APPENDIX A – PEDESTRIAN DEMAND MODEL

Overview

The SMTC Pedestrian Demand Model was developed in ArcGIS version 10.1 using various Spatial Analyst tools and ModelBuilder. This type of analysis can be done using a basic layer overlay mapping technique, but due to the number of data layers and the level of detail required for the analysis it was determined that using Spatial Analyst and ArcGIS ModelBuilder would be the most effective and efficient approach.

SMTC's pedestrian demand model is based on similar models developed by counties and metropolitan planning organizations across the country. SMTC's model divides the planning area into a 10 meter grid (10m x 10m cells) and assigns a value to each cell based on the sum of the values of all layers present in that cell. The values assigned to each layer were determined by research on other similar models, professional judgment of SMTC staff and input from a Study Advisory Committee.

A total of 18 data layers were used for this analysis, which were grouped into three main categories: destinations, neighborhood characteristics and pedestrian detractors. The maximum score for any cell was 100. Higher scores represent areas that have a higher pedestrian demand. The model results showed the highest scores in the City of Syracuse. The next highest score were located in village centers and in larger multi-use corridors. Sidewalk priority zones were created based on high score areas, road functional classifications and adjacent land uses. The purpose of these priority zones is to identify places where it makes the most sense to focus resources to improve pedestrian access.

The sections below describe additional details of the SMTC Pedestrian Demand Model.

Process

The first step of the modeling process was to gather and verify data that would be useful for the analysis. SMTC staff worked with local agencies to develop a comprehensive set of data: specifically, the locations of destinations such as schools, grocery stores, parks, post offices, convenience stores and pharmacies. Destinations were represented in the model by points, based on an extensive file of addresses maintained by Onondaga County's 911 program. This file includes the approximate location and use of individual buildings. Destinations outside of Onondaga County were identified by parcel data, using property class code. All data gathered for this analysis was reviewed for accuracy and completeness. The review process consisted of comparing similar datasets, internet research and field verification.

TABLE A1 – Model Structure	Data Layer Scoring	Total Possible Points		Data Layer Scoring	Total Possible Points
Destinations		**55**	**Neighborhood Characteristics**		**40**
Critical Destinations	**22**		**Population Density**		
Schools			>25	14	
0.125 mile	10		10 to 25	10	
0.25 mile	10		5 to 10	6	
0.5 mile	10		0 to 5	0	
0.75 mile	8		**Employee Density****		
1 mile	5		High	8	
Grocery Stores*			Medium	6	
Pharmacies*			Low	4	
0.125 mile	6		**HHs w/o vehicles**		
0.25 mile	6		>36%	6	
0.5 mile	6		24 to 36%	4	
0.75 mile	5		12 to 24%	2	
1 mile	3		<12%	0	
Neighborhood Destinations	**18**		**Pct Walking to Work**		
Libraries/Community Centers*			90th Percentile and Above	6	
Post Offices*			80th to 90th Percentile	4	
Town/Village/City Hall*			70th to 80th Percentile	2	
Parks*			**Pct >65 years**		
Convenience Stores*			**Pct <18 years**		
Transit Stops*			90th Percentile and Above	2	
0.125 mile	3		80th to 90th Percentile	2	
0.25 mile	2		70th to 80th Percentile	1	
0.5 mile	1		**Refugee Resettlement (Households)*****		
0.75 mile	0		>50	2	
1 mile	0		20 to 50	1	
Community Core**	**15**		<20	0	
High	15				
Medium	10		**Pedestrian Detractors**		**5**
Low	5		**Pedestrian/Vehicle Collision Density****		
			High	5	
			Medium	3	
			Low	2	

*Each of these is a separate layer in the model.

**High / Medium / Low scores are based on evaluations of the outputs of the ArcGIS kernel density tool.

***Based on approximate number of refugee households resettled within Census Tracts in the Study Area.

A major component of building the model was determining how each data layer would be scored or weighted (the proportion of the total score allotted for each layer). The SMTC developed its scoring system through a combination of internal discussions and research on similar models from across the country. Table A1 displays the final scores for each data layer. Scores for destinations are based on a sliding scale. For example, the score for proximity to schools decreases as distance from schools increases. The score for population density decreases as population become less dense.

A suitability analysis using ArcGIS Spatial Analyst requires that all input files be in raster format (a raster consists of a matrix of cells/pixels organized into a grid). Vector files (points, lines and polygons) were converted to a grid-based raster format so that each 100 square meter cell within the SMTC planning area can be assigned a value for each input as well as a final value once the model is run.

