APPENDIX B

URBAN LANDSCAPE SCALE ANALYSIS: GIS METHODOLOGY

GIS METHODOLOGY

The following appendix summarizes the general GIS methods used to characterize the landscape of the City of Mississauga. The methodology summarizes data sources/preparation, landscape characterization terminology, and spatial (GIS) methods used to characterize the landscape based on ecosystem functions.

DATA PREPARATION

Initially, a review of existing spatial data was conducted to assess the best ecological and non-ecological data available for the landscape characterization. The most detailed base layer for ecological data was the ELC (Ecological Land Classification) community series (OMNRSTU 1996, Lee et al. 1998, OMNR 1999) and land use layer. ELC layer was last updated in early 2010 using the Orthophotos from 2009. The layer is in the scale of 1:10,000. The base layer was used to develop two classifications; habitat patch, and ELC Community series, to describe the configuration and composition of natural patches in the landscape. Table 1 outlines the three hierarchical classifications.

TABLE 1: HABITAT PATCH COMPOSITION AND NATURAL FEATURE CLASSIFICATIONS

Habitat patch	Community type	ELC (Ecological Land Classification) series
Habitat patch	**Forest**	Coniferous forest (FOC)
		Deciduous forest (FOD)
		Mixed forest (FOM)
	Wetland	Coniferous swamp (SWC)
		Deciduous swamp (SWD)
		Marsh (MA)
		Mixed swamp (SWM)
		Shurb bog (BOS)
		Open fen (FEO)
		Shrub fen (FES)
		Treed fen (FET)
		Thicket swamp (SWT)
		Treed bog (BOT)
	Successional	Cultural meadow (CUM)
		Cultural savannah (CUS)
		Cultural thicket (CUT)
	Cultural Forest	Coniferous plantation (CUP3)
		Cultural woodland (CUW)
		Deciduous plantation (CUP1)
		Mixed plantation (CUP2)
	Woodland[1]	Coniferous forest (FOC)

		Coniferous plantation (CUP3)
		Coniferous swamp (SWC)
		Cultural woodland (CUW)
		Deciduous forest (FOD)
		Deciduous plantation (CUP1)
		Deciduous swamp (SWD)
		Mixed forest (FOM)
		Mixed plantation (CUP2)
		Mixed swamp (SWM)
	Other Natural	Open beach/bar (BBO)
		Treed beach/bar (BBT)
		Open bluff (BLO)
		Shurb bluff (BLS)
		Treed bluf (BLT)
		Shrub cliff (CLS)
		Open rock barren (RBO)

[1]Woodland consists of some wetlands, forests and cultural forest

[1] A fifth community type, namely **Woodland**, was created for part of the analysis involving the importance of wooded areas for species habitat. This patch was composed of a combination of other patch components with significant tree cover: coniferous/deciduous/mixed forest, coniferous/deciduous/mixed swamp, coniferous/deciduous/mixed plantation, and cultural woodland.

In addition to ecological landscape data (e.g. Habitat Patches), study boundary limits were defined. Generally, a landscape is defined as "an area of land containing a mosaic of patches or landscape elements" (McGarigal, 2001). Defining the study area is based on two key requirements: extent and grain (scale), which are strongly influenced by available coverage of data and mapping/digitizing guidelines for minimum mapable unit (MMU) size. In the case of the TEEM analysis, the study area boundary was predefined as the city of Mississauga which includes the limitation in data availability and is not guided by ecological principles or boundaries. If any of the ELC boundaries extend beyond the limit of City of Mississauga, either a major highway or another type of ecological land classification unit were used as a cut off in the boundary in order to include the ecological benefits received by the particular ELC unit. These boundaries do not necessarily define the limits of the hydrological boundary neither do they provide the ecological boundaries.

Secondly, the grain (scale) used for features was defined based on the MMU for natural and non-natural features. The minimum unit size selected was 0.5 ha based on mapping methodology guidelines developed by NHP (Natural Heritage Program) (CVC, 1998), however, some exceptions were made in order to include some urban wetlands that are <=0.5 ha in size due to their overall scarcity in urban areas. Overall, original ELC and land use mapping contained features with the minimum threshold size. If some ELC series had a total area under the minimum threshold size (0.5 ha) but were linked to other natural areas (See Table 3) that would together constitute an area of 0.5 ha, they were

included in the analysis. If the total size of interconnected MMU was less than the minimum threshold, they were not included in the analysis.

DATA SOURCES

The data used for these analyses come from a variety of sources. However, major data layers were created in-house by digitizing and updating data received from external sources (i.e. MNR). For the majority of the database, geo-rectified orthophotos from 2009 (Scale 1:10,000) were used to verify and update the spatial accuracy; however some of the data sources might be at higher scale (lower resolution). GIS, as a tool, is not error-free. There can be variety of errors introduced from the conceptual phase of the databases, to digitizing and spatial output. Table 2 below shows the year of known data sources and their associated scales.

TABLE 2: BASE AND ANCILLARY DATA SOURCES

Base Data Source	Year	Scale
ELC Community Series and Land Use	2009	1:10,000
Ancillary Data Source	**Year**	**Scale**
City of Mississauga Boundary	2010	1:10,000
Mississauga NAS	2006 & 2008	1:10,000
Streams and Rivers (including HRCA and TRCA jurisdiction)	2009	1:10,000
Meander belt	2010	1:10,000
Floodplain (CVC and TRCA)	2010	1:10,000
Lake Ontario Shoreline	2008	1:50,000
Roads	2009	1:10,000
Crest of Slope	2005	1:10,000
Lake Ontario hazard	unknown	Unknown
Credit River Watershed	2008	1:10,000
Credit River Subwatershed	2008	1:10,000
Physiographic zone	unknown	Unknown
Orthophotos	2009	1:10,000

HARDWARE AND SOFT WARE REQUIREMENT

The accuracy and standardization of data collection and management play crucial roles in analyses and decision-making. In order to ensure a high standard in the process, it is important to be consistent with the software, hardware and the professionals involved in the projects wherever possible. A desktop computer with Intel(R) Core(TM) 2 Duo with 2.66 GHz of processor and 2 GB RAM was used as primary hardware for the analyses. The software products from Environmental Systems Research Institute (ESRI) 2006 and 2008 were used as primary software for the analyses. ArcGIS 9.2 and 9.3 were used as major platforms for the GIS analyses whereas ArcView 3.3 was used in order to carry out

some other limited analyses (i.e. matrix analysis extension: developed in-house only for ArcView 3.3). For some of the analyses, Spatial Analyst extension for either ArcGIS 9x or 3x is required. Windows Picture and Fax Viewer, Microsoft Picture Managers, and Adobe Acrobat Readers are some other software used to view the exported maps. Professional skills in raster-, spatial-, and vector-analysis are required to complete the project.

