# Transdisciplinary Research on Energetics + Cancer - IDEA Project <br> Environment, Food, + Youth: GIS Protocols <br> Version 1.3, November 2007 

## Editor: Ann Forsyth

Contributors (alphabetically):
Ann Forsyth, PhD
Environmental Measurement Lead

Leslie Lytle, PhD
Project PI, TREC-IDEA Grant

## Nishi Mishra

GIS Research Assistant

## Pétra Noble

Research Fellow/Coordinator

## David Van Riper

GIS Research Fellow

## Assistance from:

Ed D'Sousa
GIS Research Assistant
A Companion Volume to Environment and Physical Activity: GIS Protocols, Versions 4.0 and 4.1 at www.designforhealth.net/GISprotocols.htm edited by Ann Forsyth and with contributions from
Edward D'Sousa, Ann Forsyth, PhD, Joel Koepp, J. Michael Oakes, PhD, Kathryn H. Schmitz, PhD, David Van Riper, and Jason Zimmerman

C/o www.designforhealth.net/, forsyth @ cornell.edu
Preparation of this manual was assisted by a grant from the National Institutes of Health

```
This is a work i n progres s
```


## Environment, Food, and Youth: GIS Protocols

## TABLE OF CONTENTS

Note TCWS = Twin Cities Walking Study

1. CONCEPTUAL ISSUES ..... 5
1.1. Protocol Purposes and Audiences ..... 5
1.2 Organization of the Protocols Manual ..... 5
1.3 The Context of the Manual: TREC-IDEA ..... 5
1.4 Steps in Developing the Manual ..... 6
1.5 Data. ..... 6
US Census ..... 6
MetroGIS ..... 6
Health and Agriculture Department Data ..... 7
Commercial Data ..... 7
1.6 Measurement Units ..... 10
1.7 Measurement Logistics ..... 10
1.8 General Measurement Geographies ..... 10
2. FUNDAMENTAL PROTOCOLS AND PROCEDURES ..... 11
Background ..... 11
2.1 Net Land Area (without water): See TCWS GIS Protocol 2.1 ..... 11
2.2 Gross Area (including water): See TCWS GIS Protocol 2.2 ..... 11
2.3 Measurement Geography Type 1: Straight Line or Airline Buffer; See TCWS GIS Protocol 2.5 ..... 11
2.4 Measurement Geography Type 2: Network or Street Distance Buffer ..... 11
2.5 Measurement Geography Type 3: Straight Line or Airline Distance to Nearest Feature; See TCWS GIS Protocol 2.7 ..... 21
2.6 Measurement Geography Type 4: Network or Street Distance to Nearest Feature ..... 21
2.7 Measurement Geography Type 5: Home to School Route Buffer ..... 24
3. RESTAURANTS A.K.A. FOOD SERVICES. ..... 27
3.1 Distance to Nearest Restaurant ..... 27
3.2 Restaurant Density ..... 31
3.3: Distance to Fast Food Restaurants ..... 34
3.4 Fast Food Restaurant Density ..... 38
3.5 Distance to Fast Food Restaurant Subtypes ..... 42
3.6 Density Fast Food Restaurant Subtypes ..... 43
3.7 Distance to Non Fast Food Restaurants. ..... 43
3.8 Density of Non Fast Food Restaurants ..... 47
4. FOOD STORES ..... 52
4.1 Distance to any Retail Food Outlet--All Stores Selling Food (not restaurants) ..... 52
4.2 Density of all Retail Food Outlets (not restaurants) ..... 57
4.3 Distance to Groceries, Supermarkets, or Super Centers ..... 61
4.4 Density of Groceries, Supermarkets, or Super Centers ..... 65
4.5 Distance to Large Supermarkets or Super Center ..... 69
4.6 Density of Large Supermarkets or Super Centers ..... 73
4.7 Type of Nearest Retail Food Outlet ..... 77
4.8 Distance to Nearest Convenience Store Including Gas Stations ..... 82
4.9. Density of Convenience Stores Including Gas Stations ..... 85
4.10 Distance to Farmers Market ..... 89
4.11 Distance to Alcohol Sales Places ..... 94
4.12 Density of Alcohol Sales Places ..... 98
5. YOUTH AND UTILITARIAN OR RECREATIONAL PHYSICAL ACTIVITY ..... 100
DENSITY ..... 100
5.1 Raw Population per Unit Land Area (TCWS GIS Protocol 3.1) ..... 100
5.2 Population per Unit Land Area (without water):(TCWS GIS Protocol 3.2) ..... 103
5.3 Residential Population in Residential Parcels (Residential Density) (without water): (TCWS GIS Protocol 3.4) ..... 106
5.4 Employment Per Unit Land Area: (TCWS GIS Protocol 3.6 ) ..... 109
PEDESTRIAN INFRASTRUCTURE ..... 111
5.5 Distance to Nearest Transit Stop (TCWS GIS Protocol 4.10) ..... 112
5.6 Transit Stop Density (TCWS GIS Protocol 4.11) ..... 116
LAND-USE MIX ..... 117
5.7 Percentage of Total Parcel Area in Major Land Uses (residential, commercial, office, industrial, institutional, park and recreation, vacant):(TCWS GIS Protocol 5.1) ..... 117
5.8 Retail Employment Density (TCWS GIS Protocol 5.11) ..... 122
5.9 Distance to Nearest Facility (Mentioned in the Survey): Stores in Total, Hardware Stores ..... 124
STREET PATTERN ..... 129
5.10 Average Census Block Area (TCWS GIS Protocol 6.1) ..... 129
5.11 Median Census Block Area: See TCWS GIS Protocol 6.2 ..... 133
5.12 Number of Access Points (TREC version) ..... 135
5.13 Road Length per Unit Area (TREC Version) ..... 138
5.14 Intersections per Unit Area (TREC version) ..... 140
OTHER BUILT-ENVIRONMENT RELATED/SPATIAL VARIABLES ..... 141
5.15 Proportion of High Functional Classifications [i.e. busy streets]: See TCWS GIS Protocol 7.1 ..... 141
5.16 Distance to Nearest Park ..... 144
5.17 Distance to Nearest Gym or Fitness Facility ..... 149
5.18 Distance to Nearest Recreation Center, Community Center, or School ..... 155
5.19 Distance to Nearest Bicycle or Pedestrian Trail Access Point ..... 160
5.20 Distance to School Attended ..... 165
6. CENSUS DATA—GIS MEASURES ..... 171
Background ..... 171
7. DATA STORAGE AND SHARING ..... 173
Steps/Problems with Obtaining Data ..... 173
Storing/Sharing Data. ..... 173
APPENDICES ..... 175
Appendix 1A: Food Data Comparison ..... 175
Appendix 1B: Licensing Information for Food, Beverage, and Lodging in the Twin Cities ..... 177
Study Area Geography and Licensing Jurisdictions ..... 177
Minnesota Department of Health ..... 177
Counties ..... 178
Anoka County: ..... 178
Washington County FBL Licensing Information ..... 178
Hennepin County FBL Licensing Information ..... 179
Ramsey County ..... 179
Cities ..... 179
Bloomington, City of ..... 179
Brooklyn, City of ..... 179
Crystal, City of ..... 179
Edina, City of ..... 179
Hopkins, City of. ..... 179
Maplewood, City of ..... 180
Minneapolis, City of, FBL Licensing Information ..... 180
Minnetonka, City of ..... 180
New Brighton, City of ..... 180
St. Louis Park, City of ..... 180
St. Paul, City of, FBL Licensing Information ..... 180
Wayzata, City of. ..... 181
Appendix 1C; Food, Beverage, and Lodging (FBL) Contacts ..... 182
Appendix 1D: Dun and Bradstreet Data. ..... 183
Sample Document ..... 183
Appendix 1E: Notes on SIC and NAICS coding ..... 185
Sources for SIC and NAICS Code Lists ..... 188
Appendix 1F: Protocol/Geography/Data Matrix ..... 189
Appendix 3A: Wikipedia and Quick Serve Restaurant Fast Food Lists ..... 192
Appendix 4A: Wikipedia Supermarket List ..... 194
REFERENCES ..... 200

## 1. CONCEPTUAL ISSUES

### 1.1. Protocol Purposes and Audiences

This manual provides protocols for measuring environmental variables associated with food, youth and physical activity used in the Minnesota TREC-IDEA study (TREC = Transdisciplinary Research on Energetics and Cancer). It is a companion to an earlier manual Environment and Physical Activity: GIS Protocols, developed for the Twin Cities Walking Study (TCWS) (Forsyth 2005, 2006, 2007) and available at http:/ /www.designforhealth.net/GISprotocols.html.

The manual has three purposes:

- To record the methods for environmental measurement used in the study.
- To document methods for replication.
- To make GIS research methods and data sources less opaque


### 1.2 Organization of the Protocols Manual

The manual is organized into eight sections.

1. This introduction that provides and overview of the study and data
2. Fundamental protocols and procedures for measuring land area and various buffer areas, distances, and paths. These are used in all other measurers
3. Food service measurement protocols--measuring densities of and distances to various kinds of restaurants as a proxy for measuring food quality
4. Food store measurement protocols--from convenience grocery to super centers, as another proxy for quality
5. Measurement protocols related to utilitarian and recreational physical activity among youth. Many of these protocols simply refer the reader to Environment and Physical Activity: GIS Protocols, developed for the Twin Cities Walking Study (TCWS GIS Protocols): http://www.designforhealth.net/GISprotocols.html. This includes distances to parks, gyms, and trails.
6. Protocols related to census variables
7. Protocols for data storage and data sharing
8. Appendices, keyed to specific chapters, followed by references

Protocols themselves take a specific format. Each one contains six main parts that are described in more depth in a related article (Forsyth et al 2006). These are: Basic Concept; Basic Formula, Basic Definition, or Basic Procedure; Detailed Formula or Detailed Definition; Comments and Explanations; GIS Approach; and GIS Steps. It should be noted that these steps often indicate one of several ways to do measurements.

### 1.3 The Context of the Manual: TREC-IDEA

The manual was written in the context of a research project measuring the neighborhood built environment related to healthy (and otherwise) eating and physical activity of youth part of a
larger project on Transdisciplinary Research on Energetics and Cancer, Examining the Obesity Epidemic through Youth, Family, and Young Adults led by PI Robert Jeffrey and Project PI Leslie Lytle. Overweight and obesity among adolescents is increasing across the globe, but the rise is particularly dramatic in the United States. This study looks at cancer and obesity risks by examining psychological, social, genetic, and environmental features. This manual focuses on one component, measuring the built environment at a community level including such factors as population density, street pattern, mixed use, pedestrian infrastructure, and access to different kinds of food stores and restaurants. For more information about the larger TREC program see: https:/ /www.compass.fhcrc.org/trec/

### 1.4 Steps in Developing the Manual

This manual follows the approach of the Environment and Physical Activity GIS Protocols Manual but is based on further review of the literature on health and food. In addition, a number of changes in ArcGIS came about after the physical activity protocols manual had been developed, most notably a very significant change in the way network buffers were constructed. This manual reflects the results of investigations into the effects of those changes.

### 1.5 Data

## US Census

www.census.gov
Description: SF1 files at the block and block-group level and SF3 at the block-group level.
Metadata: Metadata for census variables are available in a number of parts of the census Web site. For details on downloading large SF\# files see
http://www.census.gov/support/SF3ASCII.html
MetroGIS
www.metrogis.org
www.datafinder.org
Description: This is the GIS group supported by the Metropolitan Council of the Twin Cities, a state agency that does planning and analysis for seven counties at the core of the Twin Cities metropolitan area. Its data include a number of useful layers complete with metadata and accessible from http:/ /www.datafinder.org/catalog.asp. Not all data are free and many require specific agreements to be made between the user and the data owner:

General data
2000 Digital Orthophotos (2 feet per pixel resolution)
Generalized Land Use, 2000
Counties, Cities and Townships
MetroGIS Regional Parcel Dataset - Current (updated quarterly)
Water Features from 2000 Land-Use Data (supplements Ramsey County water layer)
The Lawrence Group (TLG) Data-Streets, Points of Interest, and Census

Census Geography 2000 - TLG Aligned; Blocks, Block Groups \& Tracts This is the MetroGISendorsed version of the census data and the one we used. It has the census geographies better aligned with the TLG roads layer
TLG Landmarks - Areas of Interest
TLG Landmarks - Lines of Interest
TLG Landmarks - Points of Interest
TLG Street Centerline Edits Table
TLG Street Centerlines and Address Ranges
Buses
Bus Route Segments
Bus Routes
Bus Service
Bus Shelters
Bus Stops
Transit Centers
Other
Regional Trails - Existing and Proposed
Metadata: Most are available linked to the data finder Web site at
http://www.datafinder.org/catalog.asp

## Health and Agriculture Department Data

Businesses selling food need to be licensed by various agencies. In broad terms, restaurants are licensed by departments of health and food stores by the department of agriculture. However, many businesses combine elements of each--such as a deli selling sandwiches and packaged goods. Further businesses selling only packaged goods have specific requirements. In some states such licensing is done at the state level, providing consistent data collection.
Unfortunately this is not the case in Minnesota. Appendix 1A contains more detail about these data sources. In summary:

- Food stores including packaged goods are typically regulated by cities and countiessee Appendix 1A for sample data and Appendix 1B.
- Restaurants/food service: In Minnesota these are typically regulated by health departments. Some are regulated by the state health department but in the Twin Cities, a number of cities and counties have been delegated this role. The list of agencies is included in Appendix 1C.

Unfortunately, each jurisdiction collects different data with the only things in common being name and address (see Appendix 1A for a table showing examples of the different data). However, the data do provide an excellent master address list, particularly when combined with the commercial data (below).

## Commercial Data

There are several commercial databases available for business addresses (e.g. Dun and Bradstreet, InfoUSA/ESRI Business Analyst) as well as more specialized data for specific purposes such as stores with soda fountains. As these data can be quite expensive there is much comparative information available although our own experience with Business Analyst indicated quite a few errors.

Commercial data often includes industrial classification codes SIC/NAICS codes (old Standard Industrial Classification codes used to 1997 and North American Industrial Classification System codes used since 1997 with refinement in 2002). These codes some in a variety of levels-from 2 to six digits, with longer coded being more specific. For example, the following NAICS 2002 codes relate to food and beverage stores:

44-45 Retail Trade
445 Food and Beverage Stores 4451 Grocery Stores

44511 Supermarkets and Other Grocery (except Convenience) Stores 445110 Supermarkets and Other Grocery (except Convenience) Stores
44512 Convenience Stores $\underline{445120}$ Convenience Stores
4452 Specialty Food Stores
44521 Meat Markets
445210 Meat Markets
44522 Fish and Seafood Markets 445220 Fish and Seafood Markets
44523 Fruit and Vegetable Markets 445230 Fruit and Vegetable Markets
44529 Other Specialty Food Stores 445291 Baked Goods Stores
445292 Confectionery and Nut Stores
445299 All Other Specialty Food Stores
4453 Beer, Wine, and Liquor Stores
44531 Beer, Wine, and Liquor Stores
$\underline{445310}$ Beer, Wine, and Liquor Stores
The following refer to restaurants
72 Accommodation and Food Services
$\underline{722}$ Food Services and Drinking Places
7221 Full-Service Restaurants
72211 Full-Service Restaurants
722110 Full-Service Restaurants
7222 Limited-Service Eating Places
72221 Limited-Service Eating Places
722211 Limited-Service Restaurants
722212 Cafeterias
722213 Snack and Nonalcoholic Beverage Bars
7224 Drinking Places (Alcoholic Beverages)
72241 Drinking Places (Alcoholic Beverages)
722410 Drinking Places (Alcoholic Beverages)
However it should be noted there are other places selling food such as dinner theaters.
In addition, in the food area, NAICS has typically fewer subtypes of businesses but is potentially more accurate. For example, the following are all coded 445299 in NAICS but have several different 4-digit SIC codes

| 2002 NAICS | 1997 NAICS | 1987 SIC |
| :--- | :--- | :--- |
| 445299 | 445299 | 5499 Coffee and tea (i.e., packaged) stores |
| 445299 | 445299 | 5451 Dairy product stores |
| 445299 | 445299 | 5499 Gourmet food stores |
| 445299 | 445299 | 5451 Ice cream (i.e., packaged) stores |
| 445299 | 445299 | 5499 Soft drink stores, bottled |
| 445299 | 445299 | 5499 Specialty food stores |
| 445299 | 445299 | 5499 Spice stores |
| 445299 | 445299 | 5499 Tea and coffee (i.e., packaged) stores |
| 445299 | 445299 | 5499 Water stores, bottled |
| Source: http:/ /www.census.gov /epcd/naics02/def/ND445299.HTM |  |  |

A full list of codes in available at http://www.census.gov/epcd/naics02/naicod02.htm and a comparison between NAICS and SIC codes is at http:/ /www.census.gov/epcd/naics02/N2SIC44.HTM.

The problem faced by researchers is that the NAICS/SIC codes are not always accurately applied. However, using such databases and names of chains it is possible to classify, for example, fast food restaurants or major supermarket chains.

The following is a list of potential commercial data with sources and comments. More detail about coding is included in Appendix 1E):

- Dun and Bradstreet: is a business information provider. Companies apply for a D-U-N-S number (Dun and Bradstreet Universal Numbering System) for free. According to Wikipedia 100 million companies have done so, globally. A sample entry is included in Appendix 1D. Useful data include exact address, SIC/NAICS code, number of employees, sales volume, and square footage of buildings. Addresses can be matched to parcels. The main Dun and Bradstreet web site for the U.S. is at: http://www.dnb.com/us/. This is an excellent source of data but is quite expensiveone year of data for the Twin Cities is approximately $\$ 13,000$. Using 2005 data Krizek et al. (2007) counted 123,668 businesses in the Twin Cities metro area. We have access to a complete data set for 2006 but creating protocols using Dun and Bradstreet locks researchers into a very expensive database.
- Business Analyst (InfoUSA/ESRI): ESRI (originally the Environmental Systems Research Institute) is the creator of the ArcGIS suite of GIS software, the most used GIS software in the U.S. Business Analyst is integrated with their software and uses InfoUSA as the business database-a listing of 11 million U.S. businesses by "business name, industry description or SIC/North American Industry Classification System, sales, employees, and location"
(http://www.esri.com/software/arcgis/extensions/businessanalyst/about/highquality.html). It also includes the Directory of Major Malls, a list of 4,000 larger shopping centers. InfoUSA data are compiled from phone books, business directories, public filings, and U.S. Postal Service National Change of Address files, checked by phoning businesses. However, addresses are not always exactly matched and coding is not always precise. For example, in one part of the Twin Cities only 90 percent of addresses were matched to streets; the rest to zip codes. Most restaurants were classified as limited service (akin to fast food). The main InfoUSA web site is http:/ /list.infousa.com/. Using 2006 data Krizek et al. (2007) counted 93,840 businesses in the Twin Cities metro area.

However, this is a less expensive data source. One year of data costs approximately $\$ 3,500$ for the Twin Cities.

We decided to use Dun and Bradstreet. More details about the data are in Appendix 1D.

### 1.6 Measurement Units

This protocol manual uses metric measurement units.

### 1.7 Measurement Logistics

These protocols generally use existing data and did not involve fieldwork. However, collecting government licensing data involved significant work contacting individual agencies, specifying data needs quite exactly, and organizing licensing agreements for data. Some charged fees that though modest still required work to arrange.

In addition, the GIS measures involved a collaboration between the University of Minnesota's Metropolitan Design Center, Minnesota Population Center, and the School of Public Health. Cornell University Department of City and Regional Planning will become a partner.

### 1.8 General Measurement Geographies

This study of youth examines two major youth environments-home and school. Other parts of the study look at the environments within the home and school. This study of the "neighborhood" or nearby environment looks at the following areas. It should be noted that in early versions of the companion Environment and Physical Activity: GIS Protocols we also examined 200 m network buffers. Changes in network analyst made it problematic to ue the 200m network buffers (there were many oddly shaped of zero size buffers, but of a different shape to previous versions). Further, ongoing research did not show any special association between these buffers and physical activity. For these reasons we dropped the 200m network buffer.

| School | Home | Home to School ${ }^{* *}$ |
| :--- | :--- | :--- |
|  |  |  |
| Straight line | Straight line | Straight line |
| 200 m | 200 m | 50 m either side |
| 400 m | 400 m |  |
| 800 m | 800 m |  |
| 1600 m | 1600 m |  |
| 3000 m | 3000 m | Network |
| Network | Network | 50 m either side |
| 400 m | 400 m |  |
| 800 m | 800 m |  |
| 1600 m | 1600 m |  |
| 3000 m | Distance to nearest feature |  |
| Distance to nearest feature |  |  |
|  |  |  |
| The measurement geographies are described in more detail in chapter 2. |  |  |

## 2. FUNDAMENTAL PROTOCOLS AND PROCEDURES

Note: these protocols draw on work previously done in the companion physcial activity protocols but were updated and modified for this study by Ann Forsyth (selection of protocols) and Nishi Mishra and David Van Riper (GIS steps).

## Background

This project includes buffers and distance measures for three areas: home, school, and the path between. The key issue these protocols had to deal with was that with the introduction of a new version of network analyst, the program that creates street distance (network) buffers for ArcGIS 9. In 2006 the software programmers radically changed the way that buffers are made. However, they did not document this. The issues around these changes are described in more detail in the protocols for network buffers.

### 2.1 Net Land Area (without water): See TCWS GIS Protocol 2.1.

This uses the existing TCWS GIS Protocol. Be sure to use the latest version--4.0 or later--as this version corrects errors, simplifies some steps, or at least indicates where protocols are in need of revision.

### 2.2 Gross Area (including water): See TCWS GIS Protocol 2.2.

This uses the existing TCWS GIS Protocol. Be sure to use the latest version--4.0 or later--as this version corrects errors, simplifies some steps, or at least indicates where protocols are in need of revision.

### 2.3 Measurement Geography Type 1: Straight Line or Airline Buffer; See TCWS GIS Protocol 2.5.

This uses the existing TCWS GIS Protocol. Be sure to use the latest version--4.0 or later--as this version corrects errors, simplifies some steps, or at least indicates where protocols are in need of revision.

### 2.4 Measurement Geography Type 2: Network or Street Distance Buffer

Note: This is adapted from the TCWS GIS Protocol 2.6 but deals with updates to Arc GIS that fairly radically changed the method of creating network buffers and thus their area and shape. It was updated slightly in Version 1.3 correcting some errors in the GIS steps.

## 1. Basic Concept

A network buffer includes the area within x distance along a street network from the starting point (a school or home in this case). In ArcGIS9 a new version of network analyst fundamentally changed the way network buffers are created.

All street network buffers aim to measure the environment that can be reached by someone on foot along the street network. However, the way they calculate this can lead to quite different shapes and areas. The study team is still investigating the amount of difference between the old version--from ArcView 3.3--and the new version. However, the images below illustrate some of the differences between ArcView 3.3, and the detailed and generalized buffers. In the earlier version the network buffer merely joined the points furthest out $x$ distance along the roads from the starting point. This was, or at least approximated, a shape known as a convex hull. This is not available in the new network
analyst, instead there are to more fitted shapes, one more complex (detailed) and one simpler (generalized). The following illustrations demonstrate some of these changes for a single case.


The outer greenish line is the traditional, ArcView 3.3 network buffer for 11600 m distance.
The purple line is the "generalized" buffer from ArcGIS 9.1 for a 1600m distance.
The yellow area is the "detailed" buffer from ArcGIS 9.1 for a 1600m distance.


Comparison of 200m, 400m, 800m and 1600m ArcView 3.3 network buffers, ArcGIS 9.1 generalized buffers, and ArcGIS 9.1 detailed buffers. Notice that the detailed buffers are often in quite different locations to the generalized and ArcView buffers.

The following table, to be updated as analysis occurs, illustrates the differences in area among the different buffers and illustrating that in area, if not in shape and location, the generalized buffers are closest to the old network buffers.

## Area of Buffers Around One Point

1600 m ArcView $3.3=1866166.16725 \mathrm{sq} \mathrm{m} / 186.62$ hectares
1600 m generalized buffer $=1678756.48148 \mathrm{sq} \mathrm{m} / 167.88$ hectares
1600 m detailed buffer $=1976928.43402 \mathrm{sq} \mathrm{m} / 197.69$ hectares
800 m ArcView $3.3=384657.620882 / 38.471$ hectares
800 m generalized buffer $=343218.353395 / 34.32$ hectares
800 m detailed buffer $=586742.068519 / 58.67$ hectares
400 m ArcView $3.3=73484.750545 / 7.35$ hectares
400 m generalized buffer $=60505.556168 / 6.05$ hectares
400 m detailed buffer $=194117.956987 / 19.41$ hectares
200 m ArcView $3.3=7566.379119$ / 0.76 hectares
200 m generalized buffer $=4377.928967 / 0.44$ hectares
200 m detailed buffer $=48506.559253 / 4.85$ hectares
However, it is also possible to just buffer roads with a kind of network of sausages following the roads. This may well be a more replicable method across program revisions and from program to program (given other GIS programs are more popular in Europe, for example). We will thus be testing four sorts of buffers:

- ArcView 3.3--close to a convex hull (See above)
- Network Analyst generalized buffer
- Network Analyst detailed buffer
- Sausage network buffer--that is a buffer constructed using a different function in ArcGIS and merely buffering $x$ meters (we have chosen 50 ) on either side of all streets near the point out $y$ meters (the buffer length). The following diagram illustrates these four options.


The outer gray line is the traditional, ArcView 3.3 network buffer for 1400 m distance.
The blue line is the "generalized" buffer from ArcGIS 9.1 for a 400 m distance.
The red line is the "detailed" buffer from ArcGIS 9.1 for a 400m distance.
The yellow area is the "sausage" buffer with straight ends.
Area of the Buffers:
ArcView 3.3 Buffer $=28.5461571$ hectares
ArcGIS 9.1 Generalized Buffer $=24.5858564$ hectares
ArcGIS 9.1 Detailed Buffer $=26.8620836$ hectares
ArcGIS 9.1 Sausage Network Buffer $=28.2005548$ hectares


Area of the Buffers:
ArcView 3.3 Buffer $=7.34847505$ hectares
ArcGIS 9.1 Generalized Buffer $=6.05055562$ hectares
ArcGIS 9.1 Detailed Buffer $=19.4117957$ hectares
ArcGIS 9.1 Sausage Network Buffer $=7.51097019$ hectares

## Comparison of Different Network/Street Distance Buffers (400 m) : Grid Pattern



Area of 400 m Buffers:
ArcView 3.3 Buffer $=12.9709341$ hectares
ArcGIS 9.1 Generalized Buffer $=11.8642397$ hectares
ArcGIS 9.1 Detailed Ber Susfor $=12.0684016$
Area of the Buffers:
ArcView 3.3 Buffer = 12.9709341 hectares
ArcGIS 9.1 Generalized Buffer $=11.8642397$ hectares
ArcGIS 9.1 Detailed Buffer $=15.2897065$ hectares
ArcGIS 9.1 Sausage Network Buffer $=12.0684016$ hectares


Area of 400 m Buffers:
ArcView 3.3 Buffer $=26.0152559$ hectares
ArcGIS 9.1 Generalized Buffer $=23.2198419$ hectares
ArcGIS 9.1 Detailed Bd 27.232183 heclase
$\begin{array}{llll}\mathrm{N} & 0.05 & 0.1 & 0.2 \\ & & 0.0\end{array}$

ArcGIS 9.1 Sausage Network Buffer $=17.9720354$ hectares
Area of the Buffers:
ArcView 3.3 Buffer $=26.0152559$ hectares
ArcGIS 9.1 Generalized Buffer $=23.2198419$ hectares
ArcGIS 9.1 Detailed Buffer $=27.5418183$ hectares
ArcGIS 9.1 Sausage Network Buffer $=17.9720354$ hectares

## 2. Basic Definition

A network buffer is an area within X-meters street distance of a point (or a polygon).

## 3. Detailed Definition

A network buffer is an area within X-meters street distance of a point (or a polygon). In the case of this study, with a sample based on residential environments, the street network distance is from a participant's home. More specifically, it is the network distance from the house or building on the participant's parcel, where the building is located visually from aerial photos. We have yet to decide which exact type of network buffer will be used though it will likely be the generalized or sausage buffer.

## 4. Comments and Explanations

This is a little trickier to do in GIS than the straight-line buffer.

## 5. GIS Approach

Use Network Analyst extension for ArcGIS 9.2to determine the new service area around the set of point features, in this case participants or schools. Line features such as roads or trails are used to create the network which is used to calculate all possible routes of a specified distance from the selected points.
6. GIS Steps

The following procedure was completed using ArcInfo 9.2
Requirements:

1. Road Layer polyline
2. Point Features for buffer
3. Network Analyst Extension for ArcGIS 9.2
I. Create a New Network Dataset
4. Start ArcCatalog.
5. On the Main Menu click Tools and Click on Extensions.
a. Check Network Analyst Extension.
b. Click Close.
6. In the catalog tree, navigate to the feature dataset if you are creating a geodatabase based network dataset. If you are creating a shapefile based network dataset navigate to the shapefile location in the catalog tree.
7. If you are creating a geodatabase based network dataset right click on the feature dataset and point to New and then click Network Dataset. If you are creating a shapefile based network dataset right click on the shapefile and click New Network Dataset.
8. In the New Network Dataset Wizard
a. Type a name for the network dataset and Click Next.
b. Check the Road feature classes that will be used as network source in the network and Click Next.
c. Accept the default connectivity settings and Click Next.
d. Accept the default option NO to modify the connectivity with elevation field data or elevation field settings and Click Next.
e. Accept the default YES to model Turn in the Network and Click Next.
f. Click Add
i. Type Length in the Name field.
ii. Select Cost as Usage Type, if it is not already selected.
iii. Select Meters as the Units.
iv. Select Double as the Data type, if it is not already selected.
v. Click OK.
vi. Click Next.
g. Accept the default Yes to use the default directions settings to establish driving directions for the network dataset and Click Next.
h. Review the network dataset summary to check the options are correctly selected and Click Finish.
9. Click Yes to build the Network Dataset.
II. Create the Network or Street Distance Buffer
10. Start ArcMap
11. On the Main Menu click Tools and Click on Extensions.

## a. Check Network Analyst Extension.

b. Click Close
3. Click the Add Data button on the Standard Toolbar
a. Navigate to the Network Dataset location, created earlier in Step I
b. Click on the Network Dataset and click Add to add the Network Dataset to ArcMap.
c. Click Yes to add all the feature classes, that participate in the network, to the map.
4. Click the Add Data button $V$ on the Standard Toolbar
a. Navigate to the Point Layer to be used for analysis, in this case Participant location/School Locations
b. Click on the Point Layer and click Add to add it to ArcMap.
5. In the Table of Contents Right Click the Point Layer and click on Open Attribute Table
a. In the Attribute Table
i. Click Options
ii. Click Add Field
iii. Add the School_Id/Participant_Id as Text

- Type School_Id/Participant_Id in the Name field
- Select Text (50) as Type
- Accept default for Length
- Click OK
iv. Add the School_Id/Participant_Id as Integer
- Type School_Id/Participant_Id in the Name field
- Select Short Integer as Type
- Accept default (0) for Precision
- Click OK
v. Enter the assigned Id for the participants and schools

6. On the main menu click View
a. Click on Toolbars
b. In the side menu click Network Analyst to add the Network Analyst toolbar to ArcMap
7. Click Network Analysis Toolbar
a. Click Network Analyst Window button $\square$ to add the Network Analyst Window to the map
8. On the Network Analyst Toolbar Click Network Analyst Dropdown Menu
a. Click New Service Area
b. The Table of contents and the Network Analyst Window contains empty list of Facilities, Barriers and Polygon Categories.
9. On the Network Analyst Window right Click Facilities and Click Load Locations
a. In Load Locations Window
i. Click Browse and Navigate to the point feature layer
ii. Click on the Point feature layer and click Add
iii. Choose the Participant ID/School Id as the Name field. Accept the default for other Location Analysis Properties
iv. Accept the default Location Position
v. Click OK
10. To set the properties to be used in the Analysis, In the Table of Contents Right Click the Service Area Layer and Click Properties
a. Click on Analysis Settings Tab
i. Choose Length (Meters) for Impedance.
ii. Type the Buffer Distance for Default Breaks
iii. Choose Away From Facility as Direction
iv. Choose Everywhere for Allow U-Turns
v. Uncheck the box next to Oneway Restrictions.
b. Click on Polygon Generation Tab
i. Check Polygon generation
ii. Choose Generalized as the Polygon Type
iii. Uncheck Trim Polygons
iv. Choose Overlapping for Multiple Facility Options
v. Choose Rings as the Overlap Type
c. Click Ok
11. On the Network Analyst Toolbar, Click Solve Button
12. Joining attributes with Source Point Layer to carry over the data.
a. Right Click the Polygons Layer
b. Click Joins and Relates and then Join
i. Choose Facility Id as the Field to base the join on
ii. Choose the School/Participant Layer as the Table to Join to this layer
iii. Choose the School/Participant ID as the field in the table to base the join on
d. Right Click the Polygons Layer
e. Click on Data and then Export Data
i. Choose this layer's source data for the coordinate system
ii. Specify the Output location

### 2.5 Measurement Geography Type 3: Straight Line or Airline Distance to Nearest Feature; See TCWS GIS Protocol 2.7.

This uses the existing TCWS GIS Protocol. Be sure to use the latest version--4.0 or later--as this version corrects errors, simplifies some steps, or at least indicates where protocols are in need of revision.

### 2.6 Measurement Geography Type 4: Network or Street Distance to Nearest Feature <br> Note: this is similar to a protocol in the TCWS manual but this one is most up to date.

## 1. Basic Concept

The airline distance to a feature such as a restaurant may be important, but the street distance may well be closer to people's experiences. While the street distance does not always match the distance via pedestrian paths, sidewalks, and short cuts, in the TREC study we were not able to do data collection of such paths. In addition, the new ArcGIS created a new method for calculating such distances.

## 2. Basic Definition

The street distance between a youth's home or school and the feature of interest.

## 3. Detailed Definition

The street distance between a youth's home or school and the feature of interest calculated using the TLG roads layer for the Twin Cities (modified from the census) and ArcGIS 9.2 network analyst.

## 4. Comments and Explanations

This is done by using the Find Closest Facility option in Network Analyst Extension of ArcGIS 9.2. A point layer, to which the shortest network distance is to be calculated, is specified as the "facility" layer and the point, from which the distance is to be calculated, serves as the origin. The shortest path to the 'facility" from the specified origin is calculated using the road network.

## 5. GIS Approach

The approach for this measure is to load a set of origins and destinations, then use the Closest Facility feature in Network Analyst to calculate the network distance from each origin to the nearest destination.

## 6. GIS Steps

Requirements for ArcGIS 9.2:

1. Road Layer polyline
2. Point Features to calculate the nearest distance from (Participant layer/ school layer).
3. The feature of interest layer (Point features) to calculate the nearest distance to (Restaurants/Gym/Retail food outlet)
4. Network Analyst Extension for ArcGIS 9.2

## Calculate the Network Distance to Nearest Restaurant

1. Start ArcMap
2. On the Main Menu click Tools and Click on Extensions.
a. Check Network Analyst Extension.
b. Click Close
3. Click the Add Data button $\vee$ on the Standard Toolbar
a. Navigate to the Network Dataset location, created earlier
b. Click on the Network Dataset and click Add to add the Network Dataset to ArcMap.
c. Click Yes to add all the feature classes, that participate in the network, to the map.
4. Click the Add Data button on the Standard Toolbar
a. Navigate to the Point Layers to be used for analysis, in this case Participant location and Feature of Interest Locations
b. Click on the Point Layers and click Add to add it to ArcMap.
5. In the Table of Contents Right Click the Point Layer and click on Open Attribute Table a. In the Attribute Table
i. Click Options
ii. Click Add Field
iii. Add the Feature_Of_Interest_Id)/Participant_Id as Text

- Type FOI_Id_T(Feature of interest)/Part_Id_T in the Name field
- Select Text (50) as Type
- Accept default for Length
- Click OK
iv. Add the Feature_Of_Interest_Id/Participant_Id as Integer
- Type FOI_Id/Part_Id in the Name field
- Select Short Integer as Type
- Accept default (0) for Precision
- Click OK
v. Enter the assigned Id for the participants and schools

6. On the main menu click View
a. Click on Toolbars
b. In the side menu click Network Analyst to add the Network Analyst toolbar to ArcMap
7. Click Network Analysis Toolbar
a. Click Network Analyst Window button 围 to add the Network Analyst Window to the map
8. On the Network Analyst Toolbar Click Network Analyst Dropdown Menu
a. Click New Closest Facility
b. The Table of contents and the Network Analyst Window contains empty list of Facilities, Incidents, Routes and Barriers Categories.
9. On the Network Analyst Window right Click Facilities and Click Load Locations
a. In Load Locations Window
i. Click Browse and navigate to the Feature of Interest Locations, Point feature layer
ii. Click on the Feature of Interest Locations layer and click Add
iii. Choose the Feature of Interest Id as the Sort field
iv. Choose the Feature of Interest Id Text as the Name field. Accept the default for other Location Analysis Properties
v. Use $\mathbf{5 0}$ Meters for Location Position, Use Geometry (increase the search tolerance if many locations are unlocated)
vi. Click OK
10. On the Network Analyst Window right Click Incidents and Click Load Locations
a. In Load Locations Window
i. Click Browse and navigate to the Participant Locations, Point feature layer
ii. Click on the Participant Locations layer and click Add
iii. Choose the Participant ID/School Id as the Sort field
iv. Choose the Participant ID/School Id Text as the Name field. Accept the default for other Location Analysis Properties
v. Accept the default Location Position
vi. Click OK
11. To set the properties to be used in the Analysis, In the Table of Contents Right Click the Closest Facility Layer and Click Properties
a. Click on Analysis Settings Tab
i. Choose Length (Meters) for Impedance
ii. Choose None for Default Cutoff Values
iii. Choose Facilities To Find as 1
iv. Choose Travel From as Incident To Facility
v. Choose Everywhere for Allow U-Turns
vi. Choose Output Shape Type as True Shape
vii. Check the box to Ignore Invalid Locations
b. Click Ok
12. On the Network Analyst Toolbar, Click Solve Button
13. Joining attributes with Source Point Layer to carry over the data (only for ArcGIS 9.1)
a. Right Click the Routes Layer
b. Click Joins and Relates and then Join
i. Choose Facility Id as the Field to base the join on
ii. Choose the Restaurant Layer as the Table to Join to this layer
iii. Choose the Restaurant ID as the field in the table to base the join on
iv. Click Ok
c. Right Click the Routes Layer
d. Click on Data and then Export Data
iii. Choose this layer's source data for the coordinate system
iv. Specify the Output location

In ArcGIS 9.2 the name field of routes contains the Incident Id (Participant Id) to Facility ID (Feature of Interest ID). It indicates which Participant is connected to which Feature of Interest via the route.

The length of the nearest distance segment from a participant's location to the nearest feature of interest is stored in the Total Length attribute.

### 2.7 Measurement Geography Type 5: Home to School Route Buffer

Note: this was updated slightly in Version 1.3 to take account of home-schooled children and change the buffer from 100 m to 50 m on either side of the route.

## 1. Basic Concept

The idea behind this measure is that the home to school route is important for youth, and the features (businesses, recreation opportunities, densities, etc) along the route may be an important part of the youth's daily environment. Complications occur because youth may take the bus or be driven and they may not take the shortest route. This measurement is exploratory.

## 2. Basic Definition

The shortest network path between home to school and an area 50 m on either side of it.

## 3. Detailed Definition

The shortest network path between home to school and an area 50 m on either side of it

## 4. Comments and Explanations

This is fairly easy to do in ArcGS 9.2 compared to ArcGIS 9.1 due to the ability of ArcGIS 9.2 to calculate multiple routes. We initially proposed to exclude freeways and other limited access highways which would not be accessible to pedestrians, but because students going to school might well be in cars we decided that this would not be an appropriate exclusion. Also, we removed home-schooled students from the participant dataset before calculating the route. ArcGIS 9.2 will not calculate a route if the student's school and home are the same location.

## 5. GIS Approach

The GIS Approach for this protocol is a two stage process. First, create the shortest network path between Home to School, and then buffer it for a distance of 50 meters. The route solver with multiple routes in Network Analyst 9.2 creates the route from each participant home location to the respective school. The route created by Network Analyst is then buffered using Buffer Tool in ArcToolbox, the buffer created represents the area of 50 meters around the route. Round buffer type is used to be able to cover all the area accessible to the participant.

## 6. GIS Steps

Requirements:

1. Roads Layer Network dataset
2. Participant Home Location Point Feature Layer for origin
3. School Location Point Feature Layer for destination
4. Network Analyst Extension for ArcGIS 9.2
I. Create Home To School Route
5. Start ArcMap
6. On the Main Menu click Tools and Click on Extensions.
a. Check Network Analyst Extension.

## b. Click Close

3. Click the Add Data button on the Standard Toolbar
a. Navigate to the Network Dataset location.
b. Click on the Network Dataset and click Add to add the Network Dataset to ArcMap.
c. Click No to add all the feature classes, which participate in the network, to the map.
4. Click the Add Data button $\underset{ }{ \pm}$ on the Standard Toolbar
a. Navigate to the Point Layers to be used for analysis, in this case Participant Home location and School Locations
b. Click on the Point Layers and click Add to add it to ArcMap.
5. If the School Id and Participant ID's are already assigned go to next step else, In the Table of Contents Right Click the Point Layer and click on Open Attribute Table
a. In the Attribute Table
i. Click Options
ii. Click Add Field
iii. Add the School_Id/Participant_Id as Text

- Type School_Id_T/Participant_Id_T in the Name field
- Select Text (100) as Type
- Accept default for Length
- Click OK
iv. Add the School_Id/Participant_Id as Integer
- Type School_Id/Participant_Id in the Name field
- Select Short Integer as Type
- Accept default (0) for Precision
- Click OK
v. Enter the assigned Id for the participants and schools

6. On the main menu click View
a. Click on Toolbars
b. In the side menu click Network Analyst to add the Network Analyst toolbar to ArcMap
7. Click Network Analysis Toolbar
a. Click Network Analyst Window button 国 to add the Network Analyst Window to the map
8. In ArcToolbox Click on Network Analyst Tools and then Click on Calculate Locations
a. Add the School Location Point layer as the Input Point Layer
b. Add the Road Network Dataset as the Input Analysis network
c. Accept all other defaults
d. Click Ok
9. Join the School and Participant layer using School Id,
a. In the Table of contents Right Click Participant Location layer
b. Click Join and Relates and then Join
i. Choose School Id as the field to base the join on
ii. Choose the School Location layer as the Table to Join to this layer
iii. Choose the School Id as the field in the table to base the join on
iv. Click Ok
10. On the Network Analyst Toolbar Click Network Analyst Dropdown Menu
a. Click New Route
b. The Table of contents and the Network Analyst Window contains empty list of Stops, Barriers and Routes Categories.
11. On the Network Analyst Window right click Stops and then click Load Locations, to add the origin locations
a. In Load Locations Window
i. Choose the Participant Location layer for Load from, these points would be the origin stops.
ii. Choose Participant Id as the Sort Field
iii. Choose the Participant Id as the Name and RouteName
iv. Choose Search Tolerance of $\mathbf{1 0 0}$ meters for location position
v. Click OK
12. Again right click Stops and then click Load Locations, to add the destination locations
a. In Load Locations Window
i. Choose the Participant Location layer for Load from
ii. Choose School.School Id as the Sort Field
iii. Choose the School.School Id as the Name
iv. Choose the Participant.Participant Id as the RouteName
v. Choose Use Network Location Fields, calculated in Step 8 for location position

- Choose PosAlong from School Point layer attributes for PosALong Property
- Choose SideOfEdge from School Point layer attributes for SideOfEdge Property
- Choose SourceID from School Point layer attributes for SourceID Property
- Choose SourceOID from School Point layer attributes for SourceOID Property
vi. Click on Advance Tab
- Check Snap to Position Along Network
- Check Loading locations using locations fields
vii. Click OK

13. Click Solve Button to generate the routes
14. Join the route layer with Source Point layer to carry over the data
a. Right Click the Routes Layer
b. Click Joins and Relates and then Join
i. Choose Name as the Field to base the join on
ii. Choose the Participant Location Layer as the Table to Join to this layer
iii. Choose the Participant ID Text as the field in the table to base the join on
iv. Click Ok
e. Right Click the Routes Layer
f. Click on Data and then Export Data
v. Choose this layer's source data for the coordinate system
vi. Specify the Output location
II. Create 100 meters buffer around the route from Home to School
15. Click Analysis Tools
16. Click Proximity
17. Click Buffer
a. Add the Route layer created in Step 14 as the Input Layer
b. Name the output feature class appropriately
c. Type 50 meters as the Linear unit for Distance
d. Choose Full as Side Type
e. Choose Round as the End Type
f. Choose None as Dissolve Type
g. Click Ok

You now have the route layer and the area of 50 meters around it.

## 3. RESTAURANTS A.K.A. FOOD SERVICES

Note: these protocols were developed by Ann Forsyth (definitions and concepts) and Nishi Mishra (GIS steps).
Typically, in research to date, restaurants have been identified in four ways.

- Some municipalities have very detailed land use data allowing identification of restaurants as a group and of different types (Forsyth 2006). Such data are not consistently available across the seven counties of the Twin Cities Metropolitan area.
- Some areas have a consistent food service licensing process across the relevant study area meaning similar data are collected and stored. As is explained in chapter 1, this is not the case in the Twin Cities as there is a maze of licensing bodies.
- Many researchers have used lists of chain restaurant names to identify major fast food restaurants in either GIS studies or for surveys (e.g. Pereira et al 2005; Block et al 2004). This study proposes to take this approach and to use a number of different lists focusing on different definitions of fast food. A key issue is that fast food is a broad category including not only the prototypical burger joints but potentially also such limited service chains as Starbucks.
- Other researchers have used SIC or NAICS codes to classify types of stores. As was noted in chapter 1, the accuracy of these classifications varies greatly across databases. We propose to use Dun and Bradstreet that seems, in our initial assessment, to have more accurate and detailed classifications than other available sources. However, in future work we will be checking whether this is the case. The various measures also have various levels of cross checking of addresses and other features.

There are three sorts of measures that are included in these protocols:

- Some measures repeat those already used in the literature.
- Other measures try to take advantage of improvements in data or GIS technologies to develop new measures to more effectively measure food quality. After all, it is not really important whether someone eats at a fast food restaurant or a restaurant with table service. What is most important is the quality and character of the food that they purchase and eat.
- Others try to measure using GIS what is also being measures via survey or checklist in other parts of the study. In this way we can analyze perceived vs. GIS or observed vs. GIS measures.


### 3.1 Distance to Nearest Restaurant

## 1. Basic Concept

The idea of this measure is that the street distance or straight line to any away from home restaurant will affect the number of away from home meals. This measure does not distinguish between types of restaurants.

## 2. Basic Definition

Distance to nearest restaurant = The shortest network or straight line path between home or school and the nearest restaurant.

## 3. Detailed Definition

Distance to nearest restaurant = The shortest network or straight line path between home or school and the nearest restaurant where restaurants are defined as the following NAICS codes:

722110 Full-Service Restaurants
722211 Limited-Service Restaurants

```
7 2 2 2 1 2 ~ C a f e t e r i a s ~
722213 Snack and Nonalcoholic Beverage Bars (part)
```

As this is a study of adolescents, we did not include alcoholic beverage drinking places or dinner theaters. The measure uses Dun and Bradstreet data checked against local government address data.

## 4. Comments and Explanations

This is done by using the Find Closest Facility option in Network Analyst Extension of ArcGIS 9.1. A point layer, to which the shortest network distance is to be calculated, is specified as the "facility" layer and the point, from which the distance is to be calculated, serves as the origin. The shortest path to the 'facility" from the specified origin is calculated using the road network.

For points that do not fall on the network, there is a dialog box when using this extension that allows the user to decide how far away from the network to search for points to use in the processing. Points outside that distance will not be used.

## 5. GIS Approach

The approach for this measure is to load a set of origins and destinations, then use the Closest Facility feature in Network Analyst to calculate the network distance from each origin to the nearest destination. The straightline distance is calculated using the Near Tool in ArcToolbox.