The model for this project was set up as six individual models using ArcGIS ModelBuilder, based on the model structure seen in Table A1. These models included: Critical Destinations, Neighborhood Destinations, Community Core, Neighborhood Characteristics and Pedestrian Detractors, as well as a final model that combined the results of the other five and calculates a final score for each grid cell. Having smaller individual model components allowed the analyst to make a change without having to re-run the entire model.

Data Layers

The data layers used, data ranges and scores are shown in Table A1. A total of 18 different data layers were used for this analysis.

Critical Destinations

- Schools
- Grocery Stores
- Pharmacies

The pedestrian demand model was not designed primarily to make it easier for pedestrians to get from home to nearby destinations that they may need to reach on a daily or weekly basis. A review of available research indicated that schools and grocery stores are frequently identified as key destinations for pedestrians. Additionally, conversations with stakeholders indicated that pharmacies are often critical destinations. Because of the importance of these destinations, the walkable radius was set at a mile from the destination. Schools are given the highest scores of any single destination, because students are obliged to reach their school daily. In the City of Syracuse, students must find their own transportation (either on foot, bike or riding with an adult) if they live within 1.5 miles of their school. A radius of one mile was used because, given the proximity of schools within the city to one another, a radius of 1.5 miles would have meant that virtually the entire city was covered in school proximity scores, effectively neutralizing this as a variable.

Neighborhood Destinations

- Libraries/Community Centers
- Post Offices
- Town/Village/City Hall
- Parks
- Convenience Stores
- Transit Stops

The set of Neighborhood Destinations was originally conceptualized as being places within a neighborhood that are "unique." Most neighborhoods have a single post office, library or community center. In a village, there will typically be one key government center, such as a village hall. As the model was refined, it was recommended that parks, convenience stores and transit stops be added, because of their importance as pedestrian destinations. The relative importance of these destinations to pedestrians is debatable; values were discussed and agreed upon after extensive discussion. It is a recognized limitation of the model that unique circumstances, such as a convenience store being the only place in a neighborhood that sells groceries, cannot be reflected in the model.

Community Core

While the Critical and Neighborhood Destinations take many key, individual destinations into consideration, they may not always capture the sense of a community or neighborhood's central business district. Community Core scores are based on the clustering of non-residential land uses, including restaurants, shopping, cafes, religious facilities and recreational uses. See the Model Structure Overview for information on how this score was generated.

Neighborhood Characteristics

The inputs used in the Neighborhood Characteristics element of the model are listed in Table A2. A review of research literature indicated that population density was a factor frequently correlated to pedestrian activity levels. While a lot of research identifies 10 people per acre as the level of density at which an urban land use pattern starts to emerge, making it easier for people to get from home to their desired destination, a review of actual densities in villages and city neighborhoods indicated that densities between 5 and 10 people per acre should be given a value in the model.

Other demographic characteristics were chosen based on their correlation with the need to walk for transportation.

Table A2 – Neighborhood Characteristics Model Inputs

Data Layer	Units	Data Source
Population Density	People per acre, Census Blocks	US Census
Employee Density	Employees per business (kernel density)	New York State
Households without Vehicles	Percent of households without vehicles by Census Tract	US Census
Percent Walking to Work	Percent of workers walking to work by Census Tract	US Census
Percent Over 65 Years	Proportion of population over age 65, with scores based on Census Tracts' percentile ranking within the study area	US Census
Percent Under 18	Proportion of population under age 18, with scores based on Census Tracts' percentile ranking within the study area	US Census
Refugee Resettlement Households	Number of households resettled within a given Census Tract, based on historic data from resettlement agencies	Syracuse Community Geographer

Pedestrian Detractors

The SMTC reviewed several models that included inputs under the category of "pedestrian detractors." These included roadway characteristics, such as speed limit and traffic volume – both of which typically have an inverse relationship with pedestrian comfort (as speed and volume go up, the feeling of safety that a pedestrian has goes down). Unlike the other inputs to the model, which identify where there are concentrations both of people and places for them to go on foot, the pedestrian detractor data helps identify locations that are in greatest need of improvements to make them attractive to pedestrians.

Due to data limitations (a lack of data on local roadways and inconsistent data on major roadways), the SMTC used the concentration of pedestrian/vehicle collisions, as provided by the New York State Department of Motor Vehicles as the sole Pedestrian Detractor in the model. Scores for this input were based on kernel density outputs.

Model Structure Overview

The following is a brief description of each of the six components of the SMTC Pedestrian Demand model.

The Community Core model (Figure A1) reclassifies the results of a kernel density analysis of properties identified as being potential walking destinations. The kernel density analysis calculates a magnitude per unit area from the selected point features. The model groups the data into three categories (low, medium and high density) and then reclassifies the data using the values shown in Table A1. The output is a raster file with values ranging from 0 to 15.