LANDSCAPE CHARACTERIZATION TERMINOLOGY

The following section summarizes key terminology definitions developed for TEEM (landscape characterization). The definitions reflect the four scales of analysis: habitat patch, enhancement patch, community types and ELC community series. The following descriptions demonstrate the hierarchical structure of the three classifications.

HABITAT PATCH

A habitat patch is a contiguous natural area delineated by tree lines, fencerows, roads and rivers to establish polygon boundaries (CVC, 1998) and corresponds to the coarsest scale of the hierarchical classification. A habitat patch is defined as a contiguous area, boundaries delineated by a >=2mm gap on a 1:10,000 air photo or a different landuse type that is not a part of the habitat patch (Table 1) (CVC 1998). The gap of >=2mm is normally a road, which is verified at higher resolution up to 1:2000. If the road is found to be non-existent at 1:10000 scale, then the gap is eliminated. However, it does not apply in the case of other landuse types (i.e. agriculture or urban). A habitat patch can include natural and semi-natural communities. Habitat patches were uniquely identified based on their Habitat ID. The minimum threshold size for a habitat patch is 0.5 ha (0.45 ha to 0.499 ha are rounded to 0.5 ha).

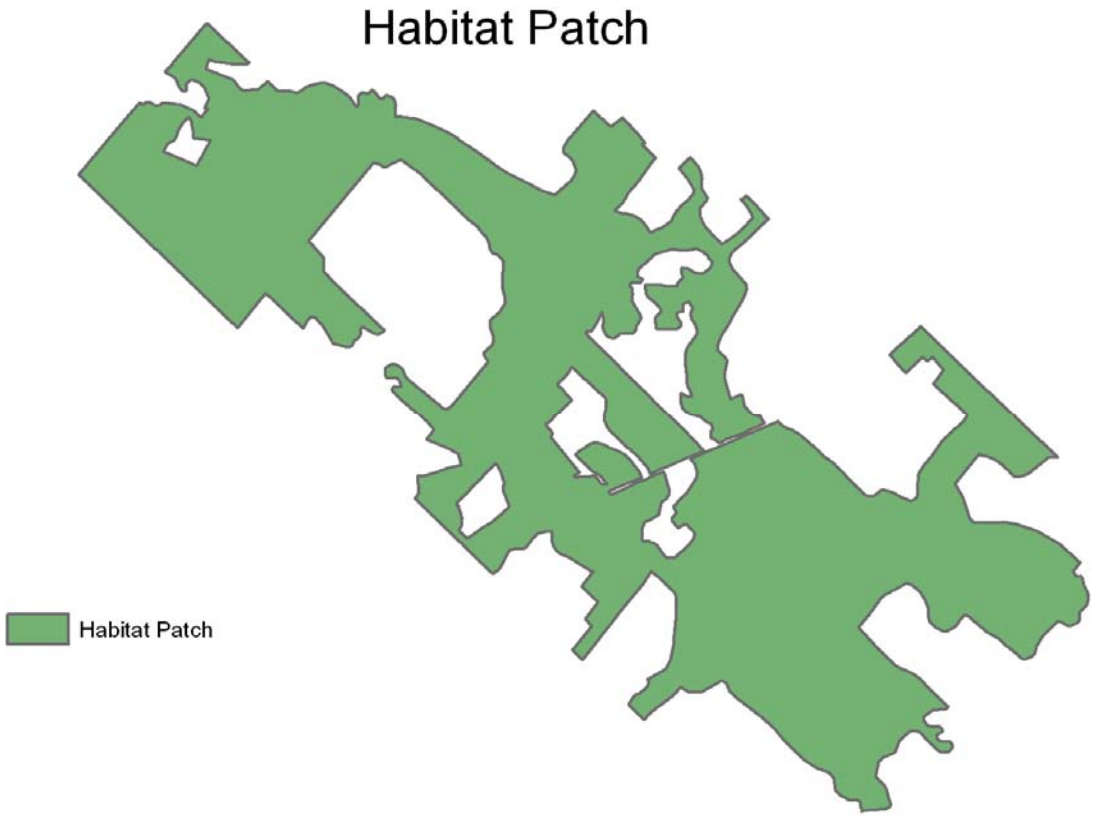

FIGURE I: HABITAT PATCH DIAGRAM

A single habitat patch is potentially comprised of natural (e.g. deciduous forest or marsh) and/or semi-natural communities, such as cultural meadow or plantation, but does not include agricultural or urban features or aquatic features. Table 1 summarizes ELC community series types which can comprise a habitat patch. An example illustrating the structure of a habitat patch is provided in Figure I.

ENHANCEMENT PATCH

An enhancement patch is a contiguous agricultural and open space area delineated by the outermost limit of those landuses, roads and rivers to establish polygon boundaries. It corresponds to one of the coarsest scales of the hierarchical classification. It is defined as a contiguous area, boundaries delineated by a >=2mm gap on a 1:10,000 air photo or a different landuse type that is not a part of the enhancement patch (Table 6) (CVC 1998). The gap of >=2mm is normally a road, which is verified at higher resolution up to 1:2000. If the road is found to be non-existent at 1:10000 scale, then the gap is eliminated. However, it does not apply in the case of other landuse types (i.e. urban or natural). An enhancement patch can include agricultural and manicured open spaces communities (Table 6). Enhancement patches were uniquely identified based on their Enhancement ID. Any mapped ELC communities that make an enhancement patch were included.