## 6. GIS Steps

Requirements:

1. Road Layer polyline
2. Point Features for origin and destinations
3. Network Analyst Extension for ArcGIS 9.1

Query and extract data for Restaurants according to specified NAICS codes from Dun \& Bradstreet data, if the restaurant layer is not already prepared

1. Start ArcMap
2. Click the Add Data button $V$ on the Standard Toolbar.
a. Navigate to the Dun \& Bradstreet data
b. Click on the Dun \& Bradstreet dataset and click Add to add the dataset to the Map
3. Right Click the Dun \& Bradstreet data and Click Open Attribute Table
a. Click on Options
b. Click Select by Attributes
i. Select Create a new selection as Method
ii. Click on "PrimaryNai" in the Attributes list and click on Unique values (since this can take substantial time, instead of this consider typing the codes as mentioned below)
iii. Click " $=$ " operator
iv. Click or Type 722110
v. Click "OR" operator
vi. Repeat steps ii to $\mathbf{v}$ changing the values to 722211, 722212, 722213
vii. The SELECT * FROM Dun \& Bradstreet WHERE: should: look like
"PrimaryNai" =722110 OR "PrimaryNai" =722211 OR "PrimaryNai" =722212 OR "PrimaryNai" =722213
viii. Click Apply
c. Right Click the Dun \& Bradstreet data and Click Data and then Export data
i. Choose Selected Features for Export
ii. Choose this layer's source data for Use the same coordinate system as:
iii. Navigate to appropriate folder and give the output file an appropriate name for Output shapefile or feature class
iv. Click OK
v. Click Yes to add the data to current data frame
A. Calculate the Network Distance to Nearest Restaurant
4. Start ArcMap
5. On the Main Menu click Tools and Click on Extensions.
c. Check Network Analyst Extension.
d. Click Close
6. Click the Add Data button $\downarrow$ on the Standard Toolbar
a. Navigate to the Network Dataset location, created earlier.
b. Click on the Network Dataset and click Add to add the Network Dataset to ArcMap.
c. Click Yes to add all the feature classes, that participate in the network, to the map.
7. Click the Add Data button $\underset{\sim}{ \pm}$ on the Standard Toolbar
a. Navigate to the Point Layers to be used for analysis, in this case Participant location and Restaurant Locations
b. Click on the Point Layers and click Add to add it to ArcMap.
8. In the Table of Contents Right Click the Point Layer and click on Open Attribute Table
a. In the Attribute Table
vi. Click Options
vii. Click Add Field
viii. Add the Restaurant_Id/Participant_Id as Text

- Type Restaurant_Id_T/Participant_Id_T in the Name field
- Select Text (50) as Type
- Accept default for Length
- Click OK
ix. Add the Restaurant_Id/Participant_Id as Integer
- Type Restaurant_Id/Participant_Id in the Name field
- Select Short Integer as Type
- Accept default (0) for Precision
- Click OK
x. Enter the assigned Id for the participants and schools

6. On the main menu click View
a. Click on Toolbars
b. In the side menu click Network Analyst to add the Network Analyst toolbar to ArcMap
7. Click Network Analysis Toolbar
a. Click Network Analyst Window button 铟 to add the Network Analyst Window to the map
8. On the Network Analyst Toolbar Click Network Analyst Dropdown Menu
a. Click New Closest Facility
b. The Table of contents and the Network Analyst Window contains empty list of Facilities, Incidents, Routes and Barriers Categories.
9. On the Network Analyst Window right Click Facilities and Click Load Locations
a. In Load Locations Window
i. Click Browse and navigate to the Restaurant Locations, Point feature layer
ii. Click on the Restaurant Locations layer and click Add
iii. Choose the Restaurant Id as the Sort field
iv. Choose the Restaurant Id Text as the Name field. Accept the default for other Location Analysis Properties
v. Accept the default Location Position
vi. Click OK
10. On the Network Analyst Window right Click Incidents and Click Load Locations
a. In Load Locations Window
i. Click Browse and navigate to the Participant Locations, Point feature layer
ii. Click on the Participant Locations layer and click Add
iii. Choose the Participant ID/School Id as the Sort field
iv. Choose the Participant ID/School Id Text as the Name field. Accept the default for other Location Analysis Properties
v. Accept the default Location Position
vi. Click OK
11. To set the properties to be used in the Analysis, In the Table of Contents Right Click the Closest Facility Layer and Click Properties
a. Click on Analysis Settings Tab
i. Choose Length (Meters) for Impedance
ii. Choose None for Default Cutoff Values
iii. Choose Facilities To Find as 1
iv. Choose Travel From as Incident To Facility
v. Choose Everywhere for Allow U-Turns
vi. Choose Output Shape Type as True Shape
vii. Check the box to Ignore Invalid Locations
b. Click Ok
12. On the Network Analyst Toolbar, Click Solve Button
13. Joining attributes with Source Point Layer to carry over the data
a. Right Click the Routes Layer
b. Click Joins and Relates and then Join
i. Choose Facility Id as the Field to base the join on
ii. Choose the Restaurant Layer as the Table to Join to this layer
iii. Choose the Restaurant ID as the field in the table to base the join on
c. Right Click the Routes Layer
d. Click on Data and then Export Data
i. Choose this layer's source data for the coordinate system
ii. Specify the Output Location

In ArcGIS 9.2 the name field of routes contains the Incident Id (Participant Id) to Facility ID (Restaurant ID). It indicates which Participant to which restaurant the route connects.

The length of the nearest distance segment from a participant's location to the nearest restaurant is stored in the Total Length attribute.
B. Straightline distance

1. Open ArcToolbox, then click Analysis Tools
2. Click on Proximity Tools
3. Click on Near tool
a. Navigate and Choose Participant Layer as the Input Features
b. Navigate and Choose Restaurant layer as Near Features
c. Check Location and angle, if need to calculate them
d. Click Ok

The straightline distance to nearest restaurant is stored in the attribute table under field name Near_Dist. The Near_FID field has the FID of the Nearest Restaurant.

### 3.2 Restaurant Density

Note: The GIS Steps fore calculating the network buffer were updated in Version 1.3.

## 1. Basic Concept

The idea behind this measure is that the density of away from home restaurants within a certain radius or street distance will affect the number of away from home meals. This measure does not distinguish between types of restaurants.

## 2. Basic Definition

Restaurant density $=$ Total restaurants per unit land area (excluding water).

## 3. Detailed Definition

Restaurant density $=$ Total restaurants per unit land area (excluding water) where restaurants are defined as the following NAICS codes:

722110 Full-Service Restaurants 722211 Limited-Service Restaurants 722212 Cafeterias 722213 Snack and Nonalcoholic Beverage Bars (part)
As this is a study of adolescents, we did not include alcoholic beverage drinking places or dinner theaters. There is, however, a separate question dealing with alcohol.

## 4. Comments and Explanations

To calculate the density of restaurants, it is necessary to first demarcate the area within which the density will be calculated (e.g. a buffer) and then count the number of restaurants in the area. After the area is demarcated and the number of restaurants is counted, the density is simply calculated by dividing the number of restaurants by the area.

## 5. GIS Approach

The GIS approach for calculating the density of restaurants, is to first generate the buffer area around the participant location within which the density will be calculated. The buffer areas are generated using the New Service Area option in the Network Analyst. Then the water feature area is erased from the buffer area, as people would not walk on water. To erase the water features Erase Tool is used from the Overlay Toolset in Analysis Toolbox of ArcToolbox. After the water features are erased from the buffer area, the area of the buffer is calculated using XTools extension. The calculated area is stored in the attribute table. The number of restaurants within this buffer area is then counted by doing a spatial join between the restaurant point layer and the polygon buffer area layer. The spatial join outputs the number of restaurant points which fall within the area of a particular buffer, as count in the attribute table. The density is then calculated by dividing the number of restaurants by the area of the buffer.
6. GIS Steps

Requirements:

1. Restaurant Layer (Point)
2. Participant Layer (Point)
3. Water feature layer (Polygon)
4. Roads Network dataset
II. Create network buffers for participant location
5. Start ArcMap
6. On the Main Menu click Tools and Click on Extensions.
e. Check Network Analyst Extension.
f. Click Close.
7. Click the Add Data button $V$ on the Standard Toolbar
a. Navigate to the Network Dataset location, created earlier. (If need to create a new Network dataset. Look at Appendix for steps to create a network dataset.)
b. Click on the Network Dataset and click Add to add the Network Dataset to ArcMap.
c. Click No when asked to add all the feature classes, which participate in the network, to the map.
8. Click the Add Data button $\downarrow$ on the Standard Toolbar
a. Navigate to the Point Layers to be used for analysis, in this case Participant location and Restaurant Locations
b. Click on the Point Layers and click Add to add it to ArcMap
9. On the main menu click View
a. Click on Toolbars
b. In the side menu click Network Analyst to add the Network Analyst toolbar to ArcMap
10. Click Network Analysis Toolbar
a. Click Network Analyst Window button

国 to add the Network Analyst Window to the map
7. On the Network Analyst Toolbar Click Network Analyst Dropdown Menu
a. Click New Service Area
b. The Table of contents and the Network Analyst Window contains empty list of Facilities, Barriers, Lines and Polygons Categories.
8. Add the Id's if not already added. Click the In the Table of Contents Right Click the Point Layer and click on Open Attribute Table
b. In the Attribute Table
i. Click Options
ii. Click Add Field
iii. Add the School_Id/Participant_Id as Text

- Type School_Id_T/Participant_Id_T in the Name field
- Select Text (50) as Type
- Accept default for Length
- Click OK
iv. Add the School_Id/Participant_Id as Integer
- Type School_Id/Participant_Id in the Name field
- Select Short Integer as Type
- Accept default (0) for Precision
- Click OK
v. Enter the assigned Id for the participants and schools

9. On the Network Analyst Window right Click Facilities and Click Load Locations
a. In Load Locations Window
i. For Load From click Browse and navigate to the Participant Locations, Point feature layer
ii. Click on the Participant Locations layer and click Add
iii. Choose the Participant Id as the Sort field
iv. Choose the Participant Id Text as the Name field.
v. Accept the default for Location Position as Use Geometry - Set the Search Tolerance to 50 meters
vi. Click OK
10. To set the properties to be used in the Analysis, In the Table of Contents Right Click the Service Area Layer and Click Properties
a. Click on Analysis Settings Tab
i. Choose Length (Meters) for Impedance.
ii. Type the required Buffer Distance for Default Breaks
iii. Choose Away From Facility as Direction
iv. Choose Everywhere for Allow U-Turns
v. Check Ignore Invalid Locations
b. Click on Polygon Generation Tab
i. Check Generate Polygons
ii. Choose Generalized as the Polygon Type
iii. Uncheck Trim Polygons
iv. Choose Overlapping for Multiple Facilities Option
v. Choose Disks as the Overlap Type
c. Click Ok
11. On the Network Analyst Toolbar, Click Solve Button
12. Joining attributes with Source Point Layer to carry over the data.
a. Right Click the Polygons Layer
b. Click Joins and Relates and then Join
c. Choose Join attributes from a table
i. Choose Facility Id as the Field to base the join on
ii. Choose the Participant Layer as the Table to Join to this layer
iii. Choose the Participant ID as the field in the table to base the join on
d. Right Click the Polygons Layer
e. Click on Data and then Export Data
i. Choose this layer's source data for the coordinate system
ii. Specify the Output location
III. Erase water features from the network buffer \& calculate area of network buffer
13. Click the Add Data button on the Standard Toolbar
a. Navigate to the Water feature Layer to be used for analysis
b. Click on the Water feature Layer and click Add to add it to ArcMap
14. In the ArcToolbox, Click on Analysis Tools
15. Click on Overlay tools, and double click Erase. In the dialog box,
a. Choose the Exported Network Buffer Layer as the Input Layer
b. Choose the Water Feature layer as the Erase Features
c. Choose an appropriate Output Location and Name for the Output Feature Class
d. Click Ok
16. Click Yes to add the exported feature layer to the map
IV. Calculate the Area of Network Buffers
17. Add area fields to the output feature class created in the previous step.
a. Right click on the Output Feature Class and select Open Attribute Table...
b. Click on the Option button and select Add Field...
c. Name the field Hectares and change the Type to Double. If an Hectares field already exists, you can cancel this operation and overwrite the hectares values
d. Click OK
18. Calculate the values for Hectares
a. Right-click the Hectares field in the Output Feature Class attribute table and select Calculate Geometry...
b. Set the Property: box to Area
c. Set the Coordinate System to "Use coordinate system of the data source"
d. Set the Units to Hectares [ha].
e. Click OK.
V. Spatial Join to calculate the number of restaurants
19. Right click the buffer layer with erased water features layer (created and added in step II)
20. Click Join and Relates and then Click Join
a. Select Join data from another layer based on spatial location for Join Type
b. Choose the Restaurant Location layer to join to this layer
c. Select the option for count field
d. Do not check any radio-dial for summarizing the data
e. Specify an appropriate location and name for the output feature class
f. Click $\mathbf{O k}$
g. Click Yes to add the feature class
VI. Calculate the density of restaurants
21. Open the attribute table of the spatial join feature class created in above step
22. Click Options and then Add field
a. Type Density for Name
b. Select Double for Type
c. Accept default for Precision and Scale
23. Right Click on the Density field and select field calculator
a. Click on Count in fields
b. Click on operator ' $l$ '
c. Click on Hectare in fields
d. The Density equation should look like: Density = Count/Hectare
e. Click Ok

The Density fields contains the density number of restaurants per square hectare of the network buffer around participant location

## 3.3: Distance to Fast Food Restaurants

Note: this was significantly updated in Version 1.3 changing the method for selecting fast food restaurants from chain names to NAICS codes.

## 1. Basic Concept

While fast food is a commonly understood term, it is actually quite difficult to define it in a meaningful way. It is also not particularly clear that fast food per se is less healthy than slower food as there are choices in both types. However, more research is needed in this area and definitional clarity will help such research.

The TREC-IDEA study uses two types of questions about this restaurant type:, one asking a global question about fast food in general and the other breaking the restaurants into subcategories. This protocol uses chain names to answer the first type of question-about fast food in general-- and the next group of protocols uses SIC/NAICS codes to look at specific types of fast food. This protocol relates to the following questions from the TREC-IDEA survey:

- PS63 In the past month, how many times did you buy food at a restaurant where food is ordered at a counter or at a drive-through window (there is no waiter/waitress)? (Based on Project EAST (10)) Fast Food
- SS163 During a normal school week, how many days per week do you get lunch off campus at a fast food restaurant? ( TACOS Student Survey (11))
- SS 173 About how long would it take to get from your home to the nearest fast food restaurant if you walked? (Adapted from NEWS B12 (14))
- PS 70During the past 7 days, how many times was a family evening meal purchased from a fast food restaurant and eaten either at the fast food restaurant or at home? (Part 1, \#4 Jayne's Family Meal Packet)

We used NAICS codes to locate fast food restaurants, specifically:
722211 Limited-Service Restaurants
722213 Snack and Nonalcoholic Beverage Bars
In comparison Dun and Bradstreet classified $48 \%$ in this category and a visual review of the data indicated that the classifications seemed largely appropriate (see Appendix 1E).

We inviestigared an alternative using chain names to classify fast food (E.g. Pereira et al 2005; Block et al. 2004: Bourdette and Whitacker 2003,59. However NAICS codes were more convenient and found some very local stores. A paper in preparation deals with these issues in more depth and is available from the editor. It is important to note that we used Dun and Bradstreet as Business Analyst was more problematic in this light, classifying $97 \%$ of restaurants in our study area as limited service.

## 2. Basic Definition

Distance to Fast Food Restaurants $=$ The shortest network or straight line distance between home or school and the nearest fast food restaurant.

## 3. Detailed Definition

Distance to Fast Food Restaurants $=$ The shortest network or straight line distance between home or school and the nearest fast food restaurant defined using NAICS codes (722211 Limited-Service Restaurants, $\underline{722213 \text { Snack and Nonalcoholic Beverage Bars) and found in Dun and Bradstreet. }}$

## 4. Comments and Explanations

This is similar to the protocol 3.1, distance to nearest restaurant, and calculates the distance to nearest fast food restaurant by using the Find Closest Facility option in Network Analyst Extension of ArcGIS 9.1 or ArcGIS 9.2.

For detailed explanation see Protocol 3.1

## 5. GIS Approach

First the Fast Food Restaurants are extracted from the master data and then the nearest distance to these locations is calculated. The basic idea is similar to the protocol 3.1, distance to nearest restaurant. Nearest network distance between a set of origin locations and destination locations is calculated using Network Analyst and straight line distance is calculated using the Near tool in ArcToolbox.

For detailed explanation see Protocol 3.1

## 6. GIS Steps

Requirements:

1. Road Network feature dataset
2. Point Features (Fast Food Restaurants layer) for finding the nearest distance to
3. Point Features (Participants layer) for finding the nearest distance from
4. Network Analyst Extension for ArcGIS 9.2
I. Query and extract data for Fast Food Restaurants from Dun and Bradstreet data, according to names specified in the master list, if the restaurant layer is not already prepared
5. Start ArcMap
6. Click the Add Data button
on the Standard Toolbar.
a. Navigate to the Dun \& Bradstreet data
b. Click on the Dun \& Bradstreet dataset and click Add to add the dataset to the Map
7. Right Click the Dun \& Bradstreet data and Click Open Attribute Table
a. Click on Options
b. Click Select by Attributes
i. Select Create a new selection as Method
ii. Click on "PrimaryNai" in the Attributes list and click on Unique values (since this can take substantial time, instead of this consider typing the codes as mentioned below)
iii. Click " $=$ " operator
iv. Click or Type 722211 (Limited-service restaurants)
v. Click "OR" operator
vi. Click on "PrimaryNai" again.
vii. Click " $=$ " operator
viii. Click or Type 722213 (Snack \& Nonalcoholic Beverage Bars)
ix. Click Apply
c. Right Click the Dun \& Bradstreet data and Click Data and then Export data
i. Choose Selected Features for Export
ii. Choose this layer's source data for Use the same coordinate system as:
iii. Navigate to appropriate folder and give the output file an appropriate name for Output shapefile or feature class
iv. Click OK
v. Click Yes to add the data to current data frame
II. Calculate the Network and Straight line Distance to Nearest Fast Food Restaurant
A. Network Distance
8. Start ArcMap
9. On the Main Menu click Tools and Click on Extensions.
a. Check Network Analyst Extension.
b. Click Close
10. Click the Add Data button on the Standard Toolbar
a. Navigate to the Network Dataset location, created earlier
b. Click on the Network Dataset and click Add to add the Network Dataset to ArcMap.
c. Click Yes to add all the feature classes, that participate in the network, to the map.
11. Click the Add Data button on the Standard Toolbar
a. Navigate to the Point Layers to be used for analysis, in this case Participant location and Fast Food Restaurant Locations
b. Click on the Point Layers and click Add to add it to ArcMap.
12. Assign Id's to the fast food restaurants and the participant's if not done already. In the Table of Contents Right Click the Point Layer and click on Open Attribute Table
a. In the Attribute Table
i. Click Options
ii. Click Add Field
iii. Add the FastfId_T/Part_Id_T as Text

- Type FastfId_T/Part_Id_T in the Name field
- Select Text (50) as Type
- Accept default for Length
- Click OK
iv. Add the Fastf_Id/Part_Id as Short Integer
- Type Fastf_Id/Part_Id in the Name field
- Select Short Integer as Type
- Accept default (0) for Precision
- Click OK
v. Enter the assigned Id for the participants and schools

6. On the main menu click View
a. Click on Toolbars
b. In the side menu click Network Analyst to add the Network Analyst toolbar to ArcMap
7. Click Network Analysis Toolbar
a. Click Network Analyst Window button

国 to add the Network Analyst Window to the map
8. On the Network Analyst Toolbar Click Network Analyst Dropdown Menu
a. Click New Closest Facility
b. The Table of contents and the Network Analyst Window contains empty list of Facilities, Incidents, Routes and Barriers Categories.
9. On the Network Analyst Window right Click Facilities and Click Load Locations
a. In Load Locations Window
i. Click Browse and navigate to the Fast Food Restaurants Locations, Point feature layer
ii. Click on the Fast Food Restaurants Locations layer and click Add
iii. Choose the Fast Food Restaurants Id as the Sort field
iv. Choose the Fast Food Restaurants Id Text as the Name field. Accept the default for other Location Analysis Properties
v. Use 50 Meters for Location Position, Use Geometry (increase the search tolerance if many locations are not located)
vi. Click OK
10. On the Network Analyst Window right click Incidents and Click Load Locations
a. In Load Locations Window
i. Click Browse and navigate to the Participant Locations, Point feature layer
ii. Click on the Participant Locations layer and click Add
iii. Choose the Participant ID/School Id as the Sort field
iv. Choose the Participant ID/School Id Text as the Name field. Accept the default for other Location Analysis Properties
v. Use 50 Meters for Location Position, Use Geometry (increase the search tolerance if many locations are not located)
vi. Click OK
11. To set the properties to be used in the Analysis, In the Table of Contents Right Click the Closest Facility Layer and Click Properties
a. Click on Analysis Settings Tab
i. Choose Length (Meters) for Impedance
ii. Choose None for Default Cutoff Values
iii. Choose Facilities To Find as 1
iv. Choose Travel From as Incident To Facility
v. Choose Everywhere for Allow U-Turns
vi. Choose Output Shape Type as True Shape
vii. Check the box to Ignore Invalid Locations
b. Click Ok
12. On the Network Analyst Toolbar, Click Solve Button
13. Joining attributes with Source Point Layer to carry over the data (only for ArcGIS 9.1)
a. Right Click the Routes Layer
b. Click Joins and Relates and then Join
i. Choose Facility Id as the Field to base the join on
ii. Choose the Fast Food Restaurants Layer as the Table to Join to this layer
iii. Choose the Fast Food Restaurants ID as the field in the table to base the join on
iv. Click Ok
c. Right Click the Routes Layer
d. Click on Data and then Export Data
i. Choose this layer's source data for the coordinate system
ii. Specify the Output location

In ArcGIS 9.2 the name field of routes contains the Incident Id (Participant Id) to Facility ID (Retail Food Outlets ID) in the format Incident Id - Facility ID. It indicates the route connects a participant to the corresponding retail food outlets.

The length of the nearest distance segment from a participant's location to the nearest retail food outlet is stored in the Total Length attribute.
B. Straight line distance

1. Open ArcToolbox, then click Analysis Tools
2. Click on Proximity Tools
3. Click on Near tool
a. Navigate and Choose Participant Layer as the Input Features
b. Navigate and Choose Fast Food Restaurants layer as Near Features
c. Check Location and angle, if need to calculate them
d. Click OK

The straightline distance to nearest fast food restaurant is stored in the attribute table under field name Near_Dist. The Near_FID field has the FID of the Nearest Restaurant.

### 3.4 Fast Food Restaurant Density

Note: This protocol was updated in Version 1.3 to use NAICS codes to identify fast food restaurants.

## 1. Basic Concept

The number of restaurants close to where someone lives or goes to school may be more important than the nearest one. After all in food, choices is often important. This measures the density of the comprehensive list of fast food restaurants in Protocol 3.3.

## 2. Basic Definition

Fast Food Restaurant Density = Total fast food restaurants per unit land area (excluding water).

## 3. Detailed Definition

Fast Food Restaurant Density = Total fast food restaurants per unit land area (excluding water) where fast food restaurants are defined as defined using NAICS codes ( 722211 Limited-Service Restaurants, 722213 Snack and Nonalcoholic Beverage Bars) and found in Dun and Bradstreet.

## 4. Comments and Explanations

The protocol is similar to the Protocol 3.2 , Density of Restaurants, However only the fast food restaurants are used in this case. The area within which the density has to be calculated is demarcated, the number of retail food outlets in the area is counted and the number is divided by the area to get the density.

## 5. GIS Approach

First, the fast food restaurants are extracted from the master data and then a buffer area is created using Network Analyst. Then, the water features are erased from the buffers using Erase tool, and then the
area of the buffer layer with erased water features is calculated. The number of retail food outlets is counted with a spatial join between the buffer layer and the retail food outlet location layer. The number of retail food outlet locations is then divided by the area in hectares to get the density.

For a detailed explanation refer to GIS Approach in Protocol 3.2

## 6. GIS Steps

Requirements:

1. Road Layer polyline
2. Point Features (Fast Food Restaurants layer) for finding the nearest distance to
3. Point Features (Participants layer) for finding the nearest distance from
4. Network Analyst Extension for ArcGIS 9.1 or ArcGIS 9.2
I. Query and extract data for Fast Food Restaurants from Dun and Bradstreet data, according to names specified in the master list, if the restaurant layer is not already prepared
5. Start ArcMap
6. Click the Add Data button $\pm$ on the Standard Toolbar.
a. Navigate to the Dun \& Bradstreet data
b. Click on the Dun \& Bradstreet dataset and click Add to add the dataset to the Map
7. Right Click the Dun \& Bradstreet data and Click Open Attribute Table
a. Click on Options
b. Click Select by Attributes
i. Select Create a new selection as Method
ii. Click on "PrimaryNai" in the Attributes list and click on Unique values (since this can take substantial time, instead of this consider typing the codes as mentioned below)
iii. Click "=" operator
iv. Click or Type 722111 (Limited-Service Restaurants)
v. Click "OR" operator
vi. Click on "PrimaryNai" again.
vii. Click " $=$ " operator
viii. Click or Type 722213 (Snack \& Nonalcoholic Beverage Bars)
ix. Click Apply
c. Right Click the Dun \& Bradstreet data and Click Data and then Export data
i. Choose Selected Features for Export
ii. Choose this layer's source data for Use the same coordinate system as:
iii. Navigate to appropriate folder and give the output file an appropriate name for Output shapefile or feature class
iv. Click OK
v. Click Yes to add the data to the current data frame
II. Create network buffers for participant location
8. Start ArcMap
9. On the Main Menu click Tools and Click on Extensions.
a. Check Network Analyst Extension.
b. Click Close.
10. Click the Add Data button $\downarrow$ on the Standard Toolbar
a. Navigate to the Network Dataset location, created earlier. (If need to create a new Network dataset. Look at Appendix for steps to create a network dataset.)
b. Click on the Network Dataset and click Add to add the Network Dataset to ArcMap.
c. Click No when asked to add all the feature classes, which participate in the network, to the map.
11. Click the Add Data button on the Standard Toolbar
a. Navigate to the Point Layers to be used for analysis, in this case Participant location and Fast Food Restaurant Locations
b. Click on the Point Layers and click Add to add it to ArcMap
12. On the main menu click View
a. Click on Toolbars
b. In the side menu click Network Analyst to add the Network Analyst toolbar to ArcMap
13. Click Network Analysis Toolbar
c. Click Network Analyst Window button ${ }^{\text {F }}$ to add the Network Analyst Window to the map
14. On the Network Analyst Toolbar Click Network Analyst Dropdown Menu
a. Click New Service Area
b. The Table of contents and the Network Analyst Window contains empty list of Facilities, Barriers, Lines and Polygons Categories.
15. Add the Id's if not already added. In the Table of Contents Right Click the Point Layer and click on Open Attribute Table
a. In the Attribute Table
i. Click Options
ii. Click Add Field
iii. Add the School_Id/Participant_Id as Text

- Type School_Id_T/Part_Id_T in the Name field
- Select Text (50) as Type
- Accept default for Length
- Click OK
iv. Add the School_Id/Participant_Id as Integer
- Type School_Id/Part_Id in the Name field
- Select Short Integer as Type
- Accept default (0) for Precision
- Click OK
v. Enter the assigned Id for the participants and schools

9. On the Network Analyst Window right Click Facilities and Click Load Locations
a. In Load Locations Window
i. For Load From click Browse and navigate to the Participant Locations, Point feature layer
ii. Click on the Participant Locations layer and click Add
iii. Choose the Participant Id as the Sort field
iv. Choose the Participant Id Text as the Name field.
v. Accept the default for Location Position as Use Geometry

- Set the Search Tolerance to $\mathbf{5 0}$ meters
vi. Click OK

10. To set the properties to be used in the Analysis, In the Table of Contents Right Click the Service Area Layer and Click Properties
a. Click on Analysis Settings Tab
i. Choose Length (Meters) for Impedance.
ii. Type the required Buffer Distance for Default Breaks
iii. Choose Away From Facility as Direction
iv. Choose Everywhere for Allow U-Turns
v. Check Ignore Invalid Locations
b. Click on Polygon Generation Tab
i. Check Generate Polygons
ii. Choose Generalized as the Polygon Type
iii. Uncheck Trim Polygons
iv. Choose Overlapping for Multiple Facilities Option
v. Choose Disks as the Overlap Type
c. Click Ok
11. On the Network Analyst Toolbar, Click Solve Button
12. Joining attributes with Source Point Layer to carry over the data.
a. Right Click the Polygons Layer
b. Click Joins and Relates and then Join
c. Choose Join attributes from a table
i. Choose Facility Id as the Field to base the join on
ii. Choose the Participant Layer as the Table to Join to this layer
iii. Choose the Participant ID as the field in the table to base the join on
d. Right Click the Polygons Layer
e. Click on Data and then Export Data
i. Choose this layer's source data for the coordinate system
ii. Specify the Output location
III. Erase water features from the network buffer \& calculate area of network buffer
13. Click the Add Data button on the Standard Toolbar
a. Navigate to the Water feature Layer to be used for analysis
b. Click on the Water feature Layer and click Add to add it to ArcMap
14. In the ArcToolbox, Click on Analysis Tools
15. Click on Overlay tools, and double click Erase. In the dialog box,
a. Choose the Exported Network Buffer Layer as the Input Layer
b. Choose the Water Feature layer as the Erase Features
c. Choose an appropriate Output Location and Name for the Output Feature Class
d. Click Ok
16. Click Yes to add the exported feature layer to the map
IV. Calculate the Area of Network Buffers
17. Add area field to the output feature class created in the previous step
a. Right-click on the Output Feature Class and select Open Attribute Table...
b. Click on the Option button and select Add Field...
c. Name the field Hectares and change the Type to Double. If an Hectares field already exists, you can cancel this operation and overwrite the hectares values
d. Click OK
18. Calculate the values for Hectares
a. Right-click the Hectares field in the Output Feature Class attribute table and select Calculate Geometry...
b. Set the Property: box to Area
c. Set the Coordinate System to "Use coordinate system of the data source"
d. Set the Units to Hectares [ha]
e. Click OK
V. Spatial Join to calculate the number of fast food restaurants
19. Right click the buffer layer with erased water features layer (created and added in step II)
20. Click Join and Relates and then Click Join
a. Select Join data from another layer based on spatial location for Join Type
b. Choose the Fast Food Restaurant Location layer to join to this layer
c. Do not check any radio-dial for summarizing the data
d. Specify an appropriate location and name for the output feature class

## e. Click Ok

f. Click Yes to add the feature class
VI. Calculate the density of fast food restaurants

1. Open the attribute table of the spatial join feature class created in above step
2. Click Options and then Add field
a. Type Density for Name
b. Select Double for Type
c. Accept default for Precision and Scale
3. Right Click on the Density field and select field calculator
a. Click on Count in fields
b. Click on operator ' $/$ '
c. Click on Hectare in fields
d. The Density equation should look like: Density = Count/Hectare
e. Click Ok

The Density field contains the density number of fast food restaurants per square hectare of the network buffer around participant location.

### 3.5 Distance to Fast Food Restaurant Subtypes

Note: These measures were put on hold as of Version 1.3 due to difficulties in comprehensively identifying subtypes.

## 1. Basic Concept

Different types of fast food restaurants may have different food quality or different levels of attractiveness to adolescents. This is the big idea behind this measure.

Several TREC-IDEA survey questions deal with this issue including:

- PS 64 If you went to these types of restaurants in the past month, which restaurants did you go to?
a. Traditional ("burger-and-fries") fast food restaurant, such as McDonalds, Burger

King, Arby's, Wendy's, White Castle
b. Mexican fast food restaurant, such as Taco Bell, Taco Johns or Chipotle
c. Fried chicken, such as KFC
d. Sandwich or sub shop, such as Subway, Panera, Quiznos
e. Pizza parlor or restaurant
f. Asian fast food (such as Chinese, Vietnamese, Korean)
g. Bakery or donut shop
h. Bagel shop
i. Coffee shop
j. Ice cream and burger shop, such as Dairy Queen or Culvers
k. Snack Bars in stores such as Target, WalMart and KMart

1. Other, please specify:

- SS174 About how long would it take to get from your home to the nearest coffee place if you walked? (Adapted from NEWS B13 (14))

This protocol uses NAICS and SIC codes, Dun and Bradstreet descriptors, and lists of chain stores to distinguish between as many of these as possible.

## 2. Basic Definition

Distance to Fast Food Restaurant Subtypes = The shortest network or straight line path between home or school and the nearest fast food restaurant subtype.

## 3. Detailed Definition

Distance to Fast Food Restaurant Subtypes = The shortest network or straight line path between home or school and the nearest fast food restaurant subtype using Dun and Bradstreet descriptors.

## 4. Comments and Explanations <br> [To add.]

## 5. GIS Approach <br> [To come.]

6. GIS Steps
[To come in the next version of these protocols.]

### 3.6 Density Fast Food Restaurant Subtypes

Note: These measures were put on hold as of Version 1.3 due to difficulties in comprehensively identifying subtypes.

1. Basic Concept

This is the density version of Protocol 3.5.

## 2. Basic Definition

Density Fast Food Restaurant Subtypes = Total fast food restaurants per unit land area (excluding water).

## 3. Detailed Definition

Density Fast Food Restaurant Subtypes = Total fast food restaurants per unit land area (excluding water) using Dun and Bradstreet descriptors.

## 4. Comments and Explanations

[To add.]

## 5. GIS Approach

[To come.]

## 6. GIS Steps

[To come in the next version of these protocols.]

### 3.7 Distance to Non Fast Food Restaurants.

Note: This protocol was updated in Version 1.3 to reflect the use of NAICS codes.

## 1. Concept

The TREC-IDEA survey asked students about their perceived distance to non fast food restaurants:

- SS 175 About how long would it take to get from your home to the nearest non-fast food restaurant if you walked? (Adapted from NEWS B15 (14))
- PS 71 During the past 7 days, how many times was a family meal purchased and eaten in other types of restaurants (i.e., full-service, sit down type)? ( Part 1, \#5 Jayne's Family Meal Packet).

To do this we will subtract the fast food restaurants identified in protocols 3.3 and 3.4 , from the total restaurants identified in protocols 3.1 and 3.2. This is a really rough measure but is the best approximation we could make given available data.

## 2. Basic Definition

Distance to Non Fast Food Restaurants = The shortest network or straight line distance between home or school and the nearest non-fast food restaurant.

## 3. Detailed Definition

Distance to Non Fast Food Restaurants $=$ The shortest network or straight line distance between home or school and the nearest non-fast food restaurant where this is defined as the universe of all restaurants using the following NAICS codes:

722110 Full-Service Restaurants 722212 Cafeterias

## 4. Comments and Explanations

This is similar to the protocol 3.1, distance to nearest restaurant, however this protocol calculates the distance to nearest non-fast food restaurant by using the Find Closest Facility option in Network Analyst Extension of ArcGIS 9.1 or ArcGIS 9.2.

For detailed explanation see Protocol 3.1

## 5. GIS Approach

First the Non-Fast Food Restaurants are extracted from the master data and then the nearest distance to these locations is calculated. The basic idea is similar to the protocol 3.1, distance to nearest restaurant. Nearest network distance between a set of origin locations and destination locations is calculated using Network Analyst and straight line distance is calculated using Near tool in ArcToolbox.

For detailed explanation see Protocol 3.1

## 6. GIS Steps

Requirements:

1. Road Layer polyline
2. Point Features (Non-Fast Food Restaurants layer) for finding the nearest distance to
3. Point Features (Participants layer) for finding the nearest distance from
4. Network Analyst Extension for ArcGIS 9.1 or ArcGIS 9.2
I. Query and extract data for Non-Fast Food Restaurants from Dun and Bradstreet data, if the restaurant layer is not already prepared. This would require the expression used to select Fast Food Restaurants

## 1. Start ArcMap

2. Click the Add Data button $\downarrow$ on the Standard Toolbar.
a. Navigate to the Dun \& Bradstreet data
b. Click on the Dun \& Bradstreet dataset and click Add to add the dataset to the Map
3. Right Click the Dun \& Bradstreet data and Click Open Attribute Table
a. Click on Options
b. Click Select by Attributes
i. Select Create a new selection as Method
ii. Click on "PrimaryNai" in the Attributes list and click on Unique values (since this can take substantial time, instead of this consider typing the codes as mentioned below)
iii. Click "=" operator
iv. Click or Type 722110 (Limited-service Restaurants)
v. Click "OR" operator
vi. Click on "PrimaryNai" again
vii. Click " $=$ " operator
viii. Click or Type 722212 (Cafeterias)
ix. Click Apply
c. Right Click the Dun \& Bradstreet data and Click Data and then Export data
i. Choose Selected Features for Export
ii. Choose this layer's source data for Use the same coordinate system as:
iii. Navigate to appropriate folder and give the output file an appropriate name for Output shapefile or feature class
iv. Click OK
v. Click Yes to add the data to current data frame
II. Calculate the Network and Straight line Distance to Nearest Non-Fast Food Restaurant
A. Network Distance
4. Start ArcMap
5. On the Main Menu click Tools and Click on Extensions.
a. Check Network Analyst Extension.
b. Click Close
6. Click the Add Data button
on the Standard Toolbar
a. Navigate to the Network Dataset location, created earlier
b. Click on the Network Dataset and click Add to add the Network Dataset to ArcMap.
c. Click Yes to add all the feature classes, that participate in the network, to the map.
7. Click the Add Data button $\mathcal{F}$ on the Standard Toolbar
a. Navigate to the Point Layers to be used for analysis, in this case Participant location and NonFast Food Restaurant Locations
b. Click on the Point Layers and click Add to add it to ArcMap.
8. Assign Id's to the fast food restaurants and the participant's if not done already. In the Table of Contents Right Click the Point Layer and click on Open Attribute Table
a. In the Attribute Table
i. Click Options
ii. Click Add Field
iii. Add the NFastf_IdT/Part_Id_T as Text

- Type NFastf_IdT/Part_Id_T in the Name field
- Select Text (10) as Type
- Accept default for Length
- Click OK
iv. Add the Fastf_Id/Part_Id as Short Integer
- Type NFastf_Id/Part_Id in the Name field
- Select Short Integer as Type
- Accept default (0) for Precision
- Click OK
v. Enter the assigned Id for the participants and schools

6. On the main menu click View
a. Click on Toolbars
b. In the side menu click Network Analyst to add the Network Analyst toolbar to ArcMap
7. Click Network Analysis Toolbar
c. Click Network Analyst Window button

国 to add the Network Analyst Window to the map
8. On the Network Analyst Toolbar Click Network Analyst Dropdown Menu
a. Click New Closest Facility
b. The Table of contents and the Network Analyst Window contains empty list of Facilities, Incidents, Routes and Barriers Categories.
9. On the Network Analyst Window right Click Facilities and Click Load Locations
a. In Load Locations Window
i. Click Browse and navigate to the Non-Fast Food Restaurants Locations, Point feature layer
ii. Click on the Non-Fast Food Restaurants Locations layer and click Add
iii. Choose the Non-Fast Food Restaurants Id as the Sort field
iv. Choose the Non-Fast Food Restaurants Id Text as the Name field. Accept the default for other Location Analysis Properties
v. Use 50 Meters for Location Position, Use Geometry (increase the search tolerance if many locations are not located)
vi. Click OK
10. On the Network Analyst Window right click Incidents and Click Load Locations
a. In Load Locations Window
i. Click Browse and navigate to the Participant Locations, Point feature layer
ii. Click on the Participant Locations layer and click Add
iii. Choose the Participant ID/School Id as the Sort field
iv. Choose the Participant ID/School Id Text as the Name field. Accept the default for other Location Analysis Properties
v. Use 50 Meters for Location Position, Use Geometry (increase the search tolerance if many locations are not located)
vi. Click OK
11. To set the properties to be used in the Analysis, In the Table of Contents Right Click the Closest Facility Layer and Click Properties
a. Click on Analysis Settings Tab
i. Choose Length (Meters) for Impedance
ii. Choose None for Default Cutoff Values
iii. Choose Facilities To Find as 1
iv. Choose Travel From as Incident To Facility
v. Choose Everywhere for Allow U-Turns
vi. Choose Output Shape Type as True Shape
vii. Check the box to Ignore Invalid Locations
b. Click Ok
12. On the Network Analyst Toolbar, Click Solve Button 茄
13. Joining attributes with Source Point Layer to carry over the data (only for ArcGIS 9.1)
a. Right Click the Routes Layer
b. Click Joins and Relates and then Join
i. Choose Facility Id as the Field to base the join on
ii. Choose the Non-Fast Food Restaurants Layer as the Table to Join to this layer
iii. Choose the Non-Fast Food Restaurants ID as the field in the table to base the join on iv. Click Ok
c. Right Click the Routes Layer
d. Click on Data and then Export Data
i. Choose this layer's source data for the coordinate system

## ii. Specify the Output location

In ArcGIS 9.2 the name field of routes contains the Incident Id (Participant Id) to Facility ID (Non fast food restaurants ID) in the format Incident Id - Facility ID. It indicates the route connects a participant to the corresponding retail food outlets.

The length of the nearest distance segment from a participant's location to the nearest Non fast food restaurants is stored in the Total Length attribute.
B. Straight line distance

1. Open ArcToolbox, then click Analysis Tool
2. Then click Proximity Tools
3. Click on Near tool
a. Navigate and Choose Participant Layer as the Input Features
b. Navigate and Choose Non-Fast Food Restaurants layer as Near Features
c. Check Location and angle, if need to calculate them
d. Click OK

The straight line distance to nearest non fast food restaurant is stored in the attribute table of Participant layer under field name Near_Dist. The Near_FID field has the FID of the Nearest Restaurant.

### 3.8 Density of Non Fast Food Restaurants

Note: This protocol was updated in Version 1.3 to reflect the use of NAICS codes.

## 1. Basic Concept

This density measure is the companion to protocols 3.7.

## 2. Basic Definition

Density of Non Fast Food Restaurants $=$ Total non fast food restaurants per unit land area (excluding water).

## 3. Detailed Definition

Density of Non Fast Food Restaurants = Total non fast food restaurants per unit land area (excluding water) where non fast food restaurants are defined as the universe of all restaurants using the following NAICS codes:

## 722110 Full-Service Restaurants

 722212 Cafeterias
## 4. Comments and Explanations

The protocol is similar to the Protocol 3.2 , Density of Restaurants, However only the non-fast food restaurants are used in this case. The area within which the density has to be calculated is demarcated, the number of retail food outlets in the area is counted and the number is divided by the area to get the density.

For a detailed explanation refer to Protocol 3.2

## 5. GIS Approach

First the non-fast food restaurants are extracted from the master data and then buffer area is created using Network Analyst. Then, the water features are erased from the buffers using Erase tool, then the area of the buffer layer with erased water features is calculated. The number of retail food outlets is
counted with a spatial join between the buffer layer and the retail food outlet location layer. The number of retail food outlet locations are then divided by the area in hectares to get the density.

For a detailed explanation refer to GIS Approach in Protocol 3.2

## 6. GIS Steps

## Requirements:

1. Road Network feature dataset
2. Point Features (Non-Fast Food Restaurants layer) for finding the nearest distance to
3. Point Features (Participants layer) for finding the nearest distance from
4. Network Analyst Extension ArcGIS 9.2
I. Query and extract data for Non-Fast Food Restaurants from Dun and Bradstreet data, if the restaurant layer is not already prepared. This would require the expression used to select Fast Food Restaurants
5. Start ArcMap
6. Click the Add Data button on the Standard Toolbar.
a. Navigate to the Dun \& Bradstreet data
b. Click on the Dun \& Bradstreet dataset and click Add to add the dataset to the Map
7. Right Click the Dun \& Bradstreet data and Click Open Attribute Table
a. Click on Options
b. Click Select by Attributes
i. Select Create a new selection as Method
ii. Click on "PrimaryNai" in the Attributes list and click on Unique values (since this can take substantial time, instead of this consider typing the codes as mentioned below)
iii. Click " $=$ " operator
iv. Click or Type $\mathbf{7 2 2 1 1 0}$ (Limited-service restaurants)
v. Click "OR" operator
vi. Click on "PrimaryNai" again
vii. Click " $=$ " operator
viii. Click or Type 722212 (Cafeterias)
ix. Click Apply
c. Right Click the Dun \& Bradstreet data and Click Data and then Export data
i. Choose Selected Features for Export
ii. Choose this layer's source data for Use the same coordinate system as:
iii. Navigate to appropriate folder and give the output file an appropriate name for Output shapefile or feature class
iv. Click OK
v. Click Yes to add the data to current data frame
II. Create network buffers for participant location
8. Start ArcMap
9. On the Main Menu click Tools and Click on Extensions.
a. Check Network Analyst Extension.
b. Click Close.
10. Click the Add Data button on the Standard Toolbar
a. Navigate to the Network Dataset location, created earlier. (If need to create a new Network dataset. Look at Appendix for steps to create a network dataset.)
b. Click on the Network Dataset and click Add to add the Network Dataset to ArcMap.
c. Click No when asked to add all the feature classes, which participate in the network, to the map.
11. Click the Add Data button on the Standard Toolbar
a. Navigate to the Point Layers to be used for analysis, in this case Participant location and NonFast Food Restaurant Locations
b. Click on the Point Layers and click Add to add it to ArcMap
12. On the main menu click View
a. Click on Toolbars
b. In the side menu click Network Analyst to add the Network Analyst toolbar to ArcMap
13. Click Network Analysis Toolbar
a. Click Network Analyst Window button

国 to add the Network Analyst Window to the map
7. On the Network Analyst Toolbar Click Network Analyst Dropdown Menu
a. Click New Service Area
b. The Table of contents and the Network Analyst Window contains empty list of Facilities, Barriers, Lines and Polygons Categories.
8. Add the Id's if not already added. In the Table of Contents Right Click the Point Layer and click on Open Attribute Table
a. In the Attribute Table
i. Click Options
ii. Click Add Field
iii. Add the School_Id/Participant_Id as Text

- Type School_Id_T/Part_Id_T in the Name field
- Select Text (50) as Type
- Accept default for Length
- Click OK
iv. Add the School_Id/Participant_Id as Integer
- Type School_Id/Part_Id in the Name field
- Select Short Integer as Type
- Accept default (0) for Precision
- Click OK
v. Enter the assigned Id for the participants and schools

9. On the Network Analyst Window right Click Facilities and Click Load Locations
a. In Load Locations Window
i. For Load From click Browse and navigate to the Participant Locations, Point feature layer
ii. Click on the Participant Locations layer and click Add
iii. Choose the Participant Id as the Sort field
iv. Choose the Participant Id Text as the Name field.
v. Accept the default for Location Position as Use Geometry

- Set the Search Tolerance to 50 meters
vi. Click OK

10. To set the properties to be used in the Analysis, In the Table of Contents Right Click the Service Area Layer and Click Properties
a. Click on Analysis Settings Tab
i. Choose Length (Meters) for Impedance.
ii. Type the required Buffer Distance for Default Breaks
iii. Choose Away From Facility as Direction
iv. Choose Everywhere for Allow U-Turns
v. Check Ignore Invalid Locations
b. Click on Polygon Generation Tab
vi. Check Generate Polygons
vii. Choose Generalized as the Polygon Type
viii. Uncheck Trim Polygons
ix. Choose Overlapping for Multiple Facilities Option

## x. Choose Disks as the Overlap Type

c. Click Ok
11. On the Network Analyst Toolbar, Click Solve Button
12. Joining attributes with Source Point Layer to carry over the data.
a. Right Click the Polygons Layer
b. Click Joins and Relates and then Join
c. Choose Join attributes from a table
i. Choose Facility Id as the Field to base the join on
ii. Choose the Participant Layer as the Table to Join to this layer
iii. Choose the Participant ID as the field in the table to base the join on
d. Right Click the Polygons Layer
e. Click on Data and then Export Data
i. Choose this layer's source data for the coordinate system
ii. Specify the Output location
III. Erase water features from the network buffer \& calculate area of network buffer

1. Click the Add Data button
on the Standard Toolbar
a. Navigate to the Water feature Layer to be used for analysis
b. Click on the Water feature Layer and click Add to add it to ArcMap
2. In the ArcToolbox, Click on Analysis Tools
3. Click on Overlay tools, and double click Erase. In the dialog box,
a. Choose the Exported Network Buffer Layer as the Input Layer
b. Choose the Water Feature layer as the Erase Features
c. Choose an appropriate Output Location and Name for the Output Feature Class
d. Click Ok
4. Click Yes to add the exported feature layer to the map
IV. Calculate the Area of Network Buffers
5. Add area fields to the output feature class created in the previous step
a. Right click on the Output Feature Class and select Open Attribute Table...
b. Click on the Option button and select Add Field...
c. Name the field Hectares and change the Type to Double. If an Hectares field already exists, you can cancel this operation and overwrite the hectares values
d. Click OK
6. Calculate the values for Hectares
a. Right-click the Hectares field in the Output Feature Class attribute table and select Calculate Geometry...
b. Set the Property: box to Area
c. Set the Coordinate System to "Use coordinate system of the data source"
d. Set the Units to Hectares [ha]
e. Click OK
V. Spatial Join to calculate the number of non fast food restaurants
7. Right click the buffer layer with erased water features layer (created and added in step II)
8. Click Join and Relates and then Click Join
a. Select Join data from another layer based on spatial location for Join Type
b. Choose the Non-Fast Food Restaurant Location layer to join to this layer
c. Do not check any radio-dial for summarizing the data
d. Specify an appropriate location and name for the output feature class
e. Click Ok
f. Click Yes to add the feature class
VI. Calculate the density of non fast food restaurants
9. Open the attribute table of the spatial join feature class created in above step
10. Click Options and then Add field
a. Type Density for Name
b. Select Double for Type
c. Accept default for Precision and Scale
11. Right Click on the Density field and select field calculator
a. Click on Count in fields
b. Click on operator ' $/$ '
c. Click on Hectare in fields
d. The Density equation should look like: Density $=$ Count/Hectare
e. Click Ok

The Density field contains the density number of non fast food restaurants per square hectare of the network buffer around participant location.

