Methodologies for Greenbelt GIS variables

GIS work contracted by:

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Disclaimer

This research is based, in part, on data provided by the Municipal Property Assessment Corporation. Any opinions, findings, conclusions, or recommendations expressed in this material are those solely of the author and not necessarily the views of the Municipal Property Assessment Corporation.

Software

- ESRI ArcGIS 9.1 (ArcInfo license)
- ESRI Spatial Analyst extension for ArcGIS 9.x
- Microsoft Excel
- XTools Pro 3.0 for ArcGIS 9.x (www.xtoolspro.com)
- Hawth's Analysis Tools for ArcGIS (Version 3.x) (www.spatialecology.com/htools)

Match MPAC parcels to Teranet polygons

Input Data:

Dataset Name & Projection	Data Type	Description	Source
TERANET_PARCELFABRIC.SHP (GCS_North_American_1983)	Polygon shapefile	Parcel Fabric*	Teranet Enterprises Inc.
ASSESSMENT_IDS_03.XLS (Non-spatial data)	Microsoft Excel Worksheet	List of study parcels by Assessment Roll Number	Municipal Property Assessment Corporation (MPAC)

*Parcel fabric covers the following Ontario counties, divisions, or regional municipalities:

Brant County
Bruce County
Dufferin County
Durham Regional Municipality
Grey County
Haldimand-Norfolk Regional Municipality
Halton Regional Municipality
Hamilton Division
Hastings County (small section only)
Huron County
Kawartha Lakes Division
Niagara Regional Municipality
Northumberland County
Oxford County
Peel Regional Municipality
Perth County
Peterborough County
Simcoe County
Toronto Division
Waterloo Regional Municipality
Wellington County
York Regional Municipality

Processing Steps:

1. **Export** ASSESSMENT_IDS_03.XLS as ASSESSMENT_IDS_03.DBF dBase IV table.

2. **Relate** ASSESSMENT_IDS_03.DBF to TERANET_PARCELFABRIC.SHP based on ROLL_NUM and ARN fields.

    a. Used a relate because there exists a Many-to-Many relationship between the input tables:
        i. One TERANET_PARCELFABRIC record may have been sold many times over the study period (many ASSESSMENT_IDS_03 records).
        ii. One ASSESSMENT_IDS_03 records may be matched against many TERANET_PARCELFABRIC records with the same roll number (rare, but exists).

3. **Select** all ASSESSMENT_IDS_03.DBF records and **activate relate** to select all matching property polygons.

    a. ASSESSMENT_IDS_03.DBF records: 21163
    b. Matching TERANET_PARCELFABRIC.SHP polygons: 18384

4. **Export** matching TERANET_PARCELFABRIC.SHP polygons as MPAC_SPARCELS_03.SHP polygons.

5. **Relate** MPAC_SPARCELS_03.SHP to ASSESSMENT_IDS_03.DBF based on ARN and ROLL_NUM fields.

    a. This relate is used to check that all the original ASSESSMENT_IDS_03.DBF records are accounted for in MPAC_SPARCELS_03.SHP

6. **Select** all MPAC_SPARCELS_03.SHP records and **activate relate** to select all matching ASSESSMENT_IDS_03.DBF records.

    a. MPAC_SPARCELS_03.SHP polygons: 18384
    b. Matching ASSESSMENT_IDS_03.DBF records: 19837
    c. Total ASSESSMENT_IDS_03.DBF records: 21163
    d. 'Missing' ASSESSMENT_IDS_03.DBF records: 01326
        i. These records have no matching TERANET_PARCELFABRIC.SHP polygon. Possibly due to subdivision of parcel after last parcel fabric update.

7. **Switch the selection** set so that all ‘Missing’ ASSESSMENT_IDS_03.DBF records are selected.

8. **Export** selection set as MISSING_DATA_03.DBF table for delivery to Brady and Richard.

Output Data:

Dataset Name & Projection	Data Type	Description
MPAC_SPARCELS_03.SHP (GCS_North_American_1983)	Polygon shapefile	Study parcels
MISSING_DATA_03.DBF (Non-spatial data)	dBase table	ASSESSMENT_IDS_03.DBF records whose roll numbers do not match the TERANET_PARCELFABRIC.SHP polygon data.

Variable indicating whether parcel is in the Greenbelt

Input Data:

Dataset Name & Projection	Data Type	Description	Source
MPAC_SPARCELS_03.SHP (GCS_North_American_1983)	Polygon shapefile	Study parcels	Derived data
GB_OUTERBOUNDARY.SHP (GCS_North_American_1983)	Polygon shapefile	Outer boundary of Greenbelt	Ontario Ministry of Municipal Affairs and Housing

Processing Steps:

1. **Create 25 m buffer** around GB_OUTERBOUNDARY.SHP called GB_OUTERBOUNDARY_BUFF25M.SHP.

    a. Purpose of buffer is to account for MPAC_SPARCEL_03.SHP polygons that should obviously be considered entirely within the Greenbelt boundary, but cross the boundary instead due to accuracy issues or digitizing error.

2. **Add field** (‘GB’, Short Integer, Precision = 4) to MPAC_SPARCEL_03.SHP polygon attribute table.

3. **Select by Location** MPAC_SPARCELS_03.SHP polygons that are ‘Completely Within’ GB_OUTERBOUNDARY.SHP.

    a. Selected set = 3245 records

4. **Calculate** GB = 1

5. **Switch** the selection set to select all remaining polygons.

