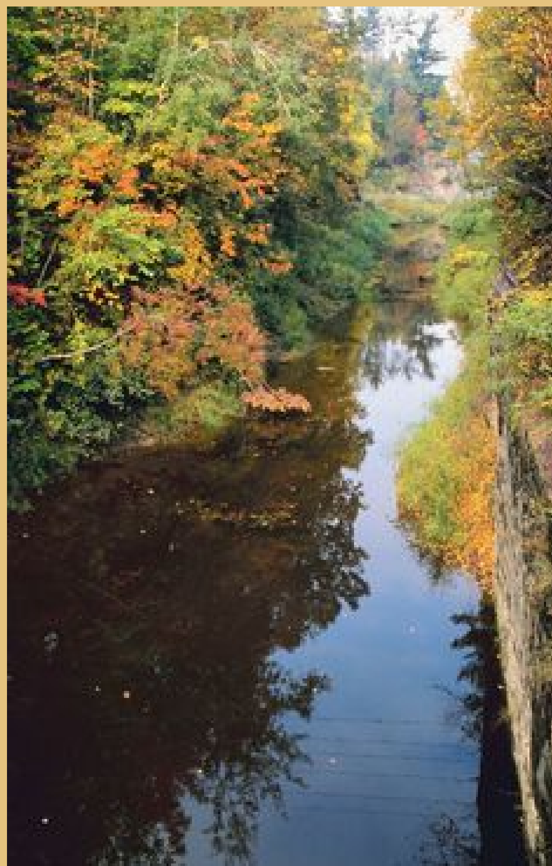

# LYNDE CREEK WATERSHED
# EXISTING CONDITIONS REPORT
# CHAPTER 10 - WATER TEMPERATURE

**June 2008**

Central
Lake Ontario
Conservation

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# 1.0 INTRODUCTION

Water temperature is one of many criteria used to assess the water quality of a stream and the health of the aquatic habitat within it. Many organisms have particular thermal requirements for existence, and cannot tolerate large changes in water temperature. As such, in-stream thermal conditions are an important indicator of overall ecosystem health. Moreover, water temperature can be correlated with the presence or absence of creekside shade-providing vegetation referred to as riparian cover, and various types of land uses within the watershed. Accurate temperature representation also provides key validation information with respect to identifying areas of potential groundwater discharge. This in turn supports the knowledge around potential groundwater flow path and recharge area identification. In view of the importance of this knowledge with respect to integrated watershed studies, water temperature has become a chapter of its own, rather than being an ancillary component of other resource disciplines.

*'in-stream thermal conditions are an important indicator of overall ecosystem health'*

**Applicable Legislation and Policies**

While primarily focused on and scoped to sources of drinking water supplies, the draft Assessment Report *Guidance Module 7, Water Budget and Water Quantity Risk Assessment* (Ontario Ministry of the Environment, 2006) prepared for the provincial Source Water Protection program under the Clean Water Act references 'cold versus warm-water streams' as one part of the surface water characterization required to support suitable water budget investigations for a watershed. Water budgets are not only a requirement for the Source Water Protection program but also for the Oak Ridges Moraine Conservation Plan (ORMCP) (MMAH, 2002).

Further, water temperature information is required in fisheries studies and in construction timing windows for in-water works as set by the MNR based on periods of fish spawning for warm and cold-water species. Any project planning must take these timing windows into account in their respective areas to ensure there is minimal impact to the fishery.

From an integrated watershed perspective, knowledge of the existing in-stream thermal regime and trends supports on-going aquatic, groundwater recharge/discharge, stream baseflow and water budget studies. In addition, water temperature information may be used as a qualitative field-verification data set for various hydrology models used to predict conditions that may result from future land use changes. This chapter provides a base understanding of the existing spatial variations of in-stream water temperatures within the watershed and points out gaps in that knowledge. This approach in turn supports an integrated ecosystem approach to the protection, conservation and enhancement of the ecological integrity of the watershed. Areas of concern may be identified and thermal classification targets may be developed in support of resource management.

*'this chapter provides a base understanding of the existing spatial variations of in-stream water temperatures…and points out gaps in that knowledge'*

# 2.0 STUDY AREA AND SCOPE

The Lynde Creek watershed is situated entirely within the Regional Municipality of Durham and covers an area of approximately 130 $km^2$ (Figure 1). The watershed drains southerly towards Lake Ontario from its headwaters in the Oak Ridges Moraine. The Lynde Creek watershed is divided into 5 subwatersheds: Lynde Main, Heber Down, Kinsale, Ashburn, and Myrtle Station. This chapter focuses on the water temperatures within Lynde Creek and its tributaries at a watershed and subwatershed scale.

The existing in-stream water temperature data measured within the Lynde Creek watershed were assessed spatially at specific sites within the watershed. However, interpolation of the in-stream temperatures between the point information is beyond the scope of this chapter due to the limited available data. This precludes the identification of cold, cool, or warm-water reaches or stream lengths between the point measurements. Such interpolation requires an increased frequency of measurements and this gap is in part being addressed by the installation of submersible temperature probes throughout the watershed. Groundwater discharge to streams information is also considered as this information assists in predicting where cold water discharge may be influencing stream water temperatures. The reader is referred to Chapter 9 – Water Budget for additional information on groundwater discharge.

*'groundwater discharge to streams information is also considered as this information assists in predicting where cold water discharge may be influencing stream water temperatures'*

Stream order may also used as a general indicator of expected thermal conditions. In this chapter, stream order is a classification system based on a drainage network and uses the Strahler Method (1964). Based on this method, streams increase in order upon converging with a stream of equal order. For example, a first order stream (typically headwaters) is a small stream without tributaries. A second order stream begins at the confluence of two first order streams and continues until it meets with another second order stream, forming a third order stream, and so forth.