## 4. FOOD STORES

Note: these protocols were developed by Ann Forsyth (definitions and concepts) and Nishi Mishra and David Van Riper (GIS steps).

Food stores come in many sizes and shapes. Typically larger stores have more variety and are more likely to contain fresh fruits and vegetables, although there are of course exceptions to this rule.

The TREC-IDEA study asks specifically about several kinds of stores selling food including Supermarkets, convenience stores, gas stations, and hardware stored (selling drinks). It also asks about farm stands and farmers markets that are seasonal and difficult to capture in databases.

These measures include:

- All food stores--from pharmacies to gas stations
- All grocery stores, only omitting convenience stores
- Large supermarkets and super centers
- Convenience stores and gas stations


### 4.1 Distance to any Retail Food Outlet--All Stores Selling Food (not restaurants)

Note: Version 1.3 added an additional NAICS code.

## 1. Basic Concept

The idea of this measure is to estimate how close participants are to food stores of any type, including those in other businesses such as gas stations. This measure will look at the distance to the nearest food store using the old SIC code 54-all food stores with the following sub-types.

| 1987SIC | 1987 SIC Description |  | $\begin{aligned} & 2002 \\ & \text { NAICS } \end{aligned}$ | 2002 NAICS US Description |
| :---: | :---: | :---: | :---: | :---: |
| 54 | Food stores |  |  |  |
| 541 | Grocery stores |  |  |  |
| 5411 | Grocery Stores | $6{ }^{6}$ |  |  |
|  | Except convenience stores, freezer plans, and grocery stores with substantial general merchandise |  | 445110 | Supermarkets and Other Grocery (except Convenience) Stores (part) |
|  | Convenience stores without gas |  | 445120 | Convenience Stores |
|  | Convenience store with gas |  | $\underline{447110}$ | Gasoline Stations with Convenience Stores (part) |
|  | Grocery stores and supermarkets selling substantial amounts of nonfood items |  | 452910 | $\frac{\text { Warehouse Clubs and Supercenters }}{\text { (part) }}$ |
|  | Frozen food and freezer plan providers |  | 454390 | Other Direct Selling Establishments (part) |
| 542 | Meat and fish (seafood) markets, including freezer provisioners |  |  |  |
| 5421 | Meat and Fish (Seafood) Markets, Including Freezer Provisioners | 6od |  |  |
|  | Meat except freezer provisioners |  | 445210 | Meat Markets (part) |


|  | Seafood | 445220 | Fish and Seafood Markets (part) |
| :---: | :---: | :---: | :---: |
|  | Freezer provisioners | 454390 | Other Direct Selling Establishments (part) |
| 543 | Fruit and vegetable markets |  |  |
| 5431 | Fruit and Vegetable Markets | 91In |  |
|  | Except temporary fruit and vegetable stands | 445230 | Fruit and Vegetable Markets (part) |
|  | Temporary fruit and vegetable stands | 454390 | Other Direct Selling Establishments (part) |
| 544 | Candy, nut, and confectionery stores |  |  |
| 5441 | Candy, Nut, and Confectionery Stores | $6{ }^{6}$ |  |
|  | Chocolate candy stores, preparing on premises | 311330 | Confectionery Manufacturing from Purchased Chocolate (part) |
|  | Nonchocolate candy stores, preparing on premises | 311340 | Nonchocolate Confectionery <br> Manufacturing (part) |
|  | Except stores preparing candy on premises | 445292 | Confectionery and Nut Stores (part) |
| 545 | Dairy products stores |  |  |
| 5451 | Dairy Products Stores | 609445299 | All Other Specialty Food Stores (part) |
| 546 | Retail bakeries |  |  |
| 5461 | Retail Bakeries | Cod |  |
|  | Bread, cake and related products baked and sold on premise | 311811 | Retail Bakeries |
|  | Selling only | 445291 | Baked Goods Stores |
|  | Snacks | 722213 | Snack and Nonalcoholic Beverage Bars (part) |
| 549 | Miscellaneous food stores |  |  |
| 5499 | Miscellaneous Food Stores | 60 |  |
|  | Poultry and poultry products | 445210 | Meat Markets (part) |
|  | Except food supplement stores and poultry stores | $\underline{445299}$ | All Other Specialty Food Stores (part) |
|  | Food supplements | 446191 | Food (Health) Supplement Stores (part) |
| Source: http://www.census.gov/epcd/naics02/SICN02G.HTM\#S54 |  |  |  |

In addition we will use other codes where appropriate including:
45291 Warehouse Clubs and Supercenters
45211 Department Stores (including discount and not),
44719 Other Gas Stations
And other food stores such as pharmacies etc. where the involve chains selling food. This is a very broad definition.

## 2. Basic Definition

Distance to any Retail Food Outlet (not restaurants) = The shortest network or straight line distance between home or school and the nearest retail food outlet.

## 3. Detailed Definition

Distance to any Retail Food Outlet (not restaurants) = The shortest network or straight line distance between home or school and the nearest retail food outlet defined with SIC/NAICS codes.

## 4. Comments and Explanations

This is similar to the protocol 3.1, distance to nearest restaurant, and is done by using the Find Closest Facility option in Network Analyst Extension of ArcGIS 9.1 or ArcGIS 9.2. Though in this case, the nearest distance is calculated only for the Retail Food outlets and not restaurants.

See Protocol 3.1 for more explanation.

## 5. GIS Approach

First the Retail Food Outlets are extracted from the master data and then the nearest distance to these locations are calculated. The basic idea is similar to the protocol 3.1, distance to nearest restaurant. Nearest network distance between a set of origin locations and destination locations is calculated using Network Analyst and straight line distance is calculated using Near tool in ArcToolbox.

See Protocol 3.1 for more explanation.

## 6. GIS Steps

Requirements:

1. Road Layer polyline
2. Point Features (Restaurant layer) for finding the nearest distance
3. Point Features (School or Participant layer) to find the distance from
4. Network Analyst Extension for ArcGIS 9.1 or ArcGIS 9.2
I. Query and extract data for Retail Food Outlet according to specified NAICS codes from Dun \& Bradstreet data, if the restaurant layer is not already prepared
5. Start ArcMap
6. Click the Add Data button on the Standard Toolbar.
a. Navigate to the Dun \& Bradstreet data
b. Click on the Dun \& Bradstreet dataset and click Add to add the dataset to the Map
7. Right Click the Dun \& Bradstreet data and Click Open Attribute Table
a. Click on Options
b. Click Select by Attributes
i. Select Create a new selection as Method
ii. Click on "PrimaryNai" in the Attributes list and click on Unique values (since this can take substantial time, instead of this consider typing the codes as mentioned below)
iii. Click " $=$ " operator
iv. Click or Type 445110
v. Click "OR" operator
vi. Repeat steps ii to $\mathbf{v}$ adding the values to $445120,447110,452910,454390,445210,445220$, 454390, 445230, 454390, 311330, 311340, 445292, 445299, 311811, 445291, 722213, 445210, 445299, 446191, 452190, 452111, 452112, 447190, 446110
vii. The SELECT * FROM Dun \& Bradstreet WHERE: should: look like
"PrimaryNai" = 445110 OR "PrimaryNai" = 445120 OR "PrimaryNai" = 447110 OR
"PrimaryNai" = 452910 OR "PrimaryNai" = 454390 OR "PrimaryNai" = 445210 OR
"PrimaryNai" = 445220 OR "PrimaryNai" = 454390 OR "PrimaryNai" = 311330 OR
"PrimaryNai" = 311340 OR "PrimaryNai" = 445292 OR "PrimaryNai" = 445299 OR
"PrimaryNai" = 311811 OR "PrimaryNai" = 445291 OR "PrimaryNai" = 722213 OR
"PrimaryNai" = 445210 OR "PrimaryNai" = 445299 OR "PrimaryNai" = 446191OR
"PrimaryNai" = 452910 OR "PrimaryNai" $=452111$ (If included) OR "PrimaryNai" = 447190 OR "PrimaryNai" $=446110$ OR "PrimaryNai" $=452112$
viii. Click Apply
c. Right Click the Dun \& Bradstreet data and Click Data and then Export data
i. Choose Selected Features for Export
ii. Choose this layer's source data for Use the same coordinate system as:
iii. Navigate to appropriate folder and give the output file an appropriate name for Output shapefile or feature class
iv. Click OK
v. Click Yes to add the data to current data frame
II. Calculate the Network Distance to Nearest Retail Food Outlet
A. Network Distance
8. Start ArcMap
9. On the Main Menu click Tools and Click on Extensions.
a. Check Network Analyst Extension.
b. Click Close
10. Click the Add Data button on the Standard Toolbar
a. Navigate to the Network Dataset location, created earlier
b. Click on the Network Dataset and click Add to add the Network Dataset to ArcMap.
c. Click Yes to add all the feature classes, that participate in the network, to the map.
11. Click the Add Data button $\mathcal{F}$ on the Standard Toolbar
a. Navigate to the Point Layers to be used for analysis, in this case Participant location and Retail Food Outlet Locations
b. Click on the Point Layers and click Add to add it to ArcMap.
12. Assign Id's to the restaurants and the participant's if not done already. In the Table of Contents Right

Click the Point Layer and click on Open Attribute Table
a. In the Attribute Table
i. Click Options
ii. Click Add Field
iii. Add the Retail_Outlet_Id/Participant_Id as Text

- Type Retail_Outlet_Id T/Participant_Id_T in the Name field
- Select Text (50) as Type
- Accept default for Length
- Click OK
iv. Add the Retail_Outlet_Id /Participant_Id as Integer
- Type Retail_Outlet_Id /Participant_Id in the Name field
- Select Short Integer as Type
- Accept default (0) for Precision
- Click OK
v. Enter the assigned Id for the participants and schools

6. On the main menu click View
a. Click on Toolbars
b. In the side menu click Network Analyst to add the Network Analyst toolbar to ArcMap
7. Click Network Analysis Toolbar
a. Click Network Analyst Window button ${ }^{\text {F }}$ to add the Network Analyst Window to the map
8. On the Network Analyst Toolbar Click Network Analyst Dropdown Menu
a. Click New Closest Facility
b. The Table of contents and the Network Analyst Window contains empty list of Facilities, Incidents, Routes and Barriers Categories.
9. On the Network Analyst Window right Click Facilities and Click Load Locations
a. In Load Locations Window
i. Click Browse and navigate to the Restaurant Locations, Point feature layer
ii. Click on the Retail Food Outlets Locations layer and click Add
iii. Choose the Retail_Outlet_Id as the Sort field
iv. Choose the Retail_Outlet_Id_T as the Name field. Accept the default for other Location Analysis Properties
v. Use 50 Meters for Location Position, Use Geometry (increase the search tolerance if many locations are unlocated)
vi. Click OK
10. On the Network Analyst Window right click Incidents and Click Load Locations
a. In Load Locations Window
i. Click Browse and navigate to the Participant Locations, Point feature layer
ii. Click on the Participant Locations layer and click Add
iii. Choose the Participant ID/School Id as the Sort field
iv. Choose the Participant ID/School Id Text as the Name field. Accept the default for other Location Analysis Properties
v. Accept the default Location Position
vi. Click OK
11. To set the properties to be used in the Analysis, In the Table of Contents Right Click the Closest Facility Layer and Click Properties
a. Click on Analysis Settings Tab
i. Choose Length (Meters) for Impedance
ii. Choose None for Default Cutoff Values
iii. Choose Facilities To Find as 1
iv. Choose Travel From as Incident To Facility
v. Choose Everywhere for Allow U-Turns
vi. Choose Output Shape Type as True Shape
vii. Check the box to Ignore Invalid Locations
b. Click Ok
12. On the Network Analyst Toolbar, Click Solve Button
13. Joining attributes with Source Point Layer to carry over the data (only for ArcGIS 9.1)
a. Right Click the Routes Layer
b. Click Joins and Relates and then Join
i. Choose Facility Id as the Field to base the join on
ii. Choose the Retail Food Outlets Layer as the Table to Join to this layer
iii. Choose the Retail Food Outlets ID as the field in the table to base the join on
iv. Click Ok
d. Right Click the Routes Layer
e. Click on Data and then Export Data
i. Choose this layer's source data for the coordinate system
ii. Specify the Output location

In ArcGIS 9.2 the name field of routes contains the Incident Id (Participant Id) to Facility ID (Retail Food Outlet ID). It indicates which Participant to which restaurant the route connects.

The length of the nearest distance segment from a participant's location to the nearest Reatail food outlet is stored in the Total Length attribute.
B. Straight line distance

1. Open ArcToolbox, then click Analysis Tools
2. Click on Proximity Tools
3. Click on Near tool
a. Navigate and Choose Participant Layer as the Input Features
b. Navigate and Choose Retail Food Outlets layer as Near Features
c. Check Location and angle, if need to calculate them
d. Click OK

The straightline distance to nearest retail food outlet is stored in the attribute table under field name Near_Dist. The Near_FID field has the FID of the Nearest Retail Food Outlet.

### 4.2 Density of all Retail Food Outlets (not restaurants)

Note: This protocol was updated in Version 1.3 to add an additional NAICS code.

## 1. Basic Concept

This is the density version of protocol 4.1.

## 2. Basic Definition

Density of all Retail Food Outlets (not restaurants) = Total retail food outlets per unit land area (excluding water).

## 3. Detailed Definition

Distance to any Retail Food Outlet (not restaurants) = The shortest network or straight line distance between home or school and the nearest retail food outlet with retail food outlets defined using SIC/NAICS codes (see protocols 4.1).

## 4. Comments and Explanations

The protocol is similar to the Protocol 3.2 , Density of Restaurants. However, in this case the retail food outlets are used. The area within which the density has to be calculated is demarcated, the number of retail food outlets in the area are counted, and the number is divided by the area to get the density.

For a detailed explanation refer to Protocol 3.2

## 5. GIS Approach

First the retail food outlets are extracted from the master data and then the buffer area is created using Network Analyst. Then, the water features are erased from the buffers using Erase tool, then the area of the buffer layer with erased water features is calculated. The number of retail food outlets is counted with a spatial join between the buffer layer and the retail food outlet location layer. The number of retail food outlet locations are then divided by the area in hectares to get the density.

For a detailed explanation refer to GIS Approach in Protocol 3.2

## 6. GIS Steps

Requirements:

1. Retail Food Outlets layer (Point)
2. Participant Layer (Point)
3. Water feature layer (Polygon)
4. Roads Network dataset
I. Query and extract data for Restaurants according to specified NAICS codes from Dun \& Bradstreet data, if the restaurant layer is not already prepared

## 1. Start ArcMap

2. Click the Add Data button on the Standard Toolbar.
a. Navigate to the Dun \& Bradstreet data
b. Click on the Dun \& Bradstreet dataset and click Add to add the dataset to the Map
3. Right Click the Dun \& Bradstreet data and Click Open Attribute Table
a. Click on Options
b. Click Select by Attributes
i. Select Create a new selection as Method
ii. Click on "PrimaryNai" in the Attributes list and click on Unique values (since this can take substantial time, instead of this consider typing the codes as mentioned below)
iii. Click " $=$ " operator
iv. Click or Type 445110
v. Click "OR" operator
vi. Repeat steps ii to $\mathbf{v}$ adding the values to $445120,447110,452910,454390,445210,445220$, 454390, 445230, 454390, 311330, 311340, 445292, 445299, 311811, 445291, 722213, 445210, 445299, 446191, 452190, 452111, 452112, 447190, 446110
vii. The SELECT * FROM Dun \& Bradstreet WHERE: should: look like
"PrimaryNai" = 445110 OR "PrimaryNai" = 445120 OR "PrimaryNai" = 447110 OR
"PrimaryNai" = 452910 OR "PrimaryNai" = 454390 OR "PrimaryNai" = 445210 OR
"PrimaryNai" = 445220 OR "PrimaryNai" = 454390 OR "PrimaryNai" = 311330 OR
"PrimaryNai" = 311340 OR "PrimaryNai" = 445292 OR "PrimaryNai" = 445299 OR
"PrimaryNai" = 311811 OR "PrimaryNai" = 445291 OR "PrimaryNai" = 722213 OR
"PrimaryNai" = 445210 OR "PrimaryNai" = 445299 OR "PrimaryNai" = 446191OR
"PrimaryNai" = 452910 OR "PrimaryNai" = 452111 (If included) OR "PrimaryNai" = 447190 OR "PrimaryNai" $=446110$ OR "PrimaryNai" $=452112$
viii. Click Apply
c. Right Click the Dun \& Bradstreet data and Click Data and then Export data
ix. Choose Selected Features for Export
x. Choose this layer's source data for Use the same coordinate system as:
xi. Navigate to appropriate folder and give the output file an appropriate name for Output shapefile or feature class
xii. Click OK
xiii. Click Yes to add the data to current data frame
II. Create network buffers for participant location
4. Start ArcMap
5. On the Main Menu click Tools and Click on Extensions.
a. Check Network Analyst Extension.
b. Click Close.
6. Click the Add Data button
on the Standard Toolbar
a. Navigate to the Network Dataset location, created earlier. (If need to create a new Network dataset. Look at Appendix for steps to create a network dataset.)
b. Click on the Network Dataset and click Add to add the Network Dataset to ArcMap.
c. Click No when asked to add all the feature classes, which participate in the network, to the map.
7. Click the Add Data button $\downarrow$ on the Standard Toolbar
a. Navigate to the Point Layers to be used for analysis, in this case Participant location and Retail Food Outlets Locations
b. Click on the Point Layers and click Add to add it to ArcMap
8. On the main menu click View
a. Click on Toolbars
b. In the side menu click Network Analyst to add the Network Analyst toolbar to ArcMap
9. Click Network Analysis Toolbar
a. Click Network Analyst Window button

国 to add the Network Analyst Window to the map
7. On the Network Analyst Toolbar Click Network Analyst Dropdown Menu
a. Click New Service Area
b. The Table of contents and the Network Analyst Window contains empty list of Facilities, Barriers, Lines and Polygons Categories.
8. Add the Id's if not already added. Click the In the Table of Contents Right Click the Point Layer and click on Open Attribute Table
a. In the Attribute Table
i. Click Options
ii. Click Add Field
iii. Add the School_Id/Participant_Id as Text

- Type School_Id_T/Part_Id_T in the Name field
- Select Text (50) as Type
- Accept default for Length
- Click OK
iv. Add the School_Id/Participant_Id as Integer
- Type School_Id/Part_Id in the Name field
- Select Short Integer as Type
- Accept default (0) for Precision
- Click OK
v. Enter the assigned Id for the participants and schools

9. On the Network Analyst Window right Click Facilities and Click Load Locations
a. In Load Locations Window
i. For Load From click Browse and navigate to the Participant Locations, Point feature layer
ii. Click on the Participant Locations layer and click Add
iii. Choose the Participant Id as the Sort field
iv. Choose the Participant Id Text as the Name field.
v. Accept the default for Location Position as Use Geometry - Set the Search Tolerance to $\mathbf{5 0}$ meters
vi. Click OK
10. To set the properties to be used in the Analysis, In the Table of Contents Right Click the Service Area Layer and Click Properties
a. Click on Analysis Settings Tab
i. Choose Length (Meters) for Impedance.
ii. Type the required Buffer Distance for Default Breaks
iii. Choose Away From Facility as Direction
iv. Choose Everywhere for Allow U-Turns
v. Check Ignore Invalid Locations
b. Click on Polygon Generation Tab
i. Check Generate Polygons
ii. Choose Generalized as the Polygon Type
iii. Uncheck Trim Polygons
iv. Choose Overlapping for Multiple Facilities Option
v. Choose Disks as the Overlap Type
c. Click Ok
11. On the Network Analyst Toolbar, Click Solve Button
12. Joining attributes with Source Point Layer to carry over the data.
a. Right Click the Polygons Layer
b. Click Joins and Relates and then Join
c. Choose Join attributes from a table
i. Choose Facility Id as the Field to base the join on
ii. Choose the Participant Layer as the Table to Join to this layer
iii. Choose the Participant ID as the field in the table to base the join on
d. Right Click the Polygons Layer
e. Click on Data and then Export Data
i. Choose this layer's source data for the coordinate system
ii. Specify the Output location
III. Erase water features from the network buffer \& calculate area of network buffer
13. Click the Add Data button $\downarrow$ on the Standard Toolbar
a. Navigate to the Water feature Layer to be used for analysis
b. Click on the Water feature Layer and click Add to add it to ArcMap
14. In the ArcToolbox, Click on Analysis Tools
15. Click on Overlay tools, and double click Erase. In the dialog box,
a. Choose the Exported Network Buffer Layer as the Input Layer
b. Choose the Water Feature layer as the Erase Features
c. Choose an appropriate Output Location and Name for the Output Feature Class
d. Click Ok
16. Click Yes to add the exported feature layer to the map
IV. Calculate the Area of Network Buffers
17. Add area fields to the output feature class created in the previous step
a. Right click on the Output Feature Class and select Open Attribute Table...
b. Click on the Option button and select Add Field...
c. Name the field Hectares and change the Type to Double. If an Hectares field already exists, you can cancel this operation and overwrite the hectares values
d. Click OK
18. Calculate the values for Hectares
a. Right-click the Hectares field in the Output Feature Class attribute table and select Calculate Geometry
b. Set the Property: box to Area
c. Set the Coordinate System to "Use coordinate system of the data source"
d. Set the Units to Hectares [ha]
e. Click OK
V. Spatial Join to calculate the number of retail food outlets
19. Right click the buffer layer with erased water features layer (created and added in step II)
20. Click Join and Relates and then Click Join
a. Select Join data from another layer based on spatial location for Join Type
b. Choose the Retail Food Outlet Location layer to join to this layer
c. Select the option for count field
d. Do not check any radio-dial for summarizing the data
e. Specify an appropriate location and name for the output feature class
f. Click Ok
g. Click Yes to add the feature class
VI. Calculate the density of retail food outlets
21. Open the attribute table of the spatial join feature class created in above step
22. Click Options and then Add field
a. Type Density for Name
b. Select Double for Type
```
    c. Accept default for Precision and Scale
3. Right Click on the Density field and select field calculator
a. Click on Count in fields
b. Click on operator '/'
c. Click on Hectare in fields
d. The Density equation should look like: Density = Count/Hectare
e. Click Ok
```

The Density fields contains the density number of retail food outlets per square hectare of the network buffer around participant location.

### 4.3 Distance to Groceries, Supermarkets, or Super Centers

## 1. Basic Concept

The basic idea of this measure is to estimate access to a wide selection of food items. This is a broad category. While technically a supermarket (selling mainly food and other groceries) is different to a super center (a supermarket added on to a discount department store) they sell similar things. The TREC-IDEA survey asks about distance to supermarkets:

Supermarkets

- SS170 About how long would it take to get from your home to the nearest supermarket if you walked? (Adapted from NEWS B2 (14))

This measure will use SIC/NAICS codes --445110 for the list. In addition, in order to find super centers, we used web sites of major retailers including Target, Walmart, and K-Mart. There were only four Costco stores in Minnesota and as it is a membership store we excluded them.

It uses the following codes.

| 2002 <br> NAICS | 1997 <br> NAICS | $\mathbf{1 9 8 7}$ <br> SIC | Corresponding Index Entries |
| :---: | :---: | :---: | :--- | :--- |
| 445110 | 445110 | 5411 | Commissaries, primarily groceries |
| 445110 | 445110 | 5411 | Delicatessens primarily retailing a range of grocery items and meats |
| 445110 | 445110 | 5411 | Food (i.e., groceries) stores |
| 445110 | 445110 | 5411 | Grocery stores |
| 445110 | 445110 | 5411 | Supermarkets |

Source: http://www.census.gov/epcd/naics02/def/NDEF445.HTM\#N44511
In addition we will use other codes where appropriate including 45291 Warehouse Clubs and Supercenters and 45211 Department Stores (including discount and not) where the involve chains selling significant amounts of food.

Laraia et al. (DATE) used USDA data to classify types of stores. A supermarket was defined in relation to other smaller food types as: "A supermarket was defined as large chain grocers with a grocer Standard Industrial Code (SIC); grocery store was defined as locally owned food market with a grocer

SIC; and convenience store was defined as a food mart without a chain gas station and [with] a convenience store SIC" (p. 870). This list focuses on the first two.

## 2. Basic Definition

Distance to Grocery, Supermarket, or Super Center = The shortest network or straight line distance between home or school and the nearest grocery, supermarket, or super center.

## 3. Detailed Definition

Distance to Grocery, Supermarket, or Super Center = The shortest network or straight line distance between home or school and the nearest grocery, supermarket, or super center where these are identified using NAICS codes and web searches for Super Targets, Super Walmarts, and Super KMarts.

## 4. Comments and Explanations

This is similar to the protocol 3.1, distance to nearest restaurant, and is done by using the Find Closest Facility option in Network Analyst Extension of ArcGIS 9.1 or ArcGIS 9.2. However in this case, the nearest distance is calculated only for the Groceries, Supermarkets, or super centers and not for restaurants.

See Protocol 3.1 for more explanation.

## 5. GIS Approach

First the Groceries, Supermarkets, or super centers are extracted from the master data and then the nearest distance to these locations are calculated. The basic idea is similar to the protocol 3.1, distance to nearest restaurant. Nearest network distance between a set of origin locations and destination locations is calculated using Network Analyst and straight line distance is calculated using Near tool in ArcToolbox.

See Protocol 3.1 for more explanation.

## 6. GIS Steps

Requirements:

1. Road Layer polyline
2. Food Outlets (Groceries, Supermarkets, or super centers) layer (Point Features) for finding the nearest distance to
3. Participants layer (Point Features) for finding the nearest distance from
4. Network Analyst Extension for ArcGIS 9.1 or ArcGIS 9.2
I. Query and extract data for Groceries, Supermarkets, or super centers according to specified NAICS codes from Dun \& Bradstreet data, if the layer is not already prepared
5. Start ArcMap
6. Click the Add Data button on the Standard Toolbar.
a. Navigate to the Dun \& Bradstreet data
b. Click on the Dun \& Bradstreet dataset and click Add to add the dataset to the Map
7. Right Click the Dun \& Bradstreet data and Click Open Attribute Table
a. Click on Options
b. Click Select by Attributes
i. Select Create a new selection as Method

- Click on "PrimaryNai" in the Attributes list and click on Unique values (since this can take substantial time, instead of this consider typing the codes as mentioned below)
- Click "=" operator
- Click or Type 445110
ii. Click on "Company" in the attributes list and click on Unique values (since this can take substantial time, instead of this consider typing the codes as mentioned below)
- Click "=" operator
- Click or Type Super Target
- Click "OR" operator
- Repeat above steps adding the values to Super Walmart, Costco
iii. The SELECT * FROM Dun \& Bradstreet WHERE: should: look like "PrimaryNai" = 445110 OR "Company" = 'Super Target' OR "Company" = 'Super Walmart'
iv. Click Apply
c. Right Click the Dun \& Bradstreet data layer and Click Data and then Export data
i. Choose Selected Features for Export
ii. Choose this layer's source data for Use the same coordinate system as:
iii. Navigate to appropriate folder and give the output file an appropriate name for Output shapefile or feature class
iv. Click OK
v. Click Yes to add the data to current data frame
II. Calculate the Network and Straight line Distance to Nearest Restaurant
A. Network Distance

1. Start ArcMap
2. On the Main Menu click Tools and Click on Extensions.
a. Check Network Analyst Extension.
b. Click Close
3. Click the Add Data button

## on the Standard Toolbar

a. Navigate to the Network Dataset location, created earlier
b. Click on the Network Dataset and click Add to add the Network Dataset to ArcMap.
c. Click Yes to add all the feature classes, that participate in the network, to the map.
4. Click the Add Data button on the Standard Toolbar
a. Navigate to the Point Layers to be used for analysis, in this case Participant location and Food Outlets (Groceries, Supermarkets, or super centers) Locations
b. Click on the Point Layers and click Add to add it to ArcMap.
5. Assign Id's to the retail food outlets and the participant's if not done already. In the Table of Contents Right Click the Point Layer and click on Open Attribute Table
a. In the Attribute Table
i. Click Options
ii. Click Add Field
iii. Add the G_S_Id_T/Part_Id_T as Text

- Type G_S_Id_T/Part_Id_T in the Name field
- Select Text (50) as Type
- Accept default for Length
- Click OK
iv. Add the G_S_Id/Part_Id as Integer
- Type G_S_Id/Part_Id in the Name field
- Select Short Integer as Type
- Accept default (0) for Precision
- Click OK
v. Enter the assigned Id for the participants and schools

6. On the main menu click View
a. Click on Toolbars
b. In the side menu click Network Analyst to add the Network Analyst toolbar to ArcMap
7. Click Network Analysis Toolbar
a. Click Network Analyst Window button 围 to add the Network Analyst Window to the map
8. On the Network Analyst Toolbar Click Network Analyst Dropdown Menu
a. Click New Closest Facility
b. The Table of contents and the Network Analyst Window contains empty list of Facilities, Incidents, Routes and Barriers Categories.
9. On the Network Analyst Window right Click Facilities and Click Load Locations
a. In Load Locations Window
i. Click Browse and navigate to the Food Outlets (Groceries, Supermarkets, or super centers) Locations, Point feature layer
ii. Click on the Food Outlets (Groceries, Supermarkets, or super centers) Locations layer and click Add
iii. Choose the Food Outlets (Groceries, Supermarkets, or super centers) Id as the Sort field
iv. Choose the Food Outlets (Groceries, Supermarkets, or super centers) Id Text as the Name field. Accept the default for other Location Analysis Properties
v. Use 50 Meters for Location Position, Use Geometry (increase the search tolerance if many locations are not located)
vi. Click OK
10. On the Network Analyst Window right click Incidents and Click Load Locations
a. In Load Locations Window
i. Click Browse and navigate to the Participant Locations, Point feature layer
ii. Click on the Participant Locations layer and click Add
iii. Choose the Participant ID/School Id as the Sort field
iv. Choose the Participant ID/School Id Text as the Name field. Accept the default for other Location Analysis Properties
v. Accept the default Location Position
vi. Click OK
11. To set the properties to be used in the Analysis, In the Table of Contents Right Click the Closest Facility Layer and Click Properties
a. Click on Analysis Settings Tab
i. Choose Length (Meters) for Impedance
ii. Choose None for Default Cutoff Values
iii. Choose Facilities To Find as 1
iv. Choose Travel From as Incident To Facility
v. Choose Everywhere for Allow U-Turns
vi. Choose Output Shape Type as True Shape
vii. Check the box to Ignore Invalid Locations
b. Click Ok
12. On the Network Analyst Toolbar, Click Solve Button
13. Joining attributes with Source Point Layer to carry over the data (only for ArcGIS 9.1)
a. Right Click the Routes Layer
b. Click Joins and Relates and then Join
i. Choose Facility Id as the Field to base the join on
ii. Choose the Food Outlets (Groceries, Supermarkets, or super centers) Layer as the Table to Join to this layer
iii. Choose the Food Outlets (Groceries, Supermarkets, or super centers) ID as the field in the table to base the join on
iv. Click Ok
c. Right Click the Routes Layer
d. Click on Data and then Export Data
i. Choose this layer's source data for the coordinate system
ii. Specify the Output location

In ArcGIS 9.2 the name field of routes contains the Incident Id (Participant Id) to Facility ID (Retail Food Outlets ID) in the format Incident Id - Facility ID. It indicates the route connects a participant to the corresponding retail food outlets.
B. Straight line distance

1. Open ArcToolbox, then click Proximity Tools
2. Click on Near tool
a. Navigate and Choose Participant Layer as the Input Features
b. Navigate and Choose Food Outlets (Groceries, Supermarkets, or super centers) layer as Near Features
c. Check Location and angle, if need to calculate them
d. Click OK

The straight line distance to nearest Food Outlets (Groceries, Supermarkets, or super centers) is stored in the attribute table under field name Near_Dist. The Near_FID field has the FID of the Nearest Food Outlets (Groceries, Supermarkets, or super centers).

### 4.4 Density of Groceries, Supermarkets, or Super Centers

Note: The steps were updated in Version 1.3 to better measure super centers.

## 1. Basic Concept

This is the density version of protocol 4.3.

## 2. Basic Definition

Density of Groceries, Supermarkets, or Super Centers = Total groceries, supermarkets, or super centers per unit land area (excluding water).

## 3. Detailed Definition

Density of Groceries, Supermarkets, or Super Centers = Total groceries, supermarkets, or super centers per unit land area (excluding water) these are identified using NAICS codes (445110) and web searches for Super Targets and Super Walmarts. (Super K-Marts would need to be added in other regions)

## 4. Comments and Explanations

The protocol is similar to the Protocol 3.2 , Density of Restaurants. However, in this case the Groceries, Supermarkets, or super centers are used. The area within which the density has to be calculated is demarcated, the number of Groceries, Supermarkets, or super centers in the area is counted, and the number is divided by the area to get the density. We decided to exclude Costco-partly because there are only four in Minnesota and partly because they require membership-however, this decision might need to be revisited.

For a detailed explanation refer to Protocol 3.2

## 5. GIS Approach

First the Groceries, Supermarkets, or super centers are extracted from the master data and then the buffer area is created using Network Analyst. Then, the water features are erased from the buffers using Erase tool, then the area of the buffer layer with erased water features is calculated. The number
of Groceries, Supermarkets, or super centers is counted with a spatial join between the buffer layer and the Groceries, Supermarkets, or super centers location layer. The number of Groceries, Supermarkets, or super centers locations is then divided by the area in hectares to get the density.

For a detailed explanation refer to GIS Approach in Protocol 3.2
6. GIS Steps

Requirements:

1. Road Layer polyline
2. Groceries, Supermarkets, or super centers layer (Point Features) for finding the nearest distance to
3. Participants layer (Point Features) for finding the nearest distance from
4. Network Analyst Extension for ArcGIS 9.1 or ArcGIS 9.2
I. Query and extract data for Groceries, Supermarkets, or super centers according to specified NAICS codes from Dun \& Bradstreet data, if the layer is not already prepared
5. Start ArcMap
6. Click the Add Data button on the Standard Toolbar.
a. Navigate to the Dun \& Bradstreet data
b. Click on the Dun \& Bradstreet dataset and click Add to add the dataset to the Map
7. Right Click the Dun \& Bradstreet data and Click Open Attribute Table
a. Click on Options
b. Click Select by Attributes
i. Select Create a new selection as Method
ii. Click on "PrimaryNai" in the Attributes list and click on Unique values (since this can take substantial time, instead of this consider typing the codes as mentioned below)
iii. Click "=" operator
iv. Click or Type 445110
v. The SELECT * FROM Dun \& Bradstreet WHERE: should: look like
"PrimaryNai" = 445110
vi. Click on "Company" in the attributes list and click on Unique values (since this can take substantial time, instead consider typing the codes as mentioned below)
vii. Click "=" operator
viii. Click or Type Super Target
ix. Click "OR" operator
x. Repeat above steps adding the values to Super Walmart
xi. The SELECT * FROM Dun \& Bradstreet WHERE: should look like "PrimaryNai" = 445110 OR "Company" = 'Super Target' OR \{"Company" = 'Super Walmart'
xii. Click Apply
c. Right Click the Dun \& Bradstreet data layer and Click Data and then Export data
i. Choose Selected Features for Export
ii. Choose this layer's source data for Use the same coordinate system as:
iii. Navigate to appropriate folder and give the output file an appropriate name for Output shapefile or feature class
iv. Click OK
v. Click Yes to add the data to current data frame
II. Create network buffers for participant location
8. Start ArcMap
9. On the Main Menu click Tools and Click on Extensions.
a. Check Network Analyst Extension.
b. Click Close.
10. Click the Add Data button
on the Standard Toolbar
a. Navigate to the Network Dataset location, created earlier. (If need to create a new Network dataset. Look at Appendix for steps to create a network dataset.)
b. Click on the Network Dataset and click Add to add the Network Dataset to ArcMap.
c. Click No when asked to add all the feature classes, which participate in the network, to the map.
11. Click the Add Data button $\square$ on the Standard Toolbar
a. Navigate to the Point Layers to be used for analysis, in this case Participant location and Groceries, Supermarkets, or super centers Locations
b. Click on the Point Layers and click Add to add it to ArcMap
12. On the main menu click View
a. Click on Toolbars
b. In the side menu click Network Analyst to add the Network Analyst toolbar to ArcMap
13. Click Network Analysis Toolbar
a. Click Network Analyst Window button ${ }^{\text {F }}$ to add the Network Analyst Window to the map
14. On the Network Analyst Toolbar Click Network Analyst Dropdown Menu
a. Click New Service Area
b. The Table of contents and the Network Analyst Window contains empty list of Facilities, Barriers, Lines and Polygons Categories.
15. Add the Id's if not already added. In the Table of Contents Right Click the Point Layer and click on Open Attribute Table
a. In the Attribute Table
i. Click Options
ii. Click Add Field
iii. Add the School_Id/Participant_Id as Text

- Type School_Id_T/Part_Id_T in the Name field
- Select Text (50) as Type
- Accept default for Length
- Click OK
iv. Add the School_Id/Participant_Id as Integer
- Type School_Id/Part_Id in the Name field
- Select Short Integer as Type
- Accept default (0) for Precision
- Click OK
v. Enter the assigned Id for the participants and schools

9. On the Network Analyst Window right Click Facilities and Click Load Locations
a. In Load Locations Window
i. For Load From click Browse and navigate to the Participant Locations, Point feature layer
ii. Click on the Participant Locations layer and click Add
iii. Choose the Participant Id as the Sort field
iv. Choose the Participant Id Text as the Name field.
v. Accept the default for Location Position as Use Geometry

- Set the Search Tolerance to $\mathbf{5 0}$ meters
vi. Click OK

10. To set the properties to be used in the Analysis, In the Table of Contents Right Click the Service Area Layer and Click Properties
a. Click on Analysis Settings Tab
i. Choose Length (Meters) for Impedance.
ii. Type the required Buffer Distance for Default Breaks
```
iii. Choose Away From Facility as Direction
iv. Choose Everywhere for Allow U-Turns
v. Check Ignore Invalid Locations
b. Click on Polygon Generation Tab
i. Check Generate Polygons
ii. Choose Generalized as the Polygon Type
iii. Uncheck Trim Polygons
iv. Choose Overlapping for Multiple Facilities Option
v. Choose Disks as the Overlap Type
c. Click Ok
```

11. On the Network Analyst Toolbar, Click Solve Button
12. Joining attributes with Source Point Layer to carry over the data.
a. Right Click the Polygons Layer
b. Click Joins and Relates and then Join
c. Choose Join attributes from a table
i. Choose Facility Id as the Field to base the join on
ii. Choose the Participant Layer as the Table to Join to this layer
iii. Choose the Participant ID as the field in the table to base the join on
d. Right Click the Polygons Layer
e. Click on Data and then Export Data
i. Choose this layer's source data for the coordinate system
ii. Specify the Output location
III. Erase water features from the network buffer \& calculate area of network buffer
13. Click the Add Data button
on the Standard Toolbar
a. Navigate to the Water feature Layer to be used for analysis
b. Click on the Water feature Layer and click Add to add it to ArcMap
14. In the ArcToolbox, Click on Analysis Tools
15. Click on Overlay tools, and double click Erase. In the dialog box,
a. Choose the Exported Network Buffer Layer as the Input Layer
b. Choose the Water Feature layer as the Erase Features
c. Choose an appropriate Output Location and Name for the Output Feature Class
d. Click Ok
16. Click Yes to add the exported feature layer to the map
IV. Calculate the Area of Network Buffers
17. Add area fields to the output feature class created in the previous step
a. Right click on the Output Feature Class and select Open Attribute Table...
b. Click on the Option button and select Add Field...
c. Name the field Hectares and change the Type to Double. If an Hectares field already exists, you can cancel this operation and overwrite the hectares values
d. Click OK
18. Calculate the values for Hectares
a. Right-click the Hectares field in the Output Feature Class attribute table and select Calculate Geometry...
b. Set the Property: box to Area
c. Set the Coordinate System to "Use coordinate system of the data source"
d. Set the Units to Hectares [ha]
e. Click OK
V. Spatial Join to calculate the number of Groceries, Supermarkets, or super centers
19. Right click the buffer layer with erased water features layer (created and added in step II)
20. Click Join and Relates and then Click Join
a. Select Join data from another layer based on spatial location for Join Type
b. Choose the Groceries, Supermarkets, or super centers layer to join to this layer
c. Do not check any radio-dial for summarizing the data
d. Specify an appropriate location and name for the output feature class
e. Click Ok
f. Click Yes to add the feature class
VI. Calculate the density of Groceries, Supermarkets, or super centers
21. Open the attribute table of the spatial join feature class created in above step
22. Click Options and then Add field
a. Type Density for Name
b. Select Double for Type
c. Accept default for Precision and Scale
23. Right Click on the Density field and select field calculator
a. Click on Count in fields
b. Click on operator '/''
c. Click on Hectare in fields
d. The Density equation should look like: Density = Count/Hectare
e. Click Ok

The Density field contains the density number of Groceries, Supermarkets, or super centers per square hectare of the network buffer around participant location.

### 4.5 Distance to Large Supermarkets or Super Center

Note: This was updated in Version 1.3 to explain finalized coding.

## 1. Basic Concept

The basic idea of this measure is to estimate access to high quality and inexpensive food and to test whether the largest stores are best

Zenk et al. (2005) used store names rather than SIC codes for classification and omitted smaller chains: "Supermarkets were defined as super centers (e.g. Meijer, Super Kmart) and full-line grocery stores (e.g. Farmer Jack, Kroger) associated with a national or regional grocery chain, i.e. a chain with 11 or more retail stores" (PAGE).

There are two potential lists of chains. The web site www.supermarketnews.com has a national supermarket list. Wikipedia has a list that includes specialty and natural food chains, retail cooperatives, regional and local chains, national chains, Hispanic/Latino chains, discount chains, and Asian chains (See Appendix 4A). Most of these would be seen as supermarkets but only some were actually in Minnesota.

We examined the various data and decided to use Dun and Bradstreet industrial classifications to locate supermarkets (NAICS 445110) and to add super centers from lists on the web sites of major chains.

## 2. Basic Definition

Distance to Supermarket or Super Center = The shortest network or straight line distance between home or school and the nearest supermarket or super center.

## 3. Detailed Definition

Distance to Supermarket or Super Center = The shortest network or straight line distance between home or school and the nearest supermarket or super center where supermarkets are defined using NAICS codes Primaryly Dun and Bradstreet codes, a modification of SIC that allows one to distinguish on size (PrimaryDnB" = 54110100 OR "PrimaryDnB" = 54110101 OR "PrimaryDnB" = 54110102 OR "PrimaryDnB" = 54110103 OR "PrimaryDnB" = 54110104) and super centers using web searchesfor Super Targets and Super Walmarts. (Super K-Marts would need to be added in other regions).

## 4. Comments and Explanations

The GIS method to find the nearest large supermarket or supercenter is similar to the protocol 3.1, distance to nearest restaurant, and is done by using the Find Closest Facility option in Network Analyst Extension of ArcGIS 9.1 or ArcGIS 9.2. Though in this case, the nearest distance is calculated only for the large supermarket or supercenter and not restaurants. The large supermarket and supercenter's are selected on the basis of Dun \& Bradstreet code and the names of three major supermarkets namely Super Target and Super Walmart,( Super Kmart's were not in the region). These three supermarkets were selected because they sell food (fruits and vegetables etc) whereas their counterparts like Target or Walmart rarely have fresh food and would not be appropriate for the measures. The NAICS code 452910 Warehouse Clubs and Supercenters and 45211 Department Stores, do not include Super Target and Super Walmart. The data for these supermarkets was downloaded from their respective websites.

See Protocol 3.1 for more explanation on finding the nearest larger supermarket.

## 5. GIS Approach

First of all the large supermarket or supercenter are extracted from the master data and then the nearest distance to these locations are calculated. The basic idea is similar to the protocol 3.1, distance to nearest restaurant. Nearest network distance between a set of origin locations and destination locations is calculated using Network Analyst and straight line distance is calculated using Near tool in ArcToolbox. However, while extracting the large supermarket or supercenter's from master data, the Dun \& Bradstreet code and the names of three major supermarkets namely Super Target, Super Walmart and Costco are used.

See Protocol 3.1 for more explanation.

## 6. GIS Steps

Requirements:

1. Road Layer polyline
2. Point Features (Large Supermarkets or Supercenter layer) for finding the nearest distance to
3. Point Features (Participants layer) for finding the nearest distance from
4. Network Analyst Extension for ArcGIS 9.1 or ArcGIS 9.2
I. Query and extract data for Large Supermarkets or Supercenters according to specified Dun \& Bradstreet codes and names of supermarkets, from Dun \& Bradstreet data, if the layer is not already prepared
5. Start ArcMap
6. Click the Add Data button on the Standard Toolbar.
a. Navigate to the Dun \& Bradstreet data
b. Click on the Dun \& Bradstreet dataset and click Add to add the dataset to the Map
7. Right Click the Dun \& Bradstreet data and Click Open Attribute Table
a. Click on Options
b. Click Select by Attributes
i. Select Create a new selection as Method

- Click on "PrimaryDnB" in the Attributes list and click on Unique values (since this can take substantial time, instead of this consider typing the codes as mentioned below)
- Click "=" operator
- Click or Type 54110100
- Click "OR" operator
- Repeat above steps adding the values to $\mathbf{5 4 1 1 0 1 0 1}, \mathbf{5 4 1 1 0 1 0 2 , 5 4 1 1 0 1 0 3 , 5 4 1 1 0 1 0 4}$
ii. Click on "Company" in the attributes list and click on Unique values (since this can take substantial time, instead of this consider typing the codes as mentioned below)
- Click "=" operator
- Click or Type Super Target
- Click "OR" operator
- Repeat above steps adding the values to Super Walmart
iii. The SELECT * FROM Dun \& Bradstreet WHERE: should: look like
"PrimaryDnB" = 54110100 OR "PrimaryDnB" = 54110101 OR "PrimaryDnB" = 54110102 OR "PrimaryDnB" = 54110103 OR "PrimaryDnB" = 54110104 OR "Company" = 'Super Target' OR "Company" = 'Super Walmart'
iv. Click Apply
c. Right Click the Dun \& Bradstreet data and Click Data and then Export data
i. Choose Selected Features for Export
ii. Choose this layer's source data for Use the same coordinate system as:
iii. Navigate to appropriate folder and give the output file an appropriate name for Output shapefile or feature class
iv. Click OK
v. Click Yes to add the data to current data frame
II. Calculate the Network and Straight line Distance to Nearest Restaurant
A. Network Distance

1. Start ArcMap
2. On the Main Menu click Tools and Click on Extensions.
a. Check Network Analyst Extension.
b. Click Close
3. Click the Add Data button on the Standard Toolbar
a. Navigate to the Network Dataset location, created earlier
b. Click on the Network Dataset and click Add to add the Network Dataset to ArcMap.
c. Click Yes to add all the feature classes, that participate in the network, to the map.
4. Click the Add Data button
on the Standard Toolbar
a. Navigate to the Point Layers to be used for analysis, in this case Participant location and Large Supermarkets or Supercenters Locations
b. Click on the Point Layers and click Add to add it to ArcMap.
5. Assign Id's to the Large Supermarkets or Supercenters outlets and the participant's if not done already. In the Table of Contents Right Click the Point Layer and click on Open Attribute Table a. In the Attribute Table
i. Click Options
ii. Click Add Field
iii. Add the SuperId_T/Part_Id_T as Text

- Type SuperId_T/Part_Id_T in the Name field
- Select Text (50) as Type
- Accept default for Length
- Click OK
iv. Add the Super_Id/Part_Id as Integer
- Type Super_Id/Part_Id in the Name field
- Select Short Integer as Type
- Accept default (0) for Precision
- Click OK
v. Enter the assigned Id for the participants and schools

6. On the main menu click View
a. Click on Toolbars
b. In the side menu click Network Analyst to add the Network Analyst toolbar to ArcMap
7. Click Network Analysis Toolbar
a. Click Network Analyst Window button 国 to add the Network Analyst Window to the map
8. On the Network Analyst Toolbar Click Network Analyst Dropdown Menu
a. Click New Closest Facility
b. The Table of contents and the Network Analyst Window contains empty list of Facilities, Incidents, Routes and Barriers Categories.
9. On the Network Analyst Window right Click Facilities and Click Load Locations
a. In Load Locations Window
i. Click Browse and navigate to the Large Supermarkets or Supercenters Locations, Point feature layer
ii. Click on the Large Supermarkets or Supercenters Locations layer and click Add
iii. Choose the Large Supermarkets or Supercenters Id as the Sort field
iv. Choose the Large Supermarkets or Supercenters Id Text as the Name field. Accept the default for other Location Analysis Properties
v. Use 50 Meters for Location Position, Use Geometry (increase the search tolerance if many locations are not located)
vi. Click OK
10. On the Network Analyst Window right click Incidents and Click Load Locations
a. In Load Locations Window
i. Click Browse and navigate to the Participant Locations, Point feature layer
ii. Click on the Participant Locations layer and click Add
iii. Choose the Participant ID/School Id as the Sort field
iv. Choose the Participant ID/School Id Text as the Name field. Accept the default for other Location Analysis Properties
v. Accept the default Location Position
vi. Click OK
11. To set the properties to be used in the Analysis, In the Table of Contents Right Click the Closest Facility Layer and Click Properties
a. Click on Analysis Settings Tab
i. Choose Length (Meters) for Impedance
ii. Choose None for Default Cutoff Values
iii. Choose Facilities To Find as 1
iv. Choose Travel From as Incident To Facility
v. Choose Everywhere for Allow U-Turns
vi. Choose Output Shape Type as True Shape
vii. Check the box to Ignore Invalid Locations
b. Click Ok
12. On the Network Analyst Toolbar, Click Solve Button
13. Joining attributes with Source Point Layer to carry over the data (only for ArcGIS 9.1)
a. Right Click the Routes Layer
b. Click Joins and Relates and then Join
i. Choose Facility Id as the Field to base the join on
ii. Choose the Retail Food Outlets Layer as the Table to Join to this layer
iii. Choose the Retail Food Outlets ID as the field in the table to base the join on
iv. Click Ok
c. Right Click the Routes Layer
d. Click on Data and then Export Data
i. Choose this layer's source data for the coordinate system
ii. Specify the Output location

In ArcGIS 9.2 the name field of routes contains the Incident Id (Participant Id) to Facility ID (Large Supermarkets or Supercenters ID) in the format Incident Id - Facility ID. It indicates the route connects a participant to the corresponding Large Supermarkets or Supercenters.
B. Straight line distance

1. Open ArcToolbox, then click Proximity Tools
2. Click on Near tool
a. Navigate and Choose Participant Layer as the Input Features
b. Navigate and Choose Large Supermarkets or Supercenters layer as Near Features
c. Check Location and angle, if need to calculate them
d. Click OK

The straightline distance to nearest restaurant is stored in the attribute table under field name Near_Dist. The Near_FID field has the FID of the Nearest Large Supermarkets or Supercenters.

