clean Water Act (2006), it may also be considered significant if it plays a necessary role in recharging cold water streams that some species of fish need to live.
- Highly Vulnerable Aquifers (HVA): Groundwater movement is typically slow (measured in cm/hr), but in HVA, there are relatively faster pathways from the ground's surface down to an aquifer, making the aquifer more vulnerable to contamination. An aquifer is considered highly vulnerable based on a number of factors, including how deep it is underground, the type of soil or rock covering it, and the characteristics of the soil or rock surrounding it.
- Wellhead Protection Areas (WHPA): A WHPA is an area surrounding a municipal wellhead where contaminants are reasonably likely to move toward or reach the well. Wellhead protection zones are defined as 100 m around the well and the time of travel. Time of travel zones (two, five, and 25 years) reflect how long it takes water to move underground through the aquifer to the well itself. The time of travel is calculated using a range of information including: pump tests, well drilling reports, information on the rise and fall of the land in the region of the well, type of soil surrounding the well and the nature of the substrate (clay, sand or gravel), the type of aquifer (bedrock or overburden), and the amount of water being pumped from the well.

The Provincial Groundwater Monitoring Network (PGMN) was developed in 2001 in cooperation with the MECP. The program was designed to collect ambient groundwater quality and quantity data. The UTRCA has 28 wells at 22 different sites (see Map 10). Additional monitoring wells were added to the PGMN in 2014 (two in the Avon watershed and two in the Fish Creek watershed). Water quality testing is done once a year. Water level (i.e., water quantity) data is collected hourly by a continuous monitoring device installed in each of the PGMN wells. The UTRCA has an additional 15 monitoring wells that are sampled for water quality, in partnership with the City of London.

The PGMN network was designed to monitor for low water conditions and site and aquifer specific groundwater quality. It was not designed to evaluate all aquifers at a subwatershed scale, as many more data sites would be needed to accomplish this. Therefore, the UTRCA does not use this information to report groundwater grades in the report cards. Some initial findings from the water quality testing of the UTRCA/PGMN have identified very few issues, with fluoride and arsenic being the only ones of concern. A large portion of Oxford and Perth Counties has fluoride in the bedrock and overburden aquifers at levels above the provincial drinking water standard. Fluoride and, to a lesser extent, arsenic are naturally occurring in some of the bedrock formations and are found in local aquifers.

1.6 Watershed Features, Action Plans,and Highlights of Progress

1.6.1 Watershed Features

In addition to the data used to calculate grades, a lot of additional information was compiled for the "Watershed Features" section of each report card. The watershed features data is summarized in maps and tables in Sections 2 and 3.

The watershed features give an indication as to why the watersheds experience good or poor health. They show examples of what changes in conditions have occurred in recent years. For example, human population (Map 11) has increased by 54,000 (2021 census) since the 2017 report cards (2015 census). Most (20 of the 28) watersheds increased in population since the last report cards. Komoka Creek subwatershed increased by 82% (added 1,480 people) while Waubuno Creek subwatershed decreased by 28% (down 1,920 people). Some changes may be due to watershed boundary adjustments.

The number of reported spills in each subwatershed between 2016 and 2020 is shown in Map 12 (Section 2) and Table 30 (Section 3). The highest number of spills is in the Forks (129), Dingman (70), and Pottersburg (42) watersheds. The total number of spills in the Upper Thames River watershed was 472 for 2016-2020, up from 390 in the previous five year period. Information on the material type is also provided.

Other features that track change include land cover, agricultural tiling, and urban drainage.

1.6.2 Great Lakes Connections

The important connection between the health of Lake Erie and the Thames River watershed is highlighted in the report cards. Major algae blooms from excess phosphorus are a critical issue for Lake Erie and Lake St. Clair, impacting aquatic health and water quality as a source of drinking water and recreation. The growing incidence of nuisance and toxic algae blooms from excess phosphorus has resulted in commitments by the United States and Canada to reduce phosphorus, addressing the problem though research to understand the issue and the implementation of the Lake Erie Action Plan by agencies and partners in the Lake Erie basin to implement solutions. Canada-US targets were set for the watersheds that deliver the largest phosphorus loads to the lakes. The Thames River is a priority Canadian watershed, with a federal target of reducing phosphorus loads by 40%. Reducing non-point source nutrient runoff from rural and urban lands across all areas of the watershed is a priority.

In 2012, partners in the Thames River watershed formed the Thames River Clear Water Revival to work together on the protection of water, with the shared goal of a healthy and vital Thames River which would also benefit Lake St. Clair and Lake Erie. This partnership brings together Indigenous peoples, three levels of government, two local CAs, and the local community. A state of the environment report with a focus on actions needed for water quantity and quality was completed in 2019: The Thames River (Deshkan Ziibi) Shared Waters Approach to Water Quality and Quantity. Implementation by all partners is underway. The Shared Waters Approach contains significant input from four of the eight distinct First Nations whose traditional territory includes the Thames River watershed and highlights the positive participation and sharing of traditional ecological knowledge within this approach.

1.6.3 Local Actions for Improvement

Using the most recent information and the expertise of UTRCA technical staff and partners, each report card lists local actions for improvement for surface water and groundwater quality, drinking water quality, and forest conditions. Some actions listed are specific to the individual watershed while others are beneficial practices that are applicable to all watersheds. It is recognized that there are many issues (e.g., economic, cultural) that factor into the existing land uses and local environmental decision-making on actions to take.

The actions listed should be viewed as a starting point for community groups, landowners, and agencies working to improve water and forest health. More detailed assessment of the watersheds would help to develop more specific priority actions and target locations.

1.6.4 Highlights of Progress since 2017

The 2022 report cards track change in watershed conditions since the last report cards in 2017. The “Highlights of Progress” section provides examples of the positive contributions being made by individuals, groups, agencies, and municipalities in each watershed since 2017. For example, from 2016-2020, the UTRCA Communities for Nature Program has planted 45,000 trees, 26,000 wildflower/grasses, and 8,100 aquatic plants at 110 sites (31 ha) with 18,900 students and community members (Table 46, Section 3). Map 14 in Section 2 shows trees planted in each watershed through all UTRCA programs, for a total of 235,000 trees from 2016-2020.

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