6. **Select by Location** (from the current selection) MPAC_SPARCELS_03.SHP polygons that are ‘Completely Within’ GB_OUTERBOUNDARY_BUFF25.SHP.

    a. Selected set = 111 records

7. **Calculate** GB = 2

8. **Switch** the selection set to select all remaining polygons.

9. **Select by Location** (from the current selection) MPAC_SPARCELS_03.SHP polygons that are 'Crossed by the outline of' GB_OUTERBOUNDARY.SHP.

    a. Selected set = 361 records

10. **Calculate** GB = 3

    a. (GB = 3) + (GB = 2) = 472 records

Output Data:

Dataset Name & Projection	Data Type	Description
MPAC_SPARCELS_03.SHP (GCS_North_American_1983)	Polygon shapefile	Study parcels

Variable indicating Greenbelt designation zone

Input Data:

Dataset Name & Projection	Data Type	Description	Source
MPAC_SPARCELS_03.SHP (GCS_North_American_1983)	Polygon shapefile	Study parcels	Derived data
GB_DESIGNATIONS.SHP (GCS_North_American_1983)	Polygon shapefile	Outer boundary of Greenbelt designation zones	Ontario Ministry of Municipal Affairs and Housing

Processing Steps:

1. **Add fields** (‘PC’, ‘NEC’, ‘ORM’, ‘NUM_GB_ZON’; Short Integer, Precision = 4) to MPAC_SPARCEL_03.SHP polygon attribute table.

2. **Select by Attributes** from GB_DESIGNATIONS.SHP LINETYPE = ‘Protected Country’.

3. **Select by Location** all MPAC_SPARCELS_03.SHP polygons that intersect with selected GB_DESIGNATIONS.SHP polygons.

4. **Calculate** PC = 1. Clear all selections.

5. **Select by Attributes** from GB_DESIGNATIONS.SHP LINETYPE = ‘NEC’.

6. **Select by Location** all MPAC_SPARCELS_03.SHP polygons that intersect with selected GB_DESIGNATIONS.SHP polygons.

    a. Some of these polygons may also intersect ‘Protected Country’.

7. **Calculate** NEC = 1. Clear all selections.

8. **Select by Attributes** from GB_DESIGNATIONS.SHP LINETYPE = ‘ORM’.

9. **Select by Location** all MPAC_SPARCELS_03.SHP polygopns that intersect with selected GB_DESIGNATIONS.SHP polygons.

    a. Some of these polygons may also intersect ‘Protected Country’ and/or ‘NEC’.

10. **Calculate** ORM = 1. Clear all selections.

11. **Calculate** NUM_GB_ZON = PC + NEC + ORM

    a. Gives the number of Greenbelt designation zones that a particular parcel overlaps.
        i. Max = 2
        ii. Min = 0 (parcel does not overlap in any way any portion of the Greenbelt)

12. **Export** ATTRIBUTES OF MPAC_SPARCELS_03.SHP as STUDYPARCELS_GREENBELTVARIABLES_03.DBF table for delivery to Brady and Richard.

Output Data:

Dataset Name & Projection	Data Type	Description
MPAC_SPARCELS_03.SHP (GCS_North_American_1983)	Polygon shapefile	Study parcels
STUDYPARCELS_GREENBELTVARIABLES_03.DBF (Non-spatial data)	dBase table	List of Greenbelt GIS study parcels with GB and Designation zone identifiers.

Variable indicating distance to closest major city in study area

Input Data:

Dataset Name & Projection	Data Type	Description	Source
MPAC_SPARCELS_03.SHP (GCS_North_American_1983)	Polygon shapefile	Study parcels	Derived data
List of study cities (Non-spatial data)		List of major southern Ontario cities to be studied	Brady Deaton & Richard Vyn
SONTARIO_FDS_ROADS.SHP (GCS_North_American_1983)	Polyline shapefile (downloaded as ArcInfo coverage)	Southern Ontario Fundamental Dataset Roads, current as of 2002	Ontario Ministry of Natural Resources
ONTARIOMUNICIPALLOWERTIER.SHP (GCS_North_American_1983)	Polygon shapefile (downloaded as ArcInfo coverage)	Ontario Fundamental Dataset lower-tier municipal units, current as of 2002	Ontario Ministry of Natural Resources

Processing Steps:

1. **Project** SONTARIO_FDS_ROADS.SHP from GCS_North_American_1983 to NAD_1983_UTM_Zone_17N

    a. Output: SONTARIO_FDS_ROADS_UTM.SHP

2. Import roads shapefiles to personal geodatabase

    a. ROADSDATA.MDB
        i. Feature dataset
            1. Geographic (GCS_North_American_1983)
            2. UTM_Z17_NAD83 (NAD_1983_UTM_Zone_17N)
        ii. Feature classes (UTM_Z17_NAD83):
            1. ON_FDS_ROADS_UTM

3. **Create Geometric Network** from ON_FDS_ROADS_UTM feature class

    a. 5 m snap tolerance
    b. Call output network UTM_Z17_NAD83_NET
        i. Junctions: UTM_Z17_NAD83_NET_Junctions
        ii. Table: UTM_Z17_NAD83_NET_BUILDERR
    c. Total number of road segments: 700147
    d. Total length of road network: ~ 189213 km

4. Use **Utility Network Analyst** to trace the portion of the ON_FDS_ROADS_UTM feature class that form a connected network:

    a. Set options to make a selection
    b. Add Junction Flag at an intersection of roads that are obviously part of the greater connected network.
    c. Set the Trace Task to "Find Connected" and **Solve** the network.