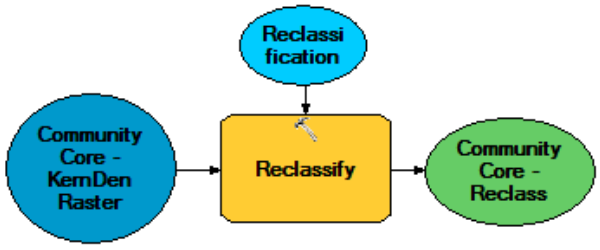

Figure A1 – Community Core Model Structure

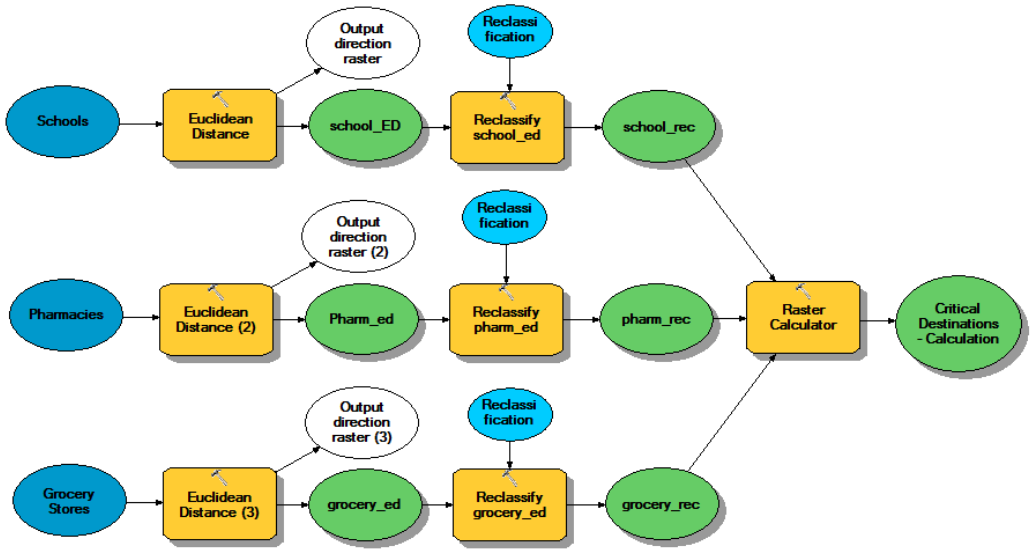

Figure A2 – Critical Destinations Model Structure

The Critical Destinations model (Figure A2) inputs include the locations of schools, pharmacies and grocery stores. The Euclidean Distance tool creates a raster output file with the straight line distances from each of the critical destinations. The results are grouped into five distance categories in ¼ mile increments and reclassified with a score as shown in Table A1. The model then takes the results from each of the three destination types and adds them together. The output is a raster file with values ranging from 0 to 22.