### 4.6 Density of Large Supermarkets or Super Centers

## 1. Basic Concept

This is the density version of protocol 4.5.

## 2. Basic Definition

Density of Supermarkets or Super Centers = Total supermarkets or super centers per unit land area (excluding water).

## 3. Detailed Definition

Density of Supermarkets or Super Centers = Total supermarkets or super centers per unit land area (excluding water) where supermarkets are defined using Primaryly Dun and Bradstreet codes, a modification of SIC that allows one to distinguish on size (PrimaryDnB" $=54110100$ OR "PrimaryDnB" $=54110101$ OR "PrimaryDnB" $=54110102$ OR "PrimaryDnB" $=54110103$ OR "PrimaryDnB" $=54110104$ ) and super centers using web searches.

## 4. Comments and Explanations

The protocol is similar to the Protocol 3.2 , Density of Restaurants. However, in this case the large supermarkets and supercenters density is calculated. The area within which the density has to be calculated is demarcated, the number of large supermarkets and supercenters in the area are counted, and the number is divided by the area to get the density. The large supermarkets and supercenter's are selected on basis of Dun \& Bradstreet code and name of three major supermarkets, namely Super Target, Super Walmart and Costco.

For a detailed explanation for calculating the density refer to Protocol 3.2.
For a detailed explanation about selecting the large supermarkets and supercenters refer to Protocol 4.5.

## 5. GIS Approach

First the large supermarkets and supercenters are extracted from the master data and then the buffer area is created using Network Analyst. Then, the water features are erased from the buffers using Erase tool, then the area of the buffer layer with erased water features is calculated. The number of large supermarkets and supercenters is counted with a spatial join between the buffer layer and the retail food outlet location layer. The number of large supermarkets and supercenters locations is then divided by the area in hectares to get the density.

For a detailed explanation refer to GIS Approach in Protocol 3.2.

## 6. GIS Steps

Requirements:

1. Road Layer polyline
2. Large Supermarkets or Supercenters layer (Point Features) for finding the nearest distance to
3. Participants layer (Point Features) for finding the nearest distance from
4. Network Analyst Extension for ArcGIS 9.1 or ArcGIS 9.2
I. Query and extract data for Large Supermarkets or Supercenters according to specified Dun \& Bradstreet codes and names of supermarkets, from Dun \& Bradstreet data, if the layer is not already prepared
5. Start ArcMap
6. Click the Add Data button on the Standard Toolbar.
a. Navigate to the Dun \& Bradstreet data
b. Click on the Dun \& Bradstreet dataset and click Add to add the dataset to the Map
7. Right Click the Dun \& Bradstreet data and Click Open Attribute Table
a. Click on Options
b. Click Select by Attributes
i. Select Create a new selection as Method

- Click on "PrimaryDnB" in the Attributes list and click on Unique values (since this can take substantial time, instead of this consider typing the codes as mentioned below)
- Click "=" operator
- Click or Type 54110100
- Click "OR" operator
- Repeat above steps adding the values to 54110101, 54110102, 54110103, 54110104
ii. Click on "Company" in the attributes list and click on Unique values (since this can take substantial time, instead of this consider typing the codes as mentioned below)
- Click "=" operator
- Click or Type Super Target
- Click "OR" operator
- Repeat above steps adding the values to Super Walmart
iii. The SELECT * FROM Dun \& Bradstreet WHERE: should: look like
"PrimaryDnB" = 54110100 OR "PrimaryDnB" = 54110101 OR "PrimaryDnB" = 54110102 OR "PrimaryDnB" = 54110103 OR "PrimaryDnB" = 54110104 OR "Company" = 'Super Target' OR "Company" = 'Super Walmart'
iv. Click Apply
c. Right Click the Dun \& Bradstreet data and Click Data and then Export data
i. Choose Selected Features for Export
ii. Choose this layer's source data for Use the same coordinate system as:
iii. Navigate to appropriate folder and give the output file an appropriate name for Output shapefile or feature class
iv. Click OK
v. Click Yes to add the data to current data frame
II. Create network buffers for participant location

1. Start ArcMap
2. On the Main Menu click Tools and Click on Extensions.
a. Check Network Analyst Extension.
b. Click Close.
3. Click the Add Data button $\downarrow$ on the Standard Toolbar
a. Navigate to the Network Dataset location, created earlier. (If need to create a new Network dataset. Look at Appendix for steps to create a network dataset.)
b. Click on the Network Dataset and click Add to add the Network Dataset to ArcMap.
c. Click No when asked to add all the feature classes, which participate in the network, to the map.
4. Click the Add Data buttonon the Standard Toolbar
a. Navigate to the Point Layers to be used for analysis, in this case Large Supermarkets or Supercenters Locations
b. Click on the Point Layers and click Add to add it to ArcMap
5. On the main menu click View
a. Click on Toolbars
b. In the side menu click Network Analyst to add the Network Analyst toolbar to ArcMap
6. Click Network Analysis Toolbar
a. Click Network Analyst Window button ${ }^{\text {F }}$ to add the Network Analyst Window to the map
7. On the Network Analyst Toolbar Click Network Analyst Dropdown Menu
a. Click New Service Area
b. The Table of contents and the Network Analyst Window contains empty list of Facilities, Barriers, Lines and Polygons Categories.
8. Add the Id's if not already added. In the Table of Contents Right Click the Point Layer and click on Open Attribute Table
a. In the Attribute Table
i. Click Options
ii. Click Add Field
iii. Add the School_Id/Participant_Id as Text

- Type School_Id_T/Part_Id_T in the Name field
- Select Text (50) as Type
- Accept default for Length
- Click OK
iv. Add the School_Id/Participant_Id as Integer
- Type School_Id/Part_Id in the Name field
- Select Short Integer as Type
- Accept default (0) for Precision
- Click OK
v. Enter the assigned Id for the participants and schools

9. On the Network Analyst Window right Click Facilities and Click Load Locations
a. In Load Locations Window
i. For Load From click Browse and navigate to the Participant Locations, Point feature layer
ii. Click on the Participant Locations layer and click Add
iii. Choose the Participant Id as the Sort field
iv. Choose the Participant Id Text as the Name field.
v. Accept the default for Location Position as Use Geometry

## - Set the Search Tolerance to 50 meters <br> vi. Click OK

10. To set the properties to be used in the Analysis, In the Table of Contents Right Click the Service Area Layer and Click Properties
a. Click on Analysis Settings Tab
i. Choose Length (Meters) for Impedance.
ii. Type the required Buffer Distance for Default Breaks
iii. Choose Away From Facility as Direction
iv. Choose Everywhere for Allow U-Turns
v. Check Ignore Invalid Locations
b. Click on Polygon Generation Tab
i. Check Generate Polygons
ii. Choose Generalized as the Polygon Type
iii. Uncheck Trim Polygons
iv. Choose Overlapping for Multiple Facilities Option
v. Choose Disks as the Overlap Type
c. Click Ok
11. On the Network Analyst Toolbar, Click Solve Button
12. Joining attributes with Source Point Layer to carry over the data.
a. Right Click the Polygons Layer
b. Click Joins and Relates and then Join
c. Choose Join attributes from a table
i. Choose Facility Id as the Field to base the join on
ii. Choose the Participant Layer as the Table to Join to this layer
iii. Choose the Participant ID as the field in the table to base the join on
d. Right Click the Polygons Layer
e. Click on Data and then Export Data
i. Choose this layer's source data for the coordinate system
ii. Specify the Output location
III. Erase water features from the network buffer \& calculate area of network buffer
13. Click the Add Data button $V$ on the Standard Toolbar
a. Navigate to the Water feature Layer to be used for analysis
b. Click on the Water feature Layer and click Add to add it to ArcMap
14. In the ArcToolbox, Click on Analysis Tools
15. Click on Overlay tools, and double click Erase. In the dialog box,
a. Choose the Exported Network Buffer Layer as the Input Layer
b. Choose the Water Feature layer as the Erase Features
c. Choose an appropriate Output Location and Name for the Output Feature Class
d. Click Ok
16. Click Yes to add the exported feature layer to the map
IV. Calculate the Area of Network Buffers
17. Add area fields to the output feature class created in the previous step
a. Right click on the Output Feature Class and select Open Attribute Table...
b. Click on the Option button and select Add Field...
c. Name the field Hectares and change the Type to Double. If an Hectares field already exists, you can cancel this operation and overwrite the hectares values
d. Click OK
18. Calculate the values for Hectares
a. Right-click the Hectares field in the Output Feature Class attribute table and select Calculate Geometry...
b. Set the Property: box to Area
c. Set the Coordinate System to "Use coordinate system of the data source"
d. Set the Units to Hectares [ha]
e. Click OK
V. Spatial Join to calculate the number of Large Supermarkets or Supercenters
19. Right click the buffer layer with erased water features layer
20. Click Join and Relates and then Click Join
a. Select Join data from another layer based on spatial location for Join Type
b. Choose the Large Supermarkets or Supercenters layer to join to this layer
c. Do not check any radio-dial for summarizing the data
d. Specify an appropriate location and name for the output feature class
e. Click Ok
f. Click Yes to add the feature class
VI. Calculate the density of Large Supermarkets or Supercenters
21. Open the attribute table of the spatial join feature class created in above step
22. Click Options and then Add field
a. Type Density for Name
b. Select Double for Type
c. Accept default for Precision and Scale
23. Right Click on the Density field and select field calculator
a. Click on Count in fields
b. Click on operator ' $/$ '
c. Click on Hectare in fields
d. The Density equation should look like: Density = Count/Hectare
e. Click Ok

The Density field contains the density number of Large Supermarkets or Supercenters per square hectare of the network buffer around participant location.

### 4.7 Type of Nearest Retail Food Outlet

Note: Updated in Version 1.3.

## 1. Basic Concept

The closest store is likely to be the one frequented.
This will build on Moore and Diez Roux (2006) who used InfoUSA to classify stores into "the following categories using the SIC codes:

- grocery stores and supermarkets (541101, 541104-541106);
- convenience stores $(541102,541103)$;
- meat and fish markets (5421, 549907, 549911);
- fruit and vegetable markets (543101-543103, 549933);
- bakeries (541);
- natural food stores $(549901,549909,549935)$;
- specialty food stores (549910, 549912, 549914, 549916-549921, 559923, 549926-549928, 549930, 549937);
- and liquor stores (5912)." (p 326, bulleting added).

However, as we have found much misclassification in this database in the Twin Cities, we will instead use Dun and Bradstreet and will use NAICS as appropriate to attempt to classify these better.While some may seem ofdd-such as confectionary manufacturing from purchased chocolate-that category includes handmade choclate stores. These include:

- 311330 Confectionery Manufacturing from Purchased Chocolate
- 311340 Nonchocolate Confectionery Manufacturing
- 311811 Retail Bakeries
- 445120 Convenience Stores
- 445210 Meat Markets
- 445220 Fish and Seafood Markets
- 445230 Fruit and Vegetable Markets
- 445291 Baked Goods Stores
- 445292 Confectionery and Nut Stores
- 445299 All Other Specialty Food Stores
- 446110 Pharmacies and Drug Stores
- 446191 Food (Health) Supplement Stores,
- 447110 Gasoline Stations with Convenience Stores
- 447190 Other Gasoline Stations (our local knowledge indicated most of these sold food)
- 452111 Department Stores (except Discount Department Stores)
- 452112 Discount Department Stores
- 452190 [typo in steps, to fix]
- 452910 Warehouse Clubs and Supercenters
- 454390Other Direct Selling Establishments
- 722213 Snack and Nonalcoholic Beverage Bars
$\bullet$


## 2. Basic Definition

Type of Nearest Retail Food Outlet = industrial code of the type of food store that is the shortest network or straight line distance between home or school.

## 3. Detailed Definition

Type of Nearest Retail Food Outlet = industrial code of the type of food store that is the shortest network or straight line distance between home or school where type of store is identified using NAICS codes above.

## 4. Comments and Explanations

The methodology to find the nearest retail food outlet is similar to the protocol 3.1, distance to nearest restaurant, and is done by using the Find Closest Facility option in Network Analyst Extension of ArcGIS 9.1 or ArcGIS 9.2. Though in this case, the type of nearest retail food outlet is the output. In case of Network distance, the type of nearest food outlet is extracted by joining the facility layer (the sub layer of closest facility) with the retail food outlet layer and then joining this combined data with the route layer. This ensures that all the routes carry over the original retail food outlet data.

See Protocol 3.1 for more explanation of finding the closest facility.

## 5. GIS Approach

First the Retail Food Outlets are extracted from the master data and then the nearest distance to these locations are calculated. The basic idea to find the nearest retail food outlet is similar to the protocol 3.1, distance to nearest restaurant. Nearest network distance between a set of origin locations and destination locations is calculated using Network Analyst and straight line distance is calculated using Near tool in ArcToolbox. In case of Network distance, the type of nearest food outlet is extracted by joining the attributes of facility layer (the sub layer of closest facility) using the Name field, with the retail food outlet layer, using the retail food outlet Id and exporting this data as new layer. Then this exported data is joined with the route layer using facility Id and object Id of exported data. This ensures that all the routes carry over the original retail food outlet data.

See Protocol 3.1 for more explanation.
6. GIS Steps

Requirements:

1. Road Layer polyline
2. Point Features (Retail Food Outlets layer) for finding the nearest distance to
3. Point Features (Participants layer) for finding the nearest distance from
4. Network Analyst Extension for ArcGIS 9.1 or ArcGIS 9.2
I. Query and extract data for Restaurants according to specified NAICS codes from Dun \& Bradstreet data, if the restaurant layer is not already prepared
5. Start ArcMap
6. Click the Add Data button ${ }^{ \pm}$on the Standard Toolbar.
a. Navigate to the Dun \& Bradstreet data
b. Click on the Dun \& Bradstreet dataset and click Add to add the dataset to the Map
7. Right Click the Dun \& Bradstreet data and Click Open Attribute Table
a. Click on Options
b. Click Select by Attributes
i. Select Create a new selection as Method
ii. Click on "PrimaryNai" in the Attributes list and click on Unique values (since this can take substantial time, instead of this consider typing the codes as mentioned below)
iii. Click "=" operator
iv. Click or Type 445110
v. Click "OR" operator
vi. Repeat steps ii to $\mathbf{v}$ adding the values to 445120, 447110, 452910, 454390, 445210, 445220, 454390, 445230, 454390, 311330, 311340, 445292, 445299, 311811, 445291, 722213, 445210, 445299, 446191, 452190, 452111,452112, 447190, 446110
vii. The SELECT * FROM Dun \& Bradstreet WHERE: should: look like
"PrimaryNai" = 445110 OR "PrimaryNai" = 445120 OR "PrimaryNai" = 447110 OR
"PrimaryNai" = 452910 OR "PrimaryNai" = 454390 OR "PrimaryNai" = 445210 OR
"PrimaryNai" = 445220 OR "PrimaryNai" = 454390 OR "PrimaryNai" = 311330 OR
"PrimaryNai" = 311340 OR "PrimaryNai" = 445292 OR "PrimaryNai" = 445299 OR
"PrimaryNai" = 311811 OR "PrimaryNai" = 445291 OR "PrimaryNai" = 722213 OR
"PrimaryNai" = 445210 OR "PrimaryNai" = 445299 OR "PrimaryNai" = 446191OR
"PrimaryNai" = 452910 OR "PrimaryNai" = 452111 (If included) OR "PrimaryNai" = 447190 OR "PrimaryNai" = 446110 OR "PrimaryNai" = 452112
viii. Click Apply
c. Right Click the Dun \& Bradstreet data and Click Data and then Export data
ix. Choose Selected Features for Export
x. Choose this layer's source data for Use the same coordinate system as:
xi. Navigate to appropriate folder and give the output file an appropriate name for Output shapefile or feature class
xii. Click OK
xiii. Click Yes to add the data to current data frame
II. Calculate the Network and Straight line Distance to Nearest Restaurant
A. Network Distance
8. Start ArcMap
9. On the Main Menu click Tools and Click on Extensions.
a. Check Network Analyst Extension.
b. Click Close
10. Click the Add Data button $\ddagger$ on the Standard Toolbar
a. Navigate to the Network Dataset location, created earlier
b. Click on the Network Dataset and click Add to add the Network Dataset to ArcMap.
c. Click Yes to add all the feature classes, that participate in the network, to the map.
11. Click the Add Data button $\downarrow$ on the Standard Toolbar
a. Navigate to the Point Layers to be used for analysis, in this case Participant location and Restaurant Locations
b. Click on the Point Layers and click Add to add it to ArcMap.
12. Assign Id's to the retail food outlets and the participant's if not done already. In the Table of Contents Right Click the Point Layer and click on Open Attribute Table
a. In the Attribute Table
i. Click Options
ii. Click Add Field
iii. Add the RetailId_T/Part_Id_T as Text

- Type RetailId_T/Part_Id_T in the Name field
- Select Text (50) as Type
- Accept default for Length
- Click OK
iv. Add the Retail_Id/Part_Id as Integer
- Type Retail_Id/Part_Id in the Name field
- Select Short Integer as Type
- Accept default (0) for Precision
- Click OK
v. Enter the assigned Id for the participants and schools

6. On the main menu click View
a. Click on Toolbars
b. In the side menu click Network Analyst to add the Network Analyst toolbar to ArcMap
7. Click Network Analysis Toolbar
a. Click Network Analyst Window button ${ }^{\text {F }}$ to add the Network Analyst Window to the map
8. On the Network Analyst Toolbar Click Network Analyst Dropdown Menu
a. Click New Closest Facility
b. The Table of contents and the Network Analyst Window contains empty list of Facilities, Incidents, Routes and Barriers Categories.
9. On the Network Analyst Window right Click Facilities and Click Load Locations
a. In Load Locations Window
i. Click Browse and navigate to the Retail Food Outlets Locations, Point feature layer
ii. Click on the Retail Food Outlets Locations layer and click Add
iii. Choose the Retail Food Outlets Id as the Sort field
iv. Choose the Retail Food Outlets Id Text as the Name field. Accept the default for other Location Analysis Properties
v. Use 50 Meters for Location Position, Use Geometry (increase the search tolerance if many locations are not located)
vi. Click OK
10. On the Network Analyst Window right click Incidents and Click Load Locations
a. In Load Locations Window
i. Click Browse and navigate to the Participant Locations, Point feature layer
ii. Click on the Participant Locations layer and click Add
iii. Choose the Participant ID/School Id as the Sort field
iv. Choose the Participant ID/School Id Text as the Name field. Accept the default for other Location Analysis Properties
v. Accept the default Location Position
vi. Click OK
11. To set the properties to be used in the Analysis, In the Table of Contents Right Click the Closest Facility Layer and Click Properties
a. Click on Analysis Settings Tab
i. Choose Length (Meters) for Impedance
ii. Choose None for Default Cutoff Values
iii. Choose Facilities To Find as 1
iv. Choose Travel From as Incident To Facility
v. Choose Everywhere for Allow U-Turns
vi. Choose Output Shape Type as True Shape
vii. Check the box to Ignore Invalid Locations
b. Click Ok
12. On the Network Analyst Toolbar, Click Solve Button
13. Joining attributes with Source Point Layer to carry over the data
a. Right Click the Facilities layer
b. Click Joins and Relates and then Join
i. Choose Name as the Field to base the join on
ii. Choose the Retail Food Outlets Layer as the Table to Join to this layer
iii. Choose the Retail Food Outlets ID Text as the field in the table to base the join on iv. Click Ok
c. Right Click the Facilities Layer
d. Click on Data and then Export Data
i. Choose this layer's source data for the coordinate system
e. Specify the Output location
f. Right Click the Routes Layer
g. Click Joins and Relates and then Join
v. Choose Facility Id as the Field to base the join on
vi. Choose the Data join layer exported in above step as the Table to Join to this layer
vii. Choose the Object ID as the field in the table to base the join on
viii. Click Ok
h. Right Click the Routes Layer
i. Click on Data and then Export Data
i. Choose this layer's source data for the coordinate system
ii. Specify the Output location

In ArcGIS 9.2 the name field of routes contains the Incident Id (Participant Id) to Facility ID (Retail Food Outlets ID) in the format Incident Id - Facility ID. It indicates the route connects a participant to the corresponding retail food outlets. To obtain the Type of Retail Food Outlet, the NAICS code corresponding to each facility can be found out from the attribute table.
B. Straight line distance

1. Open ArcToolbox, then click Proximity Tools
2. Click on Near tool
a. Navigate and Choose Participant Layer as the Input Features
b. Navigate and Choose Restaurant layer as Near Features
c. Check Location and angle, if need to calculate them
d. Click OK

The straightline distance to nearest restaurant is stored in the attribute table under field name Near_Dist. The Near_FID field has the FID of the Nearest Restaurant. To obtain the Type of Retail Food Outlet, the NAICS code corresponding to each facility can be found out from the attribute table.

### 4.8 Distance to Nearest Convenience Store Including Gas Stations

Note: NAICS codes were slightly updated in Version 1.3.

## 1. Basic Concept

The TREC-IDEA study has several questions about convenience stores:
Convenience Stores

- SS164 During a normal school week, how many days per week do you get lunch off campus at a convenience store? (TACOS Student Survey (11))
- SS169 About how long would it take to get from your home to the nearest convenience store if you walked? (Adapted from NEWS B1 (14))
- Ps 65/66 In the past month, how many times did you buy food/sweetened beverage at a convenience store, gas station, hardware store, or a vending machine?
The TREC-IDEA study has al question about gas stations
- Ps 65/66 In the past month, how many times did you buy food/sweetened beverage at a convenience store, gas station, hardware store, or a vending machine?

We use NAICS codes 44512 (convenience stores) , 44711 Gasoline Stations with Convenience Stores, and 44719 Other Gasoline Stations.

## 2. Basic Definition

Distance to nearest convenience store $=$ The shortest network or straight line distance between home or school and the nearest convenience store.

## 3. Detailed Definition

Distance to nearest convenience store $=$ The shortest network or straight line distance between home or school and the nearest convenience store defined with NAICS codes $(44512,44711,44719)$.

## 4. Comments and Explanations

This is similar to the protocol 3.1, distance to nearest restaurant, and is done by using the Find Closest Facility option in Network Analyst Extension of ArcGIS 9.1 or ArcGIS 9.2. Though in this case, the nearest distance is calculated only for the Convenience Stores (including Gas Stations) and not for restaurants.

See Protocol 3.1 for more explanation.

## 5. GIS Approach

First the Convenience Stores (including Gas Stations) are extracted from the master data and then the nearest distance to these locations are calculated. The basic idea is similar to the protocol 3.1, distance to nearest restaurant. Nearest network distance between a set of origin locations and destination locations is calculated using Network Analyst and straight line distance is calculated using Near tool in ArcToolbox.

See Protocol 3.1 for more explanation.

## 6. GIS Steps

## Requirements:

1. Road Layer polyline
2. Convenience Stores (including Gas Stations) layer (Point Features) for finding the nearest distance to
3. Participants layer (Point Features) for finding the nearest distance from
4. Network Analyst Extension for ArcGIS 9.1 or ArcGIS 9.2
I. Query and extract data for Convenience Stores (including Gas Stations) according to specified NAICS codes from Dun \& Bradstreet data, if the layer is not already prepared
5. Start ArcMap
6. Click the Add Data button $\downarrow$ on the Standard Toolbar.
a. Navigate to the Dun \& Bradstreet data
b. Click on the Dun \& Bradstreet dataset and click Add to add the dataset to the Map
7. Right Click the Dun \& Bradstreet data and Click Open Attribute Table
a. Click on Options
b. Click Select by Attributes
i. Select Create a new selection as Method
ii. Click on "PrimaryNai" in the Attributes list and click on Unique values (since this can take substantial time, instead of this consider typing the codes as mentioned below)
iii. Click "=" operator
iv. Click or Type 445120
v. Click "OR" operator
vi. Click or Type 447110
vii. Click "OR" operator
viii. Click or Type 447190
ix. The SELECT * FROM Dun \& Bradstreet WHERE: should: look like "PrimaryNai" $=445120$ OR "PrimaryNai" $=447110$ OR "PrimaryNai" $=447190$
x. Click Apply
c. Right Click the Dun \& Bradstreet data layer and Click Data and then Export data
i. Choose Selected Features for Export
ii. Choose this layer's source data for Use the same coordinate system as:
iii. Navigate to appropriate folder and give the output file an appropriate name for Output shapefile or feature class
iv. Click OK
v. Click Yes to add the data to current data frame
II. Calculate the Network and Straight line Distance to Nearest Restaurant
A. Network Distance
8. Start ArcMap
9. On the Main Menu click Tools and Click on Extensions.
a. Check Network Analyst Extension.
b. Click Close
10. Click the Add Data button
on the Standard Toolbar
a. Navigate to the Network Dataset location, created earlier
b. Click on the Network Dataset and click Add to add the Network Dataset to ArcMap.
c. Click Yes to add all the feature classes, that participate in the network, to the map.
11. Click the Add Data button $\mathcal{V}$ on the Standard Toolbar
a. Navigate to the Point Layers to be used for analysis, in this case Participant location and Convenience Stores (including Gas Stations) Locations
b. Click on the Point Layers and click Add to add it to ArcMap.
12. Assign Id's to the retail food outlets and the participant's if not done already. In the Table of Contents Right Click the Point Layer and click on Open Attribute Table
a. In the Attribute Table
i. Click Options
ii. Click Add Field
iii. Add the Conv_Id_T/Part_Id_T as Text

- Type Conv _Id_T/Part_Id_T in the Name field
- Select Text (50) as Type
- Accept default for Length
- Click OK
iv. Add the Conv _Id/Part_Id as Integer
- Type Conv _Id/Part_Id in the Name field
- Select Short Integer as Type
- Accept default (0) for Precision
- Click OK
v. Enter the assigned Id for the participants and schools

6. On the main menu click View
a. Click on Toolbars
b. In the side menu click Network Analyst to add the Network Analyst toolbar to ArcMap
7. Click Network Analysis Toolbar
a. Click Network Analyst Window button ${ }^{\text {F }}$ to add the Network Analyst Window to the map
8. On the Network Analyst Toolbar Click Network Analyst Dropdown Menu
a. Click New Closest Facility
b. The Table of contents and the Network Analyst Window contains empty list of Facilities, Incidents, Routes and Barriers Categories.
9. On the Network Analyst Window right Click Facilities and Click Load Locations
a. In Load Locations Window
i. Click Browse and navigate to the Convenience Stores (including Gas Stations) Locations, Point feature layer
ii. Click on the Convenience Stores (including Gas Stations) Locations layer and click Add
iii. Choose the Convenience Stores (including Gas Stations) Id as the Sort field
iv. Choose the Convenience Stores (including Gas Stations) Id Text as the Name field. Accept the default for other Location Analysis Properties
v. Use 50 Meters for Location Position, Use Geometry (increase the search tolerance if many locations are not located)
vi. Click OK
10. On the Network Analyst Window right click Incidents and Click Load Locations
a. In Load Locations Window
i. Click Browse and navigate to the Participant Locations, Point feature layer
ii. Click on the Participant Locations layer and click Add
iii. Choose the Participant ID/School Id as the Sort field
iv. Choose the Participant ID/School Id Text as the Name field. Accept the default for other Location Analysis Properties
v. Accept the default Location Position
vi. Click OK
11. To set the properties to be used in the Analysis, In the Table of Contents Right Click the Closest Facility Layer and Click Properties
a. Click on Analysis Settings Tab
i. Choose Length (Meters) for Impedance
ii. Choose None for Default Cutoff Values
iii. Choose Facilities To Find as 1
iv. Choose Travel From as Incident To Facility
v. Choose Everywhere for Allow U-Turns
vi. Choose Output Shape Type as True Shape
vii. Check the box to Ignore Invalid Locations
b. Click Ok
12. On the Network Analyst Toolbar, Click Solve Button 茄
13. Joining attributes with Source Point Layer to carry over the data (only for ArcGIS 9.1)
a. Right Click the Routes Layer
b. Click Joins and Relates and then Join
i. Choose Facility Id as the Field to base the join on
ii. Choose the Convenience Stores (including Gas Stations) Layer as the Table to Join to this layer
iii. Choose the Convenience Stores (including Gas Stations) ID as the field in the table to base the join on
iv. Click Ok
c. Right Click the Routes Layer
d. Click on Data and then Export Data
i. Choose this layer's source data for the coordinate system
ii. Specify the Output location

In ArcGIS 9.2 the name field of routes contains the Incident Id (Participant Id) to Facility ID (Convenience Stores (including Gas Stations) Id) in the format Incident Id - Facility ID. It indicates the route connects a participant to the corresponding Convenience Stores (including Gas Stations).

The length of the nearest distance segment from a participant's location to the nearest Convenience Stores (including Gas Stations) is stored in the Total Length attribute.
B. Straight line distance

1. Open ArcToolbox, then click Proximity Tools
2. Click on Near tool
a. Navigate and Choose Participant Layer as the Input Features
b. Navigate and Choose Convenience Stores (including Gas Stations) layer as Near Features
c. Check Location and angle, if need to calculate them
d. Click OK

The straight line distance to nearest Convenience Stores (including Gas Stations) is stored in the attribute table under field name Near_Dist. The Near_FID field has the FID of the Nearest Convenience Stores (including Gas Stations).

### 4.9. Density of Convenience Stores Including Gas Stations

Note: NAICS codes were slightly updated in Version 1.3.

## 1. Basic Concept

This is the density version of protocol 4.6.

## 2. Basic Definition

Density of all Convenience Stores = Total convenience stores per unit land area (excluding water).

## 3. Detailed Definition

Density of all Convenience Stores $=$ Total convenience stores per unit land area (excluding water) with convenience stores defined using NAICS codes (44512, 44711, 44719).

## 4. Comments and Explanations

The protocol is similar to the Protocol 3.2 , Density of Restaurants. However, in this case the Convenience Stores (including Gas Stations) are used. The area within which the density has to be calculated is demarcated, the number of Convenience Stores (including Gas Stations) in the area is counted, and the number is divided by the area to get the density.

For a detailed explanation refer to Protocol 3.2.

## 5. GIS Approach

First the Convenience Stores (including Gas Stations) are extracted from the master data and then the buffer area is created using Network Analyst. Then, the water features are erased from the buffers using Erase tool, then the area of the buffer layer with erased water features is calculated. The number of Convenience Stores (including Gas Stations) is counted with a spatial join between the buffer layer and the Convenience Stores (including Gas Stations) location layer. The number of Convenience Stores (including Gas Stations) locations is then divided by the area in hectares to get the density.

For a detailed explanation refer to GIS Approach in Protocol 3.2.

## 6. GIS Steps

Requirements:

1. Road Layer polyline
2. Convenience Stores (including Gas Stations) layer (Point Features) for finding the nearest distance to
3. Participants layer (Point Features) for finding the nearest distance from
4. Network Analyst Extension for ArcGIS 9.1 or ArcGIS 9.2
I. Query and extract data for Convenience Stores (including Gas Stations) according to specified NAICS codes from Dun \& Bradstreet data, if the layer is not already prepared
5. Start ArcMap
6. Click the Add Data button on the Standard Toolbar.
a. Navigate to the Dun \& Bradstreet data
b. Click on the Dun \& Bradstreet dataset and click Add to add the dataset to the Map
7. Right Click the Dun \& Bradstreet data and Click Open Attribute Table
a. Click on Options
b. Click Select by Attributes
i. Select Create a new selection as Method
ii. Click on "PrimaryNai" in the Attributes list and click on Unique values (since this can take substantial time, instead of this consider typing the codes as mentioned below)
iii. Click "=" operator
iv. Click or Type 445120
v. Click "OR" operator
vi. Click or Type 447110
vii. Click "OR" operator
viii. Click or Type 447190
ix. The SELECT * FROM Dun \& Bradstreet WHERE: should: look like
"PrimaryNai" = 445120 OR "PrimaryNai" $=447110$ OR "PrimaryNai" $=447190$
x. Click Apply
c. Right Click the Dun \& Bradstreet data layer and Click Data and then Export data
i. Choose Selected Features for Export
ii. Choose this layer's source data for Use the same coordinate system as:
iii. Navigate to appropriate folder and give the output file an appropriate name for Output shapefile or feature class
iv. Click OK
v. Click Yes to add the data to current data frame
II. Create network buffers for participant location
8. Start ArcMap
9. On the Main Menu click Tools and Click on Extensions.
a. Check Network Analyst Extension.
b. Click Close.
10. Click the Add Data button on the Standard Toolbar
a. Navigate to the Network Dataset location, created earlier. (If need to create a new Network dataset. Look at Appendix for steps to create a network dataset.)
b. Click on the Network Dataset and click Add to add the Network Dataset to ArcMap.
c. Click No when asked to add all the feature classes, which participate in the network, to the map.
11. Click the Add Data button on the Standard Toolbar
a. Navigate to the Point Layers to be used for analysis, in this case Convenience Stores (including Gas Stations) Locations
b. Click on the Point Layers and click Add to add it to ArcMap
12. On the main menu click View
a. Click on Toolbars
b. In the side menu click Network Analyst to add the Network Analyst toolbar to ArcMap
13. Click Network Analysis Toolbar
a. Click Network Analyst Window button 菷 to add the Network Analyst Window to the map
14. On the Network Analyst Toolbar Click Network Analyst Dropdown Menu
a. Click New Service Area
b. The Table of contents and the Network Analyst Window contains empty list of Facilities, Barriers, Lines and Polygons Categories.
15. Add the Id's if not already added. In the Table of Contents Right Click the Point Layer and click on Open Attribute Table
a. In the Attribute Table
i. Click Options
ii. Click Add Field
iii. Add the School_Id/Participant_Id as Text

- Type School_Id_T/Part_Id_T in the Name field
- Select Text (50) as Type
- Accept default for Length
- Click OK
iv. Add the School_Id/Participant_Id as Integer
- Type School_Id/Part_Id in the Name field
- Select Short Integer as Type
- Accept default (0) for Precision
- Click OK
v. Enter the assigned Id for the participants and schools

9. On the Network Analyst Window right Click Facilities and Click Load Locations
a. In Load Locations Window
i. For Load From click Browse and navigate to the Participant Locations, Point feature layer
ii. Click on the Participant Locations layer and click Add
iii. Choose the Participant Id as the Sort field
iv. Choose the Participant Id Text as the Name field.
v. Accept the default for Location Position as Use Geometry

- Set the Search Tolerance to $\mathbf{5 0}$ meters
vi. Click OK

10. To set the properties to be used in the Analysis, In the Table of Contents Right Click the Service Area Layer and Click Properties
b. Click on Analysis Settings Tab
i. Choose Length (Meters) for Impedance.
ii. Type the required Buffer Distance for Default Breaks
iii. Choose Away From Facility as Direction
iv. Choose Everywhere for Allow U-Turns
v. Check Ignore Invalid Locations
c. Click on Polygon Generation Tab
i. Check Generate Polygons
ii. Choose Generalized as the Polygon Type
iii. Uncheck Trim Polygons
iv. Choose Overlapping for Multiple Facilities Option
v. Choose Disks as the Overlap Type
d. Click Ok
11. On the Network Analyst Toolbar, Click Solve Button
12. Joining attributes with Source Point Layer to carry over the data.
a. Right Click the Polygons Layer
b. Click Joins and Relates and then Join
c. Choose Join attributes from a table
i. Choose Facility Id as the Field to base the join on
ii. Choose the Participant Layer as the Table to Join to this layer
iii. Choose the Participant ID as the field in the table to base the join on
d. Right Click the Polygons Layer
e. Click on Data and then Export Data
i. Choose this layer's source data for the coordinate system
ii. Specify the Output location
III. Erase water features from the network buffer \& calculate area of network buffer
13. Click the Add Data button ${ }^{\star}$ on the Standard Toolbar
a. Navigate to the Water feature Layer to be used for analysis
b. Click on the Water feature Layer and click Add to add it to ArcMap
14. In the ArcToolbox, Click on Analysis Tools
15. Click on Overlay tools, and double click Erase. In the dialog box,
a. Choose the Exported Network Buffer Layer as the Input Layer
b. Choose the Water Feature layer as the Erase Features
c. Choose an appropriate Output Location and Name for the Output Feature Class
d. Click Ok
16. Click Yes to add the exported feature layer to the map
IV. Calculate the Area of Network Buffers
17. Add area fields to the output feature class created in the previous step
a. Right click on the Output Feature Class and select Open Attribute Table
b. Click on the Option button and select Add Field...
c. Name the field Hectares and change the Type to Double. If an Hectares field already exists, you can cancel this operation and overwrite the hectares values
d. Click OK
18. Calculate the values for Hectares
a. Right-click the Hectares field in the Output Feature Class attribute table and select Calculate Geometry...
b. Set the Property: box to Area
c. Set the Coordinate System to "Use coordinate system of the data source"
d. Set the Units to Hectares [ha]
e. Click OK
V. Spatial Join to calculate the number of Convenience Stores (including Gas Stations)
19. Right click the buffer layer with erased water features layer
20. Click Join and Relates and then Click Join
a. Select Join data from another layer based on spatial location for Join Type
b. Choose the Convenience Stores (including Gas Stations) layer to join to this layer
c. Do not check any radio-dial for summarizing the data
d. Specify an appropriate location and name for the output feature class
e. Click Ok
f. Click Yes to add the feature class
VI. Calculate the density of Convenience Stores (including Gas Stations)
21. Open the attribute table of the spatial join feature class created in above step
22. Click Options and then Add field
a. Type Density for Name
b. Select Double for Type
c. Accept default for Precision and Scale
23. Right Click on the Density field and select field calculator
a. Click on Count in fields
b. Click on operator ' $/$ '
c. Click on Hectare in fields
d. The Density equation should look like: Density = Count/Hectare
e. Click Ok

The Density field contains the density number of Convenience Stores (including Gas Stations) per square hectare of the network buffer around participant location.

### 4.10 Distance to Farmers Market

Note. New in version 1.2.

## 1. Basic Concept

Farmers markets provide access to fresh local produce during the growing season. They are much promoted as providing a healthy option but do they make a real difference?

## 2. Basic Definition

Straight line or street network distance to the nearest farmers market.

## 3. Detailed Definition

Straight line or street network distance to the nearest farmers market as specified in the local web listing of farmers markets including those opening between twice a week and once a month.

## 4. Comments and Explanations

The farmer's markets in the Twin Cities were listed on the Minneapolis Star Tribune's website (http://www.startribune.com/438/story/1187326.html). The addresses for every market were extracted from the website and geocoded using ArcGIS 9.0.

## 5. GIS Approach

The GIS approach is to use the Find Closest Facility option in the Network Analyst Extension of ArcGIS 9.2 to find the closest farmer's market to a participant's home. The point layer containing the farmer's markets are the "facilities" in Network Analyst, and the participant locations are the "incidents" in Network Analyst. A street network is required for calculating the distance between farmer's markets and participant locations.

In the Network Analyst Extension, specify the "facilities" and the "incidents" and solve for the closest facility to each incident. Attach the distance to the closest facility to each incident.

The straight-line distance is calculated using the Near Tool in ArcToolbox.

## 6. GIS Steps

Requirements:

1. Road Network dataset
2. Participants' Locations Point Feature Layer for incidents (origins)
3. Farmer's Market Locations Point Feature Layer for facilities (destinations)
4. Network Analyst Extension for ArcGIS 9.2

Calculate the Network Distance to the nearest farmer's market

1. Start ArcMap
2. On the Main Menu, click Tools and click on Extensions
a. Check Network Analyst Extension
b. Click Close
3. Click the Add Data button on the Standard Toolbar
a. Navigate to the Network Dataset location
b. Click on the Network Dataset and click Add to add the Network Dataset to ArcMap
c. Click Yes to add all the feature classes that participate in the network to the map
4. Click the Add Data button on the Standard Toolbar
a. Navigate to the Point Layers to be used for the analysis, in this case Participant Locations and Farmer's Markets
b. Select the Point Layers and click Add to add them to ArcMap
5. If the Farmer's Market IDs and Participant IDs are already assigned, go to the next step. Otherwise in the Table of Contents, right-click on the Participant Locations point layer and select Open Attribute Table
a. In the Attribute Table
i. Click Options
ii. Click Add Field
iii. Add Par_ID_T as Text
6. Type Par_ID_T in the Name field
7. Select Text as Type
8. Set the Length to $\mathbf{2 0}$
9. Click OK
iv. Click Options and select Add Field
v. Add Par_ID as Integer
10. Type Par_ID in the Name field
11. Select Short Integer as Type
12. Accept default (0) for Precision
13. Click OK
vi. Right-click on the Par_ID field and select Field Calculator...
14. Set the Par_ID equal to [FID] + $\mathbf{1}$
15. Click OK
vii. Right-click on the Par_ID_T field and select Field Calculator...
16. Set the Par_ID_T equal to Par_ID
17. Click OK
b. Right-click on the Farmer's Market point layer and select Open Attribute Table
i. Click the Options button and select Add Field
18. Add Farm_ID_T as Text
a. Type Farm_ID_T in the Name field
b. Select Text as Type
c. Set the Length to $\mathbf{2 0}$
d. Click OK
19. Click the Options button and select Add Field
20. Add Farm_ID as Integer
a. Type Farm_ID in the Name field
b. Select Short Integer as Type
c. Accept default (0) for Precision
d. Click OK
21. Right-click on the Farm_ID field and select Field Calculator...
a. Set the Farm_ID equal to [FID] + 1
b. Click OK
22. Right-click on the Farm_ID_T field and select Field Calculator...
a. Set the Farm_ID_T equal to Farm_ID
b. Click OK
23. Load the Network Analyst toolbar
a. On the Main Menu, click on View
b. Click on Toolbars
c. In the side menu, click Network Analyst to add the Network Analyst toolbar to ArcMap
24. Load the Network Analyst Window
a. Click on the Show/Hide Network Analyst Window to open the window
25. Create a New Closest Facility
a. Click on the Network Analyst button on the Network Analyst toolbar
b. Select New Closest Facility from the dropdown menu
c. The Table of Contents and the Network Analyst Window will now contain a Closest Facility
layer, which contains Facilities, Incidents, Barriers, and Routes categories
26. Load the Farmer's Markets into the Facilities category in Network Analyst
a. In the Network Analyst window, right-click Facilities and click Load Locations. This will open the Load Locations Window
b. In the Load Locations Window
i. Select the point layer containing the Farmer's Market locations from the dropdown box next to Load From. If the required point layer is not in the dropdown box, click on the Browse for Point Features to Load icon and navigate to the point layer.
ii. Choose the Farm_ID as the Sort field
iii. Choose the Farm_ID_T for the Name property under Locational Analysis properties
iv. Accept the defaults for the other Locational Analysis properties
v. Choose a suitable Search Tolerance for the Location Position. If features cannot be located on the network dataset, this tolerance may need to be increased
vi. Click OK
c. To verify all Farmer's Market locations were located on the network dataset, do one of the following. If any feature has a status of Not Located, the search tolerance in 9.b.v may need to be increased for the feature reviewed for correct location.
i. For small datasets, scroll through the resulting lists of Facilities in the Network Analyst Window, looking for features with RED questions marks
ii. For large datasets, it may be easier to right-click on the Facilities in the Network Analyst Window, Open Attribute Table and sort descending on the STATUS column. The Not Located features should sort to the top.
27. Load the Participant locations into the Incidents category in Network Analyst
a. In the Network Analyst window, right-click Incidents and click Load Locations. This will open the Load Locations Window.
b. In the Load Locations Window
i. Select the point layer containing the Participant locations from the dropdown box next to Load From. If the required point layer is not in the dropdown box, click on the Browse for Point Features to Load icon and navigate to the point layer.
ii. Choose the Par_ID as the Sort field
iii. Choose the Par_ID_T for the Name property under Locational Analysis properties.
iv. Accept the defaults for the other Locational Analysis properties
v. Choose a suitable Search Tolerance for the Location Position. If features cannot be located on the network dataset, this tolerance may need to be increased.
vi. Click OK
c. To verify that all Participant Locations were located on the network dataset, do one of the following. If any feature has a status of Not Located, the search tolerance in 10.b.v may need to be increased or the feature reviewed for correct location.
i. For small datasets, scroll through the resulting lists of Incidents in the Network Analyst Window, looking for features with RED questions marks.
ii. For large datasets, it may be easier to right-click on the Incidents in the Network Analyst Window, select Open Attribute Table and sort descending on the STATUS column. The Not Located features should sort to the top.
28. Set the properties for the analysis
a. In the Table of Contents, right-click Closest Facility and click Properties. This will open the Closest Facility properties dialog box.
b. Click on the Analysis Settings Tab
i. Choose Length (meters) for Impedence
ii. Choose None for Default Cutoff Values
iii. Set Facilities to Find to 1
iv. Set the Travel From option to Incident to Facility
v. Set Allow U-Turns to Everywhere
vi. Set Output Shape Type to True Shape
vii. Check the box to Ignore Invalid Locations
c. Click OK
29. To calculate the closest Farmer's Market to a Participant Location, click the Solve Button on the Network Analyst Toolbar
a. When Network Analyst has solved the calculations, the Routes layer will be populated with line segments joining each participant location to its closest farmer's market. The Routes attribute table contains the unique IDs for the participant and the farmer's market along with the network length separating them and the route name (a concatenation of the participant ID and the farmer's market ID).
30. Join the Farmer's Markets and the Participants to the results of the Find Closest Facility analysis
a. Right-click the Routes layer
b. Select Joins and Relates and then click Join
i. Choose Facility ID as the field to base the join on
ii. Choose the Farmer's Market layer as the Table to Join to this layer
iii. Choose Farm_ID as the field in the table to base the join on
iv. Click OK
c. Right-click the Routes layer
d. Select Joins and Relates and then click Join
i. Choose Incident_ID as the field to base the join on
ii. Choose the Participant layer as the Table to Join to this layer
iii. Choose Par_ID as the field in the table to base the join on
iv. Click OK
e. Right-click the Routes layer
f. Select Data and then click Export Data
i. Choose this layer's source data for the coordinate system
ii. Specify the Output Location
iii. A new shapefile will be created in the output location. This shapefile will contain the routes from each participant location to the nearest farmer's market. Each route will contain the attributes of the participant and the nearest farmer's market.

## Calculate the straight-line distance to the nearest farmer's market

To follow this protocol, you will need:

1. Participant Locations Point Feature layer for incidents (origins)
2. Farmer's Market Point Feature layer for facilities (destinations)

Calculate the straight-line distance to the nearest farmer's market

1. Start ArcMap.
2. Click the Add Data button on the Standard Toolbar.
a. Navigate to the Point Layers to be used in the analysis, in this case Participant locations and the Farmer's Market locations.
b. Select the Point Layers and click Add to add them to ArcMap.
3. Open ArcToolbox by clicking on the icon.
4. Navigate to the Near tool (Analysis Tools $->$ Proximity) and double-click to open it.
5. Click the down-arrow in the Input Features box and select the Participant Locations feature layer.
6. Click the down-arrow in the Near Features box and select the Farmer's Market feature layer.
7. Leave the Search Radius (optional) box empty. This will guarantee that every Participant Location will have its nearest farmer's market found.
8. Leave the Location (optional) and Angle (optional) check boxes unchecked.
9. Click OK to execute the tool.
10. The tool will find the nearest farmer's market to each participant location and measure the straight-line distance between those points. The tool will add two attributes to the participant location attribute table, NEAR_DIST and NEAR_FID. NEAR_DIST will contain the distance, in the units of the Layers (e.g., meters, feet, etc.). NEAR_FID will contain the feature ID of the closest farmer's market. Use the NEAR_FID attribute to join the farmer's market feature layer to the participant location layer.