5. **Export** selected connected road segments as ON_FDS_UTM_CON feature class:

    a. Number of Road Segments: 679295 (97.02 % of total)
    b. Total length of connected network: ~ 184330 km (97.42 % of total)

6. **Switch** the selection set to select all remaining polylines.

7. **Export** selected disconnected road segments as ON_FDS_UTM_DIS feature class:

    a. Total Number of Road Segments: 20872 (2.98 % of total)
    b. Total length of connected network: ~ 4883 km (2.58 % of total)

8. **Export** ON_FDS_UTM_CON and ON_FDS_UTM_DIS feature classes as SONTARIO_FDS_ROADS_UTM_CONNECTED.SHP and SONTARIO_FDS_ROADS_UTM_DISCONNECTED.SHP.

9. **Convert** SONTARIO_FDS_ROADS_UTM_CONNECTED features to ON_RDS_CON raster:

    a. Field: DESCR
    b. Extent: Same as layer 'SONTARIO_FDS_ROADS_UTM_CONNECTED.SHP'
    c. Cell size (m): 20

10. **Select** from ONTARIOMUNICIPALLOWERTIER.SHP records where LOC_NAME = any of the study cities.

11. **Export** selected set as STUDYCITIES.SHP. Check for any duplicate cities (two lower tier municipal units with the same name) and edit accordingly.

12. **Project** STUDYCITIES.SHP from GCS_North_American_1983 to NAD_1983_UTM_Zone_17N.

    a. Call output STUDYCITIES_UTM.SHP.

13. **Convert** STUDYCITIES_UTM.SHP features to STUDYCITIES raster:

a. Field: LOC_NAME
b. Extent: Same as layer 'ON_RDS_CON'
c. Cell size: Same as layer 'ON_RDS_CON'

14. Use Spatial Analyst **Cost Weighted** tool to calculate the distance, by road, from each road cell to the closest major city.

    a. Input rasters: STUDYCITES, ON_RDS_CON
    b. Output rasters: ALLO_CITIES (closest city allocation raster), CDST_CITIES (cost-weighted distance raster)

15. Convert MPAC_SPARCELS_03 polygons to centroids using XTOOLS PRO.

    a. Output: MPAC_SPARCELS_03_CENTROIDS.SHP

16. **Project** MPAC_SPARCELS_03_CENTROIDS.SHP from GCS_NORTH_AMERICAN_1983 to NAD_1983_UTM_Zone_17N.

    a. Output: MPAC_SPARCELS_03_CENTROIDS_UTM.SHP

17. Use **Hawth's Tools** extension to snap MPAC_SPARCELS_03_CENTROIDS_UTM.SHP to SONTARIO_FDS_ROADS_UTM_CONNECTED.SHP.

    a. Output: MPAC_SPARCELS_03_CENTROIDS_UTM_RSNAP.SHP
    b. Output attribute table includes SNAPDST field – the snap distance in map units (metres)

18. **Extract Values to Points** using CDST_CITIES raster and MPAC_SPARCELS_03_CENTROIDS_UTM_RSNAP.SHP as inputs.

    a. No interpolation of values
    b. Output: TEMP.SHP
    c. Output attribute table includes RASTERVALU field. **Rename** RASTERVALU as ROADDIST (Add ROADDIST, calculate ROADDIST = RASTERVALU, and delete RASTERVALU)

19. **Extract Values to Points** using ALLO_CITIES raster and MPAC_SPARCELS_03_CENTROIDS_UTM_RSNAP.SHP as inputs.

    a. No interpolation of values
    b. Output: TEMP2.SHP
    c. Output attribute table includes RASTERVALU field. **Rename** RASTERVALU as NEARCITY (Add NEARCITY, calculate NEARCITY = RASTERVALUE, and delete RASTERVALU)

20. **Join** attributes of STUDYCITIES raster to TEMP2.SHP using VALUE and NEARCITY fields as key fields. **Export** output and delete all fields originally from STUDYCITIES raster except LOC_NAME.

    a. Output: TEMP3.SHP

21. **JOIN** attributes of TEMP3.SHP to TEMP.SHP using ARN field as key field. **Export** output.

    a. Output: ALLCITIESDISTFINAL.SHP

22. **Add field** (“TOTALDIST “, Double, P = 18, S = 0) to ALLCITIESDISTFINAL.SHP.

23. **Calculate** TOTALDIST = SNAPDIST + ROADDIST (metres, no decimal).

24. **Export** attributes of ALLCITIESDISTFINAL.SHP as ALLCITIESDISTALLOC.DBF for delivery to Brady and Richard.

25. **Delete** TEMP.SHP, TEMP2.SHP, and TEMP3.SHP

Output Data:

Dataset Name & Projection	Data Type	Description
SONTARIO_FDS_ROADS_UTM.SHP (NAD_1983_UTM_Zone_17N)	Polyline shapefile	Southern Ontario Fundamental Dataset Roads, current as of 2002
ROADSDATA.MDB (GCS_North_American_1983) (NAD_1983_UTM_Zone_17N)	Personal geodatabase	Holds roads data in GCS and UTM feature datasets, as well as network and connected and disconnected road feature classes
SONTARIO_FDS_ROADS_UTM_CONNECTED.SHP (NAD_1983_UTM_Zone_17N)	Polyline shapefile	Road segments connected to main network
SONTARIO_FDS_ROADS_UTM_DISCONNECTED.SHP (NAD_1983_UTM_Zone_17N)	Polyline shapefile	Road segments disconnected from main network
ON_ROADS_CON (NAD_1983_UTM_Zone_17N)	ESRI GRID	Road segments connected to main network
STUDYCITIES.SHP (GCS_North_American_1983)	Polygon shapefile	Lower-tier municipal units that define Greenbelt GIS study cities
STUDYCITIES_UTM.SHP (NAD_1983_UTM_Zone_17N)	Polygon shapefile	Lower-tier municipal units that define Greenbelt GIS study cities
STUDYCITIES (NAD_1983_UTM_Zone_17N)	ESRI GRID	Lower-tier municipal units that define Greenbelt GIS study cities
ALLO_CITIES (NAD_1983_UTM_Zone_17N)	ESRI GRID	Lower-tier municipal unit ID that designates the closest Greenbelt GIS study city, by road
CDST_CITIES (NAD_1983_UTM_Zone_17N)	ESRI GRID	Distance by road (m) to the closest Greenbelt GIS study city
MPAC_SPARCELS_03_CENTROIDS.SHP (GCS_North_American_1983)	Point shapefile	Study parcel centroids
MPAC_SPARCELS_03_CENTROIDS_UTM.SHP (NAD_1983_UTM_Zone_17N)	Point shapefile	Study parcel centroids
MPAC_SPARCELS_03_CENTROIDS_UTM_RSNAP.SHP (NAD_1983_UTM_Zone_17N)	Point shapefile	Road-snapped study parcel centroids
ALLCITIESDISTFINAL.SHP (NAD_1983_UTM_Zone_17N)	Point shapefile	Road-snapped study parcel centroids with distance and allocation to closest city by road attributes
ALLCITIESDISTALLOC.DBF (Non-spatial data)	dBase table	List of Greenbelt GIS study parcels with distance and allocation to closest city by road attributes

Variable indicating distance to each major city in study area

Input Data:

Dataset Name & Projection	Data Type	Description	Source
ON_ROADS_CON (NAD_1983_UTM_Zone_17N)	ESRI GRID	Road segments connected to main network	Derived data
STUDYCITIES (NAD_1983_UTM_Zone_17N)	ESRI GRID	Lower-tier municipal units that define Greenbelt GIS study cities	Derived data
MPAC_SPARCELS_03_CENTROIDS_UTM_RSNAP.SHP (NAD_1983_UTM_Zone_17N)	Point shapefile	Road-snapped study parcel centroids	Derived data

Processing Steps:

Python script: BatchCostDistance.py

```
#*******************************************************************************
#*******************************************************************************
#                                                                            **
# Name:         BatchCostDistance.py                                         **
#                                                                            **
# Purpose:      Calculates a cost-weighted distance surface to the closest   **
#               Greenbelt study city, using the connected road network as a  **
#               cost input and the cities raster as the basis to calculate   **
#               cost weighted distances to.  First version is hard-coded.    **
#                                                                            **
# Author:       Adam Bonnycastle                                             **
# Date:         October 30, 2006                                             **
#                                                                            **
# Project:      Greenbelt GIS:  Brady Deaton                                 **
#                               University of Guelph                         **
#                               Food, Agricultural & Resource Economics      **
#                                                                            **
# Last Update:  February 01, 2007                                            **
#*******************************************************************************
#*******************************************************************************

#***************************************************************************
# Access libraries, geoprocessor object, and ESRI Spatial Analyst extension
#***************************************************************************

# Import standard library modules
import win32com.client
import sys
import os

# Instantiate the geoprocessor object
GP = win32com.client.Dispatch("esriGeoprocessing.GpDispatch.1")
GP.SetProduct("ArcInfo")

#*****************************************
# Set user-defined environment variables
#*****************************************
```

```
# Set the input workspace
GP.workspace = "C:/AdamB/Greenbelt/RasterData"

# Set the input cost raster
inCostRaster = "C:/AdamB/Greenbelt/RasterData/on_rds_con"

# Set the input Distance To raster
inDistanceToRaster = "C:/AdamB/Greenbelt/RasterData/studycities"

# Set the output workspace
outWorkspace = "C:/AdamB/Greenbelt/RasterData"

#************************
# Process input datasets
#************************


# Check-out ESRI Spatial Analyst extension
GP.CheckOutExtension("Spatial")

#*********************************
# Process each city (id = 1 to 27)
#*********************************

# Set City ID variable; also used to count through while loop
id = 1
while id < 28:
    # Extract the individual city
    print "Extracting City " + str(id) + "..."
    in_raster = inDistanceToRaster
    where_clause = "Value = " + str(id)
    out_city_raster = "C:/AdamB/Greenbelt/RasterData" + "/CITY_" + str(id)
    GP.ExtractByAttributes_sa (in_raster, where_clause, out_city_raster)

    # Calculate cost-weighted distance raster for that city
    print "Processing City " + str(id) + "..."
    in_source_data = out_city_raster
    in_cost_raster = inCostRaster
    out_distance_raster = "C:/AdamB/Greenbelt/RasterData" + "/CDST_" + str(id)
    maximum_distance = ""
    out_backlink_raster = ""
    GP.CostDistance_sa (in_source_data, in_cost_raster, out_distance_raster, maximum_distance, out_backlink_raster)
    print "Completed processing City " + str(id) + "."

    #Copy rasters from C: drive to the I: drive and remove from the C: drive
    print "Move rasters to the I: drive..."
    copy_city_raster = "I:/RasterData" + "/CITY_" + str(id)
    copy_distance_raster = "I:/RasterData" + "/CDST_" + str(id)

    GP.CopyRaster_management (out_city_raster, copy_city_raster)
    GP.CopyRaster_management (out_distance_raster, copy_distance_raster)

    GP.Delete_management (out_city_raster)
    GP.Delete_management (out_distance_raster)
    print "Complete moving City " + str(id) + "."

    # Move to next city
    id = id + 1
```