COMMUNITY TYPES

A community is defined as a contiguous, relatively homogeneous area, boundaries delineated by a patch of a different landuse type or by a >=2mm gap on a 1:10,000 air photo (CVC 1998). A community consists of one of the following types: Forest, Wetland, Cultural Forest, or Successional. A fifth community type, Woodland, consists of a combination of Forest, Cultural Forest, and treed Wetland. Figure II illustrates the community types comprising the habitat patch shown in Figure I. Each community type is uniquely identified; however the woodland community type consists of all forest community types, treed wetland community types, and cultural woodlands (see Table 1).

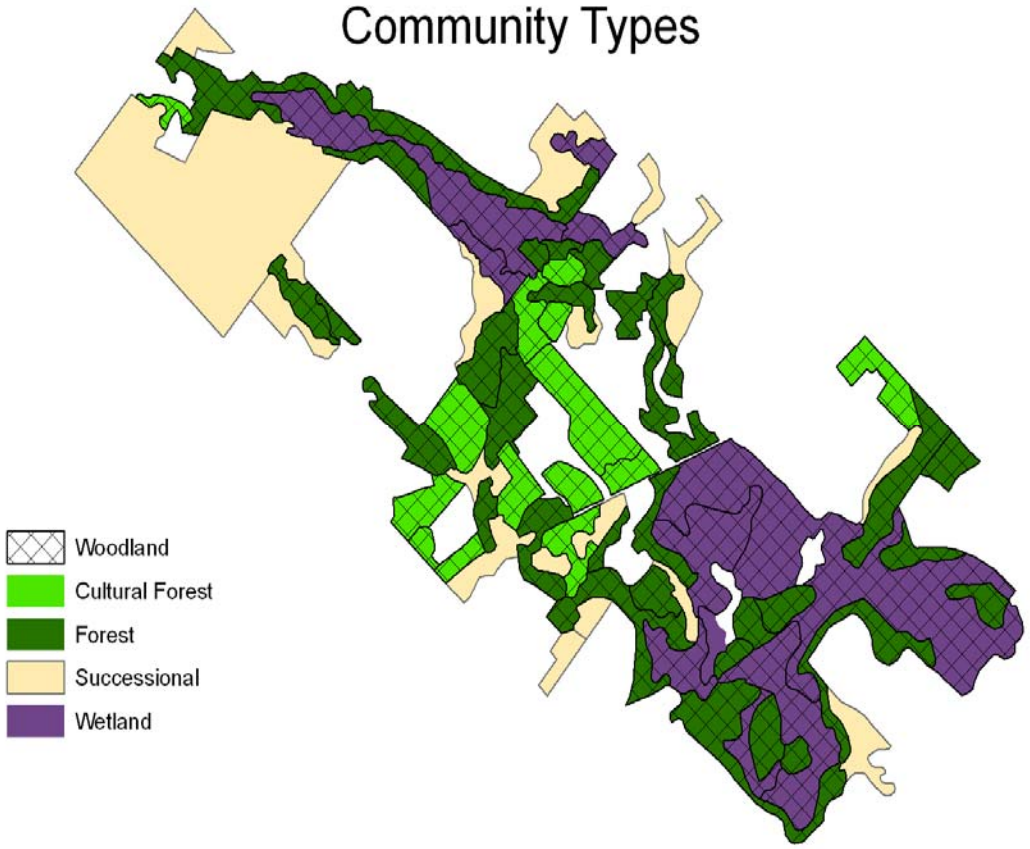

FIGURE II: COMMUNITY TYPE DIAGRAM

The following definitions summarize the community type classes: woodland, forest, cultural forest, successional and wetland.

WOODLAND

A woodland is defined as a single isolated or generally continuous grouping of natural or semi-natural tree and/or shrub dominated community(ies) which is greater than 0.5ha (0.45 ha to 0.499 ha are rounded to 0.5 ha) in size and with greater than 35% tree cover. The Provincial Policy Statement (PPS 2005) defines woodlands as follows:

"Woodlands mean treed areas that provide environmental and economic benefits such as erosion prevention, water retention, provision of habitat, recreation and the sustainable harvest of woodland products. Woodlands include treed areas, woodlots, or forested areas and vary in their level of significance".

The composition of the woodland community type is outlined in Table 1.

FOREST

A Forest is defined as a terrestrial vegetation community with at least 60% tree cover (Lee et al. 1998). In this analysis, the following ELC communities were defined as Forest: coniferous forest, deciduous forest, and mixed forest.

CULTURAL FOREST

A cultural forest is defined as a cultural community with >35% tree cover; this includes coniferous plantation, deciduous plantation, mixed plantation; and cultural woodland. The definition of plantation excludes areas that are managed for the production of fruits, nuts, Christmas trees or nursery stock (CVC 1998).

SUCCESSIONAL

A successional community type is a human-disturbed land dominated by native and non-native graminoid or shrub vegetation (CVC 1998). The following ELC communities were defined as successional: cultural meadow, cultural savannah, and cultural thicket. For the purposes of community type definitions, the ELC community series types included are shown in Table 1.

WETLAND

A wetland is defined as an area of land that is saturated with water long enough to promote hydric soils or aquatic processes as indicated by poorly drained soils, hydrophytic vegetation and various kinds of biological activity that are adapted to wet environments (Lee et al. 1998). The following ELC communities were defined as wetlands: coniferous swamp, deciduous swamp, mixed swamp, marsh, thicket swamp, bog and fen.

ELC COMMUNITY SERIES

The ELC layer (spatial) is based on the Ontario Ministry of Natural Resources (OMNR) Ecological Land Classification System (ELC), which was developed to provide a comprehensive and consistent province-wide framework upon which ecosystems can be described, inventoried and managed (OMNR, 1996). The ELC layer contains the finest watershed-wide ecological data (spatial) available and is equivalent to community series type in the ELC manual (CVC, 1998). Figure III illustrates the ELC community series types or ELC units located within the boundaries of a habitat patch (see Figure I for comparison). Each ELC unit is uniquely identified based on their ELC ID and are linked to their associated community types and Habitat IDs based on their spatial occurrence.