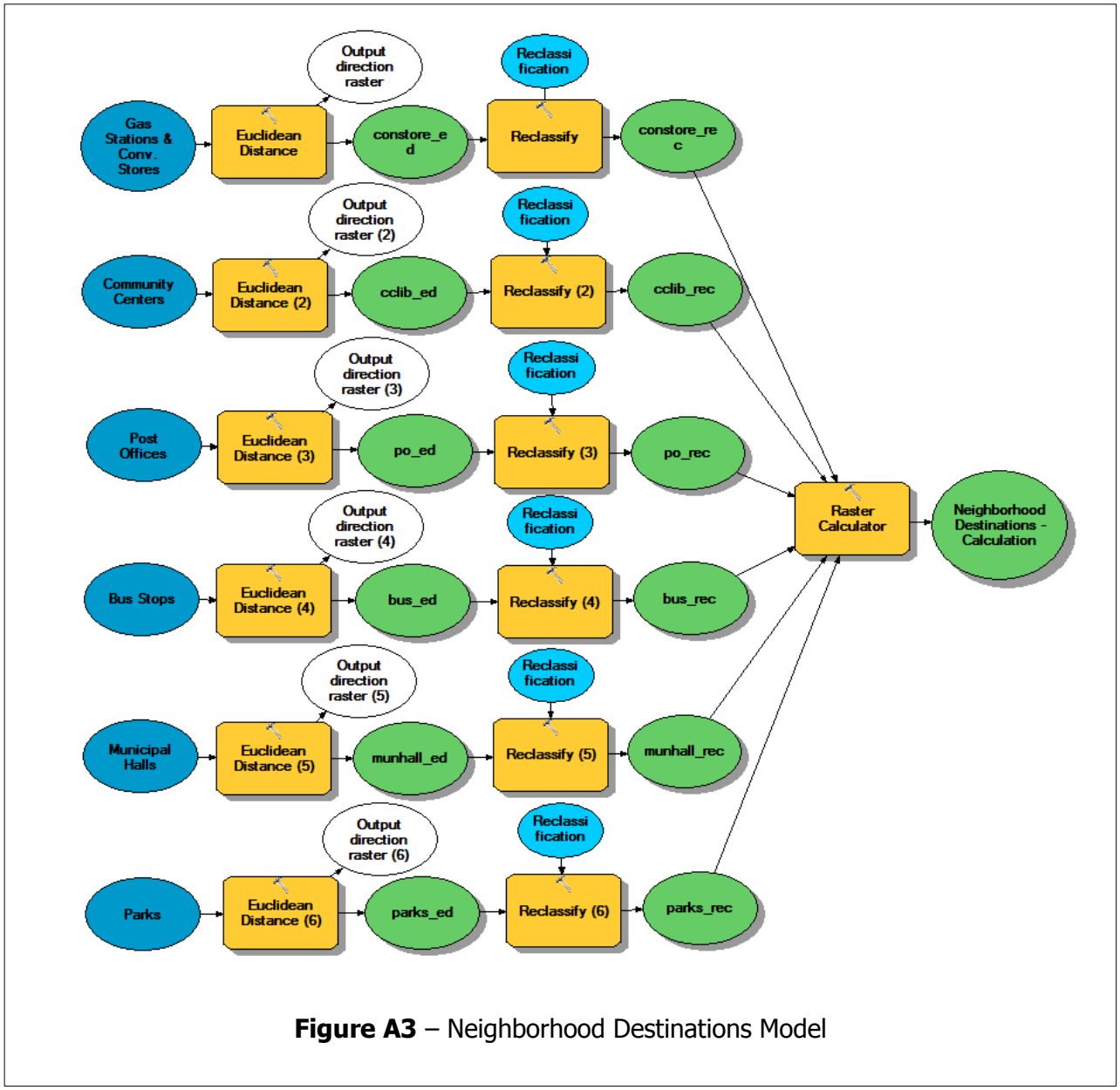

Figure A3 – Neighborhood Destinations Model

The Neighborhood Destinations model (Figure A3) uses locations of gas stations/convenience stores, community centers, post offices, municipal halls, parks and bus stops as inputs. Similar to the Critical Destinations model, this model uses the Euclidean Distance tool. The distance value for each of these destinations is grouped into quarter-mile increments from a quarter-mile to one mile and given a score as shown in in Table A1. The model adds the reclassified values and the output raster file scores range from 0 to 18.

The Neighborhood Characteristics model (Figure A4) includes the following: population density, employee density, percent of households with no vehicles, percent of workers that walk to work, percent of population above 65 years of age, percent of population below 18 year of age and refugee resettlement areas. The model converts the files from vector polygons to a raster format. The input data was reviewed and ranges and scores were determined for each characteristic. The employee density raster was created using a kernel density analysis of business point locations and number of employees at each location. Each of the inputs were then reclassified in groups and given scores as shown in in Table A1. The data ranges and scores for each characteristic were determined based on internet research of other similar analysis and input from the project's study advisory committee and SMTC staff. The output is a raster file with values ranging from 0 to 40.

The Pedestrian Detractor model (Figure A5) consisted of only one data set. A raster file was created using a kernel density analysis of pedestrian/vehicle collision data for a five year period (6/07-6/12). The model grouped the data into low, medium and high density areas. The data was then reclassified using the values as shown in in Table A1. The output is a raster file with values ranging from 0-5.