*Lynde Creek near Brawley Rd.* *© CLOCA*

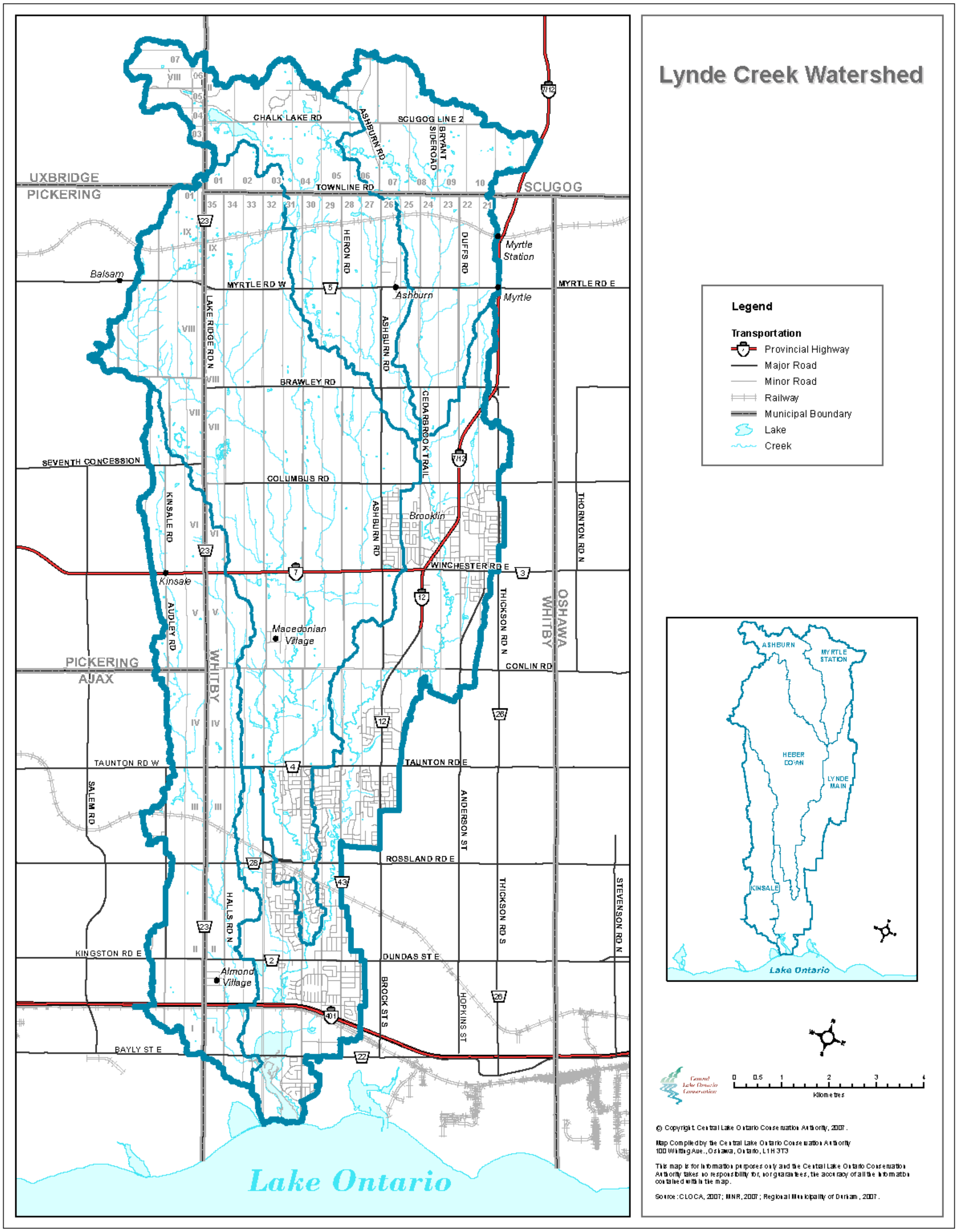



Figure 1: Lynde Creek watershed.

# 3.0 METHODOLOGY

Stream temperatures were sampled at 60 sites throughout the watershed as part of an aquatic and fish inventory study undertaken in 2001. These sites were classified into cold, cool or warm-water based on the methodology developed by Stoneman and Jones (1996) as part of the Ontario Stream Assessment Protocol (OSAP) (Stanfield et al. 1998). Stream temperature data was collected during periods of extreme heat, representing stream temperature upper extremes. Stream temperature was taken using a thermometer after three consecutively hot days during the months of July and August. Air temperatures were also recorded at each site using a thermometer.

This method generates estimates of thermal stability of a site based on one temperature measurement of air and water. Using this protocol, cold, cool or warm-water habitats are differentiated using a measurement taken from various locations throughout the Lynde Creek watershed. The results were mapped as points and summarized by subwatershed. These points were overlain with the discharge to stream estimates generated from the current water budget models (see Chapter 9 – Water Budget for more detail) to place the point measurements in the context of expected areas of groundwater discharge within streams.

*'sites were classified into cold, cool or warm-water'*

While every effort has been made to accurately present the findings reported in this chapter, factors such as significant digits and rounding, and processes such as computer digitizing and data interpretation may influence results. For instance, in data tables no relationship between significant digits and level of accuracy is implied, and as values may not always sum to the expected total.

# 4.0 FINDINGS

The following sections describe the most current available in-stream temperature information for the Lynde Creek watershed. Additionally, influencing factors such as discharge to streams, stream order, land use, and fisheries information are briefly described. Note that the daily temperature data recorded by recently installed in-stream probes was not available at the time of writing this chapter.