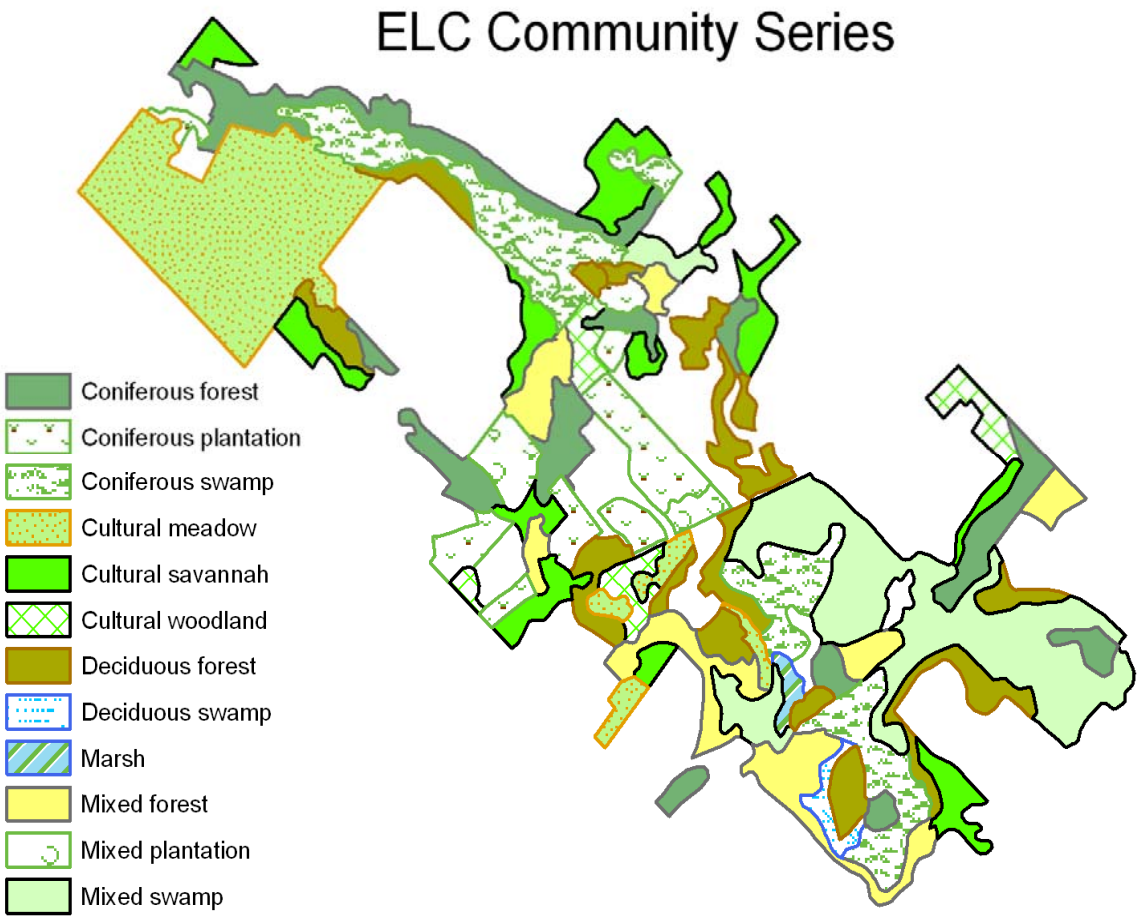

FIGURE III: ELC COMMUNITY SERIES DIAGRAM

LANDSCAPE CHARACTERIZATION

LANDSCAPE SCALE ANALYSIS: HABITAT PATCHES

The following section describes the criteria and thresholds used to assess the relative importance of habitat patches with respect to ecosystem functioning within the City of Mississauga. Habitat patches are given a score of one or zero on the following nine components: woodlands, wetlands, successional habitat, valleylands and riparian areas, habitat diversity, uncommon vegetation communities, ecological proximity, sub-regional connectivity, and provincial connectivity. Table 1 shows the compostion of habitat patches that are used in the landscape scale analysis. Table 3 lists the criteria and thresholds used to score habitat patches (please see the main report for details).

TABLE 3. CRITERIA AND THRESHOLDS USED TO IDENTIFY HABITAT PATCHES THAT ARE HIGH FUNCTIONING WITH RESPECT TO ECOSYSTEM FUNCTION COMPONENTS IN THE CITY OF MISSISSAUGA.

#	Criterion	Scoring criteria and thresholds (if any criterion is met, habitat patch receives a score of 1 for that component; otherwise, it receives a score of 0)
A.	Woodlands	i) All habitat patches containing woodlands >=2ha
B.	Wetlands	i) All habitat patches containing wetlands >=0.5ha
C.	Successional	i) All habitat patches containing cultural meadows, cultural thickets , and/or

#	Criterion	Scoring criteria and thresholds (if any criterion is met, habitat patch receives a score of 1 for that component; otherwise, it receives a score of 0)
	habitat	cultural savannah >=10ha
D.	Riparian habitat and valleylands	i.) All habitat patches that are contained within or intersect the greater of: - Crest of slope - Meander belt (none for Mississauga) - Engineered flood plain - <=30m on all open watercourses, *or* ii.) All habitat patches that are contained within or intersecting the greater of: - Lake Ontario Flood Hazard, - Lake Ontario Erosion Hazard, - Lake Ontario Dynamic Beach Hazard, or - <=30m from the Lake Ontario shoreline
E.	Habitat diversity	i) All habitat patches containing >=2 ELC community series types
F.	Uncommon vegetation communities	i) All habitat patches containing locally rare ELC community series (community series <=5% area of all natural) *or* ii) All habitat patches containing locally rare ELC vegetation types (<=5% area of all natural, identified in NAS)
G.	Ecological proximity	i) All habitat patches with matrix quality within top quartile of habitat patches (top 25th percentile) for Mississauga (TRCA method to calculate matrix quality)
H.	Sub-Regional Connectivity	i.) All habitat patches within or intersecting 50m on each side of identified city-scale corridors, including Cooksville Creek, Little Etobicoke Creek, and semi-natural right-of way corridors (scored utilizing association with Highways 403, 410 and Easatgate Parkway)
I.	Regional and Provincial connectivity	i.) All habitat patches <=2km of the L. Ontario shoreline *or* ii.) All habitat patches within or intersecting 500m on each side of the Credit River and Etobicoke/Mimico Creeks up to 5km from the Lake Ontario shoreline or iii.) All habitat patches within or intersecting 300m on each side of the Credit River beyond 5km from the shoreline.