Join the Participant Location layer to the Farmer's Market layer using the NEAR_FID attribute.

1. Right-click on the participant location layer and select Joins and Relates $->$ Join...
2. Choose NEAR_FID as the field to base the join on.
3. Choose the Farmer's Market layer as the Table to Join to this layer.
4. Choose the FID attribute as the field in the table to base the join on.
5. Click OK. The Farmer's Market attributes will be joined to the Participant locations.
6. Right-click on the Participant Locations layer and select Data-> Export Data.
a. Choose this layer's source data for the coordinate system.
b. Specify the Output Location.
c. Click OK.

A new shapefile will be created in the output location. This shapefile will contain the participant locations and the attributes of the nearest farmer's market to each participant location.

### 4.11 Distance to Alcohol Sales Places

Note. New in version 1.2.

## 1. Basic Concept

While the focus of these protocols is on youth, alcohol is still an issue. This protocol examines both bars and stores selling alcohol. It omits restaurants as these require significant additional purchases.

## 2. Basic Definition

Distance to alcohol sales = Straight line or street network distance to the nearest store or bar selling alcohol.

## 3. Detailed Definition

Distance to alcohol sales = Straight line or street network distance to the nearest store, bar, or restaurant selling alcohol using NAICS codes 7224: Drinking Places (Alcoholic Beverages) and 4453Beer, Wine, and Liquor Stores.

## 4. Comments and Explanations <br> [To add.]

## 5. GIS Approach

The GIS approach is to use the Find Closest Facility option in the Network Analyst Extension of ArcGIS 9.2 to find the closest Alcohol Sales Place to a participant's home. The point layer containing the alcohol sales places are the "facilities", and the participant locations are the "incidents" in Network Analyst. A street network is required for calculating the distance between alcohol sales places and participant locations.

In the Network Analyst Extension, specify the "facilities" and the "incidents" and solve for the closest facility to each incident. Attach the distance to the closest facility to each incident.

The straight-line distance is calculated using the Near Tool in ArcToolbox.

## 6. GIS Steps

The following procedures were completed in ArcMap (ArcInfo) 9.2.
To follow this protocol you will need:

1. Road Network dataset
2. Alcohol Sales Places point feature layer for facilities (destinations)
3. Participants' Locations for incidents (origins)
4. Network Analyst Extension for ArcGIS 9.2

Calculate the Network Distance to the nearest alcohol sales place

1. Start ArcMap.
2. On the Main Menu, click Tools and click on Extensions
a. Check Network Analyst Extension
b. Click Close
3. Click the Add Data button on the Standard Toolbar
a. Navigate to the Network Dataset location
b. Click on the Network Dataset and click Add to add the Network Dataset to ArcMap
c. Click Yes to add all the feature classes that participate in the network to the map
4. Click the Add Data button on the Standard Toolbar
a. Navigate to the Points Layers to be used for the analysis, in this case the Participant locations and the Alcohol Sales places
b. Select the Point Layers and click Add to add them to ArcMap
5. If the Alcohol Sales IDs and the Participant IDs are already assigned, go to the next steps. Otherwise, in the Table of Contents, right-click on the Participant locations point layer and select Open Attribute Table
a. In the Attribute Table
i. Click Options
ii. Click Add Field...
iii. Add Par_ID_T as Text
6. Type Par_ID_T in the Name field
7. Select Text as Type
8. Set the Length to 20
9. Click OK
iv. Click Options and select Add Field...
v. Add Par_ID as Integer
10. Type Par_ID in the Name field
11. Select Short Integer as Type
12. Accept default (0) for Precision
13. Click OK
vi. Right-click on the Par_ID field and select Field Calculator...
14. Set the Par_ID equal to [FID] + $\mathbf{1}$
15. Click OK
vii. Right-click on the Par_ID_T field and select Field Calculator...
16. Set the Par_ID_T equal to Par_ID
17. Click OK
b. Right-click on the Alcohol Sales point layer and select Open Attribute Table
i. Click the Options button and select Add Field
ii. Add Alc_ID_T as Text
18. Type Alc_ID_T in the Name field
19. Select Text as Type
20. Set the Length to 20
21. Click OK
iii. Click the Options button and select Add Field
iv. Add Alc_ID as Integer
22. Type Alc_ID in the Name field
23. Select Short Integer as Type
24. Accept default (0) for Precision
25. Click OK
v. Right-click on the Alc_ID field and select Field Calculator...
26. Set the Alc_ID equal to [FID] +1
27. Click OK
vi. Right-click on the Alc_ID_T field and select Field Calculator...
28. Set the Alc_ID_T equal to Alc_ID
29. Click OK
30. Load the Network Analyst toolbar
a. On the Main Menu, click on View
b. Click on Toolbars
c. In the side menu, click Network Analyst to add the Network Analyst toolbar to ArcMap
31. Load the Network Analyst Window
a. Click on the Show/Hide Network Analyst Window to open the window
32. Create a New Closest Facility
a. Click on the Network Analyst button on the Network Analyst toolbar
b. Select New Closest Facility from the dropdown menu
c. The Table of Contents and the Network Analyst Window will now contain a Closest Facility layer, which contains Facilities, Incidents, Barriers, and Routes categories
33. Load the Alcohol Places in the Facilities category in Network Analyst
a. In the Network Analyst window, right-click Facilities and click Load Locations. This will open the Load Locations Window
b. In the Load Locations Window
i. Select the point layer containing the Facilities locations from the dropdown box next to Load From. If the required point layer is not in the dropdown box, click on the Browse for Point Features to Load icon and navigate to the point layer.
ii. Choose the Alc_ID as the Sort field
iii. Choose the Alc_ID_T for the Name property under Locational Analysis properties.
iv. Accept the defaults for the other Locational Analysis properties.
v. Choose a suitable Search Tolerance for the Location Position. If features cannot be located on the network dataset, this tolerance may need to be increased.
vi. Click OK
c. To verify all Alcohol Places were located on the network dataset, do one of the following. If any feature has a status of Not Located, the search tolerance in 9.b.v may need to be increased or the feature reviewed for its correct location.
i. For small datasets, scroll through the resulting lists of Facilities in the Network Analyst Window, looking for features with RED question marks.
ii. For large datasets, it may be easier to right-click on the Facilities in the Network Analyst Window, select Open Attribute Table and sort descending on the STATUS column. The Not Located features should be sorted to the top.
34. Load the Participant locations into the Incidents category in Network Analyst
a. In the Network Analyst window, right-click Incidents and click Load Locations. This will open the Load Locations Window.
b. In the Load Locations Window
i. Select the point layer containing the Participant locations from the dropdown box next to Load From. If the required point layer is not in the dropdown box, click on the Browse for Point Features to Load icon and navigate to the point layer.
ii. Choose the Par_ID as the Sort field.
iii. Choose the Par_ID_T for the Name property under Locational Analysis properties.
iv. Accept the defaults for the other Locational Analysis properties.
v. Choose a suitable Search Tolerance for the Location Position. If features cannot be located on the network dataset, this tolerance may need to be increased.
vi. Click OK.
c. To verify all Participant locations were located on the network dataset, do one of the following. If any feature has a status of Not Located, the search tolerance in 10.b.v may need to be increased or the feature reviewed for correct location.
i. For small datasets, scroll through the resulting lists of Incidents in the Network Analyst Window, looking for features with RED question marks.
ii. For large datasets, it may be easier to right-click on the Incidents in the Network Analyst Window, select Open Attribute Table and sort descending on the STATUS column. The Not Located features should sort to the top.
35. Set the properties for the analysis
a. In the Table of Contents, right-click Closest Facility and click Properties. This will open the Closest Facility properties dialog box.
b. Click on the Analysis Settings Tab
i. Choose length (meters) for Impedence.
ii. Choose None for Default Cutoff Values.
iii. Set Facilities to Find to 1.
iv. Set the Travel From option to Incident to Facility .
v. Set Allow U-Turns to Everywhere.
vi. Set Output Shape Type to True Shape.
vii. Check the box to Ignore Invalid Locations

## c. Click OK

12. To calculate the closest Alcohol Sales place to a Participant location, click the Solve Button on the Network Analyst Toolbar.
a. When Network Analyst has solved the calculations, the Routes layer will be populated with line segments joining each participant location to its closest alcohol sales place. The Routes attribute table contains the unique IDs for the participant and the alcohol sales place along with the network length separating them and the route name (a concatenation of the participant ID and the facility ID).
13. Join the Alcohol Sales places and the Participants to the results of the Find Closest Facility analysis.
a. Right-click the Routes layer
b. Select Joins and Relates and then click Join
i. Choose Facility ID as the field to base the join on
ii. Choose the Alcohol Sales layer as the Table to Join to this layer
iii. Choose the Alc_ID as the field in the table to based the join on
iv. Click OK
c. Right-click on the Routes layer
d. Select Joins and Relates and then click Join
i. Choose Incident_ID as the field to base the join on
ii. Choose the Participant layer as the Table to Join to this layer
iii. Choose the Par_ID as the field in the table to base the join on
iv. Click OK
e. Right-click on the Routes layer
f. Select Data and then click Export Data
i. Choose this layer's source data for the coordinate system
ii. Specify the Output location
iii. A new shapefile will be created in the output location. This shapefile will contain the routes from each participant location to the nearest alcohol sales place. Each route will contain the attributes of the participant and the nearest facility.

Calculate the straight-line distance to the nearest alcohol sales place
To follow this protocol, you will need:

1. Participant Locations Point Feature Layer for incidents (origins)
2. Alcohol Sales Places Point Feature Layer for facilities (destinations

Calculate the straight-line distance to the nearest

1. Star t ArcMap
2. Click the Add Data button on the Standard Toolbar
a. Navigate to the Point Layers to be used in the analysis, in this case the Participant locations and the Alcohol Sales Places.
b. Select the Point Layers and click Add to add them to ArcMap.
3. Open ArcToolbox by clicking on the icon.
4. Navigate to the Near tool (Analysis Tools -> Proximity) and double-click to open it.
5. Click the down-arrow in the Input Features box and select the Participant Locations feature layer.
6. Click the down-arrow in the Near Features box and select the Alcohol Sales Places feature layer.
7. Leave the Search Radius (optional) box empty. This will guarantee that every Participant Location will have its nearest alcohol sales place found.
8. Leave the Location (optional) and Angle (optional) check boxes unchecked.
9. Click OK to execute the tool.
10. The tool will find the nearest alcohol sales place to each participant location and measure the straight-line distance between those points. The tool will add two attributes to the participant location attribute table, NEAR_DIST and NEAR_FID. The NEAR_DIST will contain the distance, in the units of the Layers (e.g., meters, feet). NEAR_FID will contain the feature ID of the closest alcohol sales place. Use the NEAR_FID attribute to join the Alcohol Sales Places layer to the Participant Location layer to determine the characteristics of the nearest Alcohol Sales Place.

Join the Alcohol Sales Places Layer to the Participant Locations layer using the NEAR_FID attribute.

1. Right-click on the Participant Location layer and select Joins and Relates -> Join...
2. Choose NEAR_FID as the field to base the join on.
3. Choose the Alcohol Sales Place layer as the Table to Join to this layer.
4. Choose the FID attribute as the field in the table to base the join on.
5. Click OK. The Alcohol Sales Place attributes will be joined to the Participant locations.
6. Right-click on the Participant Locations Layer and select Data -> Export Data.
a. Choose this layer's source data for the coordinate system.
b. Specify the Output Location.
c. Click OK.

A new shapefile will be created in the output location. This shapefile will contain the particpant locations and the attributes of the nearest alcohol sales place to each participant location.

### 4.12 Density of Alcohol Sales Places

## 1. Basic Concept

Like the previous protocols his protocol examines both bars and stores selling alcohol. It omits restaurants as these require significant additional purchases.

## 2. Basic Definition

Density of alcohol sales $=$ Total number of stores or bars selling alcohol divided by the land area (excluding water).

## 3. Detailed Definition

Density of alcohol sales $=$ Total number of stores or bars selling alcohol divided by the land area (excluding water). using NAICS codes 7224: Drinking Places (Alcoholic Beverages) and 4453Beer, Wine, and Liquor Stores.

## 4. Comments and Explanations

[To add.]

## 5. GIS Approach

The GIS approach is to perform a spatial join between the measurement geographies and the alcohol sales places. This will count the number of alcohol sales places in each measurement geography. Then divide this number by the net land area of each measurement geography.

## 6. GIS Steps

The following procedures were completed using ArcMap (ArcInfo) 9.2.
To complete this protocol you will need:

1. Study-site Layer (polygon)
2. Alcohol Sales Places Layer (point)

Refer to protocol 2.1 for the procedures to calculate net land area (land area with water features removed)
Add the Alcohol Sales Places and Study-Site layer to an ArcMap Document.

1. Right-click on the Study-Site Layer and choose Joins and Relates -> Join.
2. Under the dropdown box labeled What do you want to join to this layer?, choose Join data from another layer based on spatial location.
3. In Step 1 of the dialog box, choose the Alcohol Sales Places layer.
4. In Step 2, click the button to choose Each polygon will be given a summary of the numeric attributes...
5. In Step 3, choose a name and location for the output layer.
6. Click OK.
7. The output layer now contains a Count field with the number of alcohol sales places found in each features of the Study-Site layer.

Calculate the alcohol sales places per net land area:

1. Right-click on the output layer of the spatial join and select Open Attribute Table.
2. Click Options and choose Add Field.
3. Name the field AlcDens and change the type to Double.
4. Click OK to add the field.
5. In the Table of Contents, right-click on the output layer from the spatial join performed above and choose Joins and Relates -> Join.
6. In the dropdown box, choose to Join Attributes from a table.
7. In Step 1, choose to base the join on the field containing the unique ID of the measurement geographies.
8. In Step 2, load the table from the result of following protocol 2.1, Net Land Area.
9. In Step 3, choose the field in the Net Land Area Layer's table containing the unique ID of the measurement geographies.
10. Click OK.
11. Open the Attribute Table of the output layer from the spatial join, which now has the net land area table joined to it.
12. Right-click on the AlcDens field and choose Field Calculator...
13. In the Field Calculator dialog box, click the Count field, then click the / button, and finally click the name of the field containing the net land area.
14. Click OK.

The AlcDens field now contains the density of alcohol sales places (number of alcohol sales places divided by the net land area in whichever units you used).

## 5. YOUTH AND UTILITARIAN OR RECREATIONAL PHYSICAL ACTIVITY

Note: Many of these protocols draw on work previously done in the companion physical activity protocols but were updated and modified for this study by Ann Forsyth (selection of protocols, concepts, definitions) and David Van Riper (GIS steps).

Research on adult physical activity has mixed results but focuses attention on a number of aspects of the environment including density, pedestrian infrastructure, land-use mix, street pattern, and recreational faculties. Research on youth focuses on many similar things.

## DENSITY

### 5.1 Raw Population per Unit Land Area (TCWS GIS Protocol 3.1)

This uses the TCWS GIS Protocol 3.1, updated as it appears in Version 4.1.
Note: Previous versions of this protocol used the Geoprocessing Wizard and Xtools. ArcGIS 9.2 has replaced the Geoprocessing Wizard with the Intersect Tool, and it offers a Calculate Geometry dialog box, negating a need for Xtools. The protocol detailed below has been tested in ArcGIS 9.2.

## 1. Basic Concept

This is the most basic gross measure of population density, defined as the population of those who reside in housing in the area. It should be noted that this measure is independent of scale and could be used to measure the population per hectare of a small grid cell or an entire metropolis (and therefore would have different names, e.g., raw grid cell density, raw metropolitan density).

Sources that have used this measure, typically at a neighborhood or census tract level, and that will be more fully discussed in the next draft of this manual include Frank and Pivo (1994, 46), Hess et al. (1999, 1), Schimek (1996, 121), and Dunphy and Fisher $(1996,91)$.

Because the Twin Cities has a great many lakes, we generally used the next protocol, which excludes water.

## 2. Basic Formula

Raw Population per Unit Land Area $=$ Persons in housing units per unit area with no exclusions.

## 3. Detailed Formula

Raw Population per Unit Land Area $=$ Persons in housing units as measured in the US Census per unit area with no exclusions.

## 4. Comments and Explanations

Where census blocks are cut by the end of the measurement geography, the population is apportioned according to the percentage of land area falling inside and outside the line.

## 5. GIS Approach

Use ArcGIS to intersect study sites with census blocks. Retain the original area of each census block and then use Calculate Geometry to update the areas after performing the intersect procedure. Find the proportion of new area to original area and multiply the census population figure by that same proportion. Finally, divide this apportioned population figure by the updated area.

The following procedures were completed using ArcMap (ArcInfo) 9.2.
To follow this protocol you will need:

1. Study-Site Layer (polygon) with unique ID field
2. Census Block Layer (polygon) with field containing population

Determine the apportioned census population figure for each site:

1. Add the Study-Site Layer and Census Block Layer to your Map Document.
2. Add the area fields to the Census Block Layer
a. Right-click on the Census Block Layer and select Open Attribute Table.
b. Click on the Option button and select Add Field...
c. Name the field Area and change the Type to Double.
i. If a field named Area already exists, change the name in the Add Field... dialog box to something else
d. Click OK.
e. Click on the Option button again and select Add Field...
f. Name the field Acres and change the Type to Double.
i. If a field named Acres already exists, change the name in the Add Field... dialog box to something else

## g. Click OK.

h. Click on the Option button again and select Add Field...
i. Name the field Hectares and change the Type to Double
i. If a field named Hectares already exists change the name in the Add Field... dialog box to something else
j. Click OK.
3. Calculate the values for Area, Acres, and Hectares
a. For the Area field,
i. Right-click the Area field in the Census Block Layer attribute table and select Calculate Geometry...
ii. Set the Property: box to Area.
iii. Set the Coordinate System to "Use coordinate system of the data source:"
iv. Set the Units to the desired type. For the Area attribute, square meters, miles or feet is probably appropriate.
v. Click OK.
b. For the Acres field,
i. Right-click the Acres field in the Census Block Layer attribute table and select Calculate Geometry...
ii. Set the Property: box to Area.
iii. Set the Coordinate System to "Use coordinate system of the data source:".
iv. Set the Units to Acres US [ac].
v. Click OK.
c. For the Hectares field,
i. Right-click the Hectares field in the Census Block Layer attribute table and select Calculate Geometry...
ii. Set the Property: box to Area.
iii. Set the Coordinate System to "Use coordinate system of the data source:".
iv. Set the Units to Hectares [ha].
v. Click OK.
4. Open ArcToolbox by clicking on the icon and navigate to the Intersect tool (Analysis Tools $->$ Overlay $->$ Intersect). Double-click the Intersect tool to open it.
a. For the Input Features, click on the down-arrow and select the Census Block Layer from the list of layers.
b. Repeat 4.a and select the Study -Site Layer.
c. Specify a name and location for the output layer in the Output Feature Class box.
d. Set the JoinAttributes drop-down box to ALL.
i. The ALL option will transfer the all attributes from the input features to the output feature class.
e. Leave the XY Tolerance box empty.
f. Set the Output Type to INPUT.
i. The INPUT option will return intersections with the same geometry type as the Input Feature with the lowest geometry dimension.
g. Click OK to execute the Intersect. The output feature class will be added to the Map Document.
5. Open the Attribute Table of the clipped Census Block Layer created in the previous step.
a. Click on Options and choose Add Field.
b. Name the field OrigHect and change the Type to Double and click OK.
c. Right-click on the OrigHect field.
d. Choose Field Calculator.
e. In the Field Calculator, click Hectares and click OK.
f. You have now copied the values from Hectares to OrigHect.
6. Update the Hectares attribute in the clipped Census Block Layer
a. Right-click on the Hectares field and select Calculate Geometry...
b. Set the Property: box to Area.
c. Set the Coordinate System to "Use coordinate system of the data source:".
d. Set the Units to Hectares [ha].
e. Click OK. This will overwrite the values in the Hectares field with the new correct values (since the shapes have been clipped to the extent of the Study-Site Layer), yet the original number of hectares is preserved in the OrigHect field.
7. To perform the population apportionment, open the Attribute Table of the clipped Census Block Layer again.
a. Click on Options and choose Add Field.
b. Name the field PopSplit and make it of type Double.
c. Back in the Attribute Table, right-click on the name of the PopSplit field.
d. Choose Field Calculator...
e. In the Field Calculator, click Hectares, then click the / button, then click OrigHect, click the * button, and finally click the name of your Population field
f. Click OK.
8. The result is a field called PopSplit that contains the same proportion of the original census population figure as the proportion of the clipped census block area to the original area.

Perform final calculation

1. In the Attribute Table of the clipped Census Block Layer, right-click on the name of the site ID field and choose Summarize.
a. In the box beneath Choose one or more summary statistics, click the + next to PopSplit.
b. Check the box next to Sum.
c. Choose a name and location for the Output Summary Table.
d. Click OK.
2. Add PopPerHect attribute to Study-Site Layer Table.
a. Open the Study-Site Layer attribute table.
b. Click the Option button and select Add Field...
c. Add a new field called PopPerHect and select type Double.
3. Join this Summary Table into the Study-Site Layer Table using the ID field.
a. Right-click the Study-Site Layer and select Joins and Relates -> Join...
b. From the box entitled "1. Choose the field in this layer that the join will be based on:", choose the unique ID field for the Study-Site Layer.
c. From the box entitled " 2 . Choose the data to join to this layer, or load the table from disk:", choose the Summary Table created in the previouw step.
d. From the box entitled " 3 . Choose the field in the table to base the join on:", choose the unique ID field for the Study-Site Layer.
e. Click OK.
4. Calculate the population per hectare for the Study-Site Layer.
a. Open the Study-Site Layer attribute table.
b. Right-click on this new field and choose Field Calculator.
c. In the Field Calculator, click on the PopSplit field, then click the / button, and finally click on the Hectares field from the Study-Site Layer.
d. Click OK.

The PopPerHect field now contains the total apportioned population per hectare for each study site.

### 5.2 Population per Unit Land Area (without water):(TCWS GIS Protocol 3.2)

This uses the the TCWS GIS Protocol 3.2 in version 4.1 of that document.
Note:Previous versions of this protocol used the Geoprocessing Wizard and Xtools. ArcGIS 9.2 has replaced the Geoprocessing Wizard with the Intersect Tool, and it offers a Calculate Geometry dialog box, negating a need for Xtools. The protocol detailed below has been tested in ArcGIS 9.2.

## 1. Basic Concept

In areas with many lakes, water provides an important barrier to walking. As the Twin Cities is one such area, many of our calculations used this population density measure, which is identical to the one above except that it excludes water.

## 2. Basic Formula

Population per Unit Land Area (without water) = Persons in housing units per unit gross area excluding water.

## 3. Detailed Formula

Population per Unit Land Area (without water) = Persons in housing units as measured in the US Census at the block level per unit land area excluding area of water features as measured in the Ramsey County layer.

## 4. Comments and Explanations

Where census blocks are cut by the end of the measurement geography, the population is apportioned according to the percentage of land area falling inside and outside the line.

## 5. GIS Approach

The approach to this measurement is to intersect census blocks with study sites, preserving the original area of each block and then recalculating it after the spatial intersect procedure. Calculate the apportioned population and divide it by the total area that has been recalculated after removing the area of all water features.

## 6. GIS Steps

The following procedures were completed using ArcMap (ArcInfo) 9.2.

1. To follow this protocol you will need:
2. Study-Site Layer with Water Features removed (polygon) with unique ID field
3. Census Block Layer with field containing population

Create the Census Block Layer with water features removed:

1. Add the Census Block Layer and Water Features layer to your Map Document
2. Open ArcToolbox and navigate to the Erase tool (Analysis Tools -> Overlay). Open the Erase tool by double-clicking it.
3. In the Input Features drop-down box, select the Census Block layer.
4. In the Erase Features drop-down box, select the Water Features layer.
5. Specify the location and name of the output feature class.
6. Click OK.
7. The output feature class will be generated and added to the map document.

Determine the apportioned census population figure for each site:

1. Add the Study-Site Layer with Water Features removed and Census Block Layer with Water Features removed to your Map Document.
a. If the Study-Site Layer with Water Features removed does not exist, please complete TREC Protocol 2.1 before continuing.
2. Add the area fields to the Census Block Layer with Water Features removed
a. Right-click on the Census Block Layer and select Open Attribute Table.
b. Click on the Option button and select Add Field...
c. Name the field Area and change the Type to Double.
i. If a field named Area already exists, change the name in the Add Field... dialog box to something else.
d. Click OK.
e. Click on the Option button again and select Add Field...
f. Name the field Acres and change the Type to Double.
i. If a field named Acres already exists, change the name in the Add Field... dialog box to something else.
g. Click OK.
h. Click on the Option button again and select Add Field...
i. Name the field Hectares and change the Type to Double.
i. If a field named Hectares already exists, change the name in the Add Field... dialog box to something else.
j. Click OK.
3. Calculate the values for Area, Acres, and Hectares
a. For the Area field,
i. Right-click the Area field in the Census Block Layer with Water Features removed attribute table and select Calculate Geometry...
ii. Set the Property: box to Area.
iii. Set the Coordinate System to "Use coordinate system of the data source:"
iv. Set the Units to the desired type. For the Area attribute, square meters, miles or feet is probably appropriate.
v. Click OK.
b. For the Acres field,
i. Right-click the Acres field in the Census Block Layer with Water Features removed attribute table and select Calculate Geometry...
ii. Set the Property: box to Area.
iii. Set the Coordinate System to "Use coordinate system of the data source:".
iv. Set the Units to Acres US [ac].
v. Click OK.
c. For the Hectares field,
i. Right-click the Hectares field in the Census Block Layer with Water Features removed attribute table and select Calculate Geometry...
ii. Set the Property: box to Area.
iii. Set the Coordinate System to "Use coordinate system of the data source:".
iv. Set the Units to Hectares [ha].
v. Click OK.
4. Open ArcToolbox by clicking on the icon and navigate to the Intersect tool (Analysis Tools -> Overlay -> Intersect). Double-click the Intersect tool to open it.
a. For the Input Features, click on the down-arrow and select the Census Block Layer with Water Features removed from the list of layers.
b. Repeat 4.a and select the Study-Site Layer with Water Features removed.
c. Specify a name and location for the output layer in the Output Feature Class box.
d. Set the JoinAttributes drop-down box to ALL
i. The ALL option will transfer all the attributes from the input features to the output feature class.
e. Leave the XY Tolerance box empty.
f. Set the Output Type to INPUT.
i. The INPUT option will return intersections with the same geometry type as the Input Feature with the lowest geometry dimension.
g. Click OK to execute the Intersect. The output feature class will be added to the Map Document.
5. Open the Attribute Table of the clipped Census Block Layer with Water Features removed created in the previous step.
a. Click on Options and choose Add Field...
b. Name the field OrigHect and change the Type to Double and click OK.
c. Right-click on the OrigHect field.
d. Choose Field Calculator...
e. In the Field Calculator, click Hectares and click OK.
f. You have now copied the values from Hectares to OrigHect.
6. Update the Hectares attribute in the clipped Census Block Layer with Water Features removed
a. Right-click on the Hectares field and select Calculate Geometry...
b. Set the Property: box to Area.
c. Set the Coordinate System to "Use coordinate system of the data source:".
d. Set the Units to Hectares [ha].
e. Click OK. This will overwrite the values in the Hectares field with the new correct values (since the shapes have been clipped to the extent of the Study-Site Layer with Water Features removed), yet the original number of hectares is preserved in the OrigHect field.
7. To perform the population apportionment, open the Attribute Table of the clipped Census Block Layer with Water Features removed again.
a. Click on Options and choose Add Field.
b. Name the field PopSplit and make it of type Double.
c. Right-click on the name of the PopSplit field.
d. Choose Field Calculator...
e. In the Field Calculator, click Hectares, then click the / button, then click OrigHect, then click the * button, and finally click the name of the Population field.
f. Click OK.
8. The result is a field called PopSplit that contains the same proportion of the original census population figure as the proportion of the clipped census block area to the original area.

## Perform final calculation

1. In the Attribute Table of the clipped Census Block Layer with Water Features removed, right-click on the name of the site ID field and choose Summarize.
e. In the box beneath Choose one or more summary statistics, click the + next to PopSplit.
f. Check the box next to Sum.
g. Choose a name and location for the Output Summary Table.
h. Click OK.
2. Add PopPerHect attribute to Study-Site Layer with Water Features removed Table.
i. Open the Study-Site Layer with Water Features removed attribute table.
j. Click the Option button and select Add Field...
k. Add a new field called PopPerHect and select type Double.
3. Join this Summary Table into the Study-Site Layer Table with Water Features removed using the ID field.
4. Right-click the Study-Site Layer with Water Features removed and select Joins and Relates -> Join...
m . From the box entitled " 1 . Choose the field in this layer that the join will be based on:", choose the unique ID field for the Study-Site Layer with Water Features removed.
n. From the box entitled " 2 . Choose the data to join to this layer, or load the table from disk:", choose the Summary Table created in the previouw step.
o. From the box entitled " 3 . Choose the field in the table to base the join on:", choose the unique ID field for the Study-Site Layer with Water Features removed.
p. Click OK.
5. Calculate the population per hectare for the Study-Site Layer with Water Features removed.
a. Open the Study-Site Layer with Water Features removed attribute table.
b. Right-click on this new field and choose Field Calculator.
c. In the Field Calculator, click on the PopSplit field, then click on the / button, and finally click on the Hectares field from the Study-Site Layer with Water Features removed.
d. Click OK.

The PopPerHect field now contains the total apportioned population per hectare for each study site.

### 5.3 Residential Population in Residential Parcels (Residential Density) (without water): (TCWS GIS Protocol 3.4)

Note: This protocol was significantly revised for Version 1.3. updated Note: Previous versions of this protocol used the Geoprocessing Wizard and Xtools. ArcGIS 9.2 has replaced the Geoprocessing Wizard with the Intersect Tool, and it offers a Calculate Geometry dialog box, negating a need for Xtools. The protocol detailed below has been tested in ArcGIS 9.2.

## 1. Basic Concept

This density calculation reflects the kinds of densities that are talked about by developers, rather than the experience of place. That is, while people experience a whole environment - including roads and non-residential uses - developers build on parcels and density is often debated in those terms.

We propose to do some measurements using this definition of density to see if it has any relation at all to actual physical activity in a specific place.

## 2. Basic Formula

Residential Population in Residential Parcels $=$ Persons in housing units per unit land area in residential parcels.

## 3. Detailed Formula

Residential Population in Residential Parcels $=$ Persons in housing units as measured in the US Census at the block level per unit land area in residential parcels, excluding rights of ways, water bodies, and land not in parcels.

## 4. Comments and Explanations

This calculation requires that the parcels layer contain land-use information that can identify residential parcels. Also, Where census blocks are cut by the end of the measurement geography, the population is apportioned according to the percentage of land area falling inside and outside the line.

## 5. GIS Approach

Use a definition query to display only residential parcel layer. Intersect these residential parcels with the measurement geographies. Summarize the resulting layer's attribute table by measurement geography and sum the area. Apportion the census population by intersecting the census blocks with the measurement geographies. Summarize the resulting layer's attribute table by measurement geography ID and sum the population. For each measurement geography, divide the sum of apportioned population by the sum of residential hectares.
6. GIS Steps

The following procedures were completed using ArcMap (ArcInfo) 9.2.
To follow this protocol you will need:

1. Study-site layer (polygon) with unique ID field
2. Parcels Layer (polygon)
3. Census Block Layer (polygon) with field containing population

Use a Definition Query to display only residential parcels

1. In the Table of Contents (the pane with the list of layers), right-click on the Parcels Layer and choose Properties.
2. Go to the Definition Query tab and click Query Builder.
3. Construct an SQL expression that applies to whichever field contains the land-use data of the parcels and selects the values that identify residential uses.
4. Click Ok to close the Query Editor and then OK again to close the Layer Properties window.
5. Ensure that only the residential parcels in your Parcels Layer are displayed.

Intersect residential parcels with the study-site layer:

1. Add the Study-Site Layer to your Map Document.
2. Open ArcToolbox and navigate to the Intersect tool (Analysis Tools $->$ Overlay $->$ Intersect). Doubleclick the Intersect tool to open it.
a. For the Input Features, click on the down-arrow and select the Land-Use Parcels Layer from the list of Layers.
b. Repeat step 2.a and select the Study-Site Layer.
c. Specify a name and location for the output layer in the Output Feature Class box.
d. Set the JoinAttributes drop-down box to ALL.
i. The ALL option will transfer all the attributes from the input features to the output feature class.
e. Leave the XY tolerance box empty.
f. Set the Output Type to INPUT.
i. The INPUT option will return intersections with the same geometry type as the Input Feature with the lowest geometry dimension.
g. Click OK to execute the Intersect. The output feature class will be added to the Map Document.
h. The Parcels will now be clipped to the study-site boundaries and be assigned the ID associated with the study-site in which it is located. Note that parcels which exist in two or more
overlapping study-sites will be represented by two or more identical (except for Study-Site ID number) rows in the Attribute Table.

Calculate the area of the residential parcels within each study-site:

1. Right-click on the layer created by the Intersect tool and select Open Attribute Table.
2. Click on the Options button and select Add Field...
3. Type Hectares in the Name field and set the Type to Double.
4. Click OK.
5. Right-click on the Hectares field and select Calculate Geometry...
6. Set the Property: box to Area.
7. Set the Coordinate System to "Use coordinate system of the data source:".
8. Set the Units to Hectares [ha].
9. Click OK. This will calculate the area, in hectares, of each land-use type within a given study-site.

Determine the total area of residential parcels within each study-site:

1. Open the attribute table of the layer created by the Intersect tool.
2. Right-click on the study-site ID and select Summarize...
3. In the Summarize... dialog box, click on the plus sign next to the Hectares field.
4. Click the checkbox next to Sum. This will add the hectares of residential parcels in each study-site.
5. Specify a name and location for the output file.
6. Click OK. The output table will be added to the Map Document.

Create the Census Block Layer with water features removed:

1. Add the Census Block Layer and Water Features layer to your Map Document.
2. Open ArcToolbox and navigate to the Erase tool (Analysis Tools -> Overlay). Open the Erase tool by double-clicking it.
3. In the Input Features drop-down box, select the Census Block layer.
4. In the Erase Features drop-down box, select the Water Features layer.
5. Specify the location and name of the output feature class.
6. Click OK.
7. The output feature class will be generated and added to the map document.

Determine the apportioned census population figure for each site:

1. Calculate the area for the census block layer with the water removed.
a. Right-click on the census block layer with water removed and select Open Attribute Table...
b. Click on the Option button and select Add Field...
c. Type Hectares in the Name field and set the Type to Double.
d. Click OK.
e. Right-click on the Hectares field and select Calculate Geometry...
f. Set the Property: box to Area.
g. Set the Coordinate System to "Use coordinate system of the data source:"
h. Set the Units to Hectares [ha].
i. Click OK.
2. Intersect the census block layer with water removed with the Study-Site layer.
a. Open ArcToolbox and navigate to the Intersect tool (Analysis Tools $->$ Overlay $->$ Intersect). Double-click the Intersect tool to open it.
b. For the Input Features, click on the down-arrow and select the Census Block Layer with Water Features removed.
c. Repeat 2.b and select the Study-Site layer.
d. Specify a name and location for the output layer in the Output Feature Class box.
e. Set the JoinAttributes drop-down box to ALL.
i. The ALL option will transfer all the attributes from the input features to the output feature class.
f. Leave the XY Tolerance box empty.
g. Set the Output Type to INPUT.
i. The INPUT option will return intersections with the same geometry type as the Input Feature with the lowest geometry dimension.
h. Click OK to execute the Intersect. The output feature class will be added to the Map Document.
3. Update the areas of the clipped census block layer with water features removed.
a. Open the Attribute Table of the clipped Census Block Layer with water features removed created in the previous step.
b. Click on Options and choose Add Field...
c. Type OrigHect in the Name field and set the Type to Double.
d. Right-click on the OrigHect field.
e. Choose Field Calculator...
f. In the Field Calculator, click Hectares and click OK.
g. You have now copied the values from Hectares to OrigHect.
h. Right-click on the Hectares field and select Calculate Geometry...
i. Set the Property: box to Area.
ii. Set the Coordinate System to "Use coordinate system of the data source:"
iii. Set the Units to Hectares [ha].
iv. Click OK.
4. Perform the population apportionment.
a. Open the Attribute table of the clipped Census Block Layer with water features removed.
b. Click on the Option button and select Add Field...
c. Type PopSplit in the Name field and set the Type to Double.
d. Click OK.
e. Right-click on the PopSplit field and select Field Calculator...
f. In the Field Calculator, click Hectares, then click the " $l$ " operator, then click OrigHect, then click the "*" operator, and finally click the name of the Population field.
g. Click OK.
5. Calculate the total population of each study-site.
a. Open the Attribute table of the clipped Census Block Layer with water features removed.
b. Right-click on the attribute containing the study-site ID and choose Summarize...
i. In the box beneath Choose one or more summary statistics, click the plus sign next to PopSplit.
ii. Click the checkbox next to Sum.
iii. Choose a name and location for the Output Summary Table.
iv. Click OK.
c. The output summary table will contain the apportioned population sum for each study-site.

Perform the final calculation:

1. Open the output summary table created in the previous step.
a. Click the Option button and select Add Field...
b. Type ResPop in the Name field and set the Type to Double.
c. Click OK.
2. Join the table containing the area of residential parcels within each study-site to the table containing the apportioned population in each study-site.
a. Right-click on the apportioned population table, select Joins and Relates..., and then Join...
b. Under 1. Choose the field in this layer that the join will be based on:, click the down-arrow and select the Study-Site ID.
c. Under 2. Choose the table to join to this layer, or load the table from disk:, click on the downarrow and select the table containing the area of residential parcels within each study-site.
d. Under 3. Choose the field in the table to base the join on:, click the down-arrow and select the Study-Site ID.
e. Click OK to execute the join.
3. Open the table containing the apportioned population in each study-site. It will now have the residential parcels area joined to it.
a. Right-click on the ResPop attribute and select Field Calculator...
b. In the Field Calculator, click the PopSplit attribute, then click the " $l$ " operator, and then click the attribute containing the sum of the residential parcels area in each study-site.

The ResPop field now contains the population per hectare of residential land in the study-site.

### 5.4 Employment Per Unit Land Area: (TCWS GIS Protocol 3.6 )

Note: This was based on the existing TCWS GIS Protocol 3.6 from version 4.1 of the manual but steps were updated significantly in Version 1.3..

## 1. Basic Concept

While residential population is the most often used density measure, and an overall activity density is likely important, a number of researchers have propose that employment density may be associated with walking. In downtown areas this is obvious as congestion makes automobiles less viable for transportation. In terms of the residential populations in the Twin Cities Walking Study, however, employment density in these neighborhoods is more likely a proxy of mixed use.

A later version of this manual will address prior studies using various employment density measures, although many were only of land in parcels, e.g., Cervero and Kockelman (1996, 8), Ewing (1995, 55), and Frank and Pivo (1994, 46-48).

## 2. Basic Formula

Employment per Unit Land Area = Total employees per unit land area (excluding water).

## 3. Detailed Formula

Employment Per Unit Area = Total employees per unit land area (excluding water).

## 4. Comments and Explanations

Area of water features is excluded in the calculation of area. The methods explained below are narrowly tailored to the nature of the employment data we purchased.

Employment is from Dun and Bradstreet with some checking of data.

## 5. GIS Approach

The approach to this measurement is to perform a spatial join between the employment data and the study sites for which employment density is needed. When doing the spatial join, calculate the sum of all employment. Finally, divide the total employment for each study site by its area.
6. GIS Steps

The following procedures were completed using ArcMap (ArcInfo) 9.2.
To follow this protocol you will need:

1. Study-Site Layer (polygon) with unique ID field
2. Employment Data Layer (point)
3. Water Features Layer (polygon)

Determine Net Land Area (without water) for each Site:

1. Add the Study-Site Layer and Water Layer to your Map Document.
2. Open ArcToolbox by clicking on the icon and navigate to the Erase tool (Analysis Tools -> Overlay -> Erase). Double-click the Erase tool to open it.
a. In the Input Features drop-down box, select the Study-Site layer.
b. In the Erase Features drop-down box, select the Water Features layer.
c. Specify a name and location for the output layer.
d. Click OK.
e. The output feature class will be generated and added to the map document.
3. Calculate the Net Land Area for the new Study-Site layer (without water).
a. Right-click on the new Study-Site layer (without water) and select Open Attribute Table
b. Click on the Option button and select Add Field...
c. Name the field Area and change to type to Double.
i. If a field named Area already exists, change the name in the Add Field... dialog box to something else.
d. Click OK.
e. Click on the Option button again and select Add Field...
f. Name the field Hectares and change the Type to Double.
i. If a field name Hectares already exists, change the name in the Add Field... dialog box to something else.
4. Calculate the values for Area and Hectares.
a. For the Area field,
i. Right-click the Area field in the new Study-Site layer (without water) attribute table and select Calculate Geometry...
ii. Set the Property: box to Area.
iii. Set the Coordinate System to "Use coordinate system of the data source:"
iv. Set the Units to the desired type. For the Area attribute, square meters, miles or feet are probably appropriate.
v. Click OK.
b. For the Hectares field,
i. Right-click the Hectares field in the new Study-Site layer (without water) and select Calculate Geometry...
ii. Set the Property: box to Area.
iii. Set the Coordinate System to "Use coordinate system of the data source:".
iv. Set the Units to Hectares [ha].
v. Click OK.

Find the employment data points within the study-sites (without layer)

1. Add the Study-Site layer (without water) and the Employment Data layer to an ArcMap Document.
2. Right-click on the Study-Site layer (without water) and choose Joins and Relates $->$ Join...
3. Under the drop-down box labeled What do you want to join to this layer? choose Join data from another layer based on spatial location.
4. In Step 1 of the dialog box, choose the Employment Data layer.
5. In Step 2, click the button to choose Each polygon will be given a summary of the numeric attributes... and also click the check-box next to Sum.
6. In Step 3, choose a name and location for the output layer.
7. Click OK.
8. The output layer now contains a Count field with the number of Businesses found within each Study Site. The Sum_Employment attribute contains the sum of employment for those businesses within each Study Site.

Calculate the employment per unit land area

1. Add an attribute to hold the Employment per Unit Land Area value to the Study-Site Layer (without water).
a. Right-click on the Study-Site Layer (without water) and select Open Attribute Table.
b. Click the Options button and select Add Field...
c. Name the field EmpPerHect and change the Type to Double.
d. Click OK.
2. Join the output layer from the previous procedure to the Study-Site Layer (without water).
a. Right-click on the Study-Site Layer (without water) and choose Joins and Relates -> Join.
b. Under the dropdown box labeled What do you want to join to this layer? choose Join attributes from a table.
c. Choose the unique ID for each study site as the field to base the join on.
d. Choose the output layer from the previous procedure as the Table to Join to this layer.
e. Choose the unique ID for each study site as the field to base the join on.
f. Click OK.
3. Perform the final calculation
a. Right-click the EmpPerHect field in the Study-Site Layer (without water) and select Field Calculator...
b. In the Field Calculator, click the field Sum_Employment, click the / button, and then click the Hectares field.
c. Click OK.

The EmpPerHect field now contains the number of employees per hectare (excluding the water of water features).

## PEDESTRIAN INFRASTRUCTURE

A number of questions in student survey ask about aspects of pedestrian infrastructure for which there would need to be extensive data collection, e.g. sidewalks and lighting. In these protocols we only deal with topics for which there is existing data.

### 5.5 Distance to Nearest Transit Stop (TCWS GIS Protocol 4.10)

Note: The steps were updated in Version 1.3. It has based on the existing TCWS GIS Protocol 4.10 in version 4.1 of the manual.

## 1. Basic Concept

People walk to transit. The distance to the nearest transit stop may be associated with physical activity.
This relates to the TREC-IDEA survey question:

- SS178 About how long would it take to get from your home to the nearest bus stop if you walked? (Adapted from NEWS B20 (14))


## 2. Basic Definition

Distance to Nearest Facility = Straight line or network distance to the centroid of the nearest store or hardware store.

## 3. Detailed Definition

As above.

## 4. Comments and Explanations

This is done using Network Analyst in ArcMap (ArcInfo) 9.2 using a function called Find Closest Facility. You can specify a point layer to use as your "facilities" and another point layer to serve as your origins or "incidents". It will then take the road network and calculate the shortest path to a facility (and it can do this using travel costs as well, if certain type of roads were considered more or less easy to use, for instance).

For points that do not fall on the network, there is an option in the Load Locations dialog box that allows the user to decide how far away from the network to search for points to use in the processing.

## 5. GIS Approach

The approach for this measure is to load a set of origins or "incidents" (in this case, participant locations) and destinations or "facilities" (transit stops). Then use the Find Closest Facility function in Network Analyst to calculate the network distance from each origin to the nearest transit stop.

```
6. GIS Steps
The following procedures were completed in ArcMap (ArcInfo) 9.2.
```

To follow this protocol you will need:

1. Road Network dataset
2. Transit Stop Locations Point Feature Layer for facilities
3. Participants' Locations Point Feature Layer for incidents
4. Network Analyst Extension for ArcGIS 9.2

Calculate the Network Distance to the nearest transit stop

1. Start ArcMap
2. On the Main Menu, click Tools and Click on Extensions.
a. Check the Network Analyst Extension.
b. Click Close.
3. Click the Add Data button $\mathbb{V}$ on the Standard Toolbar
a. Navigate to the Network Dataset location.
b. Click on the Network Dataset and click Add to add the Network Dataset to ArcMap.
c. Click No to add all the feature classes, which participate in the network, to the map.
4. Click the Add Data button
on the Standard Toolbar.
a. Navigate to the Point Layers to be used for analysis, in this case Participant Home location and Transit Stop Locations
b. Click on the Point Layers and click Add to add it to ArcMap.
5. If the Transit Stop ID's and Participant ID's are already assigned go to next step. Otherswise, in the Table of Contents Right Click the Point Layer and click on Open Attribute Table
a. In the Attribute Table,
i. Click Options
ii. Click Add Field
iii. Add the Tran_ID_T as Text

- Type Tran_ID_T in the Name field
- Select Text as Type
- Set the Length to 20
- Click OK
iv. Click Options and select Add Field
v. Add the Tran_ID as Integer
- Type Tran_ID in the Name field
- Select Short Integer as Type
- Accept default (0) for Precision
- Click OK
vi. Right-click on the Tran_ID field and select Field Calculator...
- Set the Tran_ID equal to [FID] +1
- Click OK
vii. Right-click on the Tran_ID_T field and select Field Calculator...
- Set the Tran_ID_T equal to Tran_ID
- Click OK
b. Right-click on the Participant locations point layer and select Open Attribute Table
i. In the Attribute Table
- Click the Options button and select Add Field
- Add Par_ID_T as Text
a. Type Par_ID_T in the Name field
b. Select Text as Type
c. Set the Length to $\mathbf{2 0}$
d. Click OK
- Click the Options button and select Add Field
- Add Par_ID as Integer
a. Type Par_ID in the Name field
b. Select Short Integer as Type
c. Accept default (0) for Precision
d. Click OK
- Right-click on the Par_ID field and select Field Calculator...
a. Set the Par_ID equal to [FID] +1
b. Click OK
- Right-click on the Par_ID_T field and select Field Calculator...
a. Set the Par_ID_T field equal to Par_ID
b. Click OK

6. Load the Network Analyst Toolbar
a. On the Main Menu, click on View
b. Click on Toolbars
c. In the side menu click Network Analyst to add the Network Analyst toolbar to ArcMap
7. Load the Network Analyst Window

## a. Click on the Show/Hide Network Analyst Window button Window to the map

8. Create a New Closest Facility
a. Click on the Network Analyst button on the Network Analyst toolbar
b. Select New Closest Facility from the dropdown menu
c. The Table of Contents and the Network Analyst Window will now contain a Closest Facility layer, which contains Facilities, Incidents, Barriers, and Routes categories
9. Load the Transit Stop locations in the Facilities category in Network Analyst
a. In the Network Analyst window, right-click Facilities and click Load Locations. This will open the Load Locations Window
b. In the Load Locations Window
i. Select the point layer containing the Transit Stop locations from the dropdown box next to Load From. If the required point layer is not in the dropdown box, click on the Browse for Point Features to Load icon and navigate to the point layer.
ii. Choose the Tran_Stop_ID as the Sort field.
iii. Choose the Tran_Stop_ID_T for the Name property under Location Analysis properties.
iv. Accept the defaults for the other Locational Analysis properties.
v. Choose a suitable Search Tolerance for the Location Position. If features cannot be located on the network dataset, this tolerance may need to be increased.
vi. Click OK.
c. To verify all Transit Stop locations were located on the network dataset, do one of the following. If any feature has a status of Not Located, the search tolerance in 9.b.v may need to be increased or the feature reviewed for correct location.
i. For small datasets, scroll through the resulting lists of Facilities in the Network Analyst Window, looking for features with RED questions marks.
ii. For large datasets, it may be easier to right-click on the Facilities in the Network Analyst Window, Open Attribute Table and sort decending on the STATUS column. The Not Located features should sort to the top.
10. Load the Participant locations into Incidents category in Network Analyst.
a. In the Network Analyst window, right-click Incidents and click Load Locations. This will open the Load Locations Window.
b. In the Load Locations Window,
i. Select the point layer containing the Participant locations from the dropdown box next to Load From. If the required point layer is not in the dropdown box, click on the Browse for Point Features to Load icon and navigate to the point layer.
ii. Choose the Par_ID as the Sort field.
iii. Choose the Par_ID_T for the Name property under Locational Analysis properties.
iv. Accept the defaults for the other Locational Analysis properties.
v. Choose a suitable Search Tolerance for the Location Position. If features cannot be located on the network dataset, this tolerance may need to be increased.
vi. Click OK
c. To verify all Participant locations were located on the network dataset, do one of the following. If any feature has a status of Not Located, the search tolerance in 10.b.v may need to be increased or the feature reviewed for correct location.
i. For small datasets, scroll through the resulting lists of Facilities in the Network Analyst Window, looking for features with RED questions marks.
ii. For large datasets, it may be easier to right-click on the Facilities in the Network Analyst Window, Open Attribute Table and sort decending on the STATUS column. The Not Located features should sort to the top.
11. Set the properties for the analysis
a. In the Table of Contents, right-click Closest Facility and click Properties. This will open the Closest Facility properties dialog box.
b. Click on the Analysis Settings Tab.
i. Choose Length (meters) for Impedence.
ii. Choose None for Default Cutoff Value.
iii. Set Facilities to Find to 1.
iv. Set the Travel From option to Incident to Facility.
v. Set Allow U-Turns to Everywhere.
vi. Set Output Shape Type to True Shape.
vii. Check the box to Ignore Invalid Location.
c. Click Ok
12. To calculate the closest Transit Stop to a Participant location, click the Solve Button on the Network Analyst Toolbar.
a. When Network Analyst has solved the calculations, the Routes layer will be populated with line segments joining each participant location to its closest transit stop. The Routes attribute table contains the unique IDs for the participant and the transit stop along with the network length separating them and the route name (a concatenation of the participant ID and the transit stop ID).
13. Join the Transit Stops and the Participants to the results of Find Closest Facility analysis.
a. Right click the Routes layer.
b. Select Joins and Relates and then click Join...
i. Choose Facility_ID as the field to base the join on.
ii. Choose the Transit Stop layer as the Table to Join to this layer.
iii. Choose the Tran_ID as the field in the table to base the join on.
iv. Click OK
c. Right-click the Routes layer
d. Select Data and then click Export Data.
i. Choose Incident_ID as the field to base the join on.
ii. Choose the Participant layer as the Table to Join to this layer.
iii. Choose the Par_ID as the field in the table to base the join on.
iv. Click OK.
e. Right-click the Routes layer.
f. Select Data and then click Export Data
i. Choose this layer's source data for the coordinate system.
ii. Specify the Output Location.
iii. A new shapefile will be created in the output location. This shapefile will contain the routes from each participant location to the nearest transit stop. Each route will contain the attributes of the participant and the nearest transit stop.