## 4.1 Lynde Creek Watershed

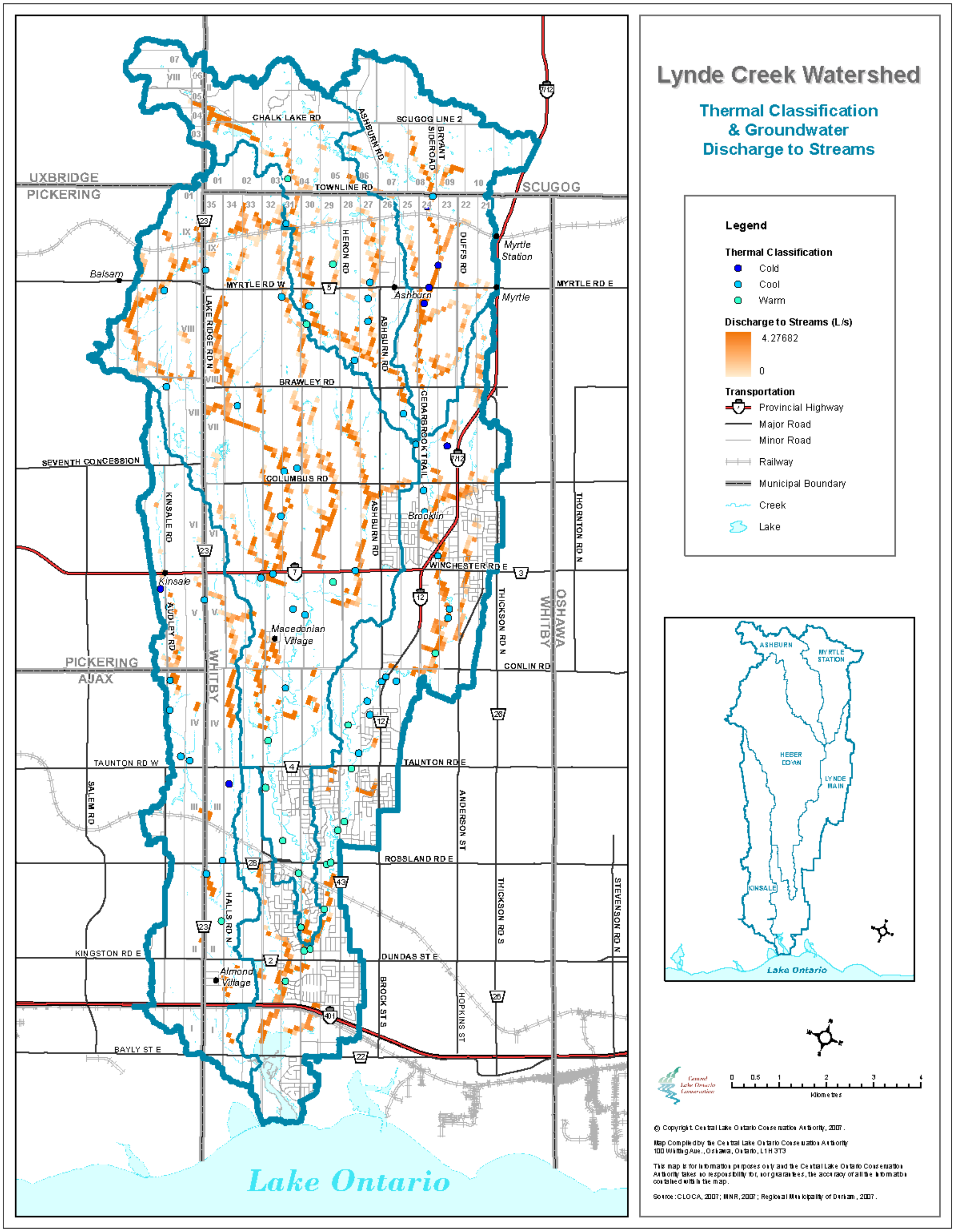
Figure 2 depicts the thermal classifications at measurement points within the watershed as cold, cool or warm-water sites. Water temperature at any given site is influenced by the cumulative effects of all landscape characteristics upstream including the state of the riparian vegetation, possible areas of groundwater discharge, land use and ambient air temperature at the time of measurement. Low-order streams are also considered an indicator of lower stream temperatures (see Chapter 16 – Fisheries and Aquatic Habitat for more detail on stream order). Headwaters generally refer to zero-order swales, first-order and second-order streams and represent reaches of potential groundwater discharge. Predicted discharge to streams is also depicted in Figure 2 to provide an indicator of where shallow cold-water groundwater is potentially discharging to a stream and possibly influencing water temperature.

Cold water sites (Figure 2) are typically characterized by upstream naturally vegetated landscapes, while warm-water sites tend to be dominated by agricultural and urban land uses and a lack of natural cover. Data from the sampling shows a general trend in the Lynde Creek watershed from cold headwater tributaries or low-order streams surrounded by natural vegetation, to cool mid-reaches dominated by agricultural land uses, to cool and warm-water higher-ordered branches that are subject to both the adjacent urbanized land and the agricultural land uses upstream (Figure 2). Anomalies to this pattern suggest the influence of localized conditions and or scarcity of data. It is, however, important to note the overall north-south warming trend within the watershed as stream order increases.

*'historically, the Lynde Creek was predominantly a cold-water system'*

Historically, the Lynde Creek was predominantly a cold-water system, however changes in land use over recent decades have caused a general warming of stream temperatures in some areas of the watershed. The Lynde Creek watershed is now a predominantly cool and warm-water system, with cool-water areas in the upstream reaches of the watershed. Cold-water sites were found in Myrtle Station and in uppermost reaches of Heber Down and Kinsale subwatersheds. Only 34% of the Lynde Creek length is protected by riparian vegetation, which may be contributing to the warm-water temperatures.

Stormwater input and high proportions of impervious cover on the landscape are also likely contributing to the warm-water temperatures in Lynde Creek southern reaches. Temperature monitoring using in-stream probes/loggers is currently being conducted to gain comprehensive knowledge of thermal influences in the watershed. This information will also provide invaluable validation data to apply against numerical model results involving baseflow simulations, along with the identification of reaches sensitive to disturbances such as land development or water takings.