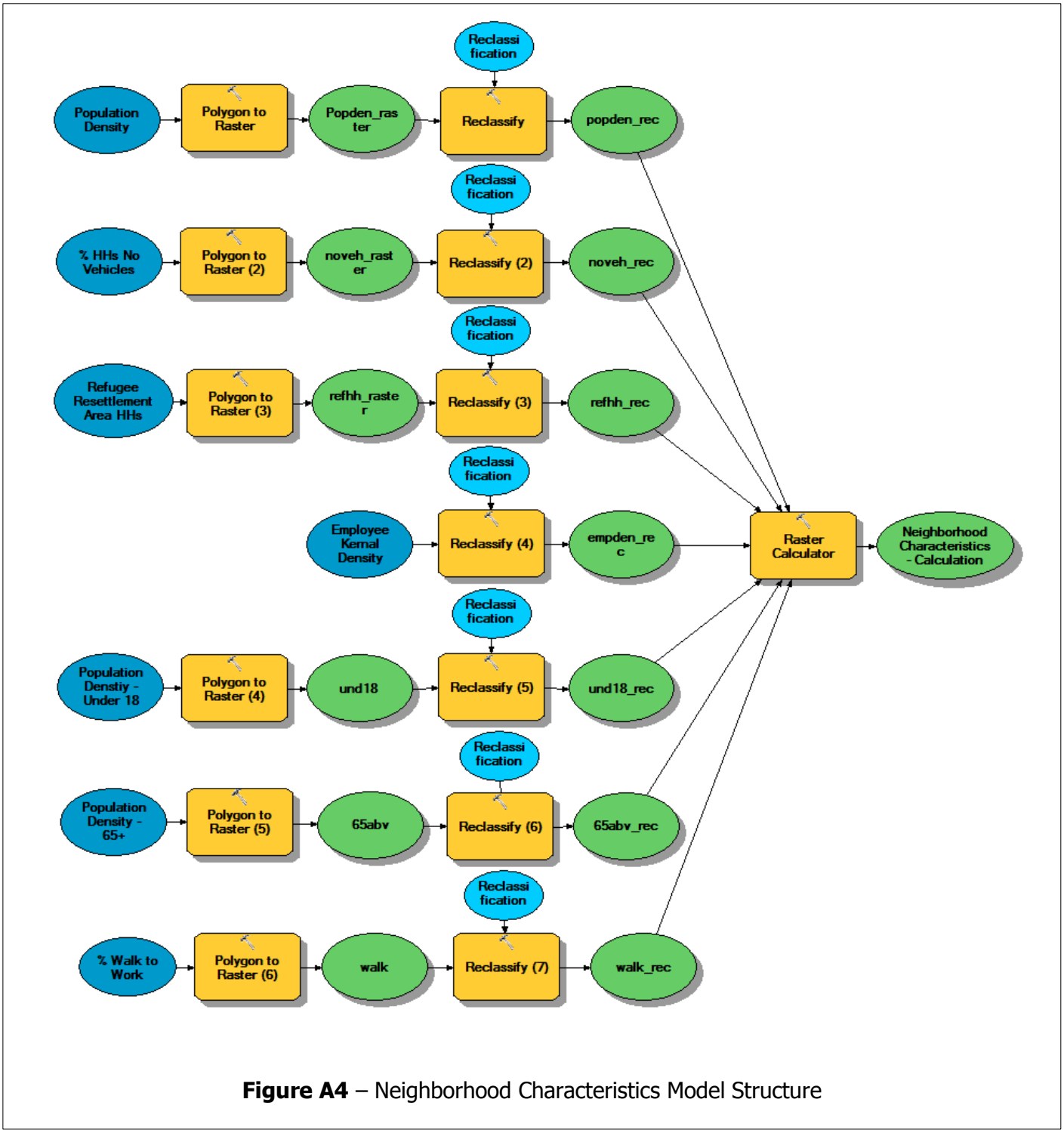

Figure A4 – Neighborhood Characteristics Model Structure

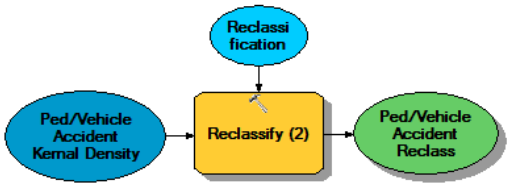

Figure A5 – Pedestrian Detractor Model Structure

The final component of the model takes the results of the other five models and adds them together (Figure A6). The output is a raster file with values ranging from 0 to 100. The results show that the highest score in the SMTC planning area is 91, which is in the City of Syracuse.