Python script: BatchExtractCostDistToPoints.Py

```
#****************************************************************************
#****************************************************************************
#                                                                         **
# Name:         BatchExtractCostDistToPoints.Py                           **
#                                                                         **
# Purpose:      Extracts cost distance values calculated with             **
#               BatchCostDistance.py                                      **
#               to road-snapped parcel centroids.                         **
#                                                                         **
# Author:       Adam Bonnycastle                                          **
# Date:         December 6, 2006                                          **
#                                                                         **
# Project:      Greenbelt GIS:  Brady Deaton                              **
#                               University of Guelph                      **
#                               Food, Agricultural & Resource Economics   **
#                                                                         **
# Last Update:  December 6, 2006                                          **
#****************************************************************************
#****************************************************************************

#**********************************************************************
#Access libraries, geoprocessor object, and ESRI Spatial Analyst extension
#**********************************************************************

#Import standard library modules
import win32com.client
import sys
import os

#Instantiate the geoprocessor object
GP = win32com.client.Dispatch("esriGeoprocessing.GpDispatch.1")
GP.SetProduct("ArcInfo")

#Check-out ESRI Spatial Analyst extension
GP.CheckOutExtension("Spatial")

#**************************************
#Set user-defined environment variables
#**************************************

#Set the main workspace
GP.workspace = "C:/AdamB/Greenbelt/VectorData"

#Set the input raster workspace
inworkspace = "I:/RasterData"

#**********************
#Process input datasets
#**********************

#Set City ID variable; also used to count through while loop

id = 1

while id < 28:
    # Process the individual city
    print "Processing City " + str(id) + "..."
    in_point_features = "C:/AdamB/Greenbelt/VectorData/MPAC_SParcels_03_Centroids_UTM_RSnap.shp"
    in_raster = inworkspace + "/cdst_" + str(id)
    out_point_features = GP.workspace + "/point_cdst_" + str(id) + ".shp"
    interpolate_values = "NONE"
    add_attributes = "VALUE_ONLY"
    GP.ExtractValuesToPoints_sa (in_point_features, in_raster, out_point_features, interpolate_values, add_attributes)
    print "Completed processing City " + str(id)

    #Move to next city
    id = id + 1
```

1. For each POINT_CDST_i.SHP dataset, **Add** a field (Double, P = 18, Scale = 8) named after the city that corresponds to each value of i (to maximum 8 characters):

    1. BARRIE
    2. PETERBOR
    3. BELLEVIL
    4. NEWMARKE
    5. OSHAWA
    6. WHITBY
    7. PICKERIN
    8. CALEDON
    9. RICHMOND
    10. MARKHAM
    11. AJAX
    12. VAUGHAN
    13. BRAMPTON
    14. MISSISSA
    15. TORONTO
    16. GUELPH
    17. WATERLOO
    18. OAKVILLE
    19. KITCHENE
    20. BURLINGT
    21. CAMBRIDG
    22. HAMILTON
    23. STCATHRI
    24. BRANTFOR
    25. LONDON
    26. NIAGARAF
    27. SARNIA

2. For each POINT_CDST_i.SHP dataset, **Calculate**
   "city" = SNAPDST + RASTERVALU

3. **Export** attributes of POINT_CDST_i.SHP datasets as "CITY"DIST.DBF for delivery to Brady and Richard, where "CITY" is:

    1. BARRIE
    2. PETERBOROUGH
    3. BELLEVILLE
    4. NEW MARKET
    5. OSHAWA
    6. WHITBY
    7. PICKERING
    8. CALEDON
    9. RICHMOND HILL
    10. MARKHAM
    11. AJAX
    12. VAUGHAN
    13. BRAMPTON
    14. MISSISSAUGA
    15. TORONTO
    16. GUELPH
    17. WATERLOO
    18. OAKVILLE
    19. KITCHENER
    20. BURLINGTON
    21. CAMBRIDGE
    22. HAMILTON
    23. ST. CATHERINES
    24. BRANTFORD
    25. LONDON
    26. NIAGARA FALLS
    27. SARNIA

Output data:

Dataset Name & Projection	Data Type	Description
CITY_i (NAD_1983_UTM_Zone_17N)	ESRI GRID	Individual city rasters, where 1 ≤ i ≤ 27 (i = City ID)
CDST_i (NAD_1983_UTM_Zone_17N)	ESRI GRID	Distance by road (m) to City_i
POINT_CDST_i.shp (NAD_1983_UTM_Zone_17N)	Point shapefile	Road-snapped study parcel centroids with distance by road (m) to City_i
"CITY"DIST.DBF ("City" = name of study city) (Non-spatial data)	dBase table	Lists of Greenbelt GIS study parcels with distance each study city by road.