The details of the criteria and the GIS methodology used for the scoring system are discussed below:

A. WOODLANDS

In landscape ecology literature, area has been described as "perhaps the single most important and useful piece of information contained in the landscape and this information is the basis for many of the patch, class, and landscape indices, but patch area has a great deal of ecological utility in its own right" (McGarigal, 1995). A variety of measures provide information concerning landscape composition. For the landscape characterization, area was determined for habitat and community types within study area boundaries.

Specifically, woodland component calculates the total area of woodlands (see Table 1 for definition) using area calculation function in ArcGIS 9.3. In order to create a woodland, all qualifying ELC (Table 1) categories were aggregated, and then separated based on the outermost boundary that separated the woodland from other woodlands because of either existing roads or other (non-qualifying) types of ELC. If there were any woodland in a habitat patch that were greater than 2 ha (Table 3), the habitat patch received a score of 1.

B. WETLANDS

Similar to the woodland criterion, this component also aggregates all qualifying ELC categories (Table 1) for wetlands. Those qualified ELC categories were then separated based on the outermost boundary that separated the wetland from other wetlands because of either exiting roads or other (non-qualifying) types of the ELC. If there were any wetland in a habitat patch that were greater than 0.5 ha (Table 3), the habitat patch received a score of 1.

C. SUCCESSIONAL HABITAT

This component includes ELC categories that are cultural meadow (CUM), cultural savannah (CUS) and cultural thicket (CUT). Those qualified ELC categories were then separated based on the outermost boundary that separated the successional from other successional communities because of either exiting roads or other (non-qualifying) types of the ELC. If a total area of those ELC categories was >=10 ha in a habitat patch (Table 3), the habitat patch received a score of 1.

D. VALLEYLANDS AND RIPARIAN AREAS

D.i. RIPARIAN AREAS (BUFFER AROUND WATERCOURSES, AND CREST OF SLOPE OF THE WATERCOURSES, MEANDER BELT AND ENGINEERED FLOODPLAINS)

Riparian areas contribute to the valleylands and riparian areas component. The base data used for the riparian areas were the hydrologic network, and their crest of slopes, meander belt and floodlines. First of all, all permanent and intermittent streams were selected from the hydrologic network layer. Using "River class and NHP codes" from hydrologic network layer, the following were included as permanent and intermittent streams:

-engineered watercourse
-intermittent watercourses
-watercourse not visible (if connected to visible watercourses)
-watercourse
-agricultural drain (stream order 2 or above)
-roadside ditch (included if it is a part of a stream, excluded if it is a stand alone)
-online ponds (all ponds from hydrologic layer were used since they were digitized if found online with a stream)
-swales (headwater swales were excluded. swales in-between watercourses (online swales), if any, were included).

Once those river classes were selected, a separate layer was created and a 30m buffer around those permanent and intermittent streams for those watercourses were created. Any habitat patch that intersected or contained those watercourses (with 30m buffer) and/or their crest of slope received a score of 1. In addition, the meander belt, engineered floodplain data were used to examine if the habitat patch contained any of them. If any of those criteria were met, the habitat patch received the score of 1. The valleylands and riparian data (i.e watercourses, floodplains) from all surrounding Conservation Authorities (CAs) were used to fill the gap in the City of Mississauga that falls outside the Credit River watershed.

D.ii. LAKE ONTARIO HAZARD ZONE OR SHORELINE

All habitat patches that contained or intersected with the Lake Ontario Hazard zone or <= 30m from the Lake Ontario shoreline (whichever is greater) were selected for this criteria. First, a buffer zone of 30m from the Lake Ontario shoreline was created using ArcGIS 9.3, and habitat patches that intersected either the hazard zone layer or the buffered zone layer (or/and both) were selected and given a score of 1.

Once all those individual sub-components were scored, the major component "riparian habitat and valleylands" received a score of 1 if a habitat patch contained any of those sub-components.

E. HABITAT DIVERSITY

The measurement of ELC community series diversity is calculated per habitat patch, not for the landscape as a whole (the case with traditional landscape metrics). Simply, habitat diversity measures the number of unique ELC community series within each habitat patch.

Values for habitat diversity were derived based on the following GIS approach: First, habitat patches and ELC category layers were converted from vector to raster to permit easier use of simple mathematical and zonal operations between two layers. Both layers were converted into 10 m grids (to remain consistent with cell resolution of DEM). Basically, zonal statistics were performed because it "summarizes the values of a raster within the zones of another dataset and reports the results to a table" (ESRI, 2006). In the case of habitat diversity, the zones are represented by Habitat ID from the habitat patch and values summarized are the number of unique (variety) ELC community series types located within each habitat patch. The output table was joined to the original habitat patch layer based on Habitat ID to determine community diversity. If a habitat patch contained >=2 ELC community series types, the habitat patch received a score of 1.

F. UNCOMMON VEGETATION COMMUNITIES AND SPECIES

F. i LOCALLY RARE ELC COMMUNITY SERIES

The ELC community series that contained <=5% of the total area of all natural areas within the study area are locally rare or uncommon ELC community series. Based on their areas in the study area, the following ELC community series were defined as uncommon community series:

a. Open Beach/Bar
b. Treed Beach/Bar
c. Coniferous Forest
d. Marsh
e. Open Rock Barren
f. Deciduous Swamp
g. Mixed Swamp
h. Thicket Swamp

If a habitat patch contained one or more than one of these uncommon community series, the habitat patch was given a score of 1. A layer containing those uncommon community series was created. Using location based queries in ArcGIS 9.3, habitat patches were given a score of 1 if they intersected or contained any of these uncommon community series.

F.ii. LOCALLY RARE ELC VEGETATION TYPES

All habitat patches containing locally rare ELC vegetation types in the City of Mississauga were given a score of 1. In order to determine the rarity of the local vegetation types, NAS 2006 data layer was used. If a vegetation type incurred <=5% of all natural areas identified in NAS, the vegetation type was considered locally rare vegetation type. A score was given to the habitat patches containing the NAS unit with those rare vegetation types under the sub-component.