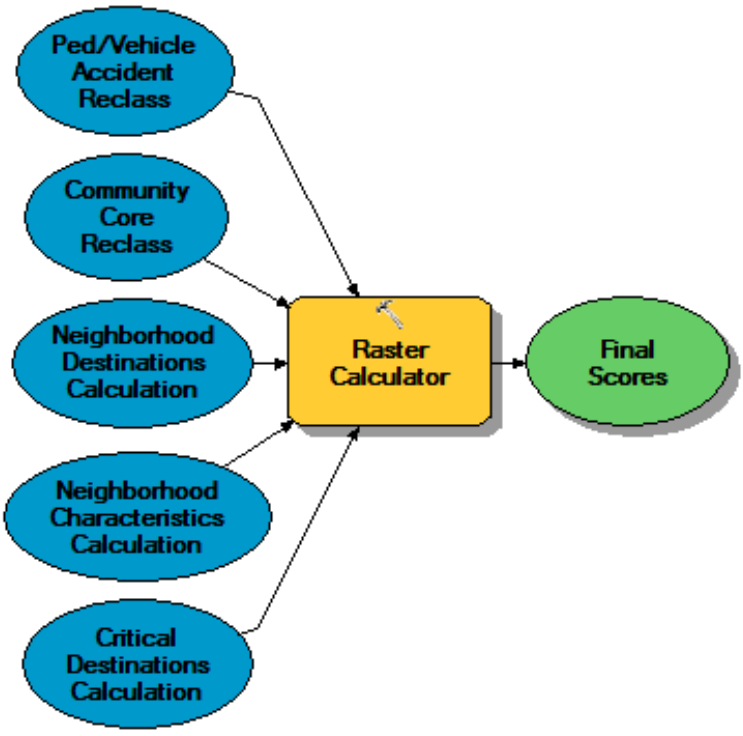

Figure A6 – Final Score Model Structure

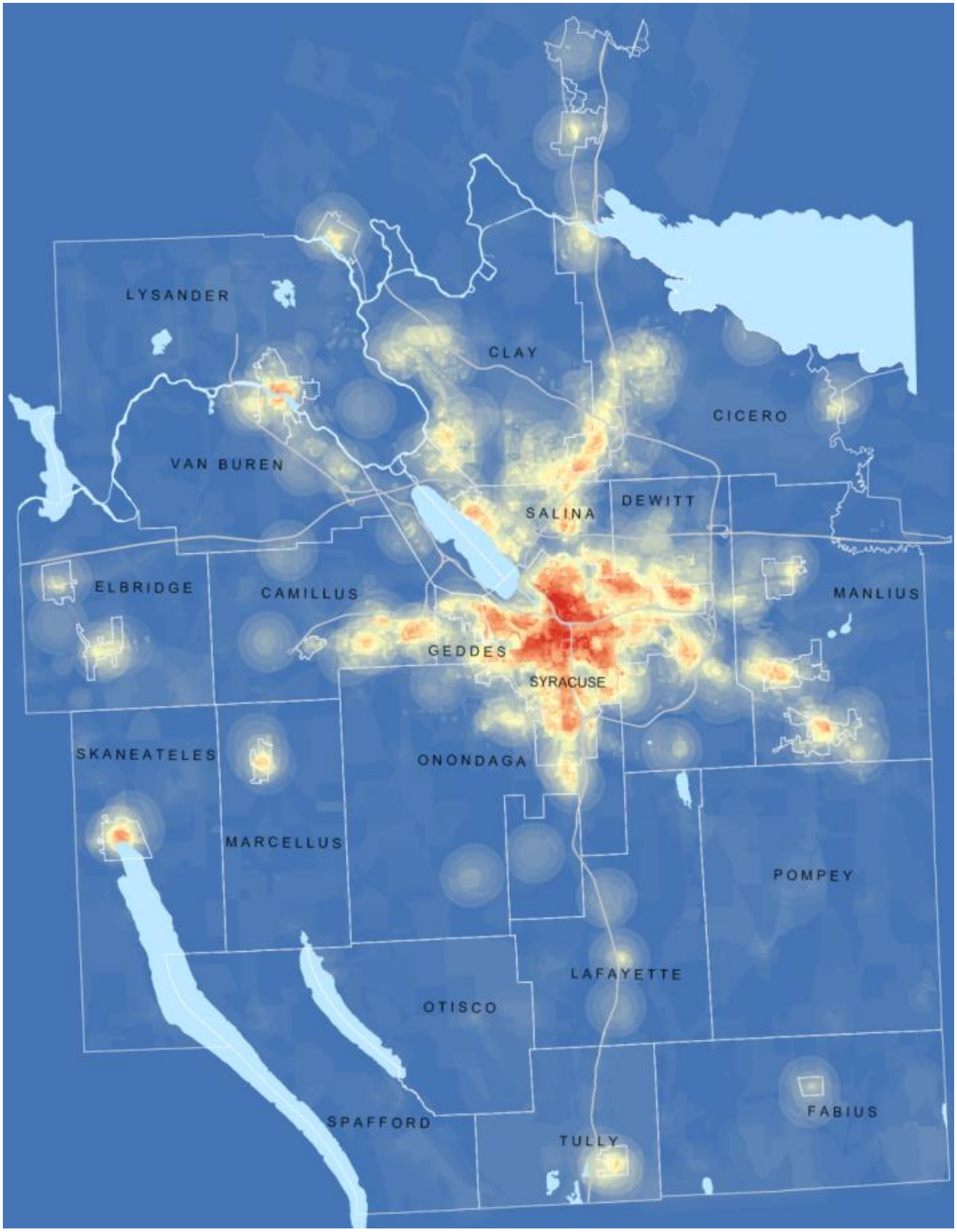

Figure A7 – Model Outputs

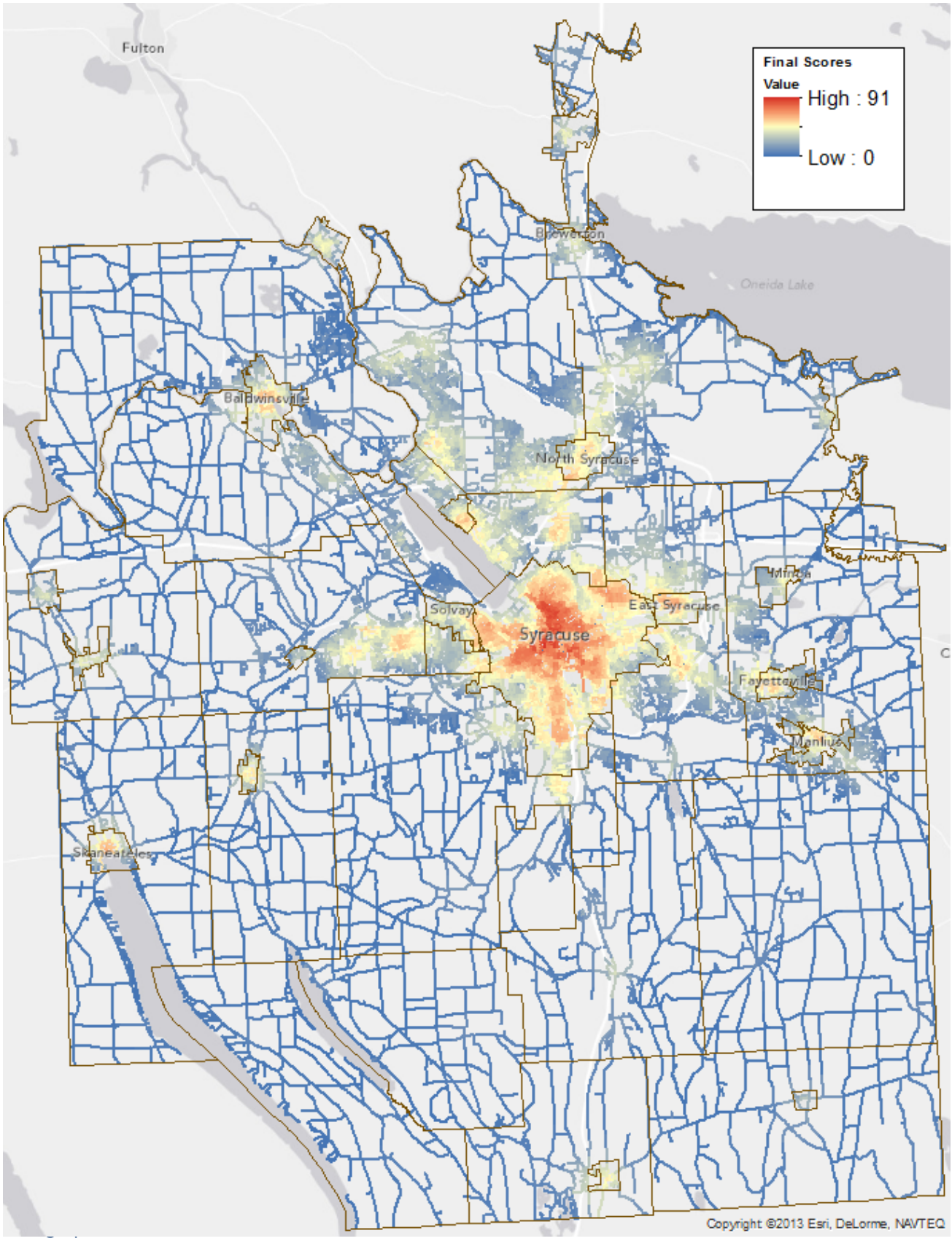

Figure A8 – Model Outputs Mapped to Surface Roads

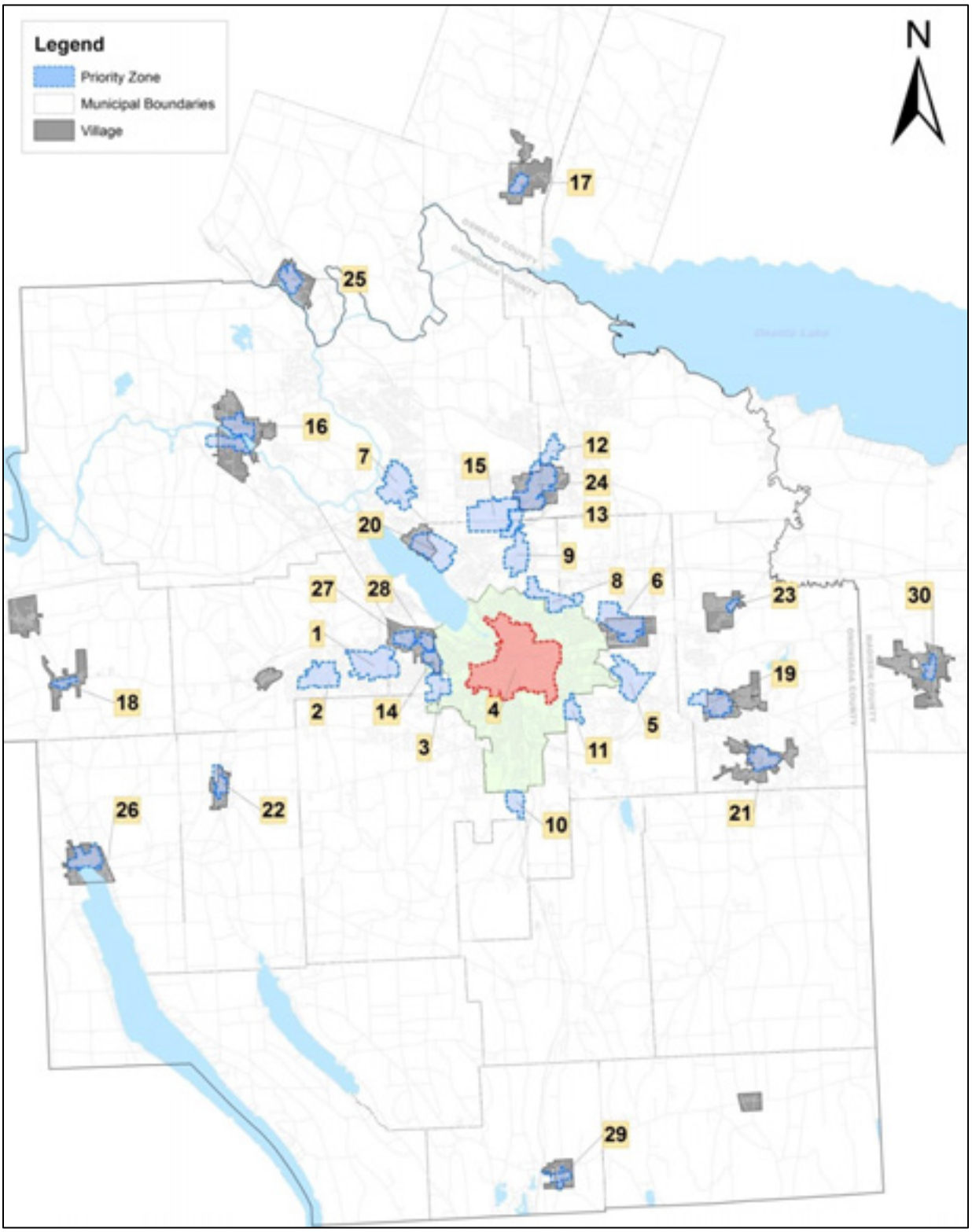

Figure A9 – Priority Zones based on Model Outputs

Output

The SMTC Pedestrian Demand model produces a raster file with 100 square meter cells that covers the SMTC planning area. Each cell is coded with a result in the range of 0 to 100 as show in Figure A7. "Hot" colors in Figure A7 (red, orange) indicate higher scores. Cooler colors (light yellow fading to dark blue) represent areas with either lower overall population density, fewer / more spread out destinations, or both.

These raw model outputs were mapped to adjacent road centerlines to better represent potential sidewalk locations. Since pedestrians do not have access to interstates, they were removed from the centerline file for this analysis. A 30-foot buffer was created for each road segment and the ArcGIS Zonal Statistics as Table tool was used to get the minimum, maximum and mean score for each segment. The results were then joined back to the road centerline file. The results are shown in Figure A8.

The model's results were analyzed at the neighborhood level and Priority Zones were identified, as shown in Figure A9. Priority Zones were defined based on areas with scores of 40 points and above, with nearby destinations considered as well.

Note that Figure A9 extends the study area's limits to include the Town of Sullivan in Madison County. This area was added to the SMTC's Metropolitan Planning Area during the development of this project. As a result, data collection and pedestrian demand analysis for the Town of Sullivan were done in 2014, well after the data collection and analysis in the majority of the study area. The Village of Chittenango's Priority Zone was added as a result of this analysis.