Variable indicating distance to nearest town with population ≥ 2000

Input Data:

Dataset Name & Projection	Data Type	Description	Source
COMMUNITY.SHP (GCS_North_American_1983)	Point shapefile (Downloaded as ArcInfo coverage)	Ontario community points	Digital Cartographic Reference Base of Ontario, Version 3.0, Geomatics Office, Ministry of Transportation, Ontario, 2000
ON_ROADS_CON (NAD_1983_UTM_Zone_17N)	ESRI GRID	Road segments connected to main network	Derived data
STUDYCITIES_UTM.SHP (NAD_1983_UTM_Zone_17N)	Polygon shapefile	Lower-tier municipal units that define Greenbelt GIS study cities	Derived data
MPAC_SPARCELS_03_CENTROIDS_UTM_RSNAP.SHP (NAD_1983_UTM_Zone_17N)	Point shapefile	Road-snapped study parcel centroids	Derived data

Steps:

1. **Project** COMMUNITY.SHP from GCS_North_American_1983 to NAD_1983_UTM_Zone_17N.
   a. Output: COMMUNITY_UTM.SHP
2. **Select by attributes** from COMMUNITY_UTM.SHP all points with POP ≥ 2000
3. **Select by location** from the selected set all COMMUNITY_UTM.SHP points within 20 km of SONTARIO_FDS_ROADS_UTM_CONNECTED.SHP
4. **Select by location** to remove from the selected set all COMMUNITY_UTM.SHP points within STUDYCITIES_UTM.SHP polygon boundaries.
5. **Export** selected set as STUDYTOWNS_UTM.SHP
6. Use **Hawth's Tools** extension to snap STUDYTOWNS_UTM.SHP to SONTARIO_FDS_ROADS_UTM_CONNECTED.SHP.
   a. Output: STUDYTOWNS_UTM_RSNAP.SHP

   b. Output attribute table includes SNAPDST field – the snap distance in map units (metres)

7. Use Spatial Analyst **Cost Weighted** tool to calculate the distance, by road, from each road cell to the closest STUDYTOWNS_UTM_RSNAP.SHP point.

   a. Input: STUDYTOWNS_UTM_RSNAP.SHP, ON_RDS_CON
   b. Output rasters: ALLO_TOWNS (closest study town allocation raster), CDST_TOWNS (cost-weighted distance raster)

8. **Extract Values to Points** using CDST_TOWNS raster and MPAC_SPARCELS_03_CENTROIDS_UTM_RSNAP.SHP as inputs.

   a. No interpolation of values
   b. Output: POINT_CDST_TOWNS.SHP
   c. Output attribute tables includes RASTERVALU field and SNAPDST field.

9. **Add Field** to POINT_CDST_TOWNS.SHP (“NEARTOWN”, Double, Precision = 18, Scale = 8).

10. **Calculate** NEARTOWN = SNAPDST + RASTERVALU

11. **Export** attributes of POINT_CDST_TOWNS.SHP as TOWNSDIST.DBF for delivery to Brady and Richard.

Output data:

Dataset Name & Projection	Data Type	Description
COMMUNITY_UTM.SHP (NAD_1983_UTM_Zone_17N)	Point shapefile	Ontario community points
STUDYTOWNS_UTM.SHP (NAD_1983_UTM_Zone_17N)	Point shapefile	Ontario community points with population GTE 2000, within 20 km of road network, and NOT within study city polygons.
STUDYTOWNS_UTM_RSNAP.SHP (NAD_1983_UTM_Zone_17N)	Point shapefile	Greenbelt GIS study towns snapped to closest road network segment.
ALLO_TOWNS (NAD_1983_UTM_Zone_17N)	ESRI GRID	Greenbelt GIS study towns ID that designates the closest Greenbelt GIS study town, by road
CDST_TOWNS (NAD_1983_UTM_Zone_17N)	ESRI GRID	Distance by road (m) to the closest Greenbelt GIS study town
POINT_CDST_TOWNS.SHP (NAD_1983_UTM_Zone_17N)	Point shapefile	Road-snapped study parcel centroids with distance to closest town by road attribute (m)
TOWNSDIST.DBF (Non-spatial data)	dBase table	List of greenbelt study parcels with distance to closest town by road attribute (m)

Variable indicating distance to nearest 400 series highway or Queen Elizabeth Way (QEW) interchange

Input Data:

Dataset Name & Projection	Data Type	Description	Source
INTERCHANGE.SHP (GCS_North_American_1983)	Point shapefile (Downloaded as ArcInfo coverage)	Ontario highway interchange points	Digital Cartographic Reference Base of Ontario, Version 3.0, Geomatics Office, Ministry of Transportation, Ontario, 2000
ON_ROADS_CON (NAD_1983_UTM_Zone_17N)	ESRI GRID	Road segments connected to main network	Derived data
MPAC_SPARCELS_03_CENTROIDS_UTM_RSNAP.SHP (NAD_1983_UTM_Zone_17N)	Point shapefile	Road-snapped study parcel centroids	Derived data

Steps:

4. Project INTERCHANGE.SHP from GCS_North_American_1983 to NAD_1983_UTM_Zone_17N

    a. Output: INTERCHANGE_UTM.SHP

5. **Select** from INTERCHANGE_UTM.SHP all points with (ROAD_NAME ≥ '400' AND ROAD_NAME ≤ '427') OR ROAD_NAME = 'QEW'.

6. **Select by location** from the selected set all INTERCHANGE_UTM.SHP points within 1000 m or SONTARIO_FDS_ROADS_UTM_CONECTED.SHP.

7. **Export** selected set as STUDYINTERCHANGE_UTM.SHP

8. Use **Hawth's Tools** extension to snap STUDYINTERCHANGE_UTM.SHP to SONTARIO_FDS_ROADS_UTM_CONNECTED.SHP

    a. Output: STUDYINTERCHANGE_UTM_RSNAP.SHP
    b. Output attribute table includes SNAPDST field – the snap distance in map units (metres)

9. Use Spatial Analyst **Cost Weighted** tool to calculate the distance, by road, from each road cell to the closest STUDYINTERCHANGE_UTM_RSNAP.SHP point.
    a. Input: STUDYITNERCHANGE_UTM_RSNAP.SHP, ON_ROADS_CON

b. Output rasters: CDST_INTER

10. **Extract Values to Points** using CDST_INTER raster and MPAC_SPARCELS_03_CENTROIDS_UTM_RSNAP.SHP as inputs.
    a. No interpolation of values
    b. Output: POINT_CDST_INTER.SHP
    c. Output attribute table includes RASTERVALU field and SNAPDST field.