Lynde Creek Watershed
Thermal Classification
& Groundwater
Discharge to Streams
Legend
Thermal Classification
Cold
Cool
Warm
Discharge to Streams (L/s)
4.27682
0
Transportation
Provincial Highway
Major Road
Minor Road
Railway
Municipal Boundary
Creek
Lake
Lake Ontario
UXBRIDGE
PICKERING
SCUGOG
AJAX
WHITBY
OSHAWA
CHALK LAKE RD
SCUGOG LINE 2
TOWNLINE RD
MYRTLE RD W
MYRTLE RD E
BRAWLEY RD
SEVENTH CONCESSION
COLUMBUS RD
WINCHESTER RD E
CONLIN RD
TAUNTON RD W
TAUNTON RD E
ROSSLAND RD E
KINGSTON RD E
DUNDAS ST E
BAYLY ST E
Balsam
Myrtle Station
Myrtle
Ashburn
Brooklin
Kinsale
Macedonian Village
Almond Village

## 4.2 Subwatershed Findings

### 4.2.1 Lynde Main Subwatershed

The Lynde Main subwatershed is considered to be a cool-warm water stream network. Land use within this subwatershed is primarily urban and agricultural (43% and 32% respectively) with 34% total riparian cover and approximately 13% forest cover exhibited within this subwatershed (CLOCA, 2007).

Interpreted thermal classifications depicted in Figure 3 show a general warm-water pattern through the urbanized areas of Whitby with cool water sites predominating in the northern reaches. Groundwater discharge to streams is predicted to occur intermittently from Columbus Rd. south to Conlin Rd. and as such could be providing shallow (cold) groundwater to the streams. Discharge is expected further to the south, though the increased streamflow in these lower order reaches likely dampen the influence of groundwater discharge on stream temperatures.

*'Lynde Main subwatershed is considered to be a cool-warm-water stream network'*

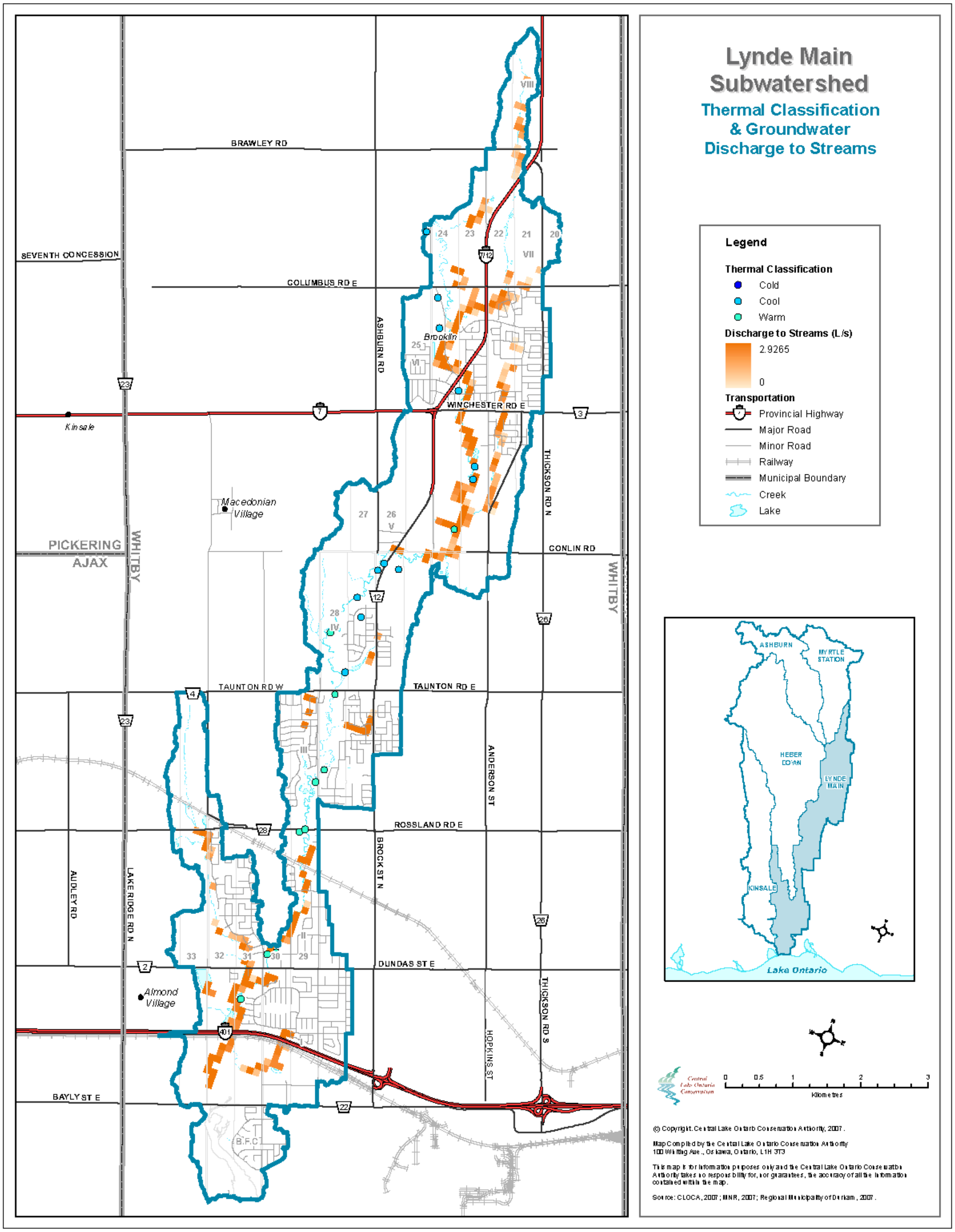
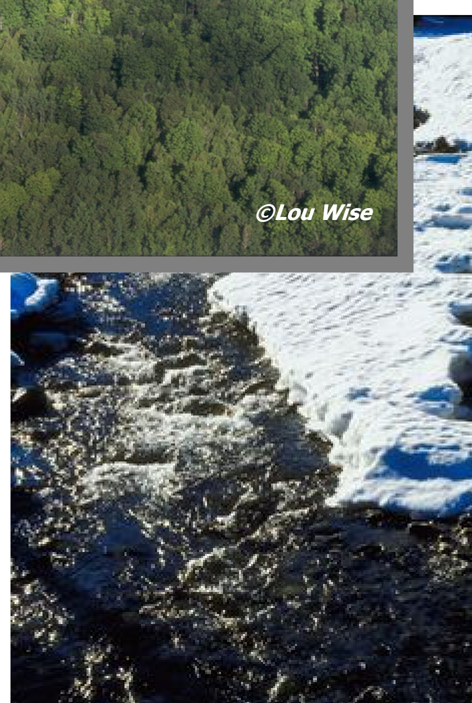