If a habitat patch contained either the locally rare ELC community series or the locally rare ELC vegetation types as identified in the NAS, the patch was given a score of 1 under the major component 'uncommon species vegetation communities'.

G. ECOLOGICAL PROXIMITY

The quality of the matrix, or area surrounding a habitat patch, has a strong influence on the ability of a species to move from one habitat patch to another. Natural areas that are closer together have a greater degree of species persistence because they favour persistence and movement of species and genes over the short and long term (Foreman and Gordon 1986, Andren 1994, OMNR 1999, Hames *et al.* 2001, Damschen *et al.* 2006). In general, matrix quality has been calculated based on the percent of natural, agriculture or urban area found within 2km of a natural area weighted by landuse. (Dunford and Freemark 2004, Henson *et al*. 2005, TRCA 2007). A weight of +1 was given to natural land uses, -1 given to urban and 0 was given to agriculture (TRCA 2007). The radius was chosen because a) the literature assumes this distance as a potential daily travel distance by predatory species with edge effects such as racoon and, b) genetic exchange among flora and fauna species as well as recreational use by humans either by walking or bicycling also are expected to occur within this radius (Austen and Bradstreet 1996, Haddad 2000, Austen et al. 2001, Hames et al. 2001, TRCA 2007).

For the purposes of this Landscape Scale Analysis, matrix quality for a habitat patch was calculated for a 2km external buffer around the patch based upon the method identified by the Toronto and Region Conservation Authority: (proportion natural areas *(1)+ (proportion neutral (Lake Ontario) area * (0) + proportion agricultural area * (0) + proportion urban areas *(-1)). This formula recognizes the relative order or permeability of various land covers, with natural being the most permeable, agricultural and neutral (Lake Ontario) being relatively neutral (permeable for some species and impermeable for others) and urban being relatively impermeable compared to natural and agricultural land cover. The values for matrix quality range from -1 to +1 where -1 represents a patch completely surrounded by urban land cover, while +1 represents a patch completely surrounded by natural land cover. A patch completely surrounded by agriculture and/or neutral area (Lake Ontario) would have a matrix quality score of 0, which is intermediate between that for a completely urban and completely natural matrix.

To measure the variable, an additional 2 km of ELC and land use data was mapped outside and adjacent to the watershed. The matrix influence extension was developed in-house at CVC for ArcView 3.3. The percent of urban, agriculture and natural within this radius was calculated. Table 4 and 5 show the aggregation of urban, agriculture and natural land cover using ELC. From a biodiversity perspective, a perfect patch would be surrounded by 100 percent natural cover within the radius. If this were the case, the patch would get a matrix quality score of 1. Scores range from negative 1 to positive 1 depending on the presence of the urban and natural cover. The following formula (TRCA 2007) summarizes the scoring method under this component:

Matrix Quality = (% urban * -1) + (% agriculture * 0) + (% neutral * 0) + (% natural * 1)

For example, if a habitat patch has 60% urban, 20 % agriculture, 10% neutral and 10% natural, the habitat patch would get a raw matrix quality score of:
(.60 * -1) + (.20 * 0) + (.10 * 0) + (.10 * 1) = -.50 (raw matrix quality score)
Similarly, if a habitat patch has 10 % urban, 20 % agriculture, 10% neutral, and 60 % natural, the habitat patch would get a raw matrix quality score of: .50.

Once the raw matrix quality scores were calculated, the habitat patches that contained the top quartile (75^{th} percentile) of the scores were selected and given a score of 1. For the Mississauga LSA (TEEM analyses), the top quartile score was found to be -0.38 implying a negative influence of the largely urbanized study area. The rest of the habitat patches were given a score of 0. Table 4 and 5 show the classifications used to calculate the percentages for agriculture, neutral, natural and urban, which excludes the area of the focal patch from the percentages.

TABLE 4: MATRIX QUALITY NATURAL CLASSES

ELC Community Series	ELC Code	Matrix Class
Coniferous Forest	FOC	**Natural**
Coniferous Plantation	CUP3	
Coniferous Swamp	SWC	
Cultural Meadow	CUM	
Cultural Savannah	CUS	
Cultural Thicket	CUT	
Cultural Woodland	CUW	
Deciduous Forest	FOD	
Deciduous Plantation	CUP1	
Deciduous Swamp	SWD	
Marsh	MA	
Mixed Forest	FOM	
Mixed Plantation	CUP2	
Mixed Swamp	SWM	

Open Aquatic	OAO	**Natural**
Open Beach/Bar	BBO	
Thicket Swamp	SWT	
Treed Beach/Bar	BBT	
Open Rock Barren	RBO	

TABLE 5: MATRIX QUALITY NON-NATURAL CLASSES

Land Use Type	ELC Code	Matrix class
Commercial/Industrial Open Space	MOC	**Agriculture**
Educational/Institutional Open Space	MOI	
Inactive Aggregate	IA	
Intensive Agriculture	AGI	
Manicured Open Space	MOS	
Non-intensive Agriculture	AGN	
Other Open Space	MOO	
Private Open Space	MOP	
Recreational Open Space	MOR	
Wet Meadow	WET	
Lake Ontario		**Neutral**
Active Aggregate	AA	**Urban**
Airport	TPA	
Collector	TPC	
Commercial/Industrial	CIC	
Construction	CON	
Educational/Institutional	CII	
High Density Residential	URH	
High Rise Residential	URR	
Highway	TPH	
Landfill	LF	
Low Density Residential	URL	
Medium Density Residential	URM	
Railway	TPX	
Regional Road	TPR	
Residential Estate	URE	
Rural Development	RD	

Urban	URB	**Urban**
Mixed Residential	URX	

H. SUB-REGIONAL CONNECTIVITY: MUNICIPAL CORRIDOR

Any habitat patches within or intersecting the 50m on each side of city-scale corridor (Cooksville Creek little Etobicoke Creek, and Highways 403 and 410, and Eastgate Parkway) are considered a part of the sub-regional connectivity. A "Location Based Query" was used to verify the habitat patches that overlap or touch the boundary of the subwatershed corridor (Figure IV).If any of the habitat patches met any of the above criteria, they were given a score of 1.