11. **Add Field** to POINT_CDST_INTER.SHP ("DIST_INTER", Double, Precision = 18, Scale = 8).

12. **Calculate** DIST_INTER = SNAPDST + RASTERVALU

13. **Export** attributes of POINT_CDST_INTER.SHP as INTERCHANGEDIST.DBF

Output data:

Dataset Name & Projection	Data Type	Description
INTERCHANGE_UTM.SHP (NAD_1983_UTM_Zone_17N)	Point shapefile	Ontario highway interchange points
STUDYINTERCHANGE_UTM.SHP (NAD_1983_UTM_Zone_17N)	Point shapefile	Greenbelt GIS study highway interchange points (400 series and QEW within 1 km of connected roads network)
STUDYINTERCHANGE_UTM_RSNAP.SHP (NAD_1983_UTM_Zone_17N)	Point shapefile	Greenbelt GIS study interchanges snapped to closest road network segment.
CDST_INER (NAD_1983_UTM_Zone_17N)	Point shapefile	Distance by road (m) to the closest Greenbelt GIS study interchange
POINT_CDST_INTER.SHP (NAD_1983_UTM_Zone_17N)	Point shapefile	Road-snapped study parcel centroids with distance to closest study interchange by road (m) attribute
INTERCHANGEDIST.DBF (Non-spatial data)	dBase table	List of greenbelt study parcels with distance to closest study interchange by road (m) attribute

Variable indicating Average Crop Heat Unit (ACHU)

Input Data:

Dataset Name & Projection	Data Type	Description	Source
COLOR_POLY.SHP (Lambert_Conformal_Conic)	Polygon shapefile	Average crop heat units (ACHU) across Canada. Polygon values are average of min/max defining isoline	Government of Canada with permission from Natural Resources Canada © 2003
MPAC_SPARCELS_03_CENTROIDS_UTM.SHP (NAD_1983_UTM_Zone_17N)	Point shapefile	Study parcel centroids	Derived data

Steps:

1. **Digitize** a study area polygon dataset that covers MPAC centroids.
    a. Output: STUDYAREA_UTM.SHP
2. **Dissolve** COLOR_POLY.SHP from on Crop55_ID field (Average CHU).
    a. Output: COLOR_DIS_CROP55.SHP
3. **Intersect** COLOR_DIS_CROP55.SHP with STUDYAREA_UTM.SHP.
    a. Output: CLIMATESTUDYAREA_UTM.SHP
4. **Convert features to raster**.
    a. Input: CLIMATESTUDYAREA_UTM.SHP.
    b. Cell size: 20 m
    c. Output raster: CLMGRD
5. **Extract Values to Points** using CLMGRD raster and MPAC_SPARCELS_03_CENTROIDS_UTM.SHP as inputs.
    a. No interpolation of values
    b. Output: POINT_ACHU.SHP
    a. Output attribute table includes RASTERVALU field which holds Average Crop Heat Unit value.
6. **Export** attributes of POINT_ACHU.SHP as HEATUNTIS.DBF

Output data:

Dataset Name & Projection	Data Type	Description
StudyArea_UTM.SHP (NAD_1983_UTM_Zone_17N)	Polygon shapefile	Study area that covers MPAC centroids.
COLOR_DIS_CROP55.SHP (Lambert_Conformal_Conic)	Polygon shapefile	Average Crop Heat Unit polygons for Canada.
CLMGRD (NAD_1983_UTM_Zone_17N)	ESRI GRID	Average Crop Heat Unit values across Study Area.

POINT_ACHU.SHP (NAD_1983_UTM_Zone_17N)	Polygon shapefile	Average Crop Heat Unit values for each MPAC centroid.
HEATUNITS.DBF (Non-spatial data)	dBase table	List of Average Crop Heat Unit values for each MPAC study parcel.

Variable indicating distance to Greenbelt boundary

Input Data:

Dataset Name & Projection	Data Type	Description	Source
GB_OUTERBOUNDARY.SHP (GCS_North_American_1983)	Polygon shapefile	Outer boundary of Greenbelt	Ontario Ministry of Municipal Affairs and Housing
MPAC_SPARCELS_03_CENTROIDS_UTM_RSNAP.SHP (NAD_1983_UTM_Zone_17N)	Point shapefile	Road-snapped study parcel centroids	Derived data
ON_ROADS_CON (NAD_1983_UTM_Zone_17N)	ESRI GRID	Road segments connected to main network	Derived data

Steps:

1. Convert GB_OUTERBOUNDARY.SHP **Feature to Line**.

    a. Output: GB_OUTERBOUNDARY_PLINE.SHP

2. Use Spatial Analyst **Cost Weighted** tool to calculate the distance, by road, from each road cell to the Greenbelt boundary line.

    a. Input: GB_OUTERBOUNDARY_PLINE.SHP, ON_ROADS_CON
    b. Output rasters: CDST_GB

3. **Extract Values to Points** using CDST_GB raster and MPAC_SPARCELS_03_CENTROIDS_UTM_RSNAP.SHP as inputs.

    a. No interpolation of values
    b. Output: GB_DST.SHP
    c. Output attribute table includes RASTERVALU field which holds distance to closest Greenbelt boundary line.

4. **Add Field** to GB_DST.SHP ("DST_GB", Double, Precision = 18, Scale = 8).