Calculate straight-line distance to nearest transit stop
To follow this protocol, you will need:

1. Participant Locations Point Feature Layer for incidents (origins)
2. Transit Stop Point Feature Layer for facilities (destinations

Calculate the straight-line distance to the nearest transit stop

1. Start ArcMap.
2. Click the Add Data button on the Standard Toolbar.
a. Navigate to the Point Layers to be used in the analysis, in this case the Participant locations and the Transit Stops.
b. Select the Point Layers and click Add to add them to ArcMap.
3. Open ArcToolbox by clicking on the iconn
4. Navigate to the Near tool (Analysis Tools -> Proximity) and double-click to open it.
5. Click the down-arrow in the Input Features box and select the Participant Locations feature layer.
6. Click the down-arrow in the Near Features box and select the Transit Stops feature layer.
7. Leave the Search Radius (optional) box empty. This will guarantee that every Participant Location will have its nearest transit stop found.
8. Leave the Location (optional) and Angle (optional) check boxes unchecked.
9. Click OK to execute the tool.
10. The tool will find the nearest transit stop to each Participant Location and measure the straight-line distance between those points. The tool will add two attributes to the participant location attribute table, NEAR_DIST and NEAR_FID. NEAR_DIST will contain the distance, in the units of the Layers (e.g., meters, feet). NEAR_FID will contain the feature ID of the closest transit stop. Use the NEAR_FID attribute to join the Transit Stop Layer to the Participant Location layer to determine the characteristics of the nearest transit stop.

Join the Participant Location Layer to the Transit Stop Layer using the NEAR_FID attribute.

1. Right-click on the Participant Location layer and select Joins and Relates -> Join...
2. Choose NEAR_FID as the field to base the join on.
3. Choose the Transit Stop layer as the Table to Join to this layer.
4. Choose the FID attribute as the field in the table to base the join on.
5. Click OK. The Transit Stop attributes will be joined to the Participant locations.
6. Right-click on the Participant Locations Layer and select Data -> Export Data.
a. Choose this layer's source data for the coordinate system.
b. Specify the Output Location.
c. Click OK.

A new shapefile will be created in the output location. This shapefile will contain the participant locations and the attributes of the nearest transit stop to each participant location.

### 5.6 Transit Stop Density (TCWS GIS Protocol 4.11)

This uses the existing TCWS GIS Protocol 4.11 in version 4.1 of the protocols.

## 1. Basic Concept

Transit stops may also be a proxy for a walkable neighborhood. Transit stop density may correlate with overall activity.

## 2. Basic Formula

Transit Stop Density $=$ Number of transit stops per unit area.

## 3. Detailed Formula

As above.

## 4. Comments and Explanations

None.

## 5. GIS Approach

The GIS approach is to perform a spatial join between the measurement geographies and the transit stops. This will count the number of stops in each measurement geography. Then divide this number by the net land area of each measurement geography.

## 6. GIS Steps

The following procedures were completed using ArcMap (ArcInfo) 9.2.
To complete this protocol you will need:

1. Study-Site Layer (polygon)
2. Transit Stops Layer (point)

Refer to protocol 2.1 for the procedures to calculate net land area (land area with water features removed).

Add the Transit Stops and Study-Site layers to an ArcMap Document.

1. Right-click on the Study-Site Layer and choose Joins and Relates $\rightarrow$ Join.
2. Under the dropdown box labeled What do you want to join to this layer? choose Join data from another layer based on spatial location.
3. In Step 1 of the dialog box, choose the Transit Stops Layer.
4. In Step 2, click the button to choose Each polygon will be given a summary of the numeric attributes....
5. In Step 3, choose a name and location for the output layer.
6. Click OK.
7. The output layer now contains a Count field with the number of transit stops found in each feature of the measurement geography.

Calculate transit stops per net land area:

1. Right-click on the output layer of the spatial join and select Open Attribute Table.
2. Click Options and choose Add Field.
3. Name the field StopDens and change the type to Double.
4. Click OK to add the field.
5. In the Table of Contents, right-click on the output layer from the spatial join performed above and choose Joins and Relates $\rightarrow$ Join.
6. In the dropdown box, choose to Join attributes from a table.
7. In Step 1, choose to base the join on the field containing the unique ID of the measurement geographies.
8. In Step 2, load the table from the result of following protocol 2.1, Net Land Area.
9. In Step 3, choose the field in the Net Land Area Layer's table containing the unique ID of the measurement geographies.
10. Click OK.
11. Open the Attribute Table of the output layer from the spatial join, which now has the net land area table joined into it.
12. Right-click on the StopDens field and choose Field Calculator....
13. In the Field Calculator dialog box, click the Count field, then click the / button, and finally click the name of the field containing the net land area.
14. Click OK.

This field now contains the density of transit stops (number of transit stops divided by the net land area in whichever units you used).

## LAND-USE MIX

### 5.7 Percentage of Total Parcel Area in Major Land Uses (residential, commercial, office, industrial, institutional, park and recreation, vacant):(TCWS GIS Protocol

 5.1)This is based on the existing TCWS GIS Protocol 5.1 updated for version 4.1 of the protocols however as of version 1.1 we are debating how to exclude water most effectively given changes in GIS software. This protocol will be updated before actual measurement occurs. It was updated again in Version 1.3.

## 1. Basic Concept

A simple measure of land-use percentage in major uses, this is less a measure of mix per se than the relative amount of each land use: residential, commercial, office, industrial, institutional, park and recreation, vacant.

The next draft of these protocols will review earlier work that has used similar measures, e.g., McNally and Kulkarni $(1997,109)$ examined a ratio of commercial area to total area.

## 2. Basic Formula

Percentage of Total Parcel Area in Major Land Uses = Total area in each of seven major land-use categories (residential, commercial, office, industrial, institutional, park and recreation, vacant) divided by total land area in parcels.

## 3. Detailed Formula

Percentage of Total Parcel Area in Major Land Uses = Total area in parcels in each of the seven major land-use categories (residential, commercial, office, industrial, institutional, park and recreation, vacant) divided by total land area in parcels, with water area removed. Note that some land uses (agricultural, airport, non-roadbed right of way) are not included in our seven major land-use categories, but are included in the total land area figures.


Fig. 5.1. Parcels coded with the seven major land-use categories:

Residential - yellow
Commercial - red
Institutional - purple
Office - blue
Park and recreation - green
Industrial - dark grey
Vacant - not marked

## 4. Comments and Explanations

Land uses were assigned at the parcel level and reflected the most detailed data available. These data were then generalized to our seven major land-use categories.

Complicating factors may, however, be unique to our data:
a. Two different water layers were used for exclusions (see earlier discussion in chapter 1).
b. We used two methods for assigning land uses, depending on whether the parcels were in our original Context Areas or fell within our extended buffer areas (see appendix 5C for details on how this was done).
c. In general, we field-checked in the context areas, and where large buffers fell outside the context areas, we felt that the errors from using Metropolitan Council data would not be so large.

## 5. GIS Approach

The parcel layer (with areas of water removed) was intersected with the measurement geographies and the areas of the parcels recalculated to account for those that were split by the study site boundaries. The land uses associated with each parcel were generalized into seven major land-use categories. For
each study site, the total area of each land-use category was summarized. The percentages of the total parcel area for each study site were then calculated.
6. GIS Steps [Note these steps are partially updated and should not be used!!!!!]

The following procedures were completed using ArcMap (ArcInfo) 9.2.
To complete this protocol you will need:

1. Study-Site Layer (polygon)
2. Land-Use Parcels Layer (polygon)
3. Water Features Layer (polygon)
4. Microsoft Excel or other spreadsheet program

Determine Net Land Area (without water) for each Site: Follow the steps outlined in the protocol above
Convert land uses into seven categories:

1. Add the Land-Use Parcel Layer to an ArcMap document.
2. Right-click on the Land-Use Parcel layer and select Open Attribute Table.
3. Click on the Options button and select Add Field.
4. Name the field LUC7.
5. Select Text as Type and set the Length to 20.
6. Reclassify your parcels so that the land uses are generalized into the seven major land-use categories (residential, commercial, office, industrial, institutional, park and recreation, vacant). How this is done depends on the level of detail of your existing land-use categories - for example, if you have Small-scale Commercial, Strip Commercial, and Shopping Center land uses, these would all be generalized to a new land-use code of Commercial.
7. Enter the new land-use codes in the LUC7 field.
a. Click Options and choose Select by Attributes...
i. Construct an SQL Query in the Dialog box as follows: "LUSE2005" = 100 OR "LUSE2005" $=201$ OR "LUSE2005" $=203$
ii. Click Close to execute the Query.
iii. This will select all parcels classified as Agriculture, Major Highways, or Airports.
iv. Right-click on the LUC7 field and select Field Calculator...
v. Set LUC7 equal to OTHER.
b. Click Options and choose Select by Attriubtes...
i. Construct an SQL query in the Dialog box as follows: "LUSE2005" = 111 OR "LUSE2005"
= 112 OR "LUSE2005" = 113 OR "LUSE2005" $=116$ OR "LUSE2005" $=114$ OR
"LUSE2005" = 115
ii. Click Close to execute the Query.
iii. This will select all parcels classified as Farmsteads, Single-Family Residential, or Multifamily Residential.
iv. Right-click on the LUC7 field and select Field Calculator...
v. Set LUC7 equal to RESIDENTIAL.
c. Click Options and choose Select by Attributes...
i. Construct an SQL query in the Dialog box as follows: "LUSE2005" = 120 OR "LUSE2005" = 143
ii. Click Close to execute the Query.
iii. This will select all parcels classified as Commercial - Retail or Mixed-Use Commercial.
iv. Right-click on the LUC7 field and select Field Calculator...
v. Set LUC7 equal to COMMERCIAL.
d. Click Options and choose Select by Attributes...
i. Construct an SQL query in the Dialog box as follows: "LUSE2005" = 130 OR "LUSE2005" = 141
ii. Click Close to execute the Query.
iii. This will select all parcels classified as Commercial - Office or Mixed-Use Residential.
iv. Right-click on the LUC7 field and select Field Calculator...
v. Set LUC7 equal to OFFICE.
e. Click Options and choose Select by Attributes...
i. Construct an SQL query in the Dialog box as follows: "LUSE2005" = 142 OR "LUSE2005" = 151 OR "LUSE2005" = 153 OR "LUSE2005" = 202
ii. Click Close to execute the Query.
iii. This will select all parcels classified as Mixed-Use Industrial, Industrial and Utility, Extractive, or Railway.
iv. Right-click on the LUC7 field and select Field Calculator...
v. Set LUC7 equal to INDUSTRIAL.
f. Click Options and choose Select by Attributes...
i. Construct an SQL query in the Dialog box as follows: "LUSE2005" $=160$.
ii. Click Close to execute the Query.
iii. This will select all parcels classified as Institutional.
iv. Right-click on the LUC7 field and select Field Calculator...
v. Set LUC7 equal to INSTITUTIONAL.
g. Click Options and choose Select by Attributes...
i. Construct an SQL query in the Dialog box as follows: "LUSE2005" = 170 OR "LUSE2005" = 173
ii. Click Close to execute the Query.
iii. This will select all parcels classified as Park, Rec, and Preserve or Golf Courses.
iv. Right-click on the LUC7 field and select Field Calculator...
v. Set LUC7 equal to PARK AND REC.
h. Click Options and choose Select by Attributes...
i. Construct an SQL query in the Dialog box as follows: "LUSE2005" $=210$
ii. Click Close to execute the Query.
iii. This will select all parcels classified as Undeveloped.
iv. Right-click on the LUC7 field and select Field Calculator...
v. Set LUC7 equal to VACANT.
i. Click Options and choose Select by Attributes...
i. Construct an SQL query in the Dialog box as follows: "LUSE2005" $=220$
ii. Click Close to execute the Query.
iii. This will select all parcels classified as Water.
iv. Right-click on the LUC7 field and select Field Calculator...
v. Set LUC7 equal to WATER.

Remove water from the Land-use Parcels Layer.

1. Add the Land-Use Parcel Layer and the Water Features Layer to an ArcMap document.
2. Open ArcToolbox and navigate to the Erase tool (Analysis Tools -> Overlay). Open the Erase tool by double-clicking it.
3. In the Input Features drop-down box, select the Land-Use Parcel layer.
4. In the Erase Features drop-down box, select the Water Features layer.
5. Specify the location and name of the output feature class.
6. Click OK.
7. The output feature class will be generated and added to the Map Document.

Use a Definition Query to exclude Land-use water areas from the Land-Use Parcels Layer. This will eliminate water polygons that are in the land-use parcels layer but were missed during the previous step.

1. In the Table of Contents, right-click on Land-use Parcels layer with water removed and select Properties.
2. Go to the Definition Query tab and click Query Builder.
3. Construct an SQL expression that applies to whichever field contains the land-use code and exclude values that represent water.
4. Click OK to close the Query Builder and OK to close the Layer Properties window.
5. Ensure that water parcels in the Land-use Parcels layer with water removed are excluded.
6. Right-click on the Land-use Parcels layer with water removed and select Data -> Export Data...
7. Click the radio-button next to "Use the same Coordinate System as this layer's source data" and specify a location and name for the output shapefile.
8. Click OK. This will create a shapefile with water features removed as well as water parcels removed.

Intersect parcels with study-site layer:

1. If the Study-Site Layer does not have unique IDs or names for each site, create them now.
a. Right-click on the Study-Site Layer and select Open Attribute Table.
b. Click on the Options button and select Add Field.
c. Name the field Study_ID.
d. Select Short Integer as Type and accept default (0) for Precision.
e. Click OK.
f. Right-click on the Study_ID field and select Field Calculator...
g. Set the Study_ID equal to [FID] +1.
h. Click OK.
2. Open ArcToolbox by clicking on the icon and navigate to the Intersect tool (Analysis Tools -> Overlay -
$>$ Intersect). Double-click the Intersect tool to open it.
a. For the Input Features, click on the down-arrow and select the Land-Use Parcels Layer with water features removed and water parcels excluded from the list of Layers.
b. Repeat 2.a and select the Study-Site Layer.
c. Specify a name and location for the output layer in the Output Feature Class box.
d. Set the JoinAttributes drop-down box to ALL.
i. The ALL option will transfer all the attributes from the input features to the output feature class.
e. Leave the XY Tolerance box empty.
f. Set the Output Type to INPUT.
i. The INPUT option will return intersections with the same geometry type as the Input Feature with the lowest geometry dimension.
g. Click OK to execute the Intersect. The output feature class will be added to the Map Document.
h. The parcels will now be clipped to the study-site boundaries and be assigned the ID associated with the study-site in which it is located. Note that parcels which exist in two or more overlapping study sites will be represented by two or more identical (except for Study-Site ID number) rows in the Attribute Table.

Dissolve the intersect results to create unique combinations of land use and study-site ID:

1. In ArcToolbox, find the Dissolve tool by navigating through Data Management $->$ Generalization
a. Input Features are the result of the Parcels - Study-site intersection.
b. Specify a name and location for the output layer.
c. Under Dissolve_Field(s), click the checkbox next to LUC7 and the Study-Site ID field.
d. Ensure the Multipart option (at the bottom of the dialog box) is checked.
e. Click OK.
f. The output layer will contain the polygons for each land-use type within a study-site.

Calculate the area of each land-use class contained within each study-site:

1. Right-click on the layer created by the Dissolve tool and select Open Attribute Table...
2. Click the Options button and select Add Field...
3. Type Hectares in the Name field and set the Type to Double.
4. Click OK.
5. Right-click on the Hectares field and select Calculate Geometry...
6. Set the Property: box to Area.
7. Set the Coordinate System to "Use coordinate system of the data source:".
8. Set the Units to Hectares [ha].
9. Click OK. This will calculate the area, in hectares, of each land-use type within a given study-site.

Calculate land-use percentages for each site:

1. Open ArcToolbox and find the Pivot Table tool by navigating through Data Management Tools -> Table. Double-click on the Pivot Table tool to open.
2. Click on the down-arrow button by Input Table and select the dissolved layer.
3. The Input Field is the unique ID for the study-site.
4. The Pivot Field is the field containing the land-use codes.
5. The Value Field is the field containing the Hectares values.
6. Specify the name and location of the output pivot table.
7. Click OK. This function will create a table with one row for each study-site and a column for every landuse type. If a land-use type is found in a study-site, the area of that land-use type will be contained in the cell.
8. Right-click on the study-site layer and select Open Attribute Table...
9. Add an attribute that will contain land-use percentages for each Land Use type.
a. Click the Option button and select Add Field...
b. Change the name to Perc_<Land-Use_Type>, where <Land-Use_Type> is one of the seven landuse type. Set the Type to Double and click OK.
c. Repeat steps 9 a and 9 b for the other six land-use type.
10. Join the table created by the Pivot Table tool to the study-site attribute table.
a. Right-click on the study-site attribute table and select Joins and Relates -> Join...
b. Under What do you want to join to this layer?, click the drop-down arrow and select Join attributes from a table.
c. Select the unique study-site ID for 1 . Choose the field in this layer that the join will be based on:
d. Under 2. Choose the table the join this layer, or load the table from disk:, choose the table created by the Pivot Table tool.
e. Select the unique study-site ID for 3. Choose the field in the table to base the join on:
f. Click OK.
11. Right-click on the study-site layer and select Open Attribute Table... The pivot table should be joined to the study-site layer.
12. Calculate the percentage of total parcel area in each land use.
a. For each land-use percentage attribute, right-click on the attribute and select Field Calculator...
b. Click on the field holding the hectares of the particular land-use, then click the / button, then click the field holding the total hectares for the study-site, then click the * button, and finally type 100.
c. Click OK. This will calculate the percentage of land parcel area in the particular land-use type.
d. Repeat for all other land-use type.

### 5.8 Retail Employment Density (TCWS GIS Protocol 5.11)

This uses the existing TCWS GIS Protocol 5.11 from Version 4.1 of the protocols..

## 1. Basic Concept

Retail uses are thought to promote walking.

## 2. Basic Formula

Retail Employment per Unit Area $=$ Total retail employees per unit land area (excluding water).

## 3. Detailed Formula

Retail Employment per Unit Area $=$ Total retail (SIC codes 5200-5999) employees per unit land area (excluding water).

## 4. Comments and Explanations

We used SIC codes to correspond with earlier research. In later versions of these protocols we will provide the NAICS equivalent.

Retail data came from Dun and Bradstreet but were checked against other employment data.
In an earlier version of the protocols we proposed that the measure be made in increments of 100*100meter grid cells. We gained access to point data, however, and could then use standard buffers.

## 5. GIS Approach

Divide the total retail employment in each buffer by that buffer's area (excluding water).
6. GIS Steps

The following procedures were completed using ArcMap (ArcInfo) 9.2.
To follow this protocol you will need:

1. Study-Site Layer (polygon) with unique ID field
2. Employment Data Layer (point)
3. Water Features Layer (polygon)

Query the employment data to show only retail businesses:

1. Add the Employment Data Layer to your Map Document.
2. Right-click on the Employment Data Layer in the Table of Contents and choose Properties.
3. Click the Definition Query tab.
4. Click on the Query Builder button.
5. Construct a query that will identify all retail employment businesses.
6. Click OK to close the Query Builder and OK again.
7. The Employment Data Layer should be updated to show only retail businesses in the data view.

Create a study-site layer with the water feature removed and the area field updated. Skip this step if you have already finished protocol 2.1:

1. Add the Study-Site Layer and the Water Features Layer to the Map Document.
2. Open ArcToolbox and navigate to the Erase tool (Analysis Tools $->$ Overlay). Double-click the Erase tool to open it.
3. In the Input Features drop-down box, select the Study-Site layer.
4. In the Erase Features drop-down box, select the Water Features layer.
5. Specify the location and name of the output feature class.
6. Click OK.
7. The output feature class will be generated and added to the map document.

Update the areas of the study sites after removing the water:

1. Add area fields to the output feature class created in the previous step.
a. Right-click on the Output Feature Class and select Open Attribute Table...
b. Click on the Option button and select Add Field...
c. Name the field Area and change the Type to Double. If an Area field already exists, you can Cancel this operation and overwrite the area values.
d. Click OK.
e. Click on the Option button again and select Add Field...
f. Name the field Hectares and the change the type to Double. If a Hectares field already exists, you can Cancel this operation and overwrite the hectares values.
2. Calculate the values for Area and Hectares
a. For the Area field,
i. Right-click the Area field in the Output Feature Class attribute table and select Calculate Geometry...
ii. Set the Property: box to Area.
iii. Set the Coordinate System to "Use coordinate system of the data source:"
iv. Set the Units to the desired type. For the Area attribute, square meters, miles, or feet is probably appropriate.
v. Click OK.
b. For the Hectares field,
i. Right-click the Hectares field in the Output Feature Class attribute table and select Calculate Geometry...
ii. Set the Property: box to Area.
iii. Set the Coordinate System to "Use coordinate system of the data source:"
iv. Set the Units to Hectares [ha].
v. Click OK.

Perform a spatial join between the study-site layer and employment layer:

1. Right-click the Study-Site Layer and choose Joins and Relates $\rightarrow$ Join.
2. In the top dropdown box, make sure it is set to Join data from another layer based on spatial location.
3. In the next item down, select the Employment Data Layer to be the layer to join to the buffers.
4. Select Each polygon will be given a summary of the numeric attributes and check the box below next to Sum.
5. At the bottom, choose a name and location for the output file.
6. Click on OK.

The resulting file will have a field in its Attribute Table called Sum_EMPL or similar (depending on the name of the field containing the number of employees in the original employment layer). The new layer should have the same number of features as the Study-Site Layer.

Perform the final calculation of the number of retail employees per hectare (excluding the area of water features).

1. Open the attribute table of the output file created in the previous step.
2. Click on the Option button and select Add Field...
3. Name the field RetPerHect and set the type to Double.
4. Right-click on the RetPerHect field and select Field Calculator...
5. In the Field Calculator, click on the field containing the sum of retail employees, click the / button, and then click the Hectares field.
6. Click OK.

The RetPerHect field now contains the number of employees per hectare (excluding the area of water features).

### 5.9 Distance to Nearest Facility (Mentioned in the Survey): Stores in Total, Hardware Stores

Note this builds on the Twin Cities Walking Study GIS Protocols 5.14 but has been modified to reflect the needs and interests of youth. It looks at to specific issues: total stores (including hardware stores) and hardware stores> Hardware stores are separated out because we are trying to match a question in the TREC-IDEA parent survey and are already measuring the other destinations mentioned in the survey.

## 1. Basic Concept

This related to survey questions will allow us to analyze perceived versus real distances.

- Ps 65/66 In the past month, how many times did you buy food/sweetened beverage at a convenience store, gas station, hardware store, or a vending machine?
- SS176 About how long would it take to get from your home to the nearest store (video, clothes, pharmacy) if you walked? (Adapted from NEWS B16 (14))

The nearest store will be classified as using the following NAICS codes explained at
http://www.census.gov/epcd/naics02/N2SIC44.HTM:
441 Motor Vehicle and Parts Dealers
442 Furniture and Home Furnishings Stores
443 Electronics and Appliance Stores
444 Building Material and Garden Equipment and Supplies Dealers
445 Food and Beverage Stores
446 Health and Personal Care Stores
447 Gasoline Stations
448 Clothing and Clothing Accessories Stores
451 Sporting Goods, Hobby, Book, and Music Stores
452 General Merchandise Stores
453 Miscellaneous Store Retailers
Hardware stores are defined as 44413 Hardware Stores and 44411 Home Centers.

## 2. Basic Definition

Distance to Nearest Facility = Straight line or network distance to the centroid of the nearest store (including hardware) or hardware store (alone).

## 3. Detailed Definition

Distance to Nearest Facility = Straight line or network distance to the centroid of the nearest store (including hardware) or hardware store (alone)defined using NAICS codes.

## 4. Comments and Explanations

[To add.]

## 5. GIS Approach

The GIS approach is to use the Find Closest Facility option in the Network Analyst Extension of ArcGIS 9.2 to find the closest facility to a participant's home or school. The point layer containing facilities is the "facilities" in Network Analyst, and the participant locations are the "incidents" in Network Analyst. A street network is required for calculating the distance between facilities and participant locations.

In the Network Analyst Extension, specify the "facilities" and the "incidents" and solve for the clostest facility to each incident. Attach the distance to the closest facility to each incident.

The straight-line distance is calculated using the Near Tool in ArcToolbox.

## 6. GIS Steps

The following procedures were completed in ArcMap (ArcInfo) 9.2.
To follow this protocol you will need:

1. Road Network dataset
2. Facility Point Feature Layer for facilities (destinations)
3. Participants' Locations Point Feature Layer for incidents (origins)
4. Network Analyst Extension for ArcGIS 9.2

Calculate the Network Distance to the nearest facility

1. Start ArcMap
2. On the Main Menu, click Tools and click on Extensions
a. Check Network Analyst Extension
b. Click Close
3. Click the Add Data button
on the Standard Toolbar
a. Navigate to the Network Dataset location
b. Click on the Network Dataset and click Add to add the Network Dataset to ArcMap
c. Click Yes to add all the feature classes that participate in the network to the map
4. Click the Add Data button $\downarrow$ on the Standard Toolbar
a. Navigate to the Point Layers to be used for the analysis, in this case the Participant locations and Facility locations
b. Select the Point Layers and click Add to add them to ArcMap
5. If the Facility IDs and Participant IDs are already assigned, go to the next step. Otherwise, in the Table of Contents, right-click on the Participant locations point layer and select Open Attribute Table
a. In the Attribute Table
i. Click Options
ii. Click Add Field
iii. Add Par_ID_T as Text

- Type Par_ID_T in the Name field
- Select Text as Type
- Set the Length to 20
- Click OK
iv. Click Options and select Add Field
v. Add Par_ID as Integer
- Type Par_ID in the Name field
- Select Short Integer as Type
- Accept default (0) for Precision
- Click OK
vi. Right-click on the Par_ID field and select Field Calculator...
- Set the Par_ID equal to [FID] + 1
- Click OK
vii. Right-click on the Par_ID_T field and select Field Calculator...
- Set the Par_ID_T equal to Par_ID
- Click OK
b. Right-click on the Facilities point layer and select Open Attribute Table
i. In the Attribute Table
- Click the Options button and select Add Field
- Add Fac_ID_T as Text
a. Type Fac_ID_T in the Name field
b. Select Text as Type
c. Set the Length to 20
d. Click OK
- Click the Options button and select Add Field
- Add Fac_ID as Integer
a. Type Fac_ID in the Name field
b. Select Short Integer as Type
c. Accept default (0) for Precision
d. Click OK
- Right-click on the Fac_ID field and select Field Calculator...
a. Set the Fac_ID equal to [FID] + 1
b. Click OK
- Right-click on the Fac_ID_T field and select Field Calculator...
a. Set the Fac_ID_T equal to Fac_ID
b. Click OK

6. Load the Network Analyst toolbar
a. On the Main Menu, click on View
b. Click on Toolbars
c. In the side menu, click Network Analyst to add the Network Analyst toolbar to ArcMap
7. Load the Network Analyst Window
a. Click on the Show/Hide Network Analyst Window ${ }^{\text {围 }}$ to open the window
8. Create a New Closest Facility
a. Click on the Network Analyst button on the Network Analyst toolbar
b. Select New Closest Facility from the dropdown menu
c. The Table of Contents and the Network Analyst Window will now contain a Closest Facility layer, which contains Facilities, Incidents, Barriers, and Routes categories
9. Load the Facilities in the Facilities category in Network Analyst
a. In the Network Analyst window, right-click Facilities and click Load Locations. This will open the Load Locations Window
b. In the Load Locations Window
i. Select the point layer containing the Facilities locations from the dropdown box next to Load From. If the required point layer is not in the dropdown box, click on the Browse for Point Features to Load icon and navigate to the point layer.
ii. Choose the Fac_ID as the Sort field
iii. Choose the Fac_ID_T for the Name property under Locational Analysis properties.
iv. Accept the default for the other Locational Analysis properties.
v. Choose a suitable Search Tolerance for the Location Position. If features cannot be located on the network dataset, this tolerance may need to be increased.
vi. Click OK
c. To verify all Facility locations were located on the network dataset, do one of the following. If any feature has a status of Not Located, the search tolerance in 9.b.v may need to be increased or the feature reviewed for correct location.
i. For small datasets, scroll through the resulting lists of Facilities in the Network Analyst Window, looking for features with RED question marks.
ii. For large datasets, it may be easier to right-click on the Facilities in the Network Analyst Window, Open Attribute Table and sort decending on the STATUS column. The Not Located features should sort to the top.
10. Load the Participant locations into the Incidents category in Network Analyst
a. In the Network Analyst window, right-click Incidents and click Load Locations. This will open the Load Locations Window.
b. In the Load Locations Window
i. Select the point layer containing the Participant locations from the dropdown box next to Load From. If the required point layer is not in the dropdown box, click on the Browse for Point Features to Load icon and navigate to the point layer.
ii. Choose the Par_ID as the Sort field
iii. Choose the Par_ID_T for the Name property under Locational Analysis properties.
iv. Accept the default for the other Locational Analysis properties.
v. Choose a suitable Search Tolerance for the Location Position. If features cannot be located on the network dataset, this tolerance may need to be increased.
vi. Click OK
c. To verify all Participant locations were located on the network dataset, do one of the following. If any feature has a status of Not Located, the search tolerance in 10.b.v may beed to be increased or the feature reviewed for correct location.
i. For small datasets, scroll through the resulting lists of Incidents in the Network Analyst Window, looking for features with RED question marks.
ii. For large datasets, it may be easier to right-click on the Incidents in the Network Analyst Window, Open Attribute Table and sort decending on the STATUS column. The Not Located features should sort to the top.
11. Set the properties for the analysis
a. In the Table of Contents, right-click Closest Facility and click Properties. This will open the Closest Facility properties dialog box.
b. Click on the Analysis Settings Tab
i. Choose Length (meters) for Impedence
ii. Choose None for Default Cutoff Values
iii. Set Facilities to Find to 1
iv. Set the Travel From option to Incident to Facility
v. Set Allow U-Turns to Everywhere
vi. Set Output Shape Type to True Shape
vii. Check the box to Ignore Invalid Locations
c. Click OK
12. To calculate the closest Facility to a Participant location, click the Solve Button on the Network Analyst Toolbar.
a. When Network Analyst has solved the calculations, the Routes layer will be populated with line segments joining each participant location to its closest facility. The Routes attribute table contains the unique IDs for the participant and the facility along with the network length separating them and the route name (a concatenation of the participant ID and the facility ID).
13. Join the Facilities and the Participants to the results of Find Closest Facility analysis
a. Right-click the Routes layer
b. Select Joins and Relates and then click Join
i. Choose Facility ID as the field to base the join on
ii. Choose the Facility layer as the Table to Join to this layer
iii. Choose the Fac_ID as the field in the table to base the join on
iv. Click OK
c. Right-click on the Routes layer
d. Select Joins and Relates and then click Join
i. Choose Incident_ID as the field to base the join on
ii. Choose the Participant layer as the Table to Join to this layer
iii. Choose the Par_ID as the field in the table to base the join on
iv. Click OK
e. Right-click the Routes layer
f. Select Data and then click Export Data
i. Choose this layer's source data for the coordinate system
ii. Specify the Output Location
iii. A new shapefile will be created in the output location. This shapefile will contain the routes from each participant location to the nearest facility. Each route will contain the attributes of the participant and the nearest facility.

Calculate straight-line distance to nearest facility
To follow this protocol, you will need:

1. Participant Locations Point Feature Layer for incidents (origins)
2. Facilities Point Feature Layer for facilities (destinations)

Calculate the straight-line distance to the nearest facility

1. Start ArcMap.
2. Click the Add Data button on the Standard Toolbar.
a. Navigate to the Point Layers to be used in the analysis, in this case the Participant locations and the Facilities.
b. Select the Point Layers and click Add to add them to ArcMap.
3. Open ArcToolbox by clicking on the icon.
4. Navigate to the Near tool (Analysis Tools -> Proximity) and double-click to open it.
5. Click the down-arrow in the Input Features box and select the Participant Locations feature layer.
6. Click the down-arrow in the Near Features box and select the Facilities feature layer.
7. Leave the Search Radius (optional) box empty. This will guarantee that every Participant Location will have its nearest facility found.
8. Leave the Location (optional) and Angle (optional) check boxes unchecked.
9. Click OK to execute the tool.
10. The tool will find the nearest facility to each Participant Location and measure the straight-line distance between those points. The tool will add two attributes to the participant location attribute table, NEAR_DIST and NEAR_FID. NEAR_DIST will contain the distance, in the units of the Layers (e.g., meters, feet). NEAR_FID will contain the feature ID of the closest facility. Use the NEAR_FID attribute to join the Facilities Layer to the Participant Location layer to determine the characteristics of the nearest Facility.

Join the Participant Location Layer to the Facility Layer using the NEAR_FID attribute.

1. Right-click on the Participant Location layer and select Joins and Relates -> Join...
2. Choose NEAR_FID as the field to base the join on.
3. Choose the Facility layer as the Table to Join to this layer.
4. Choose the FID attribute as the field in the table to base the join on.
5. Click OK. The Facility attributes will be joined to the Participant locations.
6. Right-click on the Participant Locations Layer and select Data -> Export Data.
a. Choose this layer's source data for the coordinate system.
b. Specify the Output Location.
c. Click OK.

A new shapefile will be created in the output location. This shapefile will contain the participant locations and the attributes of the nearest facility to each participant location.

## STREET PATTERN <br> 5.10 Average Census Block Area (TCWS GIS Protocol 6.1)

This uses the existing TCWS GIS Protocol 6.1 in version 4.1 of the protocols.

## 1. Basic Concept

The average census block area is an easy-to-calculate approximation for street pattern. Simply put, bigger blocks have fewer streets and/or more culs-de sac and unless they also have many additional pedestrian routes they will be harder to get around. As Dill $(2003,3)$ explains, block size is only an approximation as the shape of the blocks also affects the street pattern. This has been often used in previous research because it uses some form of census block, which is easily available and average block size is easy to calculate in the ArcGIS programs (Hess et al. 1999, 1-2,10; Krizek 2003 (APA), 269; Cervero and Duncan 2003, 1480).

In general, however, we used median block size rather than average. This is because medians are, statistically, a preferred measure. As was explained in chapter 1, this meant that we picked up a number of areas with mostly small blocks but one large land use (e.g., a golf course or large industrial area) that gave them a medium average block size but a low median.

## 2. Basic Formula

Average Census Block Area = Average area for census blocks with a centroid falling within the measurement geography.

## 3. Detailed Formula

Same as above.

## 4. Comments and Explanations <br> The Centroid Rule

Because the whole block size is what matters, it is not possible to clip the blocks to the measurement geography. This leaves the question of which census blocks to include, however, in the measure. We examined a number of options including:

- All census blocks that intersect the measurement geography
- All census blocks with a centroid within the measurement geography
- All census blocks completely contained within the measurement geography

The middle approach was selected because with this approach and a measurement geography that divided up an entire study area, for example into uniform grid cells, each block would fall within one and only one cell but also, every block would be counted as part of some cell.

## Centroid Calculations-What Can Go Wrong

When using version 8.3 of Arc GIS, we calculated centroids using XTools, which creates a separate point file. XTools uses a centroid calculation method that does not require the centroid to be within the boundaries of the shape. That is, in the coordinate system, it places the centroid at the average of the shape's minimum/maximum $X$ and $Y$ values. The Select by Location tool in ArcMap, however, from all the evidence, requires the "center" of a shape to be inside that shape's boundaries. In Arc 9, the toolbox for calculating centroids of polygons allows you to explicitly choose whether or not the centroid must be located within the bounds of the polygon, however the choice is still important in particular circumstances, such as odd-shaped census blocks (e.g., that bend around lakes). In this case, results are different.

For consistency we used XTools, because these protocols do not require the centroid to be within the polygon. For processes requiring selecting features based on whether or not their centroids are inside a focus/context area, that selection process needs to use an actual centroid point file in the Select by Location dialog, instead of using the polygons from which those centroids were derived and letting ArcMap use its different "have their centers in" method. [This will be explained more clearly in future versions of the manual.]

## Change in Protocol

The earlier TCWS version of this protocol calculated the average area of census blocks within a studysite differently from this version. TCWS first selected census block centroids that fell within a studysite. Then it used those centroids to select the actual census block polygons. Finally, it used two methodologies, one for non-overlapping study sites and one for overlapping study sites, to calculate the average area. The methodology for overlapping sites involved selecting each site individually and calculating the average area. Individual attention was required because of ArcGIS' Spatial Join function. When a spatial join is performed on two polygon layers, the software intersects the polygons and transfers the attributes based on the intersection. When one of the layers contains overlapping
features, the spatial join only transfers the attributes of the first study-site that intersects with the census blocks. Thus, the second study-site will be missing the attributes of some census blocks with which it intersects. While the methodology for overlapping sites works, the individual attention required is not feasible for hundreds of study-sites.

Instead of performing the spatial join between two polygon layers, this protocol spatially joins the census block centroids (a point layer) to the study-sites. For overlapping study-sites, the spatial join will assign points that fall withing the overlap area to all study-sites that share the overlap. Thus, individual attention is not required for overlapping study-sites when joining points to polygons.

## 5. GIS Approach

Identify all census blocks with centroids in the measurement geography. Use a spatial join or an intersect to associate each census block with the ID of the measurement geography in which it is located. Summarize the attributes by the measurement geography ID, calculating the average of the Hectares field in the process.

After testing this protocol with different-sized buffers around schools, we have eliminated the 200 m buffer from this protocol. In a number of cases, the 200 m buffer failed to intersect with any census block centroids (Figure X). Instead of including buffers with an average census block area of 0, we have eliminated this small buffer and use only the $400 \mathrm{~m}, 800 \mathrm{~m}$, and 1600 m buffers in this protocol.

6. GIS Steps

The following procedures were completed using ArcMap (ArcInfo) 9.2.
To complete this protocol you will need:

1. Study-Site Layer (polygon) - Buffers

## 2. Census Block Layer (polygon)

Calculate Census Blocks Areas:

1. Add the area fields to the Census Block Layer
a. Right-click on the Census Block Layer and select Open Attribute Table.
b. Click on the Option button and select Add Field...
c. Name the field Area and change the Type to Double.
i. If a field named Area already exists, change the name in the Add Field... dialog box to something else.
d. Click OK.
e. Click on the Option button again and select Add Field...
f. Name the field Hectares and change the Type to Double.
i. If a field name Hectares already exists, change the name in the Add Field... dialog box to something else.
g. Click OK.
2. Calculate the values for Area and Hectares
a. For the Area field,
i. Right-click the Area field in the Census Block Layer attribute table and select Calculate Geometry...
ii. Set the Property: box to Area.
iii. Set the Coordinate System to "Use coordinate system of the data source:"
iv. Set the Units to the desired type. For the Area attribute, square meters, miles or feet is probably appropriate.
v. Click OK.
b. For the Hectares field,
i. Right-click the Hectares field in the Census Block Layer attribute table and select Calculate Geometry...
ii. Set the Property: box to Area.
iii. Set the Coordinate System to "Use coordinate system of the data source:"
iv. Set the Units to Hectares [ha].
v. Click OK.

Create Census Block centroid layer:

1. Open ArcToolbox by clicking on the icon.
2. Navigate to the Feature to Point tool (Data Management -> Features). Double-click on the tool to open it.
3. Click on the down arrow in the Input Features box and select the Census Block Layer from the list of layers.
4. Specify the name and location of the output feature class.
5. Do NOT click the check box next to Inside. By not click the check box, ArcGIS will create the actual geometric centroid of each census block. The centroid may not fall within its census block, but it is not forced inside the block.
6. Click OK. The centroid layer will be created and added to the Map Document.

Calculate the Average Census Block Area for the Study-Site Layer:

1. If the Study-Site Layer does not have unique IDs or names for each site, create them now.
2. Use the Spatial Join to calculate the average census block area for each study-site
a. Right-click on the Study-Site Layer and select Joins and Relates -> Join...
b. Under "What to you want to join to this layer?", choose Join data from another layer based on spatial location.
c. Under 1. Choose the layer to join to this layer, or load spatial data from disk:, click the downarrow and select the Census Block centroid layer from the list.
d. Click the radio button for "Each polygon will be given a summary of the numeric attributes of the points that fall inside it, and a count field showing how many points fall inside it".
e. Under How do you want the attributes to be summarized?, click the check-box next to Average.
f. Specify the location and name of the output layer.
g. Click OK.
3. The output layer will contain one polygon for each study-site. One of the attributes of this layer will be the average hectares for all centroids falling inside a study-site.

### 5.11 Median Census Block Area: See TCWS GIS Protocol 6.2

This protocol combines both versions available in the TCWS Protocol 6.2 in versions up to 4.0. It was updated slightly in Version 1.3.

## 1. Basic Concept

As with the average census block area, the median block area is an approximation for street pattern where bigger blocks have fewer streets and / or more culs-de sac and, unless they also have many additional pedestrian routes, they will be harder to get around.

This measure is not as easy to calculate as an average, because the calculation needs to be done partly in Excel.

## 2. Basic Formula

Median Census Block Area $=$ Median area for census blocks with a centroid falling within the measurement geography.

## 3. Detailed Formula

Same as above.

## 4. Comments and Explanations

The centroid rule and the inconsistent centroid calculations issues in the previous protocol are the same for this one.

## 5. GIS Approach

The GIS approach is to perform a spatial identity between the census block centroids and study sites. The attribute table of the resulting layer is imported into Microsoft Excel and summarized using the PivotTable feature. This creates a list of all the census blocks whose centroids are in a given study site. The median area can then be calculated automatically.

## 6. GIS Steps

The following procedures were completed using ArcMap (ArcInfo) 8.3.
To complete this protocol you will need:

1. Study-Site Layer (polygon)
2. Census Block Layer (polygon)
3. Microsoft Excel

Calculate Census Block Areas:

1. Add the area fields to the Census Block Layer.
a. Right-click on the Census Block Layer and select Open Attribute Table.
b. Click on the Option button and select Add Field...
c. Name the field Area and change the Type to Double.
i. If a field named Area already exists, change the name in the Add Field... dialog box to something else.
d. Click OK.
e. Click on the Option button again and select Add Field...
f. Name the field Hectares and change the Type to Double.
i. If a field named Hectares already exists, change the name in the Add Field... dialog box to something else.
g. Click OK.
2. Calculate the values for Area and Hectares
a. For the Area field,
i. Right-click the Area field in the Census Block Layer attribute table and select Calculate Geometry...
ii. Set the Property: box to Area.
iii. Set the Coordinate System to "Use coordinate system of the data source:"
iv. Set the units to the desired type. For the Area attribute, square meters, miles, or feet is probably appropriate.
v. Click OK.
b. For the Hectares field,
i. Right-click the Hectares field in the Census Block Layer attribute table and select Calculate Geometry...
ii. Set the Property: box to Area.
iii. Set the Coordinate System to "Use coordinate system of the data source:"
iv. Set the Units to Hectares [ha].
v. Click OK.

## Create Census Block centroid layer:

1. Open ArcToolbox by clicking on the icon.
2. Navigate to the Feature to Point tool (Data Management -> Features). Double-click on the tool to opent it.
3. Click on the down arrow in the Input Features box and select Census Block Layer from the list of layers.
4. Specify the name and location of the output feature class.
5. Do NOT click the check box next to Inside. By not clicking on the check box, ArcGIS will create the actual geometric centroid of each census block. The centroid may not fall within its census block, but it it not forced inside the block.
6. Click OK. The centroid layer will be created and added to the Map Document.

Intersect the Census Block centroids with the Study-Site Layer:

1. Add the Study-Site Layer to the Map Document if it is not there already.
2. Open ArcToolbox by clicking on the icon.
3. Navigate to the Intersect tool (Analysis Tools -> Overlay). Double-click on the tool to open it.
4. Click on the down arrow in the Input Features box and select the Census Block centroid layer from the list of layers.
5. Click on the down arrow in the Identity Features box and select the Study-Site layer from the list of layers.
6. Specify the name and location of the output feature class.
7. Set the JoinAttributes option to ALL.
8. Set the XY Tolerance to $\mathbf{0}$ and leave the Keep Relationships check box unchecked.
9. Click OK.
10. A feature class containing the census block centroids with the appropriate study-site attributes attached will be created and added to the Map Document. If a census block centroid intersects with two or more overlapping study-sites, the output feature class will contain one record for each study-site with which the centroid intersected.

Import data into Microsoft Excel:

1. Right-click on the layer created in the previous Identiy step and select Open Attribute Table.
2. Click on the Option button and select Export.
3. Set the Export: box to All Records. Then, specify a name and location for the output DBF file.
4. Click OK.
5. Open Microsoft Excel and then open the DBF file created in the previous step.
6. Open a blank Microsoft Excel workbook and copy and paste all the data from the DBF file into the workbook.
7. From the Data menu, select PivotTable and PivotChart Report...
8. Select all the data in the workbook for the PivotTable and click Next. Then click Finish to create the Pivot Table.
9. From the PivotTable Field List, drag and drop the field containing the unique study-site ID onto the large window where it says Drop Column Fields Here.
10. From the PivotTable Field List, drag and drop the field containing the unique Census block centroid ID onto the large window where it says Drop Row Fields Here.
11. From the PivotTable Field List, drag and drop the field containing the Census Block Hectares values onto the large window where it says Drop Data Items Here.
12. Find the row beneath the last row containing any values (each column will have a different number of values depending on how many census block centroids were found in each measurement geography).
13. Calculate the median of all cells in each column. This will provide the median census block size, in hectares, for the census blocks whose centroids fall within a study-site.

### 5.12 Number of Access Points (TREC version)

This simplifies the alternate access point calculation in TCWS GIS Protocol 6.4 , which relies heavily on the hand-removal of parkway (at-grade divided roads) and interstate highways from the analysis. This is useful for smaller studies but very time intensive. Instead of examining each study-site and removing parkways and interstate highways, this protocol removes interstate highways from the Road Centerline Layer before creating the access points. Since identifying the parkways and at-grade divided roads for every study-site will be too timeconsuming, they are left in the Road Centerline Layer.

## 1. Basic Concept

Access points are a measure of the amount of connection an area has to its surroundings. We are not convinced it is a good measure of walkability, but we are testing it.