I. REGIONAL AND PROVINCIAL CONNECTIVITY (LAKE ONTARIO SHORELINE, CREDIT AND ETOBICOKE RIVER CORRIDOR)

I.i. LAKE ONTARIO SHORELINE CORRIDOR

Any habitat patches within or intersecting the 2km buffer zone from Lake Ontario shoreline are considered a part of the regional and provincial connectivity. "Intersect" method was used in ArcGIS 9.3 in order to determine the overlap. A "Location Based Query" was used to verify the boundaries of habitat patches that overlapped or touched the boundary of Lake Ontario shoreline corridor (Figure V).

I.ii.CREDIT/ETOBICOKE RIVER CORRIDOR

Any habitat patches within or intersecting 500m on each side of the Credit River and Etobiocoke Creek up to 5 km from the Lake Ontario shoreline are considered a part of the regional and provincial connectivity. A "Location Based Query" was used to verify the habitat patches that overlapped or touched the boundary of the Credit River corridor (Figure IV).

I.iii.CREDIT RIVER CORRIDOR BEYOND5KM FROM THE LAKE ONTARIO

Any habitat patches within or intersecting the 300m on each side of the Credit River beyond 5 km from the Lake Ontario shoreline are considered a part of the regional and provincial connectivity. A "Location Based Query" was used to verify the habitat patches that overlapped or touched the boundary of the Credit River corridor (Figure IV).

If any of the habitat patches met any of the above criteria (Lake Ontario shoreline corridor, Credit/Etobicoke River Corridors), they are given a score of 1.

LANDSCAPE SCALE ANALYSIS: ENHANCEMENT OPPORTUNITIES

The following section describes the criteria and thresholds used to assess the relative importance of potential enhancement areas with respect to ecosystem functioning within the City of Mississauga. Enhancement patches are given a score of one or zero on the following eight components: woodlands, wetlands, valleylands and riparian habitat, habitat diversity, uncommon vegetation communities and species, ecological proximity, sub-regional connectivity, and regional and provincial connectivity. Table 6 shows the composition of the enhancement patches.

TABLE 6: COMPOSITION OF ENHANCEMENT PATCHES

Land Use Type	ELC Code	Patch Type
Commercial/Industrial Open Space	MOC	**Enhancement Patch**
Educational/Institutional Open Space	MOI	
Inactive Aggregate	IA	
Intensive Agriculture	AGI	
Manicured Open Space	MOS	
Non-intensive Agriculture	AGN	
Other Open Space	MOO	
Private Open Space	MOP	
Recreational Open Space	MOR	
Wet Meadow	WET	

Table 7 lists the criteria and thresholds used to score enhancement patches (please see the main report for details).

TABLE 7: CRITERIA AND THRESHOLDS USED TO IDENTIFY ENHANCEMENT OPPORTUNITIES THAT ARE HIGH FUNCTIONING WITH RESPECT TO ECOSYSTEM FUNCTION COMPONENTS IN THE CITY OF MISSISSAUGA

#	Criteria for enhancement opportunities	Scoring criteria and thresholds (if any criterion within a component is met, the enhancement patch receives a score of 1 for that component; otherwise, 0)
A.	Woodlands	i) Agriculture or manicured open space adjoining woodlands >=2ha
B.	Wetlands	i) Agriculture or manicured open space adjoining wetlands >=0.5ha
C.	Riparian habitat and valleylands	i) Agriculture or manicured open space contained within or intersecting the greater of: - Crest of slope - Meander belt (none for Mississauga) - Engineered flood plain - <=30m on all open watercourses ii) Agriculture or manicured open space contained within or intersecting the greater of: - Lake Ontario Flood Hazard - Lake Ontario Erosion Hazard - Lake Ontario Dynamic Beach Hazard - <=30m from Lake Ontario
D.	Habitat diversity	i) Agriculture or manicured open space adjoining habitat patches with >=2 ELC community series types
E.	Uncommon vegetation communities and species	i) Agriculture or manicured open space adjoining habitat patches containing locally rare ELC community series (<=5% area of all natural) ii) Agriculture or manicured open space adjoining habitat patches containing locally rare ELC vegetation types (<5% area of all natural)
F.	Ecological proximity	i) Agriculture or manicured open space adjoining habitat patches with matrix quality in top 25th percentile
G.	Sub-regional	i) Agriculture or manicured open space within or intersecting 50m on

#	Criteria for enhancement opportunities	Scoring criteria and thresholds (if any criterion within a component is met, the enhancement patch receives a score of 1 for that component; otherwise, 0)
	connectivity	each side of identified city-scale corridors, including Cooksville Creek, Little Etobicoke Creek, semi-natural right-of-way corridors (scored utilizing association with Highways 403, 410 and Eastgate Parkway)
H.	Regional and Provincial connectivity	i) Agriculture or manicured open space <=2km from the L. Ontario shoreline *or* ii) Agriculture or manicured open space within or intersecting 500m on each side of the Credit River and Etobicoke/Mimico Creeks up to 5km from the Lake Ontario shoreline *or* iii) Agriculture or manicured open space within or intersecting 300m on each side of the Credit River beyond 5km from the shoreline

Table 7 refers to the priority ranking criteria used for the enhancement opportunities. The details of the criteria and the GIS methodology used for the scoring system are discussed below:

A. WOODLANDS

Woodland component calculates the total area of woodlands (see Table 1 for definition) using area calculation function in ArcGIS 9.3. If any enhancement patch was adjoining woodlands >=2ha in size, then the enhancement patch received a score of 1.

B. WETLANDS

In this criterion, all qualifying ELC categories are aggregated for wetlands (Table 1). Those qualified ELC categories are then separated based on the outermost boundary that separates the wetland from other wetlands because of either existing roads or other (non-qualifying) types of the ELC. If there were any enhancement patch adjoining any of those wetlands >=0.5ha in size, the enhancement patch received a score of 1.