5. **Calculate** DST_GB = SNAPDST + RASTERVALU

6. **Export** attributes of GB_DST.SHP as GREENBELTDST_2.DBF

Output data:

Dataset Name & Projection	Data Type	Description
GB_OUTERBOUNDARY_PLINE.SHP (GCS_North_American_1983)	Polyline shapefile	Outer boundary of Greenbelt
CDST_GB (NAD_1983_UTM_Zone_17N)	ESRI GRID	Distance to closest Greenbelt boundary
GB_DST.SHP (NAD_1983_UTM_Zone_17N)	Point shapefile	Distance from each MPAC centroid to nearest Greenbelt boundary line.
GREENBELTDST_2.DBF (Non-spatial data)	dBase table	Distance from each MPAC centroid to nearest Greenbelt boundary line.

Variable indicating distance to "Inner"/"Outer" Greenbelt boundaries

Input Data:

Dataset Name & Projection	Data Type	Description	Source
GB_OUTERBOUNDARY_PLINE.SHP (GCS_North_American_1983)	Polygon shapefile	Outer boundary of Greenbelt	Ontario Ministry of Municipal Affairs and Housing
MPAC_SPARCELS_03_CENTROIDS_UTM_RSNAP.SHP (NAD_1983_UTM_Zone_17N)	Point shapefile	Road-snapped study parcel centroids	Derived data
ON_ROADS_CON (NAD_1983_UTM_Zone_17N)	ESRI GRID	Road segments connected to main network	Derived data

Steps:

1. **Digitize** polylines that can be used to split the GB_OUTERBOUNDARY_PLINE data according to whether the boundary line faces the GTA/Hamilton ("Inner" boundary" or the surrounding area ("Outer" boundary).
    a. Output: GREENBELTINOUTSPLIT.SHP
2. Make copy of GB_OUTERBOUNDARY_PLINE.SHP
    a. Output: GB_OUTERBOUNDARY_PLINESPLIT.SHP
3. **Edit** GB_OUTERBOUNDARY_PLINESPLIT and **Split** this data using the GREENBELTINOUTSPLIT.SHP polylines.
4. **Select** polylines from GB_OUTERBOUNDARY_PLINESPLIT.SHP that make up the "Inner" boundary, and **Export** these polylines to separate dataset.
    a. Output: GB_INNERGTABOUNDARY.SHP
5. **Select** polylines from GB_OUTERBOUNDARY_PLINESPLIT.SHP that make up the "Outer" boundary, and **Export** these polylines to separate dataset.
    a. Output: GB_OUTERGTABOUNDARY.SHP
6. For each of GB_INNERGTABOUNDARY.SHP and GB_OUTERGTABOUNDARY.SHP:

a. Use Spatial Analyst **Cost Weighted** tool to calculate the distance, by road, from each road cell to the Greenbelt boundary line.
    i. Input: GB_INNERGTABOUNDARY.SHP or GB_OUTERGTABOUNDARY.SHP, ON_ROADS_CON
    ii. Output rasters: CDST_GBINGRA or CDST_GBOUTGTA
b. **Extract Values to Points** using CDST_ GBINGRA or CDST_GBOUTGTA raster and MPAC_SPARCELS_03_CENTROIDS_UTM_RSNAP.SHP as inputs.
    i. No interpolation of values
    ii. Output: INNER_DST.SHP or OUTER_DST.SHP
    iii. Output attribute table includes RASTERVALU field which holds distance to closest Greenbelt boundary line.
c. **Add Field** to INNER_DST.SHP and OUTER_DST.SHP (“INNER_GB” or “OUTER_GB”, Double, Precision = 18, Scale = 8).
d. **Calculate** INNER/OUTER_GB = SNAPDST + RASTERVALU

7. **Export** attributes of INNER_ DST.SHP and OUTER_DST.SHP as INNER_GTA_DST.DBF or OUTER_GTA_DST.DBF

Output data:

Dataset Name & Projection	Data Type	Description
GREENBELTINOUTSPLIT.SHP (GCS_North_American_1983)	Polyline shapefile	Boundary between “Inner” and “Outer” Greenbelt boundary
GB_OUTERBOUNDARY_PLINESPLIT.SHP (GCS_North_America_1983)	Polyline shapefile	Outer boundary of greenbelt split according to “Inner”/”Outer” classification
GB_INNERGTABOUNDARY.SHP (GCS_North_America_1983)	Polyline shapefile	“Inner” Greenbelt boundary
GB_OUTERGTABOUNDARY.SHP (GCS_North_America_1983)	Polyline shapefile	“Outer” Greenbelt boundary
CDST_GBINGTA (GCS_North_America_1983)	ESRI GRID	Distance, by road (m), to the “Inner” Greenbelt boundary
CDST_GBOUTGTA (GCS_North_America_1983)	ESRI GRID	Distance, by road (m), to the “Outer” Greenbelt boundary
INNER_DST.SHP (GCS_North_America_1983)	Polyline shapefile	Distance from each MPAC centroid to nearest “Inner” Greenbelt boundary line.
OUTER_DST.SHP (GCS_North_America_1983)	Polyline shapefile	Distance from each MPAC centroid to nearest “Outer” Greenbelt boundary line.
INNER_GTA_DST.DBF (Non-spatial data)	dBase table	Distance from each MPAC centroid to nearest “Inner” Greenbelt boundary line.
OUTER_GTA_DST.DBF (Non-spatial data)	dBase table	Distance from each MPAC centroid to nearest “Outer” Greenbelt boundary line.