At its most extreme, one can imagine a gated neighborhood, inside which the neighborhood had small blocks and a highly connected street pattern, but had only one way in and out. In this case, walking to destinations outside the development would be made far more complex. Access point measures create a measurement geography, generally a grid cell, and measure how porous its edges are (Southworth 1997, McNally and Kulkarni 1997, 109).

## 2. Basic Formula

Number of Access Points = Number of times a road crosses the edge of the measurement geography.

## 3. Detailed Formula

Number of Access Points = Number of times a road crosses the edge of the measurement geography with divided at-grade roads counted once and limited access highways excluded.


Fig. 6.2. Access points are points of intersection between road centerlines and site boundaries excluding points resulting from the intersections of site boundaries with Interstates, on- and offramps, and other limited access highways.

In the diagram to the left, the four green points are access points created by the intersection of the site boundary and an Interstate and its on- and off-ramps, and therefore are excluded from the anolucie Tha rad nnint ic a valid annoce nnint

Fig. 6.3. Site boundary intersections with divided at-grade roads, such as parkways, are also counted once (as one access point) instead of twice. The green point in the diagram to the left is half of a set of paired access points created by the intersection of the site boundary and a divided parkway. Only the red access points are included in the analysis.

Fig. 6.4. Many access points, as measured, are somewhat marginal in their quality. That is, these points may exist but not provide significant access to the site, or may fall just inside the site boundary and therefore not be counted (see examples below). The red point in the middle of the image is technically an access point because the road centerline just crosses the site boundary, even though it provides no significant access to the site. However, it is extremely complex to develop rules to exclude such points-see next image for more examples.

Many access points, as measured, are somewhat marginal in their quality. That is, these points may exist but not provide significant access to the site, or may fall just inside the site boundary and therefore not be counted (see examples below). The red point in the middle of the image is technically an access point because the road centerline just crosses the site boundary, even though it provides no significant access to the site.

Fig. 6.5. The three purple circles identify points that should be included in the analysis, since they provide significant access to the site, are not because the road centerlines lie just inside the site boundary and do not intersect it.

We experimented with methods of buffering these points and derived various rules for exclusion or inclusion but in the end, determined that this opened the door to many subjective decisions. It seemed that the number of access points included that probably should be excluded would roughly offset the number of access points excluded that probably should be included and, therefore, we decided to set aside the issue of marginal access points in our analysis.

## 4. Comments and Explanations

None.

## 5. GIS Approach

Interstates and access ramps were removed from the road centerline layer. Then a point file was created that contained all points were road centerlines intersected site boundaries. The total number of access points for each study site was summed.

## 6. GIS Steps

The following procedures were completed using ArcMap (ArcInfo) 9.2.
To complete this protocol you will need:

1. Study-Site Layer (polygon)
2. Road Centerline Layer (polyline)

Remove Interstate Highways and Access Ramps from the Road Centerline Layer:

1. Right-click on the Road Centerline Layer and select Properties.
2. Click on the Definition Query tab.
3. Construct an SQL query that eliminates the Interstate Highways and Access Ramps from the layer.
a. The SQL query should be: [F_CLASS] <> 'A10' AND [F_CLASS] <> 'A15' AND [F_CLASS] <>
b. Click OK.
4. The result of the SQL query will be a Road Centerline Layer without Interstate Highways or Access Ramps.

Create the Access Point Layer:

1. Click on the Add Data icon and load the Road Centerline Layer and Study-Site Layer to the Map Document.
2. Open ArcToolbox by clicking on the icon.
3. Navigate to the Intersect tool (Analysis Tools -> Overlay) and open the tool by double-clicking on it.
4. Click on the down-arrow by the Input Features box and select the Study-Site Layer.
5. Again, click on the down-arrow by the Input Features box and select the Road Centerline Layer.
6. Specify a name and location for the output layer.
7. Set the JoinAttributes option to ALL.
8. Accept the XY Tolerance default.
9. Set the Output Type to POINT. This will generate a point layer containing the intersections of the studysites with the road centerlines.
10. Click OK.

Summarize Access Point Counts for Study-Sites:

1. If the Study-Site Layer does not have unique IDs or names for each site, create them now.
2. Use the Spatial Join to calculate the number of access points for each study-site
a. Rightl-click on the Study-Site Layer and select Joins and Relates -> Join...
b. Under "What to you want to join to this layer?", choose Join data from another layer based on spatial location.
c. Under 1. Choose the layer to join to this layer, or load spatial data from disk:, click the downarrow and select the Access Point layer from the list.
d. Click the radio button for "Each polygon will be given a summary of the numeric attributes of the points that fall inside it , and a count field showing how many points fall inside $\mathrm{it}^{\prime \prime}$.
e. Leave all the check boxes under How do you want the attributes to be summarized? unchecked.
f. Specify the location and name of the output layer.
g. Click OK.
3. The output layer will contain one polygon for each study-site. One of the attributes of this layer will be the number of access points falling inside the study-site.

### 5.13 Road Length per Unit Area (TREC Version)

This simplifies the alternate TCWS GIS Protocol 6.5, which relies heavily on the hand-removal of parkways (atgrade divided roads) and interstate highways from the analysis. Instead of examining each study-site and removing parkways and interstate highways, this protocol removes interstate highways from the Road Centerline Layer before intersecting the roads with the study-sites. Since identifying the parkways and at-grade divided roads for every study-site will be too time-consuming, they are left in the Road Centerline Layer.

## 1. Basic Concept

Road length per hectare is related to both block size and connectivity.
The next version of these protocols will contain more detail about earlier uses of this measurement.

## 2. Basic Formula

Road Length per Unit Area = Length of road with both interstates and ramps removed and divided roads averaged, per measurement area.

## 3. Detailed Formula

Road Length per Unit Area = Length of road with both interstates and ramps removed and divided roads averaged, per measurement area with water removed from land area calculation.

## 4. Comments and Explanations

Road lengths are simply the sums of the lengths of all road centerlines bounded by the study sites. Similar to the process used for access points, we ignored non-pedestrian lengths by removing Interstates and on- and off-ramps from our calculations. Also, we removed one of each pair of centerlines from all parkways and other divided at-grade roads in order to count their lengths once instead of twice.

Once this was done we used the area of each site to calculate the road length per hectare figures for each site.

## 5. GIS Approach

Delete all Interstates and on- and off-ramps. Intersect the roads layer with the measurement geographies. Recalculate the length of the road segments. Summarize the intersected layer by the measurement geography ID, calculating the sum of the Length field in the process. Divide the resulting sum of road lengths by the area in hectares of the associated measurement geography.

## 6. GIS Steps

The following procedures were completed using ArcMap (ArcInfo) 9.2.
To follow this protocol you will need:

1. Study-Site Layer (polygon)
2. Road Centerline Layer (polyline)
3. The protocol for determining Net Land Area (without water)

Determine the Net Land Area (without water) for each Study-Site:

1. Complete protocol 2.1 (Net Land Area without water)

Remove Interstate Highways and Access Ramps from the Road Centerline Layer:

1. Right-click on the Road Centerline Layer and select Properties.
2. Click on the Definition Query tab.
3. Construct an SQL query that eliminates the Interstate Highways and Access Ramps from the layer.
```
            a. The SQL query should be: [F_CLASS] <> 'A10' AND [F_CLASS] <> 'A15' AND [F_CLASS] <>
            'A63'
            b. Click OK.
```

4. The result of the SQL query will be a Road Centerline Layer without Interstate Highways or Access Ramps.

Intersect Road Centerlines and Study-Sites and calculate road lengths:

1. Click on the Add Data icon and load the Road Centerline Layer and the Study-Site Layer.
2. Open ArcToolbox by clicking on the icon.
3. Navigate to the Intersect tool (Analysis Tools -> Overlay) and open the tool by double-clicking on it.
4. Click on the down-arrow by the Input Features box and select the Study-Site Layer.
5. Again, click on the down-arrow by the Input Features box and select the Road Centerline Layer.
6. Specify a name and location for the output layer.
7. Set the JoinAttributes option to ALL.
8. Accept the XY Tolerance default.
9. Set the Output Type to LINE. This will generate a line layer containing the intersections of the study-sites with the road centerlines.
10. Click OK. A new output layer containing only road segments intersecting with study-sites will be added to the Map Document. If a road segment falls in overlapping study-sites, the output layer will contain two records, one for each study-site, for the segment.
11. Recalculate the length of the road segments in the newly intersected layer.
a. Right-click on the new layer and select Open Attribute Table.
b. Click on the Option button and select Add Field...
c. Name the field Length and change the Type to Double.
i. If a field named Length already exists, change the name in the Add Field... dialog box to something else.
d. Click OK.
e. Right-click the Length field in the attribute layer and select Calculate Geometry...
f. Set the Property: to Length.
g. Set the Coordinate System to "Use coordinate system of the data source."
h. Set the units to the desired type.
i. Click OK. The lengths of the road segments will be calculated.

Summarize Road Lengths:

1. Right-click the new Roads Layer and select Open Attribute Table.
2. In the attribute table, right-click on the field containing the study-side unique ID and select Summarize...
3. In the Summarize dialog box, click on the Length field and check the box marked Sum.
4. Also, click on the Area field and check the box marked Average. This will guarantee that the study-site area value will be part of the output table and will help ease the road length per unit area calculation.
5. Specify a name and location for the output table.
6. Click OK.
7. A table containing one row per Study-Site will be created and added to the Map Document. Each row will contain the area of the study-site and the sum of the road lengths within the study-site.

## Calculate Road Length per Hectare:

1. Open the table created in the previous step.
2. Click on the Option button and select Add Field...
3. Name the field Len_Are and change the Type to Double.
4. Click OK.
5. Right-click on the Len_Are field and select Field Calculator...
6. In the Field Calculator, click Sum_Length, then click the / button, and finally click Avg_Area.
7. Click OK.
8. The result is a field called Len_Are that contains the road length per unit area in a study-site.

### 5.14 Intersections per Unit Area (TREC version)

This is based on the TCWS protocol 6.6 but has of version 1.2 has been refined to limit the need for data cleaning. However, please note that it is NOT yet complete. It needs to be revised to remove interstate highways.

## 1. Basic Concept

The number of intersections per hectare is a measure of the connectivity of the street network (Cervero and Kockelman 1996, 8; McNally and Kulkarni 1997, 109). As can be seen from this and later protocols, however, judging an intersection can be complex, particularly in older areas, where intersections are not regularly spaced, road rights of way have varying sizes, and centerlines may be slightly offset within the right of way, creating false positives in terms of intersection counts (see below for more detail).

This is obviously an area where more research would help, to discover how much of a jog in an intersection is needed before it is perceived as two intersections. In the absence of such research, we spent some time observing difficult cases in the field.

## 2. Basic Definition

Intersections per Unit Area $=$ Number of intersections per unit land area.

## 3. Detailed Definition

Intersections per Unit Area $=$ Number of intersections per unit land area with interstate highways removed.

## 4. Comments and Explanations

The TCWS 6.6 protocol, Intersections per Unit Area, removes Interstate highways from a roads dataset, then calculates all intersections using a custom ArcGIS script, and finally creates single intersections in places where roads converge but do not perfectly align. The TREC version of this protocol simplifies the TCWS protocol. It uses the intersections generated when the user creates the road network dataset, it does not eliminate Interstate highways, and it does not create single intersections in places where roads converge but do not perfectly align.

## 5. GIS Approach

The GIS approach uses a spatial join to count the number of intersections within a study-site. The intersections come from the Junctions feature class that is created when the road network dataset is created.

## 6. GIS Steps

The following procedures were completed using ArcMap (ArcInfo) 9.2.
To follow this protocol you will need:

1. Study-Site Layer (polygon)
2. Road Network Dataset, particularly the Junctions feature class
3. The protocol for determining Net Land Area (without water)

Summarize Intersection Counts for Study-Sites:

1. Start ArcMap.
2. Click the Add Data button on the Standard Toolbar.
a. Navigate to the Road Network dataset location.
b. Click on the Network dataset and click Add to add the Network dataset to ArcMap.
c. Click Yes to add all the feature class that participate in the network to the map.
3. Click the Add Data button on the Standard Toolbar.
a. Navigate to the Study-Site polygon layer to be used for the analysis.
b. Click on the Study-Site layer and click Add to add it to ArcMap.
4. Right-click on the Study-Site layer and choose Joins and Relates -> Join...
5. Under the dropdown box labeled What do you want to join to this layer? choose Join data from another layer based on spatial location.
6. In Step 1 of the dialog box, choose the Junctions layer.
7. In Step 2, click the button to choose Each polygon will be given a summary of the numeric attributes...
8. In Step 3, choose a name and location for the output layer.
9. Click OK.
10. The output layer now contains a Count field with the number of intersections found in each feature of the Study-Site layer.

Calculate the intersections per net land area:

1. Determine the Net Land Area for the Study-Site layer if it hasn't already been calculated.
2. Right-click on the output layer from the spatial join and select Open Attribute Table.
3. Click Options and choose Add Field.
4. Name the field IntDens and change the type to Double.
5. Click OK to add the field.
6. In the Table of Contents, right-click on the output layer from the spatial join and choose Joins and Relates -> Join.
7. In the dropdown box, choose to Join attributes from a table.
8. In Step 1, choose to base the join on the field containing the unique ID of the study-sites.
9. In Step 2, load the table from the result of the Net Land Area protocol.
10. In Step 3, choose the field in the Net Land Area layer's table containing the unique ID of the study-sites.
11. Click OK.
12. Open the Attribute Table of the output layer from the spatial join, which now has the net land area table joined to it.
13. Right-click on the IntDens field and choose Field Calculator...
14. In the Field Calculator dialog box, click the Count field, then click the / button, and finally click the name of the field containing the net land area.
15. Click OK.

The field now contains the density of intersections (number of intersections divided by the net land area in whichever units you used).

## OTHER BUILT-ENVIRONMENT RELATED/SPATIAL VARIABLES <br> 5.15 Proportion of High Functional Classifications [i.e. busy streets]: See TCWS GIS Protocol 7.1

This uses the existing TCWS GIS Protocol 5.16 updated to version 4.1.

## 1. Basic Concept

Functional classifications of roads divide them into a hierarchy. In the Metropolitan Council's dataset prepared by The Lawrence Group the classifications are modified versions of the US Census Bureau's classification in TIGER Line Files including many subclasses of the following road types (US Census 2005, 3-28):

- Primary Highway With Limited Access-mostly interstates
- Primary Road Without Limited Access-mostly US and state highways
- Secondary and Connecting Road-mostly state and some county highways
- Local, Neighborhood, and Rural Road
- Vehicular Trails

This measure assesses the ratio of higher road classes to local and neighborhood roads. It would also be possible to examine the density of higher classifications.

## 2. Basic Formula

Proportion of High Functional Classifications = Length of primary, secondary, and connecting roads to length of all roads.

## 3. Detailed Formula

Proportion of High Functional Classifications = Length of primary, secondary, and connecting roads to length of all roads excluding vehicular trails, and gated roads.

## 4. Comments and Explanations

We converted the following local road classifications to classifications of high functional classes:

| A10 | 213 | Primary highway with limited access |
| :--- | :---: | :---: |
| A20 | 122 | Primary road without limited access |
| A25 | 388 | Primary road without limited access |
|  | Primary road without limited access, US highways, separated |  |
| A30 | 2144 | Secondary and connecting road |
| A63 | 348 | Road with special characteristics |
|  | Access ramp, the portion of a road that forms a cloverleaf or limited access interchange |  |
| A64 | 34 | Road with special characteristics |

Service drive, the road or portion of a road that provides access to businesses, facilities, and rest areas along a limited-access highway

Other roads:
A40 13651 Local, neighborhood, and rural road
A71 47 Road as other thoroughfare
Walkway or trail for pedestrians, usually unnamed
A73 3 Road as other thoroughfare
Alley, road for service vehicles, usually unnamed, located at the rear of buildings and property

## Excluded:

A66 114 Road with special characteristics
Gated barrier to travel
A98 $5 \quad$ * not listed *
This is the University's bus transitway, which has bike but not pedestrian access.

## 5. GIS Approach

Using the F_Class field from the road layers that had already been intersected with our buffers in previous protocols, each road segment was reclassified based on the groupings listed above (high, other, and excluded). For each buffer, the lengths of the high functional class roads were summed and divided by the sum of the lengths of all roads (not including those in the "excluded" category) to obtain the proportion of high functional class roads to all roads.

## 6. GIS Steps

The following procedures were completed using ArcMap (ArcInfo) 9.2.
To complete this protocol you will need:

1. Road Centerline Layer (polyline)

## 2. Study-Site Layer (polygon)

The basic steps are:

- Reclassify Road Segments
- Intersect Road Segments with Study-Site Layer
- Summarize Road Segment Lengths
- Calculate Proportion of High Functional Classifications

Reclassify Road Segments:

1. Right-click the Road Centerline Layer and select Open Attribute Table...
2. Click the Option button and select Add Field...
3. Name the field CLASS and change the type to Short Integer.
4. Click the Option button and select Select by Attributes.
5. Construct an SQL query to select all road segments that can be classified as "High Functional".
a. Click OK to execute the query.
6. Right-click the CLASS attribute and select Field Calculator...
a. Set the selected records equal to 1 .
7. Click the Option button and Select by Attributes.
8. Construct an SQL query to select all road segments that can be classified as "Other Roads".
a. Set the selected records equal to 2 .
9. Click the Option button and Select by Attributes.
10. Construct an SQL query to select all road segments that can be classifies as "Excluded".
a. Set the selected records equal to 3 .

Intersect Road Centerlines and Study-Sites and calculate road lengths:

1. Click on the Add Data icon and load the Road Centerline Layer and the Study-Site Layer.
2. Open ArcToolbox by clicking on the icon.
3. Navigate to the Intersect tool (Analysis Tools -> Overlay) and open the tool by double-clicking on it.
4. Click on the down-arrow by the Input Features box and select the Study-Site Layer.
5. Again, click on the down-arrow by the Input Features box and select the Road Centerline Layer.
6. Specify a name and location for the output layer.
7. Set the JoinAttributes option to ALL.
8. Accept the XY Tolerance default.
9. Set the Output Type to LINE. This will generate a line layer containing the intersections of the study-sites with the road centerlines.
10. Click OK. A new output layer containing only road segments intersecting with study-sites will be added to the Map Document. If a road segment falls in overlapping study-sites, the output layer will contain two records, one for each study-site, for the segment.
11. Recalculate the length of the road segments in the newly intersected layer.
a. Right-click on the new layer and select Open Attribute Table.
b. Click on the Option button and select Add Field...
c. Name the field Length and change the Type to Double.
ii. If a field named Length already exists, change the name in the Add Field... dialog box to something else.
d. Click OK.
e. Right-click the Length field in the attribute layer and select Calculate Geometry...
f. Set the Property: to Length.
g. Set the Coordinate System to "Use coordinate system of the data source."
h. Set the units to the desired type.
i. Click OK. The lengths of the road segments will be calculated.

Summarize Intersected Road Segment Lengths

1. Right-click on the layer containing the intersected road segments and select Open Attribute Table...
2. Click the Option button and select Select by Attributes.
3. Construct an SQL query to select the "High Functional" roads.
a. Click the Class field, then click =, and then type 1. Click OK.
4. Right-click on the study-site ID field and select Summarize.
5. For Select a Field to Summarize select your ID field.
6. Under Choose One or More Summary Statistic... expand the Length field and check the box for Sum.
7. Specify a name and location for the output table.
8. Check the box that is marked Summarize on the Selected Records Only.
9. Click OK.
10. Click the Option button and choose Select by Attributes.
11. Construct an SQL query to select all roads except those classified as "Excluded".
a. Click the Class field, then click <>, and then type 3. Click OK.
12. Right-click on the study-site ID field and select Summarize.
13. For Select a Field to Summarize select your ID field.
14. Under Choose One or More Summary Statistic...' expand the Length field and check the box for Sum.
15. Specify a name and location for the output table.
16. Check the box that is marked Summarize on the Selected Records Only.
17. Click OK.

Calculate Proportion of High Functional Classifications

1. For each study-site, you now have two tables of road length - one with the sums of the lengths of High Functional roads and one with the sums of the lengths of all roads (except those that may be excluded from the analysis).
2. Right-click on the study-site layer and select Open Attribute Table...
3. Click the Options button and select Add Field...
4. Name the field Pro_High and set the type to Double. Click OK.
5. Join the two tables of road length to the study-site layer.
a. Right-click on the study-site layer and select Joins and Relates -> Join...
b. Under What do you want to join to this layer?, click on the down-arrow and select Join attributes from a table.
c. Select the study-site ID for $\mathbf{1}$. Choose the field in this layer that the join will be based on:
d. Under 2. Choose the table to join to this layer, or load the table from disk, click the down-arrow and select the table containing the road length summaries for the High Functional class.
e. Under 3. Choose the field in the table to base the join on:, click the down-arrow and select the study-site ID.
f. Click OK.
g. Right-click on the study-site layer and select Joins and Relates -> Join...
h. Under What do you want to join to this layer?, click on the down-arrow and select Join attributes from a table.
i. Select the study-site ID for 1 . Choose the field in this layer that the join will be based on:
j. Under 2. Choose the table to join to this layer, or load the table from disk, click the down-arrow and select the table containing the road length summaries for the All Roads except Excluded class.
k. Under 3. Choose the field in the table to base the join on:, click the down-arrow and select the study-site ID.
6. Click OK.
7. Right-click on the Pro_High attribute and select Field Calculator...
8. Click the attribute containing the sum of High Functional road lengths, then click the / button, and then click the attribute containing the sum of all roads except "Excluded". Click OK to execute the calculation.
9. This calculation will yield the proportion of High Functional roads to all roads (except those excluded) in a study-site.

### 5.16 Distance to Nearest Park <br> Note: The GIS steps were updated in Version 1.3.

## 1. Basic Concept

This is related to one question in the TREC-IDEA study:

- SS179About how long would it take to get from your home to the nearest park if you walked? (Adapted from NEWS B21 (14))

It is related to the TCWS Protocol 5.14 that calculates distance to the nearest facilities of various types.

## 2. Basic Definition

Distance to Nearest Park = Straight line or network distance to the nearest part of the park border.

## 3. Detailed Definition

Distance to Nearest Park = Straight line or network distance to the nearest part of the park border where that is operationalized as the nearsest park vertex.

## 4. Comments and Explanations

The tricky component of this measure is that a park is an area and so that until Version 9.1 or 9.2, the GIS program had difficulty finding the closest point as it slowed down trying to find the exact nearest boundary point of the park. Thus, the distance to the nearest park calculation in fact started with the park, created a series of buffers at, say, 200m intervals, and measured whether homes or schools were within those buffers. As we describe in the companion TCWS protocols document:

We ... found that calculating distances to the centroids of the polygons in our parks layer would not paint a very accurate picture of the true distance to the park, since many of our parks were large and/or had intricate shapes, placing the centroid far from the nearest edges of the park. A better way to complete this measure, we decided, was to measure the distance to the nearest park vertex. Unfortunately, the extremely large number of park vertices (due, again, to the intricate shapes of the parks) crashed the computer repeatedly and we were unable to calculate the measure in this manner.

Finally, we decided revise our distance to parks measures and instead use a technique developed for a different Center project that best finds access points to parks. It creates a 15 meter buffer around each park polygon and then finds the points of intersection between the edge of the buffer and any road centerlines that cross this boundary. These points are then used as access points to the park and distances can be calculated to these points. (For more information, see the Metropolitan Design Center's Technical Paper Number 2, Mapping Park Buffers, at
http://www.designcenter.umn.edu/projects/direct_design_asst/2004/pdfs/ParkBuffering_Te ch112305.pdf.)

In addition, we decided to generalize our distances to parks to show if, for a given participant, there was a park within $200 \mathrm{~m}, 400 \mathrm{~m}, 800 \mathrm{~m}, 1600 \mathrm{~m}$, or 3200 (both straight-line and network distances) instead of focusing on specific distances to access points.

In this new version of ArcGIS we can make this measure directly.

## 5. GIS Approach

The GIS approach is to use the Find Closest Facility option in the Network Analyst Extension of ArcGIS 9.2 to find the closest park to a participant's home or school. The point layer containing parks are the
"facilities" in Network Analyst, and the participant locations are the "incidents" in Network Analyst. A street network is required for calculating the distance between parks and participant locations.

In the Network Analyst Extension, specify the "facilities" and the "incidents" and solve for the closest facility to each incident. Attach the distance to the closest facility to each incident.

The straight-line distance is calculated using the Near Tool in ArcToolbox.

## 6. GIS Steps

The following procedures were completed using ArcMap (ArcInfo) 9.2.
To complete this protocol you will need:
o Road Network dataset
o Participant Locations (point)
o Regional Parks (polygon)
o Network Analyst Extension for ArcGIS 9.2
Convert the Regional Parks (polygon) layer to a point layer

1. Add the Regional Parks (polygon) layer to an ArcMap Document.
2. Open the ArcToolbox by clicking on the icon and navigate to the Feature Vertices to Points tool (Data Management Tools $->$ Features $->$ Feature Vertices to Points). Open the tool by double-clicking it.
a. In the Input Features drop-down box, select the Regional Parks (polygon) layer.
b. Specify a name and location for the output feature class.
c. Set the Point Type (optional) to ALL.
d. Click OK.
e. This tool will create an output layer containing all vertices in the Regional Parks polygons. Each vertex will contain the attributes of the park from which it was derived. Please note that this output layer will contain many thousands of points.

Calculate the network distance to the nearest park

1. Start ArcMap
2. On the Main Menu, click Tools and click on Extensions
a. Check Network Analyst Extension
b. Click Close
3. Click the Add Data button on the Standard Toolbar
a. Navigate to the Network Dataset location
b. Click on the Network Dataset and click Add to add the Network Dataset to ArcMap.
c. Click Yes to add all the feature classes that participate in the network to the map.
4. Click the Add Data button on the Standard Toolbar
a. Navigate to the Point Layers to be used for the analysis, in this case the Participant locations and Regional Parks points (created in the previous step).
b. Select the Point Layers and click Add to add them to ArcMap.
5. If the Participant IDs and Regional Parks IDs are already assigned, go the next step. Otherwise, in the Table of Contents, right-click on the Participant locations point layer and select Open Attribute Table.
a. In the Attribute Table,
i. Click Options and select Add Field...
ii. Add Par_ID_T as Text
6. Type Par_ID_T in the Name field
7. Select Text as Type
8. Set the Length to 20
9. Click OK
iii. Click Options and select Add Field...
iv. Add Par_ID as Integer
10. Type Par_ID in the Name field
11. Select Short Integer as Type
12. Accept default (0) for Precision
13. Click OK
v. Right-click on the Par_ID field and select Field Calculator...
14. Set the Par_ID equal to [FID] $+\mathbf{1}$
15. Click OK
vi. Right-click on the Par_ID_T field and select Field Calculator...
16. Set the Par_ID_T equal to Par_ID
17. Click $\mathbf{O K}$
b. Right-click on the Regional Parks point layer and select Open Attribute Table.
i. In the Attribute Table,
18. Click the Options button and select Add field...
19. Add Pk_ID_T as Text
a. Type Pk_ID_T in the Name field
b. Select Text as Type
c. Set the Length to 20
d. Click OK
20. Click the Options button and select Add Field
21. Add Pk_ID as Integer
a. Type Pk_ID in the Name field
b. Select Short Integer as Type
c. Accept default (0) for Precision
d. Click OK
22. Right-click on the Pk_ID field and select Field Calculator...
a. Set the Pk_ID equal to [FID] $\mathbf{+ 1}$
b. Click OK
23. Right-click on the Pk_ID_T field and select Field Calculator...
a. Set the Pk_ID_T equal to Pk_ID
b. Click OK
24. Load the Network Analyst toolbar
a. One the Main Menu, click on View
b. Click on Toolbars
c. In the side menu, click Network Analyst to add the Network Analyst toolbar to ArcMap
25. Load the Network Analyst Window
a. Click on the Show/Hide Network Analyst Window to open the window
26. Create a New Closest Facility
a. Click on the Network Analyst button on the Network Analyst toolbar
b. Select New Closest Facility from the dropdown window
c. The Table of Contents and the Network Analyst Window will now contain a Closest Facility layer, which contains Facilities, Incidents, Barriers, and Routes categories.
27. Load the Regional Parks points into the Facilities category in Network Analyst
a. In the Network Analyst window, right-click Facilities and click Load Locations. This will open the Load Locations Window
b. In the Load Locations Window
i. Select the point layer containing the Regional Parks points from the drop-down box next to Load From. If the required point layer is not in the drop-down box, click on the Browse for Point Features to Load icon and navigate to the point layer.
ii. Choose the Pk_ID as the Sort field.
iii. Choose the Pk_ID_T for the Name property under Locational Analysis properties.
iv. Accept the default for the other Locational Analysis properties.
v. Choose a suitable Search Tolerance for the Location Position. Since the Regional Parks point layer contains so many points, we recommend constraining the tolerance to approximately 1000 meters.
vi. Click OK. This process will take two to three hours to finish.
c. To verify all Regional Parks points were located on the network dataset, do the following.
i. Right-click on the Facilities in the Network Analyst Window, Open Attribute Table and sort descending on the STATUS column. The Not Located features should be sorted to the top.
ii. It is likely that some Regional Parks points will be not be located because they fall outside of the tolerance. Those points usually fall along the interiors of parks and can safely be ignored for this analysis.
28. Load the Participant locations into the Incidents category in Network Analysst.
a. In the Network Analyst window, right-click Incidents and click Load Locations. This will open the Load Locations Window.
b. In the Load Locations Window
i. Select the point layer containing the Participant locations from the drop-down box next to Load From. If the required point layer is not in the drop-down box, click on the Browse for Point Features to Load icon and navigate to the point layer.
ii. Choose the Par_ID as the Sort field.
iii. Choose the Par_ID_T for the Name property under Locational Analysis properties.
iv. Accept the default for the other Locational Analysis properties.
v. Choose a suitable Search Tolerance for the Location Position. If features cannot be located in the network dataset, this tolerance may need to be increased.
vi. Click OK.
c. To verify all Participant locations were located on the network dataset, do one of the following. If any feature has a status of Not Located, the search tolerance in 10.b.v may need to be increased or the feature reviewed for correct location.
i. For small datasets, scroll through the resulting list of Incidents in the Network Analyst Window, looking for features with RED questions marks.
ii. For large datasets, it may be easier to right-click on the Incidents in the Network Analyst Window, Open Attribute Table and sort decending on the STATUS column. The Not Located features should sort to the top.
29. Set the properties for the analysis
a. In the Table of Contents, right-click Closest Facility and click Properties. This will open the Closest Facility properties dialog box.
b. Click on the Analysis Settings Tab
i. Choose Length (meters) for Impedence
ii. Choose None for Default Cutoff Values
iii. Set Facilities to Find to 1
iv. Set Travel From option to Incident to Facility
v. Set Allow U-Turns to Everywhere
vi. Set Output Shape Type to True Shape
vii. Check the box to Ignore Invalid Locations
c. Click OK.
30. To calculate the closest Regional Park point to a Participant location, click the Solve Button on the Network Analyst Toolbar.
a. When Network Analyst has solved the calculations, the Routes layer will be populated with line segments joining each participant location to its closest Regional Park point. The Routes Attribute table contains the unique IDs for the participants and the regional parks along with the network length separating them and the route name (a concatenation of the participant ID and the regional park point ID).
31. Join the Regional Park points and the Participants to the results of Find Closest Facility analysis
a. Right-click the Routes layer.
b. Select Joins and Relates and then click Join.
i. Choose Facility_ID as the field to base the join on
ii. Choose the Regional Parks point layer as the Table to Join to this layer
iii. Choose the Pk_ID as the field in the table to base the join on
iv. Click OK
c. Right-click on the Routes layer.
d. Select Joins and Relates and then click Join.
i. Choose Incident_ID as the field to base the join on
ii. Choose the Participant layer as the Table to Join to this layer
iii. Choose the Par_ID as the field in the table to base the join on
iv. Click OK
e. Right-click the Routes layer
f. Select Data and then click Export Data
i. Choose this layer's source data for the coordinate system
ii. Specify the Output Location
iii. A new shapefile will be created in the output location. This shapefile will contain the routes from each participant location to the nearest regional park. Eeach route will contain the attributes of the participant and the nearest regional park.

Calculate straight-line distance to nearest park
To follow this protocol, you will need:

1. Participant Locations Point Feature Layer for incidents (origins)
2. Regional Parks Point Feature Layer for faciliites (destinations), created in previous steps

Calculate the straight-line distance to the nearest park

1. Start ArcMap.
2. Click thd Add Data button on the Standard Toolbar.
a. Navigate to the Point Layers to be used in the analysis, in this case the Participant locations and the Regional Parks point feature layer.
b. Select the Point Layers and click Add to add them to ArcMap.
3. Open ArcToolbox by clicking on the icon.
4. Navigate to the Near tool (Analysis Tools -> Proximity) and double-click to open it.
5. Click the down-arrow in the Input Features box and select the Participant Locations feature layer.
6. Click the down-arrow in the Near Features box and select the Regional Parks Point feature layer.
7. Leave the Search Radius (optional) box empty. This will guarantee that every Participant Location will have it nearest regional park point found.
8. Leave the Location (optional) and Angle (optional) check boxes unchecked.
9. Click OK to execute the tool.
10. The tool will find the nearest regional park point to each Participant Location and measure the straight-line distance between those points. The tool will add two attributes to the participant location attribute table, NEAR_DIST and NEAR_FID. NEAR_DIST will contain the distance, in the units of the Layers. NEAR_FID will contain the feature ID of the closest regional park point. Use the NEAR_FID attribute to join the Regional Park Point Layer to the participant location layer to determine the characteristics of the nearest regional park point.

Join the Participant Location Layer to the Regional Park Point Layer using the NEAR_FID attribute.

1. Right-click on the Participant Location layer and select Joins and Relates $->$ Join...
2. Choose NEAR_FID as the field to base the join on.
3. Choose the Regional Park Point layer as the Table to Join to this layer.
4. Choose the FID attribute as the field in the table to base the join on.
5. Click OK. The Regional Park Point attributes will be joined to the Participant locations.
6. Right-click on the Participant Locations Layer and select Data -> Export Data...
a. Choose this layer's source data for the coordinate system.
b. Specify the Output Location.
c. Click OK.

A new shapefile will be created in the output location. This shapefile will contain the participant locations and the attributes of the nearest regional park to each participant location.

### 5.17 Distance to Nearest Gym or Fitness Facility

Note: The steps were updated in Version 1.3. Note. This protocol is being checked.

## 1. Basic Concept

This is a fairly simple distance to a nearest parcel (centroid) calculation. What is most important is defining a gym or fitness facility as these can be public or private. It is related to the following TRECIDEA question:

- SS181 About how long would it take to get from your home to the nearest gym or fitness facility if you walked? (Adapted from NEWS B23 (14) )

The issue is defining a gym or fitness facility. Looking at the list below (which does not include dance studios) it can be sent there are a variety of definitions but the best fit is: 71394 Fitness and Recreational Sports Centers.

713 Amusement, Gambling, and Recreation Industries

| $\begin{gathered} 2002 \\ \text { NAICS } \end{gathered}$ | 2002 NAICS U.S. Description (with link to definition) | $\begin{aligned} & \text { Com- } \\ & \text { para- } \\ & \text { bility } \end{aligned}$ | $\begin{aligned} & 1987 \\ & \text { SIC } \end{aligned}$ | 1987 U.S. SIC Description (with link to definition) |
| :---: | :---: | :---: | :---: | :---: |
| 7139 | Other Amusement and Recreation Industries |  |  |  |
| 71391 | Golf Courses and Country Clubs |  |  |  |
| 713910 | Golf Courses and Country Clubs | $6{ }^{\text {cod }}$ |  |  |
|  |  |  | 7992 | Public Golf Courses |
|  |  |  | $\underline{7997}$ | Membership Sports and Recreation Clubs (Golf clubs) |
| 71392 | Skiing Facilities |  |  |  |
| 713920 | Skiing Facilities | 6 | 7999 | Amusement and Recreation Services, NEC (Skiing facilities) |
| 71393 | Marinas |  |  |  |
| 713930 | Marinas | amb | 4493 | Marinas |
| 71394 | Fitness and Recreational Sports Centers |  |  |  |
| 713940 | Fitness and Recreational Sports Centers | $6{ }^{\text {cod }}$ |  |  |
|  |  |  | $\underline{7991}$ | Physical Fitness Facilities |
|  |  |  | $\underline{7997}$ | Membership Sports and Recreation Clubs (Recreation clubs with facilities) |
|  |  |  | $\underline{7999}$ | Amusement and Recreation Services, NEC (Nonmembership fitness and recreational sports centers) |
| 71395 | Bowling Centers |  |  |  |
| 713950 | Bowling Centers | ald | 7933 | Bowling Centers |

Source: http:/ /www.census.gov/epcd/naics02/N2SIC71.HTM\#N713

## 2. Basic Definition

Distance to Nearest Gym or Fitness Facility = Straight line or network distance to the centroid of the nearest Gym or Fitness facility.

## 3. Detailed Definition

Distance to nearest gym or fitness facility $=$ Shortest straight line or network path between home or school and the nearest gym or fitness facility where gyms or fitness facilities are defined as the following NAICS codes in Dun and Bradstreet:

## 71394 Fitness and Recreational Sports Centers

## 4. Comments and Explanations

[To add.]

## 5. GIS Approach

The GIS approach is to use the Find Closest Facility option in the Network Analyst Extension of ArcGIS 9.2 to find the closest gym or fitness facility to a participant's home or school. The point layer containing gyms or fitness facilities are the "facilities" in Network Analyst, and the participant locations are the "incidents" in Network Analyst. A street network is required for calculating the distance between gyms/fitness facilities and participant locations.

In the Network Analyst Extension, specify the "facilities" and the "incidents" and solve for these closest facility to each incident. Attach the distance to the closest facility to each incident.

## 6. GIS Steps

The following procedures were completed in ArcMap (ArcInfo) 9.2.
To follow this protocol you will need:

1. Road Network dataset
2. Gym and Fitness Facility Point Feature Layer for facilities (destinations)
3. Participants' Locations Point Feature Layer for incidents (origins)
4. Network Analyst Extension for ArcGIS 9.2

Calculate the Network Distance to the nearest gym or fitness facility.

1. Start ArcMap.
2. On the Main Menu, click Tools and click on Extensions.
a. Click the check-box next to the Network Analyst extension.
b. Click Close.
3. Click the Add Data button $\underset{\sim}{\text { on the Standard Toolbar }}$
a. Navigate to the Network Dataset location.
b. Click on the Network Dataset and click Add to add the Network Dataset to ArcMap.
c. Click Yes to add all the feature class that participate in the network to the map.
4. Click the Add Data button $\boldsymbol{\pm}$ on the Standard Toolbar
a. Navigate to the Point Layers to be used for the analysis, in this case the Participant Locations and Gym and Fitness Facility locations.
b. Select the Point Layers and click Add to add them to ArcMap.
5. If the Gym and Fitness Facility IDs and Participant IDs are already assigned, go to the next step.

Otherwise, in the Table of Contents, right-click on the Participant locations point layer and select Open Attribute Table...
a. In the Attribute Table,
i. Click the Options button and select Add Field...
ii. Add Par_ID_T as Text.
iii. Type Par_ID_T in the Name field.
iv. Select Text as Type.
v. Set the Length to 20.
vi. Click OK.
b. Click the Options button and select Add Field...
i. Add Par_ID as Integer.
ii. Type Par_ID in the Name field.
iii. Select Short Integer as Type.
iv. Accept default (0) for Precision.
v. Click OK.
c. Right-click on the Par_ID field and select Field Calculator...
i. Set the Par_ID equal to [FID] $\mathbf{+ 1}$.
ii. Click OK.
d. Right-click on the Par_ID_T field and select Field Calculator...
i. Set the Par_ID_T equal to Par_ID.
ii. Click OK.
e. Right-click on the Gyms and Fitness Facilities point layer and select Open Attribute Table
i. Click the Options button and select Add Field...
ii. Add Gyms_ID_T as Text
iii. Type Gym_ID_T in the Name field
iv. Select Text as Type
v. Set the Length to 20
vi. Click OK
f. Click the Options button and select Add Field...
i. Add Gym_ID as an Integer
ii. Type Gym_ID in the Name field
iii. Select Short Integer as Type.
iv. Accept default (0) for Precision.
v. Click OK.
g. Right-click on the Gym_ID field and select Field Calculator...
i. Set the Gym_ID equal to [FID] + $\mathbf{1}$
ii. Click OK
h. Right-click on the Gym_ID_T field and select Field Calculator...
i. Set the Gym_ID_T equal to Gym_ID.
ii. Click OK.
6. Load the Network Analyst toolbar.
a. On the Main Menu, click on View.
b. Click on Toolbars.
c. In the side menu, click Network Analyst to add the Network Analyst toolbar to ArcMap
7. Load the Network Analyst Window
a. Click on the Show/Hide Network Analyst Window ${ }^{\text {围 }}$ to open the window
8. Create a New Closest Facility
a. Click on the Network Analyst button on the Network Analyst toolbar
b. Select New Closest Facility from the dropdown menu
c. The Table of Contents and the Network Analyst Window will now contain a Closest Facility layer, which contains Facilities, Incidents, Barriers, and Routes categories
9. Load the Gyms and Fitness Facilities in the Facilities category in Network Analyst
a. In the Network Analyst window, right-click Facilities and click Load Locations. This will open the Load Locations Window
b. In the Load Locations Window
i. Select the point layer containing the Gyms and Fitness Facilities locations from the dropdown box next to Load From. If the required point layer is not in the dropdown box, click on the Browse for Point Features to Load icon and navigate to the point layer.
ii. Choose the Gym_ID as the Sort field.
iii. Choose the Gym_ID_T for the Name property under Locational Analysis properties.
iv. Accept the default for the other Locational Analysis properties.
v. Choose a suitable Search Tolerance for the Location Position. If features cannot be located on the network dataset, this tolerance may need to be increased.
vi. Click OK.
c. To verify all Gym and Fitness Facility locations were located on the network dataset, do one of the following. If any feature has a status of Not Located, the search tolerance in 9.b.v may need to be increased or the feature reviewed for correct location.
i. For small datasets, scroll through the resulting lists of Facilities in the Network Analyst Window, looking for features with RED question marks.
ii. For large datasets, it may be easier to right-click on the Facilities in the Network Analyst Window, Open Attribute Table and sort decending on the STATUS column. The Not Located features should sort to the top.
10. Load the Participant locations into the Incidents category in Network Analyst.
a. In the Network Analyst window, right-click Incidents and click Load Locations. This will open the Load Locations Window.
b. In the Load Locations Window,
i. Select the point layer containing the Participant locations from the dropdown box next to Load From. If the required point layer is not in the dropdown box, click on the Browse for Point Features to Load icon and navigate to the point layer.
ii. Choose the Par_ID as the Sort field.
iii. Choose the Par_ID_T for the Name property under Locational Analysis properties.
iv. Accept the default for the other Locational Analysis properties.
v. Choose a suitable Search Tolerance for the Location Position. If features cannot be located on the network dataset, this tolerance may need to be increased.
vi. Click OK.
c. To verify all Participant locations were located on the network dataset, do one of the following. If any feature has a status of Not Located, the search tolerance in 10.b.v may beed to be increased or the feature reviewed for correct location.
i. For small datasets, scross through the resulting lists of Incidents in the Network Analyst Window, looking for features with RED question marks.
ii. For large datasets, it may be easier to right-click on the Incidents in the Network Analyst Window, Open Attribute Table and sort decending on the STATUS column. The Not Located features should sort to the top.
11. Set the properties for the analysis.
a. In the Table of Contents, right-click Closest Facility and click Properties. This will open the Closest Facility properties dialog box.
b. Click on the Analysis Settings Tab.
i. Choose Length (meters) for Impedence.
ii. Choose None for Default Cutoff Values.
iii. Set Facilities to Find to 1.
iv. Set the Travel From option to Incident to Facility.
v. Set Allow U-Turns to Everywhere.
vi. Set Output Shape Type to True Shape.
vii. Check the box to Ignore Invalid Locations.
c. Click OK.
12. To calculate the closest Gym or Fitness Facility to a Participant location, click the Solve Button on the Network Analyst Toolbar.
a. When Network Analyst has solved the calculations, the Routes layer will be populated with line segments joining each participant location to its closest gym or fitness facility. The Routes attribute table contains the unique IDs for the participant and the gym/fitness facility along with the network length separating them and the route name (a concatenation of the participant ID and the gym/fitness facility ID).
13. Join the Gyms and Fitness Facilities and the Participants to the results of Find Closest Facility analysis.
a. Right-click the Routes layer,
i. Select Joins and Relates and then click Join...
ii. Choose the Gym and Fitness Facility layer as the Table to Join to this layer.
iii. Choose the Gym_ID as the field in the table to base the join on.
iv. Click OK.
b. Right-click on the Routes layer,
c. Select Joins and Relates and then click Join...
i. Choose Incident_ID as the field to base the join on.
ii. Choose the Participant layer as the Table to Join to this layer.
iii. Choose the Par_ID as the field in the table to base the join on.
iv. Click OK.
d. Right-click the Routes layer,
e. Select Data and then click Export Data...
i. Choose this layer's source data for the coordinate system.
ii. Specify the Output Location.
iii. A new shapefile will be created in the output location. This shapefile will contain the routes from each participant location to the nearest gym or fitness facility. Each route will contain the attributes of the participant and the nearest gym or fitness facility.

Calculate straight-line distance to nearest gym
To follow this protocol, you will need:

1. Participant Locations Point Feature Layer for incidents (origins)
2. Gym or Fitness Facility Point Feature Layer for facilities (destinations)

Calculate the straight-line distance to the nearest transit stop

1. Start ArcMap.
2. Click the Add Data button on the Standard Toolbar.
a. Navigate to the Point Layers to be used in the analysis, in this case the Participant locations and the Gym or Fitness Facility.
b. Select the Point Layers and click Add to add them to ArcMap.
3. Open ArcToolbox by clicking on the icon.
4. Navigate to the Near tool (Analysis Tools -> Proximity) and double-click to open it.
5. Click the down-arrow in the Input Features box and select the Participant Locations feature layer.
6. Click the down-arrow in the Near Features box and select the Gym or Fitness Facility feature layer.
7. Leave the Search Radius (optional) box empty. This will guarantee that every Participant Location will have its nearest gym or fitness facility found.
8. Leave the Location (optional) and Angle (optional) check boxes unchecked.
9. Click OK to execute the tool.
10. The tool will find the nearest gym or fitness facility to each Participant Location and measure the straightline distance between those points. The tool will add two attributes to the participant location attribute table, NEAR_DIST and NEAR_FID. NEAR_DIST will contain the distance, in the units of the Layers (e.g., meters, feet). NEAR_FID will contain the feature ID of the closest gym or fitness facility. Use the NEAR_FID attribute to join the Gym or Fitness Facility Layer to the Participant Location layer to determine the characteristics of the nearest gym or fitness facility.

Join the Participant Location Layer to the Gym or Fitness Facility Layer using the NEAR_FID attribute.

1. Right-click on the Participant Location layer and select Joins and Relates -> Join...
2. Choose NEAR_FID as the field to base the join on.
3. Choose the Gym or Fitness Facility layer as the Table to Join to this layer.
4. Choose the FID attribute as the field in the table to base the join on.
5. Click OK. The Gym or Fitness Facility attributes will be joined to the Participant locations.
6. Right-click on the Participant Locations Layer and select Data -> Export Data...
a. Choose this layer's source data for the coordinate system.
b. Specify the Output Location.
c. Click OK.

A new shapefile will be created in the output location. This shapefile will contain the participant locations and the attributes of the nearest gym or fitness facility to each participant location.

### 5.18 Distance to Nearest Recreation Center, Community Center, or School

Note: The steps were updated in Version 1.3.

## 1. Basic Concept

This is a fairly simple distance to a nearest parcel (centroid) calculation. What is most important is finding data on such facilities. It is related to two questions in

- SS180 About how long would it take to get from your home to the nearest recreation center (community center, school in your neighborhood) if you walked? (Adapted from NEWS B22 (14))

Again definitions are complex and might include:

- 71394 Fitness and Recreational Sports Centers
- 6111 Elementary and Secondary Schools

However in the Twin Cities school data were best obtained form a public source.

## 2. Basic Definition

Distance to Nearest Recreation Center, Community Center, or School = Straight line or network distance to the centroid of the nearest facility of that type.

## 3. Detailed Definition

Distance to Nearest Recreation Center, Community Center, or School = Straight line or network distance to the centroid of the nearest facility of that type with data from Dun and Bradstreet and from The Lawrence Group (TLG) Geospatial Landmark data for schools.

## 4. Comments and Explanations

The Dun and Bradstreet data contain few elementary and secondary schools ( 369 total, but many of these addresses are for school district headquarters instead of actual schools); therefore, a new data source was required. The Lawrence Group (TLG) Geospatial Landmark data, updated quarterly and available from the MetroGIS' datafinder (http://www.datafinder.org/metadata/tlg_landmarks.htm), contains 808 public and private elementary, middle, and high schools. Those 808 schools are used for this protocol.