Figure 3: Lynde Main subwatershed thermal classifications and discharge to streams.

### 4.2.2 Heber Down Subwatershed

The Heber Down subwatershed is considered to be a cold-warm stream network consisting of first to fourth order streams. The subwatershed land use is predominantly agricultural and urban (52% and 17% respectively), and has an estimated 34% total riparian cover (CLOCA, 2007).

Interpreted thermal classifications depicted in Figure 4 show a general cool-water pattern throughout the subwatershed. This subwatershed is predicted as an area of higher than average watershed discharge, with higher discharge rates occurring predominantly along the south flank of the Oak Ridges Moraine (ORM) and in some reaches just north of Winchester Rd. An area of groundwater discharge is also predicted to occur north and south of Conlin Rd. which could also be influencing stream temperatures.

*'Heber Down subwatershed is considered to be a cold-warm stream network'*

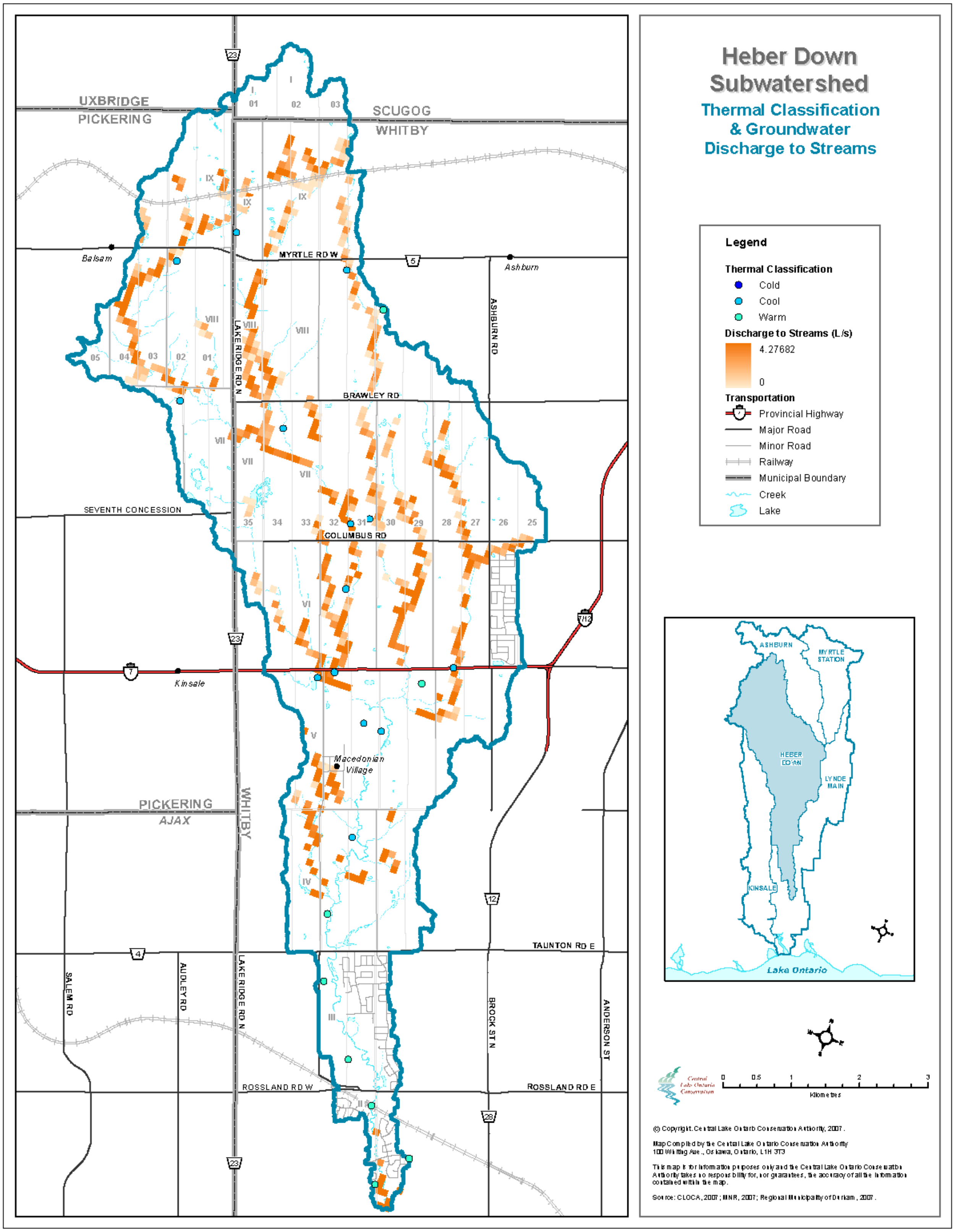



Figure 4: Heber Down subwatershed thermal classifications and discharge to streams.