C. RIPARIAN HABITAT AND VALLEYLANDS

C.i. RIPARIAN AREAS (BUFFER AROUND WATERCOURSES, AND CREST OF SLOPE OF THE WATERCOURSES, MEANDER BELT AND ENGINEERED FLOODPLAINS)

The base data used for the riparian areas are the hydrologic network, and their crest of slopes, meander belt and floodlines. Watercourses are defined from the hydrologic network (see definition in habitat patch section above). If any enhancement patch intersected the 30m buffer on those watercourses, their crest of slope, meander belt and or engineered floodplains (if any, based on available data), the enhancement patch received a score of 1.

D. HABITAT DIVERSITY

The ELC diversity was calculated using existing GIS methodology (see habitat diversity part under habitat patch section above) and the number of ELC series per habitat patch are assigned. Any enhancement patch that was adjoining habitat patches containing >=2 ELC community series types was given a score of 1.

E. UNCOMMON VEGETATION COMMUNITIES AND SPECIES

E. i LOCALLY RARE ELC COMMUNITY SERIES

The ELC community series that contained <=5% of the total area of all natural areas within the study area are locally rare or uncommon ELC community series (see locally rare ELC community series part under habitat patch section above for details). If an enhancement patch was adjoining habitat patches containing locally rare ELC community series, the enhancement patch received a score of 1.

E. ii LOCALLY RARE VEGETATION TYPES

Locally rare vegetation types are determined using the NAS (2006) data from the City of Mississauga (see locally rare vegetation types under habitat patch section above for details). If an enhancement patch was adjoining habitat patches containing locally rare vegetation types, the enhancement patch received a score of 1.

F. ECOLOGICAL PROXIMITY

Matrix influence for each habitat patch was calculated (see details in ecological proximity part under habitat patch section above). Based on the influence of surrounding quality of natural areas, the top quartile (top 25^{th} percentile) of the habitat patches were given a score of 1. Any enhancement patch that was adjoining the habitat patches with high (top 25^{th} percentile) matrix quality was given a score of 1.

G. SUB-REGIONAL CONNECTIVITY

50m buffer on each side of city-scale corridor (Cooksville Creek little Etobicoke Creek, and Highways 403, 410 and Eastgate Parkway) are considered a part of the sub-regional connectivity. Any enhancement patch that was adjoining any of those corridors was given a score of 1.

H. REGIONAL AND PROVINCIAL CONNECTIVITY

H.i. LAKE ONTARIO SHORELINE CORRIDOR

Any enhancement patch within or intersecting the 2km buffer zone from Lake Ontario shoreline are considered a part of the regional and provincial connectivity. “Intersect” method was used in ArcGIS 9.3 in order to determine the overlap. A “Location Based Query” was used to verify the boundaries of enhancement patches that overlapped or touched the boundary of Lake Ontario shoreline corridor (Figure IV).

H.ii.CREDIT/ETOBICOKE RIVER CORRIDOR

Any enhancement patches within or intersecting 500m on each side of the Credit River and Etobiocoke Creek up to 5km from the Lake Ontario shoreline are considered a part of the regional and provincial connectivity. A “Location Based Query” was used to verify the enhancement patches that overlapped or touched the boundary of the Credit River corridor (Figure IV).

H.iii.CREDIT RIVER CORRIDOR BEYOND 5KM FROM THE LAKE ONTARIO

Any enhancement patches within or intersecting the 300m on each side of the Credit River beyond 5 km from the Lake Ontario shoreline are considered to be a part of the regional and provincial connectivity. A "Location Based Query" was used to verify the enhancement patch that overlapped or touched the boundary of the Credit River corridor (Figure IV).

FIGURE IV: AN EXAMPLE SHOWING THE DATA SOURCES USED FOR REGIONAL AND PROVINCIAL CONNECTIVITY

If any of the enhancement patches met any of the above criteria (Lake Ontario shoreline corridor, Credit/Etobicoke River Corridors), they were given a score of 1.

Once all those eight criteria were scored and quality control (see below for details) was completed, the total scores were calculated by simply adding the scores from those nine individual criteria. The total scores from the criteria reflect a relative importance of a particular habitat patch in relation to other patches in terms of ecological functioning in the watershed.

QUALITY ASSURANCE AND QUALITY CONTROL (QA/QC)

Once all criteria for the landscape characterization of habitat patches and the enhancement patches were scored, quality assurance and quality control (QA/QC) were conducted in order to ensure the confidence in the results. The QA/QC was conducted in the scores assigned to all individual criteria. Since it is not possible to check every individual record, a rule was developed to verify the percentage of scoring errors and corrections (if needed).

A tool called 'assign random values' was used to assign random values from 0 to 1 for all available habitat patch records and enhancement patch records. These values randomly assign number which avoids a chronological numbering of the records depending on how the sorting was done. In order to select a sample size out of the total records, approximately top 5% those randomly generated values were selected. The top 5% values approximately refer to the random values >0.95 (between 0 to 1). Please note that the top 5% doesn't mean any of the ecological functions or actual "top rated" patches. This threshold was simply used because we wanted to sample approximately 5% records in both of the analyses. If >=5% of those selected records had any issues with the analyses or the results, the rule was to re-do the analyses. Similarly, if <=5% of those selected records had any issues, the rule was to re-do the process/es involving the issues. If a minor incident of errors (generally 1 or 2 errors in total) were noted, the rule was to note them and fix them individually.

The QA/QC was done on all criteria within the selected samples (~5%). Each of the selected patches was visually inspected to determine if the scores given to the major criteria or sub-components were accurate. No major issues were noted during the QA/QC in the analysis. A computer-generated geo-processing error was noted in two patches while assigning a score of 1 to the patches based on the woodland criterion. Those two patches were initially scored under woodland criterion using the model-based geoprocessing, but were found not to have met the criterion after the QA/QC was done. The error had occurred because the geoprocessing tool calculated the distance and rounded the values making those two smaller woodlands connected to larger (>=2ha in size) woodlands although there was a very small gap in the habitat patches in the exact location. The issue was addressed, and the scores of those two patches were adjusted. Those errors were noted in the Habitat ID 118 and 125, and were manually fixed. The error accounts for 0.24% out of the total number of the habitat patches (822). However, this doesn't include the potential errors associated with the GIS data which can be accumulated while digitizing or receiving data files in different resolution. Every modelled landscape gets introduced to potential errors at different phases. Therefore, field verifications will be required to make micro-level decisions on the ground.

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