### 4.2.3 Kinsale Subwatershed

The Kinsale subwatershed is considered to be a cool-warm stream network consisting of a low stream-order system (first to third). Historically, the Kinsale subwatershed was likely connected to Cranberry Marsh and subsequently diverted from the marsh to Lynde Creek (CLOCA, 2007). The dominant land use/land cover types within the subwatershed are agriculture (66%), urban development (15%), and forest (13%), with the riparian cover estimated at 38%.

Interpreted thermal classifications depicted in Figure 5 show a general cool-water pattern throughout the subwatershed with a cold-water site in a northern reach where groundwater seeps have been reported. Groundwater discharge to stream is predicted to occur only within the Iroquois Shoreline area and in some smaller areas around Rossland Rd. and Halls Rd. intersection and again just north of Hwy. 401, where the water table appears to be close to ground surface. These areas of potential cold water discharge would be expected to influence stream temperatures.

*'Kinsale subwatershed is considered to be a cool-warm stream network'*

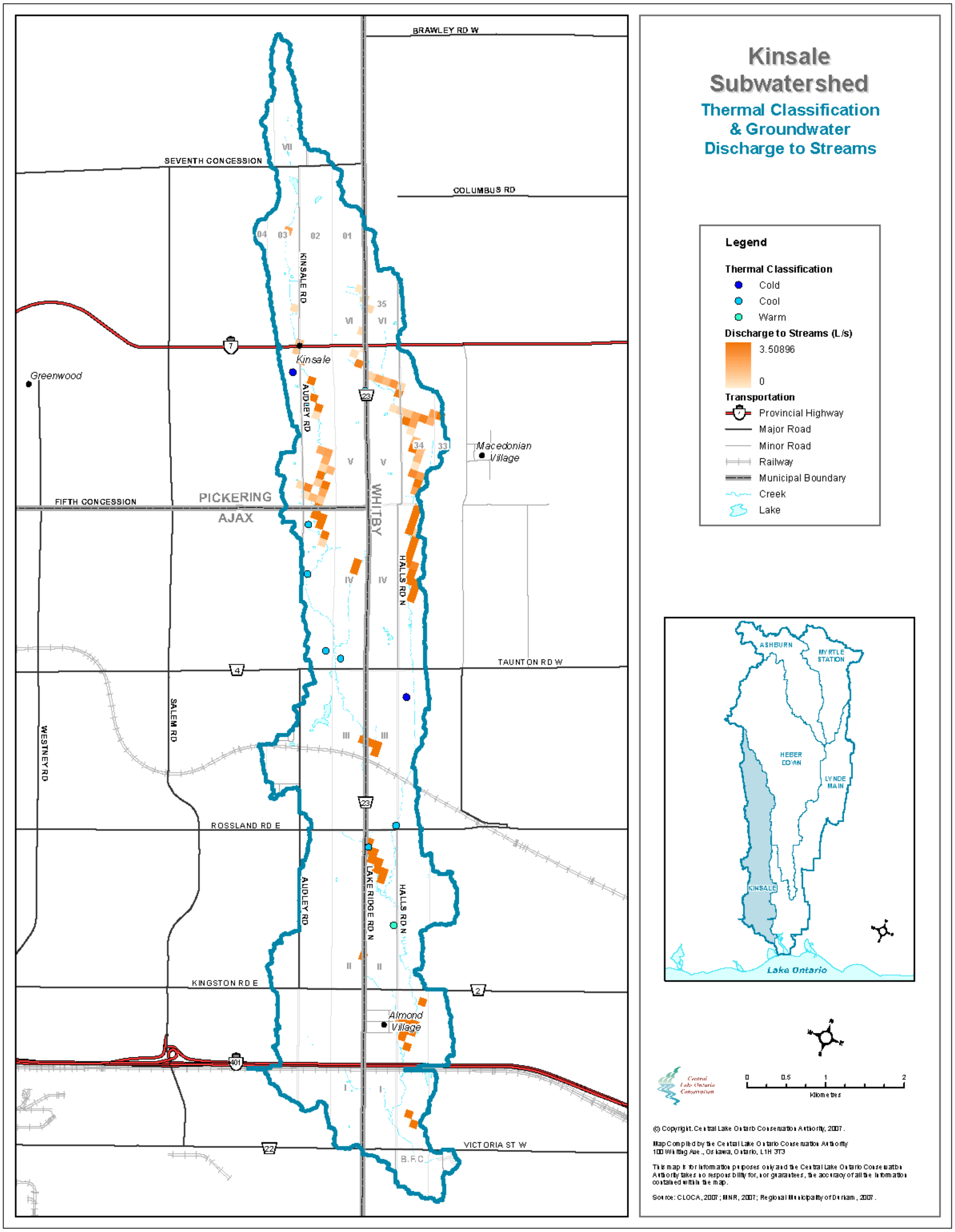



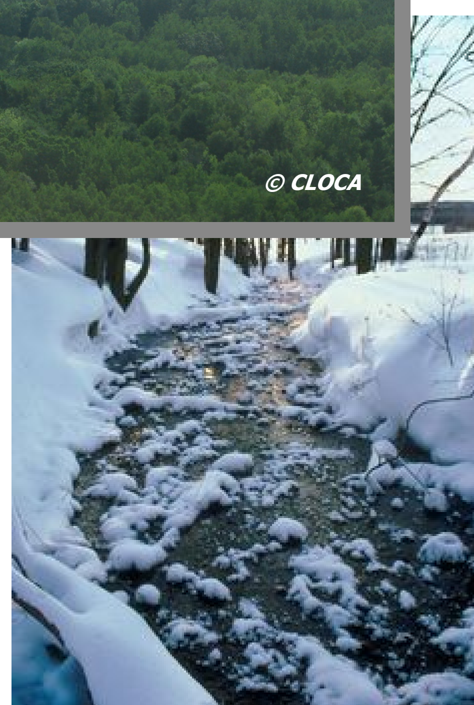

Figure 5: Kinsale subwatershed thermal classifications and discharge to streams.

### 4.2.4 Ashburn Subwatershed

The Ashburn subwatershed is considered to be a cold-cool water stream network with 66% of its total stream length as first-order (CLOCA, 2007). The subwatershed has 29% riparian cover and is dominated by agricultural land uses (42%) with a relatively large proportion of forest cover (26.5%).

Interpreted thermal classifications depicted in Figure 6 show a general cool-water pattern throughout the subwatershed. Fish species indicative of cold-water conditions have been noted in tributaries of this subwatershed. Groundwater discharge to streams is expected to occur intermittently throughout most of the stream network with higher rates of discharge beginning on the south flank of the ORM and continuing south to the Brawley Rd. area.

*'Ashburn subwatershed is considered to be a cold-cool water stream network'*

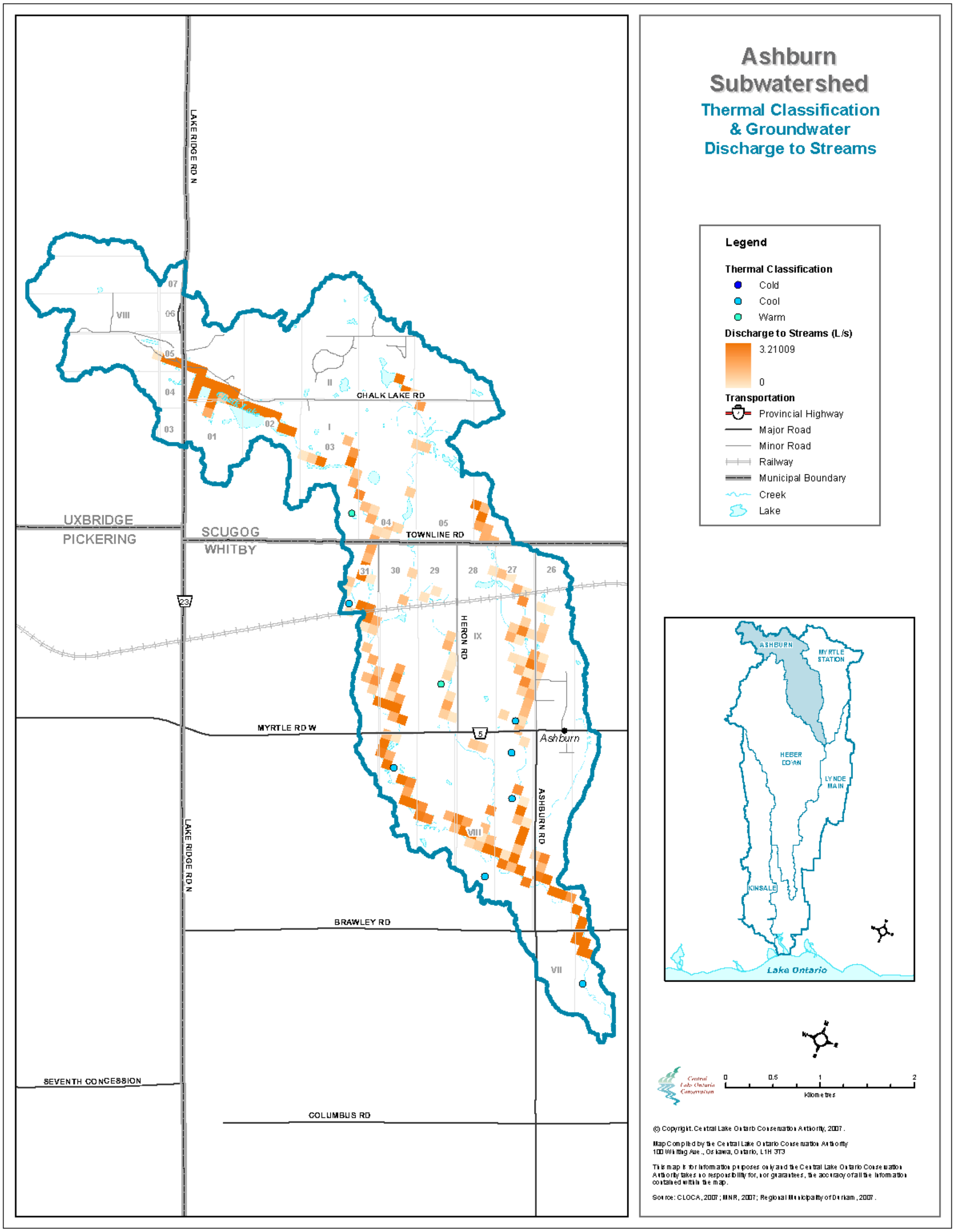



Figure 6: Ashburn subwatershed thermal classifications and discharge to streams.

### 4.2.5 Myrtle Station Subwatershed

The Myrtle Station subwatershed is considered to be a cold-cool water stream network with 77% of the network being first-order streams. The entire subwatershed has 35% riparian cover and the dominant land use/land cover types within the subwatershed are agriculture (59%), forest (17%) and urban development (9%) (CLOCA, 2007).

Interpreted thermal classifications depicted in Figure 7 show a general cold-water pattern north and south of Myrtle Rd. This area corresponds to predicted higher rates of discharge to streams. These conditions are consistent with summer low-flow measurements collected at sites on both Townline and Brawley Rds. indicating significant groundwater contribution between these sites.


*Myrtle Station Subwatershed* *©Lou Wise*

*'Myrtle Station subwatershed is considered to be a cold-cool water stream network'*

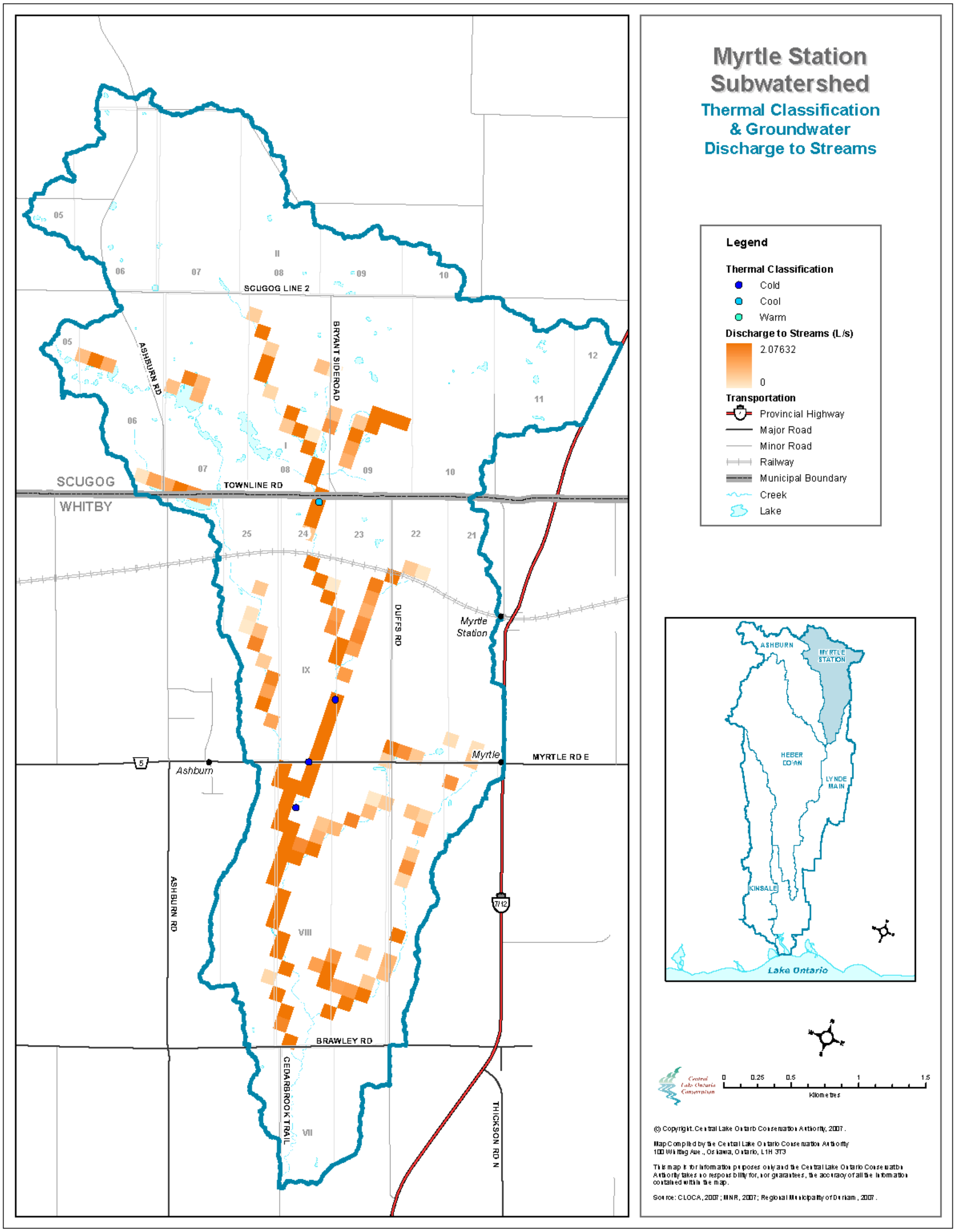


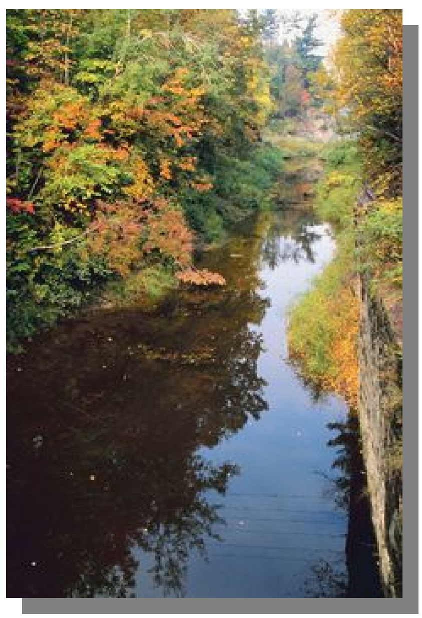

Figure 7: Myrtle Station subwatershed thermal classifications and discharge to streams.

# 5.0 CONCLUSIONS

While the Lynde Creek was historically a predominantly cold-water system, changes in land use over recent decades have caused a general warming of stream temperatures in some areas of the watershed. The Lynde Creek watershed is now predominantly a cool and warm-water system. Reduced riparian vegetation, stormwater input, on-line ponds and increasing impervious cover, are likely contributing to the warming of stream temperatures. Like most areas in the GTA, the Lynde Creek watershed will see future development. The implications of this development will bring additional pressure on the thermal stability of the Lynde Creek.

The lack of current in-stream temperature data precludes further refinement of the thermal classifications. In addition, the tools required to interpret daily water temperature data need to be explored. This information will prove invaluable in resource studies when combined with other hydrology investigations and low-flow streamflow field collection programs which in part, provide insight into the possible influences on in-stream temperatures.

*'changes in land use over recent decades have caused a general warming of stream temperatures in some areas of the watershed'*



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