## 5. GIS Approach

The GIS approach is to use the Find Closest Facility option in the Network Analyst Extension of ArcGIS 9.2 to find the closest recreation center, community center, or school to a participant's home. The point layer containing recreation centers, community centers, or schools are the "facilities" in Network Analyst, and the participant locations are the "incidents" in Network Analyst. A street network is required for calculating the distance between recreation centers, community centers, or schools and participant locations.

In the Network Analyst Extension, specify the "facilities" and the "incidents" and solve for the closest facility to each incident. Attach the distance to the closest facility to each incident.

The straight-line distance is calculated using the Near Tool in ArcToolbox.

## 6. GIS Steps

The following procedures were completed in ArcMap (ArcInfo) 9.2.
To follow this protocol you will need:

1. Road Network dataset
2. Recreation Center, Community Center, or School Point Feature Layer for facilities (destinations)
3. Participants' Locations Point Feature Layer for incidents (origins)
4. Network Analyst Extension for ArcGIS 9.2.

Merge the Recreation Center/Community Center points with the School points to create a single Recreation
Center, Community Center, or School Point Feature Layer

1. Open ArcToolbox.
2. Navigate to the Merge tool (Data Management Tools -> General). Double-click on Merge to open the tool.
3. Click on the folder icon next to the Input Datasets box and navigate to the location of the School points. Click on the School points and click OK to add them to the tool.
4. Click on the folder icon again and navigate to the location of the Recreation Center/Community Center points. Click on the Recreation Center/Community Center points and click OK to add them to the tool.
5. Specify the name and location of the Output Dataset.
6. Click OK to execute the Merge tool.
7. When the Merge tool finished, the merged shapefile will be added to the Table of Contents. Use this merge dataset for all subsequent steps in this protocol.

Calculate the Network Distance to the nearest recreation center, community center, or school.

1. Start ArcMap.
2. On the Main Menu, click Tools and click on Extensions.
a. Check the box next to the Network Analyst Extension.
b. Click Close
3. Click the Add Data button $\pm$ on the Standard Toolbar
a. Navigate to the Network Dataset location.
b. Click on the Network Dataset and click Add to add the Network Dataset to ArcMap.
c. Click Yes to add all the feature classes that participate in the network to the map
4. Click the Add Data button $\underset{ }{ \pm}$ on the Standard Toolbar
a. Navigate to the Point Layers to be used for the analysis, in this case the Participant locations and Recreation Center, Community Center, or School locations
b. Select the Point Layers and click Add to add them to ArcMap
5. If the Recreation Center, Community Center, or School IDs and Participant IDs are already assigned, go to the next step. Otherwise, in the Table of Contents, right-click on the Participant locations point layer and select Open Attribute Table.
a. In the Attribute Table,
i. Click the Options button and select Add Field...
ii. Add Par_ID_T as Text.
iii. Type Par_ID_T in the Name field.
iv. Select Text as Type.
v. Set the Length to 20.
vi. Click OK.
vii. Click the Options button again and select Add Field...
viii. Add Par_ID as Integer.
ix. Type Par_ID in the Name field.
x. Select Short Integer as Type.
xi. Accept default (0) as Precision.
xii. Click OK.
b. Right-click on the Par_ID field and select Field Calculator.
i. Set the Par_ID equal to [FID] +1
ii. Click OK
c. Right-click on the Par_ID_T field and select Field Calculator.
i. Set the Par_ID_T equal to Par_ID.
ii. Click OK.
d. Right-click on the Recreation Center, Community Center, or School point layer and select Open Attribute Table.
i. Click the Options button and select Add Field.
ii. Add Rec_ID_T as Text.
iii. Type Rec_ID_T in the Name field.
iv. Select Text as Type.
v. Set the Length to 20.
vi. Click OK.
vii. Click the Options button again and select Add Field.
viii. Add Rec_ID as Integer.
ix. Type Rec_ID in the Name field.
x. Select Short Integer as Type.
xi. Accept default (0) for Precision.
xii. Click OK.
e. Right-click on the Rec_ID field and select Field Calculator.
i. Set the Rec_ID equal to [FID] + $\mathbf{1}$
ii. Click OK.
f. Right-click on the Rec_ID_T field and select Field Calculator...
i. Set the Rec_ID_T equal to Rec_ID.
ii. Click OK.
6. Load the Network Analyst toolbar.
a. On the Main Menu, click on View.
b. Click on Toolbars.
c. In the side menu, click Network Analyst to add the Network Analyst toolbar to ArcMap.
7. Load the Network Analyst Window
a. Click on the Show/Hide Network Analyst Window ${ }^{\text {F }}$ to open the window.
8. Create a New Closest Facility
a. Click on the Network Analyst button on the Network Analyst toolbar.
b. Select New Closest Facility from the dropdown menu.
c. The Table of Contents and the Network Analyst Window will now contain a Closest Facility layer, which contains Facilities, Incidents, Barriers, and Routes categories.
9. Load the Gyms and Fitness Facilities in the Facilities category in Network Analyst
a. In the Network Analyst window, right-click Facilities and click Load Locations. This will open the Load Locations Window.
b. In the Load Locations Window,
i. Select the point layer containing the Recreation Center, Community Center, or School locations from the dropdown box next to Load From. If the required point layer is not in the dropdown box, click on the Browse for Point Features to Load icon and navigate to the point layer.
ii. Choose the Rec_ID as the Sort field.
iii. Choose the Rec_ID_T for the Name property under Locational Analysis properties.
iv. Accept the default for the other Locational Analysis properties.
v. Choose a suitable Search Tolerance for the Location Position. If features cannot be located on the network dataset, this tolerance may need to be increased.
vi. Click OK.
c. To verify all Recreation Center, Community Center, or School locations were located on the network dataset, do one of the following. If any feature has a status of Not Located, the search tolerance in 9.b.v may need to be increased or the feature reviewed for correct location.
i. For small datasets, scroll through the resulting lists of Facilities in the Network Analyst Window, looking for features with RED question marks.
ii. For large datasets, it may be easier to right-click on the Facilities in the Network Analyst Window, Open Attribute Table and sort decending on the STATUS column. The Not Located features should sort to the top.
10. Load the Participant locations into the Incidents category in Network Analyst
a. In the Network Analyst window, right-click Incidents and click Load Locations. This will open the Load Locations Window.
b. In the Load Locations Window,
i. Select the point layer containing the Participant locations from the dropdown box next to Load From. If the required point layer is not in the dropdown box, click on the Browse for Point Features to Load icon and navigate to the point layer.
ii. Choose the Par_ID as the Sort field.
iii. Choose the Par_ID_T for the Name property under Locational Analysis properties.
iv. Accept the default for the other Locational Analysis properties.
v. Choose a suitable Search Tolerance for the Location Position. If features cannot be located on the network dataset, this tolerance may need to be increased.
vi. Click OK.
c. To verify all Participant locations were located on the network dataset, do one of the following. If any feature has a status of Not Located, the search tolerance in 10.b.v may beed to be increased or the feature reviewed for correct location.
i. For small datasets, scross through the resulting lists of Facilities in the Network Analyst Window, looking for features with RED question marks.
ii. For large datasets, it may be easier to right-click on the Facilities in the Network Analyst Window, Open Attribute Table and sort decending on the STATUS column. The Not Located features should sort to the top.
11. Set the properties for the analysis
a. In the Table of Contents, right-click Closest Facility and click Properties. This will open the Closest Facility properties dialog box.
b. Click on the Analysis Settings Tab.
i. Choose Length (meters) for Impedence.
ii. Choose None for Default Cutoff Values.
iii. Set Facilities to Find to 1.
iv. Set the Travel From option to Incident to Facility.
v. Set Allow U-Turns to Everywhere.
vi. Set Output Shape Type to True Shape.
vii. Check the box to Ignore Invalid Location.
viii. Click OK.
12. To calculate the closest Recreation Center, Community Center, or School to a Participant location, click the Solve Button 睤 on the Network Analyst Toolbar
a. When Network Analyst has solved the calculations, the Routes layer will be populated with line segments joining each participant location to its closest recreation center, community center, or school. The Routes attribute table contains the unique IDs for the participant and the recreation center/community center/school facility along with the network length separating them and the route name (a concatenation of the participant ID and the recreation center/community center/school ID).
13. Join the Recreation Center, Community Center, or School and the Participants to the results of Find Closest Facility analysis
a. Right-click the Routes layer.
b. Select Joins and Relates and then click Join...
i. Choose Facility ID as the field to base the join on.
ii. Choose the Recreation Center, Community Center, or School layer as the Table to Join to this layer.
iii. Choose the Rec_ID as the field in the table to base the join on.
iv. Click OK.
c. Right-click on the Routes layer.
d. Select Joins and Relates and then click Join...
i. Choose Incident_ID as the field to base the join on.
ii. Choose the Participant layer as the Table to Join to this layer.
iii. Choose the Par_ID as the field in the table to base the join on.
iv. Click OK.
e. Right-click the Routes layer.
f. Select Data and then click Export Data.
i. Choose this layer's source data for the coordinate system.
ii. Specify the Output Location.
iii. A new shapefile will be created in the output location. This shapefile will contain the routes from each participant location to the nearest recreation center, community center, or school. Each route will contain the attributes of the participant and the nearest recreation center, community center, or school.

Calculate straight-line distance to nearest rec center
To follow this protocol, you will need:

1. Participant Locations Point Feature Layer for incidents (origins)
2. Recreation Center, Community Center or School Point Feature Layer for facilities (destinations)

Calculate the straight-line distance to the nearest recreation center, community center, or school

1. Start ArcMap.
2. Click the Add Data button on the Standard Toolbar.
a. Navigate to the Point Layers to be used in the analysis, in this case the Participant locations and the Recreation Centers, Community Centers, or Schools.
b. Select the Point Layers and click Add to add them to ArcMap.
3. Open ArcToolbox by clicking on the icon.
4. Navigate to the Near tool (Analysis Tools -> Proximity) and double-click to open it.
a. Click the down-arrow in the Input Features box and select the Participant Locations feature layer.
b. Click the down-arrow in the Near Features box and select the Recreation Centers, Community Centers, or Schools feature layer.
c. Leave the Search Radius (optional) box empty. This will guarantee that every Participant Location will have its nearest recreation center, community center, or school found.
d. Click OK to execute the tool.
5. The tool will find the nearest recreation center, community center, or school to each Participant Location and measure the straight-line distance between those points. The tool will add two attributes to the participant location attribute table, NEAR_DIST and NEAR_FID. NEAR_DIST will contain the distance, in the units of the Layers (e.g., meters, feet). NEAR_FID will contain the feature ID of the closest recreation center, community center, or school. Use the NEAR_FID attribute to join the Recreation Center, Community Center, or School Layer to the Participant Location layer to determine the characteristics of the nearest recreation center, community center, or school.

Join the Participant Location Layer to the Recreation Center, Community Center, or School Layer using the NEAR_FID attribute.

1. Right-click on the Participant Location layer and select Joins and Relates $->$ Join
2. Choose NEAR_FID as the field to base the join on.
3. Choose the Recreation Center, Community Center, or School Layer as the Table to Join to this layer.
4. Choose the FID attribute as the field in the table to base the join on.
5. Click OK. The Recreation Center, Community Center, or School attributes will be joined to the Participant locations.
6. Right-click on the Participant Locations Layer and select Data -> Export Data.
a. Choose this layer's source data for the coordinate system.
b. Specify the Output Location.
c. Click OK.

A new shapefile will be created in the output location. This shapefile will contain the participant locations and the attributes of the nearest recreation center, community center, or school to each participant location.

### 5.19 Distance to Nearest Bicycle or Pedestrian Trail Access Point

Note: This protocol was updated in Version 1.3.

## 1. Basic Concept

Again, another distance to nearest feature, except in this case it is a distance to a line (a trail). It is related to the following question in the TREC-IDEA study:

- SS 183 There are bicycle or pedestrian trails in or near my neighborhood that are easy to get to (E3 NEWS (14))


## 2. Basic Definition

Distance to Nearest Bicycle or Pedestrian Trail = Straight line or network distance to the closes intersection with a facility of that type.

## 3. Detailed Definition

Distance to Nearest Bicycle or Pedestrian Trail = Straight line or network distance to the closest intersection with a facility of that type using trail data from the Metropolitan Council.

## 4. Comments and Explanations

Bicycle trails and pedestrian trails were obtained from the Metropolitan Council's DataFinder website. The bicycle trails metadata can be found at http://www.datafinder.org/metadata/bikeways.htm and the pedestrian trails metadata can be found at http://www.datafinder.org/metadata/trails regional.htm .

The pedestrian trail dataset contains trails that are existing, under acquisition, planned, or proposed. This protocol only uses trails that are existing.

The bicycle trail dataset contains trails, bike lanes, and paved shoulders. This protocol only uses trails.

## 5. GIS Approach

The GIS approach is to use the Find Closest Facility option in the Network Analyst Extension of ArcGIS 9.2 to find the closest bicycle or pedestrian trail to a participant's home or school. The point layer containing bicycle or pedestrian trails are the "facilities in Network Analyst, and the participant locations are the "incidents" in Network Analyst. A street network is required for calculating the distance between bicycle or pedestrian trails and participant locations.

In the Network Analyst Extension, specify the "facilities" and the "incidents" and solve for the closest facility to each resident. Attach the distance to the closest facility to each incident.

The straight-line distance is calculated using the Near Tool in ArcToolbox.

## 6. GIS Steps

The following procedures were completed using ArcMap (ArcInfo) 9.2.
To complete this protocol you will need:

1. Road Network dataset
2. Participant Locations (point)
3. Bicycle or Pedestrian Trails (line)
4. Network Analyst Extension for ArcGIS 9.2

Select the existing pedestrian trails from the full pedestrian trails dataset

1. Start ArcMap.
2. Click the Add Data button on the Standard Toolbar
a. Navigate to the location of the pedestrian trails.
b. Click on the pedestrian trails dataset and click Add to add the dataset to ArcMap.
3. Use the Select by Attributes... dialog to select Existing pedestrian trails.
a. Click the Selection menu item and then click Select by Attributes...
b. Select the Pedestrian Trails from the dropdown box next to Layer:
c. From the Fields: box, double- click on "Status".
d. Then, click the = button.
e. Click the Get Unique Values and then double click 'Existing'.
f. Click Apply to execute the query and then click Close.
4. Right-click on the Pedestrian Trails layer in the Table of Contents and select Data...-> Export Data.
a. Choose this layer's source data for the coordinate system.
b. Specify the Output Location.
c. Click OK.
d. If ArcMap prompts you to add the exported shapefile to the Table of Contents, click Yes.

Select the trails from the full bicycle trails dataset

1. Start ArcMap.
2. Click the Add Data button on the Standard Toolbar.
a. Navigate to the location of the bicycle trails.
b. Click on the bicycle trails dataset and click Add to add the dataset to ArcMap.
3. Use the Select by Attributes... dialog to select only trails.
a. Click the Selection menu item and then click Select by Attributes.
b. Select the Bicycle Trails from the dropdown box next to Layer:
c. From the Fields: box, double-click "TYPE".
d. Then, click the = button.
e. Click the Get Unique Values button.
f. Double-click 'Non-paved Trail'.
g. Click the OR button and then double-click "TYPE".
h. Click the = button, and then double-click 'One-way Paved Trail'.
i. Click the OR button and then double-click "TYPE".
j. Click the = button, and then double-click 'Paved Trail'.
k. Click Apply to execute the query and then click Close.
4. Right-click on the Bicycle Trials layer in the Table of Contents and select Data...-> Export Data.
a. Choose this layer's source data for the coordinate system.
b. Specify the Output Location.
c. Click OK.
d. If ArcMap prompts you to add the exported shapefile to the Table of Contents, click Yes.

Merge the Bicycle Trails and Pedestrian Trails datasets together to create one dataset.

1. Open ArcToolbox.
2. Navigate to the Merge tool (Data Management Tools $\rightarrow$ General). Double-click on Merge to open the tool.
a. Click on the down arrow by Input Datasets: and select the Pedestrian Trails dataset created above.
b. Again, click on the down arrow by Input Datasets: and select the Bicycle Trails dataset created above
c. Specify the Output Dataset.
d. Click OK to execute the Merge tool
3. When the Merge tool finishes, the merged shapefile will be added to the Table of Contents. Use this merged dataset for all subsequent steps in this protocol.

Convert the Bicycle or Pedestrian Trails layer to a point layer.

1. Open the ArcToolbox by clicking on the icon and navigate to the Feature Vertices to Points tool (Data Management Tools -> Features -> Feature Vertices to Points). Open the tool by double-clicking it.
a. In the Input Features drop-down box, select the Bicycle or Pedestrian Trails (line) layer.
b. Specify a name and location for the output feature class.
c. Set the Point Type (optional) to ALL.
d. Click OK.
e. This tool will create an output layer containing all vertices in the Bicycle or Pedestrian Trails lines. Each vertex will contain the attributes of the bicycle or pedestrian trail from which it was derived.

Calculate the network distance to the nearest bicycle or pedestrian trail.

1. Start ArcMap.
2. On the Main Menu, click Tools and click on Extensions.
a. Check Network Analyst Extension.
b. Click Close.
3. Click the Add Data button on the Standard Toolbar.
a. Navigate to the Network Dataset location.
b. Click on the Network Dataset and click Add to add the Network Dataset to ArcMap.
c. Click Yes to add all the feature classes that participate in the network to the map.
4. Click the Add Data button on the Standard Toolbar.
a. Navigate to the Point Layers to be used for the analysis, in this case the Participant locations and Bicycle or Pedestrian Trail points (created in the previous step).
b. Select the Point Layers and click Add to add them to ArcMap.
5. If the Participant IDs and Bicycle or Pedestrian Trail IDs are already assigned, go the next step. Otherwise, in the Table of Contents, right-click on the Participant locations point layer and select Open Attribute Table.
a. In the Attribute Table,
i. Click Options and select Add Field...
ii. Add Par_ID_T as Text.
6. Type Par_ID_T in the Name field.
7. Select Text as Type.
8. Set the Length to 20.
9. Click OK.
iii. Click Options and select Add Field...
iv. Add Par_ID as Integer.
10. Type Par_ID in the Name field.
11. Select Short Integer as Type.
12. Accept default (0) for Precision.
13. Click OK.
v. Right-click on the Par_ID field and select Field Calculator.
14. Set the Par_ID equal to [FID] $\mathbf{+ 1}$.
15. Click OK.
vi. Right-click on the Par_ID_T field and select Field Calculator...
16. Set the Par_ID_T equal to Par_ID.
17. Click OK.
b. Right-click on the Bicycle or Pedestrian Trail point layer and select Open Attribute Table.
i. Click the Options button and select Add field...
ii. Add Bp_ID_T as Text.
18. Type Bp_ID_T in the Name field.
19. Select Text as Type.
20. Set the Length to 20.
21. Click OK.
iii. Click the Options button and select Add Field...
iv. Add Bp_ID as Integer.
22. Type Bp_ID in the Name field.
23. Select Short Integer as Type.
24. Accept default (0) for Precision.
25. Click OK.
v. Right-click on the Bp_ID field and select Field Calculator...
26. Set the $\mathbf{B p}$ _ID equal to $[$ FID $]+1$.
27. Click OK.
vi. Right-click on the Bp_ID_T field and select Field Calculator...
28. Set the $\mathbf{B p}$ _ID_T equal to $\mathbf{B} p_{-}$ID.
29. Click OK.
30. Load the Network Analyst toolbar.
a. On the Main Menu, click on View.
b. Click on Toolbars.
c. In the side menu, click Network Analyst to add the Network Analyst toolbar to ArcMap.
31. Load the Network Analyst Window.
a. Click on the Show/Hide Network Analyst Window to open the window.
32. Create a New Closest Facility.
a. Click on the Network Analyst button on the Network Analyst toolbar.
b. Select New Closest Facility from the dropdown window.
c. The Table of Contents and the Network Analyst Window will now contain a Closest Facility layer, which contains Facilities, Incidents, Barriers, and Routes categories.
33. Load the Bicycle or Pedestrian Trail points into the Facilities category in Network Analyst.
a. In the Network Analyst window, right-click Facilities and click Load Locations. This will open the Load Locations Window.
b. In the Load Locations Window,
i. Select the point layer containing the Bicycle or Pedestrian Trail points from the dropdown box next to Load From. If the required point layer is not in the drop-down box, click on the Browse for Point Features to Load icon and navigate to the point layer.
ii. Choose the Bp_ID as the Sort field.
iii. Choose the $\mathbf{B p}$ _ID_T for the Name property under Locational Analysis properties.
iv. Accept the default for the other Locational Analysis properties.
v. Choose a suitable Search Tolerance for the Location Position. Since the Regional Parks point layer contains so many points, we recommend constraining the tolerance to approximately 1000 meters.
vi. Click OK. This process will take two to three hours to finish.
c. To verify all Bicycle or Pedestrian Trail points were located on the network dataset, do the following:
i. Right-click on the Facilities in the Network Analyst Window, Open Attribute Table and sort descending on the STATUS column. The Not Located features should be sorted to the top.
ii. It is likely that some Bicycle or Pedestrian Trail points will be not be located because they fall outside of the tolerance. Those points usually fall along the interiors of parks and can safely be ignored for this analysis.
34. Load the Participant locations into the Incidents category in Network Analyst.
a. In the Network Analyst window, right-click Incidents and click Load Locations. This will open the Load Locations Window.
b. In the Load Locations Window,
i. Select the point layer containing the Participant locations from the drop-down box next to Load From. If the required point layer is not in the drop-down box, click on the Browse for Point Features to Load icon and navigate to the point layer.
ii. Choose the Par_ID as the Sort field.
iii. Choose the Par_ID_T for the Name property under Locational Analysis properties.
iv. Accept the default for the other Locational Analysis properties.
v. Choose a suitable Search Tolerance for the Location Position. If features cannot be located in the network dataset, this tolerance may need to be increased.
vi. Click OK.
c. To verify all Participant locations were located on the network dataset, do one of the following. If any feature has a status of Not Located, the search tolerance in 10.b.v may need to be increased or the feature reviewed for correct location.
i. For small datasets, scroll through the resulting list of Incidents in the Network Analyst Window, looking for features with RED questions marks.
ii. For large datasets, it may be easier to right-click on the Incidents in the Network Analyst Window, Open Attribute Table and sort decending on the STATUS column. The Not Located features should sort to the top.
35. Set the properties for the analysis,
a. In the Table of Contents, right-click Closest Facility and click Properties. This will open the Closest Facility properties dialog box.
b. Click on the Analysis Settings Tab.
i. Choose Length (meters) for Impedence.
ii. Choose None for Default Cutoff Values.
iii. Set Facilities to Find to 1.
iv. Set Travel From option to Incident to Facility.
v. Set Allow U-Turns to Everywhere.
vi. Set Output Shape Type to True Shape.
vii. Check the box to Ignore Invalid Locations.
viii. Click OK.
36. To calculate the closest Bicycle or Pedestrian Trail point to a Participant location, click the Solve Button on the Network Analyst Toolbar.
a. When Network Analyst has solved the calculations, the Routes layer will be populated with line segments joining each participant location to its closest Bicycle or Pedestrian Trail point. The Routes Attribute table contains the unique IDs for the participants and the bicycle or pedestrian trail along with the network length separating them and the route name (a concatenation of the participant ID and the bicycle or pedestrian trail point ID).
37. Join the Bicycle or Pedestrian Trail points and the Participants to the results of Find Closest Facility analysis.
a. Right-click the Routes layer.
b. Select Joins and Relates and then click Join...
i. Choose Facility_ID as the field to base the join on.
ii. Choose the Bicycle or Pedestrian Trail point layer as the Table to Join to this layer.
iii. Choose the Bp_ID as the field in the table to base the join on.
iv. Click OK.
c. Right-click on the Routes layer.
d. Select Joins and Relates and then click Join...
i. Choose Incident_ID as the field to base the join on.
ii. Choose the Participant layer as the Table to Join to this layer.
iii. Choose the Par_ID as the field in the table to base the join on.
iv. Click OK.
e. Right-click the Routes layer.
f. Select Data and then click Export Data.
i. Choose this layer's source data for the coordinate system.
ii. Specify the Output Location.
iii. A new shapefile will be created in the output location. This shapefile will contain the routes from each participant location to the nearest bicycle or pedestrian trail. Eeach route will contain the attributes of the participant and the nearest bicycle or pedestrian.

Calculate straight-line distance to nearest bicycle or pedestrian trail access points
To follow this protocol, you will need:

1. Participant Locations Point Feature Layer for incidents (origins)
2. Bicycle or Pedestrian Trail Point Feature Layer for facilities (destinations)

Calculate the straight-line distance to the nearest bicycle or pedestrian trail access point

1. Start ArcMap.
2. Click the Add Data button on the Standard Toolbar.
a. Navigate to the Point Layers to be used in the analysis, in this case the Participant locations and the Bicycle or Pedestrian Trail Access Point.
b. Select the Point Layers and click Add to add them to ArcMap.
3. Open ArcToolbox by clicking on the icon.
4. Navigate to the Near tool (Analysis Tools $->$ Proximity) and double-click to open it.
a. Click the down-arrow in the Input Features box and select the Participant Locations feature layer.
b. Click the down-arrow in the Near Features box and select the Bicycle or Pedestrian Trail Access Point feature layer.
c. Leave the Search Radius (optional) box empty. This will guarantee that every Participant Location will have its nearest bicycle or pedestrian trail access point found.
d. Leave the Location (optional) and Angle (optional) check boxes unchecked.
e. Click OK to execute the tool.
5. The tool will find the nearest bicycle or pedestrian trail access point to each Participant Location and measure the straight-line distance between those points. The tool will add two attributes to the participant location attribute table, NEAR_DIST and NEAR_FID. NEAR_DIST will contain the distance, in the units of the Layers (e.g., meters, feet). NEAR_FID will contain the feature ID of the closest bicycle or pedestrian trail access point. Use the NEAR_FID attribute to join the Bicycle or Pedestrian Trail Access Point Layer to the Participant Location layer to determine the characteristics of the nearest bicycle or pedestrian trail access point.

Join the Participant Location Layer to the Bicycle or Pedestrian Trail Access Point Layer using the NEAR_FID attribute.

1. Right-click on the Participant Location layer and select Joins and Relates -> Join...
2. Choose NEAR_FID as the field to base the join on.
3. Choose the Bicycle or Pedestrian Trail Access Point layer as the Table to Join to this layer.
4. Choose the FID attribute as the field in the table to base the join on.
5. Click OK. The Bicycle or Pedestrian Trail Access Point attributes will be joined to the Participant locations.
6. Right-click on the Participant Locations Layer and select Data -> Export Data.
a. Choose this layer's source data for the coordinate system.
b. Specify the Output Location.
c. Click OK.

A new shapefile will be created in the output location. This shapefile will contain the participant locations and the attributes of the nearest bicycle or pedestrian trail access point to each participant location.

### 5.20 Distance to School Attended

Note: This protocol was updated in Version 1.3.

## 1. Basic Concept

Again, another distance to nearest feature. It is related to the following question in the TREC-IDEA study:

- SS172 About how long would it take to get from your home to the school you attend if you walked? (Note: there is an option to mark they don't attend school) (Adapted from NEWS B9 (14))


## 2. Basic Definition

Distance to School Attended= Straight line or network distance to the centroid of the school attended.

## 3. Detailed Definition

## [To add.]

## 4. Comments and Explanations

## [To add.]

## 5. GIS Approach

The GIS approach is to create a Route in the Network Analyst Extension connecting a participant's home with the school they attend. Join the participant's home location to their school location and then solve for the route connecting those locations. A street network is required for calculating the route between home and school.

The straight-line distance is calculated using the Near Tool in ArcToolbox.

## 6. GIS Steps

The following procedures were completed in ArcMap (ArcInfo) 9.2.
To follow this protocol you will need:

1. Roads Layer Network dataset
2. Participant Home Location Point Feature Layer for origins
3. School Location Point Feature Layer for destinations
4. Network Analyst Extension for ArcGIS 9.2

In order to successfully complete this protocol, features in the participants' location layer must have an attribute describing the school the participant attends. This attribute will be used to join the participant to the correct school features.

Create Home to School Routes

1. Start ArcMap.
2. On the Main Menu, click Tools and click on Extensions.
a. Click the checkbox next to the Network Analyst Extension.
b. Click Close.
3. Click the Add Data button on the Standard Toolbar.
a. Navigate to the Network Dataset location.
b. Click on the Network Dataset and click Add to add the Network Dataset to ArcMap.
c. Click Yes to add all the feature classes which participate in the network to the map.
4. Click the Add Data button on the Standard Toolbar.
a. Navigate to the Point Layers to be used for analysis, in this case Participant Locations and School Locations.
b. Click on the Point Layers and click Add to add them to ArcMap.
5. If the School IDs and Participant IDs are already assigned, go to the next step. If not, right-click on the Participant Locations point layer and select Open Attribute Table.
a. Click Options and select Add Field...
i. Add Par_ID_T as Text.
6. Type Par_ID_T in the Name field.
7. Select Text as Type.
8. Set the Length to 20.
9. Click OK.
b. Click Options and select Add Field...
i. Add Par_ID as Integer.
10. Type Par_ID in the Name field.
11. Select Short Integer as Type.
12. Accept default (0) for Precision.
13. Click OK.
c. Right-click on the Par_ID field and select Field Calculator...
i. Set the Par_ID equal to [FID] $\boldsymbol{+ 1}$
ii. Click OK.
d. Right-click on the Par_ID_T field and select Field Calculator...
i. Set the Par_ID_T equal to Par_ID.
ii. Click OK.
14. Right-click on the Schools point layer and select Open Attribute Table...
a. Click Options and select Add Field...
i. Add Sch_ID_T as Text.
15. Type Sch_ID_T in the Name field.
16. Select Text as Type.
17. Set the Length to 20.
18. Click OK.
b. Click Options and select Add Field...
i. Add Sch_ID as Integer.
19. Type Sch_ID in the Name field.
20. Select Short Integer as Type.
21. Accept default (0) for Precision.
22. Click OK.
c. Right-click on the Sch_ID field and select Field Calculator...
i. Set the Sch_ID equal to [FID] $\mathbf{+ 1}$.
ii. Click OK.
d. Right-click on the Sch_ID_T field and select Field Calculator...
i. Set the Sch_ID_T equal to Sch_ID.
ii. Click OK.
23. Load the Network Analyst toolbar
a. On the Main menu, click on View.
b. Click on Toolbars.
c. In the side menu, click Network Analyst to add the Network Analyst toolbar to ArcMap.
24. Load the Network Analyst Window
a. Click on Show/Hide Network Analyst Window to open the window.
25. In ArcToolbox, navigate to the Calculate Locations tool (Network Analyst Tools -> Analysis ->

Calculate Locations). Double-click on Calculate Locations to open to tool.
a. Add the School Location Point layer as the Input Point Layer.
b. Add the Road Network Dataset as the Input Analysis Network.
c. Accept all other defaults.
d. Click OK.
10. Join the Schools to the Participant Layer using the School ID
a. Right-click the Participant Location layer.
b. Click Joins and Relates and select Join...
i. Choose School ID as the field to base the join on.
ii. Choose the School Location layer as the Table to Join to this layer.
iii. Choose the School ID as the field in the table to base the join on.
iv. Click OK.
11. Create a New Route
a. Click on the Network Analyst button on the Network Analyst toolbar.
b. Select New Route from the dropdown window.
c. The Table of Contents and the Network Analyst Window will contain an empty list of Stops, Barriers and Routes categories.
12. Load the Participant Locations into the Stops categories. These will be the origins.
a. Right-click Stops and select Load Locations.
b. In the Load Locations Window, choose the Participant Location Layer from the Load From drop-down list. These points will be the origins.
c. Choose the Participant ID (Par_ID) as the Sort Field.
d. Choose the Participant ID (Par_ID) as the Name.
e. Choose the Participant ID (Par_ID) as the Route Name.
f. Set the Search Tolerance to $\mathbf{5 0}$ meters for location position.
g. Click OK.
13. Load the destination locations into the Stops categories
a. Right-click Stops and select Load Locations.
b. In the Load Locations Window, select the Participant Location Layer from the Load From dropdown list.
c. Choose the School ID (Sch_ID) from the joined School Location layer (e.g., School Location.Sch_ID) as the Sort Field.
d. Choose the School ID (Sch_ID) from the joined School Location layer (e.g., School Location.Sch_ID) as the Name.
e. Choose the Participent ID (Par_ID) as the RouteName.
f. Choose Use Network Location Fields, calculated in Step 9, for the location position.
i. Choose PosAlong from School Point layer attributes for PosAlong Property.
ii. Choose SideOfEdge from School Point layer attributes for SideOfEdge Property.
iii. Choose SourceID from School Point layer attributes for SourceID Property.
iv. Choose SourceOID from School Point layer attributes for SourceOID Property.
g. Click the Advanced... button
i. Click the check-box by Snap to Position Along Network.
ii. Click the check-box by Loading locations using locations fields.
h. Click OK.
14. Click the Solve button to generate the routes.
15. Join the Participant Home Location and School Location attributes to the route layer to carry over the data
a. Right-click on the Routes Layer.
b. Click Joins and Relates and select Join...
c. Choose Name as the field to base the join on.
d. Choose the Participant Location Layer as the Table to Join to this layer.
e. Choose the Participant ID Text field (Par_ID_T) as the field in the table to base the join on.
f. Click OK.
g. Export the Routes Layer as a new shapefile to keep all the attributes
i. Right-click on the Routes Layer.
ii. Click on Data and then Export Data.
iii. Choose this layer's source data for the coordinate system.
iv. Specify the Output location.
v. Click OK.

The resulting shapefile will contain the home-to-school route for each Participant, from their home to the actual school they attend. The shapefile will contain an attribute called Total_Length, which contains the distance from the participant's home location to the school they attend.

Calculate the straight-line distance to the school attended
To follow this protocol, you will need:

1. Participant Locations Point Feature layer
2. School Location Point Feature layer
3. Start ArcMap.
4. Click the Add Data button on the Standard Toolbar.
a. Navigate to the Point Layers to be used in the analysis, in this case the Participant locations and the School locations.
b. Select the Point Layers and click Add to add them to ArcMap.
5. Add a field to the Participant Locations layer that will hold the straight-line distance to the school attended
a. Right-click on the Participant Locations layer and select Open Attribute Table.
b. Click Options and select Add Field...
c. Add Sch_Dist as Double.
i. Type Sch_Dist in the Name field.
ii. Select Double as the Type.
iii. Accept default (0) for Precision.
iv. Click OK.
6. Join the School Locations to the Participant Locations using School ID.
a. Right-click on the Participant Locations layer and select Joins and Relates -> Join...
b. Choose the School ID (the school that the participant attends) as the field to base the join on.
c. Choose the School Location layer as the Table to Join to this layer.
d. Choose the School ID as the field in the table to base the join on
e. Click OK.
7. Use the Pythagorean theorem to calculate the straight-line distance to the school attended.
a. Right-click on the Participant Locations layer and select Open Attribute Table.
b. Right click on the Sch_Dist attribute and select Field Calculator...
c. In the Field Calculator box, click the check-box next to Advanced.
d. Build a short VBA script to calculate the distance between the participant location and the school attended.
v. Type the following three lines into the text box:

> Dim xDiff as Double
> Dim yDiff as Double
> Dim Output as Double
vi. Calculate the square of the difference betweeen the Participant Location X coordinate and the School Location $X$ coordinate.
$x$ Diff $=\operatorname{Abs}([$ Participant Location.X] $-[$ School Location.X] $) *$ Abs $([$ Participant Location. X$]-[$ School Location.X] $)$
vii. Calculate the square of the difference between the Participant Location Y coordinate and the School Location Y coordinate.
yDiff $=\operatorname{Abs}([$ Participant Location. Y$]-[$ School Location. Y$]) *$ Abs $([$ Participant Location. Y$]-[$ School Location. Y$])$
viii. You will probably need to change the terms "Participant Location" and "School Location" in the above two lines. Substitute the names of whatever the feature layers are.
ix. Calculate the square root of the sum of $x$ Diff and $y$ Diff to get the distance.

$$
\text { Output }=\text { sqrt(xDiff }+ \text { yDiff })
$$

x. Type Output into the small text box at the bottom of the Field Calculator and click OK. This will populate the Sch_Dist attribute with the straight-line distance between the participant location and the school the participant attends.
xi. Here's what the actual VBA code will look like in the text box:

Dim xDiff as Double
Dim yDiff as Double
xDiff $=\operatorname{Abs}([$ Participant Location.X] $-[$ School Location.X] $) *$ Abs $([$ Participant Location. X$]-[$ School Location. X$])$
yDiff $=\operatorname{Abs}([$ Participant Location. $Y]-[$ School Location. $Y]) *$ Abs $([$ Participant Location. $Y]-[$ School Location. $Y])$
Output $=$ sqrt $(x$ Diff $+y$ Diff $)$

The Sch_Dist attribute will contain the straight-line distance between the participant location and the school they attend.

## 6. CENSUS DATA—GIS MEASURES

## Background

There are two forms used in the census. The last census was in 2000. While projections are made in the inter-censal period, these are typically done for cities and counties and not smaller areas.

The short form goes to all households and collects:

- Age
- Hispanic or Latino origin
- Household relationship
- Race
- Sex
- Tenure
- Vacancy status

These data are available at the block level, roughly a street block. These of course vary in population and area. We use these date to create the population and housing density variables in the TREC protocols.

The long form is only asked of $1 / 6$ of the population. It has more detail but is only available at the block group level which is quite large--multiple blocks, typically from 600 to 3000 people. There are typically 2-4 block groups in a census tract: http://www.census.gov/geo/www/cob/bg_metadata.html
-
The topics available are those listed under "population" and "housing" on this page:
http://factfinder.census.gov/servlet/MetadataBrowserServlet?type=dataset\&id=DEC_2000_SF3_U\& lang=en. They include:

## Population

- Ability to speak English
- Ancestry
- Citizenship status
- Class of worker
- Disability
- Farm Residence
- Educational attainment
- Employment status
- Grandparents as caregivers
- Income in 1999
- Industry
- Journey to work (commuting)
- Language spoken at home
- Marital status
- Migration
- Occupation
- Place of birth
- Place of work
- Poverty status in 1999
- School enrollment
- Veteran status
- Work status in 1999
- Year of entry

Housing

- Heating Fuel
- Bedrooms
- Kitchen facilities
- Mortgage status
- Plumbing
- Real estate taxes
- Rooms
- Selected monthly owner costs (utilities, insurance, fuel costs)
- Telephone service
- Units in structure
- Value of home or monthly rent paid
- Vehicles available
- Year moved into residence
- Year structure built

Later versions of the protocols may contain measures based on these data.

## 7. DATA STORAGE AND SHARING

## Steps/Problems with Obtaining Data

## Accuracy of InfoUSA Data

The InfoUSA business data for USA came along with the Business Analyst extension of ArcGIS 9.1. It has all the business listings for the USA classified according to the NAICS and SIC codes. Only 90 percent of the businesses are geocoded at the street address level and 99.8 percent are assigned to census block group. Thus the accuracy of InfoUSA data was lower than appropriate for the project. Thus, Dun and Bradstreet business listing data was used for the project.

## Dun $\mathcal{E}$ Bradstreet Data

The Dun and Bradstreet data was obtained from where data was geocoded according to parcel centroid and had 86,677 geocoded business locations. This dataset was used for design and development of the protocols. However, sometimes very high tolerance of 500 meters had to be used to locate the business points while working with Network Analyst as the Network dataset was created using the The Lawrence Group (TLG) road data and the business points were located at the parcel centroid. This increased the processing time as well as sometimes led to many business points remaining not-located, while working with network dataset. Thus to increase the efficiency of protocols using the TLG Network dataset the original Dun and Bradstreet address data was acquired and Geocoded.

Thanks to Dr. Kevin Krizek and his research group for assistance and advice.

## Food Beverage Licensing Data

To check the accuracy of InfoUSA and Dun \& Bradstreet data the licensing data for the Food Establishments was obtained for the seven county area. The various counties and cities classify the licensing categories on different criteria ranging from size of establishment, number of employees, type of food served and food risk categories. The only common attribute among all the counties and cities was the name of the establishment, thus the FBL data will be geocoded and compared with the Commercial Food data based on the name of the establishments.

## Storing/Sharing Data

## Tracking Changes

Protocol Tracking Excel Sheet" An Excel spreadsheet was used to keep track of completion of Protocols within the team. The sheet was updated weekly about the progress of the Protocols.

Food Establishment Licensing data tracking sheet: This sheet was used to keep a track of the contact person to acquire the data, the procedure to acquire the data, when was the concerned person last contacted, what was the response, and whether data was obtained or not.

Decision Logs: Logs were maintained about the daily progress of the protocols, key decisions were recorded, meeting conversations were documented, notes from conversations with government representatives along with their response, and the tasks that were performed.

## Other Issues

Projections: The standard coordinate system for MetroGIS datasets is Universal Transverse Mercator (UTM) North American Datum 1983 (NAD83), Zone 15. Any working or final files created from MetroGIS data were kept in the same coordinates. The participant and school data were geocoded using the MetroGIS TLG road data, thus they automatically were projected in UTM NAD83 Zone 15 projection

## APPENDICES

## Appendix 1A: Food Data Comparison

Different jurisdictions classify their food services differently. The following lists demonstrate just a small amount of the diversity in the Twin Cities area.

## Food Establishment License Classes for Anoka County.

The following license classes apply to food establishments:
Class I Beverage service only.
Class II Food establishments serving meals, sandwiches, snacks and similar foods only.
Class III Catering food service.
Class IV Food establishment serving meals, sandwiches, snacks and similar foods with bar-type beverage service.

Class V Schools or churches.
Class VI Temporary food establishment.
Class VII Catering food vehicle.
Class VIII Unopened, pre-prepared, pre-wrapped food service only.
Class IX Limited food service, including catered day care operations, catered satellite operations in industrial settings where the commissary is on the premises, continental breakfasts serving low hazard foods, and concession stands with menus limited to low hazard foods.

Food Establishment License Classes for St. Louis Park, City of
(http:/ /www.stlouispark.org/city_hall/permits.htm)
http://www.stlouispark.org/city_hall/permit_contact.htm\#597
Food and beverage licenses

- Class L (prepackaged food)
- Class M (coffee shop)
- Class H (establishment with on-site preparation of food and dining service)
- Class H+ (establishment with on-site preparation of food as well as dining service, bar and/or catering)
- Class V (vending)

Food Establishment License Classes for Hennepin County

| ABU: Bulk Food | FLF: Limited |
| :---: | :---: |
| ACS: C-Store | FLS: Food Low Small |
| ADL: Deli Large | FOM: Commissary(L) |
| ADM: Combo Meat/Deli | FOS: On Sale Bar |
| AHB: High Bakery | FPZ: Pizza Carry,Order/Out |
| AHC: High Candy | FQU: Banquet Kitchen(S) |
| AHM: High Meat | FRK: Rental Kitchen |
| ALP: Lmt Produce | FSK: Snack Std(expanded) |
| AMG: Med Grocery | FSS: Snack Std(htd/prepkgd) |
| AMM: Medium Meat | FTK: Test Kitchen |
| APP: Prepack | FWH: Warehouse |
| APR: Medium Produce | FYT: Yacht(prep) |
| ASG: Small Grocery | SCF: School Sm Cafe |
| AVE: Vending | SLC: School Lg Cafe |
| AVG: Small Produce | SLS: School Limited Snack |
| FAS: Food Assembly With | VNR: Veh/Cart/Port Bar No |
| Sales | Refr |
| FAT: Caterer(L) | VWR: Vehicle/Cart |
| FBB: Bed and Breakfast | W/Refrigerat |
| FBH: Boarding House |  |
| FBQ: Banquet Kitchen(L) |  |
| FBT: Boat Limited Operation |  |
| FBV: Boat Small Menu |  |
| FCC: Complex Cuisine(S) |  |
| FCD: Cong Dining(prep) |  |
| FCF: Cafeteria(S) |  |
| FCG: Cong Dining(no prep) |  |
| FCM: Commissary(S) |  |
| FCT: Caterer(S) |  |
| FCV: Catering Fd Veh(no prep) |  |
| FCX: Complex Cuisine(L) |  |
| FDC: Day Care(meals provided) |  |
| FDK: Domestic Kitchen |  |
| FDL: Delicatessen |  |
| FDS: Day Care(snacks only) |  |
| FFE: Cafeteria(L) |  |
| FFF: Fast Food(S) |  |
| FFL: Full Menu(L) |  |
| FFM: Manufacturer |  |
| FFR: Full Menu(S) |  |
| FFS: Fast Food(L) |  |
| FFV: Catering Fd Veh(prep) |  |
| FHZ: Hazardous Vehicle |  |
| FIL: Large Institution |  |
| FIS: Small Institution |  |

# Appendix 1B: Licensing Information for Food, Beverage, and Lodging in the Twin Cities 

By Nishi Misha and Ed D'Sousa.

## Study Area Geography and Licensing Jurisdictions

The study area covers the following counties: Anoka, Ramsey, Hennepin, Carver, Scott, Dakota and Washington.


FULL DELEGATION LOCAL JURISDICTION FOR FOOD AND BEVERAGE AND MOBILE HOME PARK/ RECREATIONAL CAMPING AREA (MHP/RCA)

PARTIAL DELEGATION
LOCAL JURISDICTION FOR FOOD AND BEVERAGE MDH FOR MHP/RCA

MDH JURISDICTION FOR
FOOD AND BEVERAGE
AND MHP/RCA
(http://www.health.state.mn.us/divs/eh/food/license/delegation.htm)
Below is a partial list of sources of licensing data.
Minnesota Department of Health Food Code:
(http://www.health.state.mn.us/divs/eh/food/code/index.html)

## Minnesota Department of Health

Licensing: Food, Beverage and Lodging Establishment Definitions

- Base Fee - an annual fee paid by each establishment except special event food stands.
- Limited Food Menu - prepackaged food that receives heat treatment and is served in the package, continental breakfast, soft drinks, coffee, nonalcoholic beverages.
- Small Establishment - food service with no salad bar, equipment not exceeding: one deep fat fryer; one grill; two hot holding containers; microwaves, or service of dipped ice cream/soft serve frozen desserts, or breakfast service in a bed and breakfast operation, or boarding establishments. Establishments which do not provide catering service and which meet "Medium Establishment" equipment criteria but have a total seating capacity of 50 or less are "Small Establishments."
- Medium Establishment - food service using a range, oven, steam table, salad bar, or salad prep area, more than one deep fat fryer or grill, more than two hot holding containers, or involving catering.
- Large Establishment - food service that meets the full menu definition and seats more than 175 people, serves a full menu selection an average of five or more days per week or caters 500 or more meals per day.
- Beer or Wine Table Service - only beer or wine service to customers seated at tables.
- Alcohol Service From Bar - alcoholic mixed drinks are served or where beer or wine is served from a bar.
- Individual Water - a private water supply other than a community public water supply.
- Individual Sewer - a private sewage treatment system, which uses subsurface treatment and disposal.
- Lodging Per Unit - the number of guest rooms, cottages, or other rental units of a hotel, motel, lodging establishment, or resort, or the number of beds in a dormitory.
- Public Swimming Pool - any swimming pool other than a private residential swimming pool.
- Spa Pool - a public hot water pool intended for seated recreational use.
- Mobile Food Unit - a food and beverage service which is a vehicle mounted unit, either motorized or trailered, operating no more than 21 days annually at any one place or is operated in conjunction with a permanent business at the site of the permanent business by the same individual or company, and readily movable, without disassembling, for transport to another location.
- Seasonal Permanent Food Stand - a food and beverage service which is a permanent stand or building, but which operates no more than 21 days annually.
- Seasonal Temporary Food Stand - a food and beverage service stand which is disassembled and moved from location to location, but which operates no more than 21 days annually at any one location.
- Special Event Food Stand - a food and beverage service stand which is used in conjunction with celebrations and special events, and which operates at most three times annually for no more than ten total days.
- Food Cart - Means a food and beverage service, which is a non-motorized vehicle selfpropelled by the operator.
- Late Penalty - additional charge added to the license fee when a person operates a business without first having made application and fee payment for the current year's license.


## Counties

## Anoka County:

(http://www.co.anoka.mn.us/v2_dept/ches/index.asp)
Environmental Services: 763-422-7063

## Washington County FBL Licensing Information

Cindy Weckwerth
Washington County
Department of Public Health and Environment
P.O. Box 6

Stillwater, Minnesota 55082-0006
Phone: 651/430-6703
cindy.weckwerth@co.washington.mn.us
License and fee info

## Hennepin County FBL Licensing Information

(http://www.co.hennepin.mn.us/vgn/portal/internet/hcdetailmaster/0,2300,1273_81946_101187677,00.html)

- Low - Limited Food
- Low Food
- Medium Food - Limited Facilities
- Medium Food - Small Menu
- High Food - Small Facility
- High Food - Large Facility
- Food Vehicle
- Vending machines


## Ramsey County

(http://www.co.ramsey.mn.us/ph/bs/food_establishment_information.htm)

## Cities

## Bloomington, City of

 (http://www.ci.bloomington.mn.us/cityhall/dept/commdev/handouts/envhandouts.htm)
## Brooklyn, City of

(http://www.brooklynpark.org/sitepages/pid1136.php)
(http:/ /www.brooklynpark.org/sitepages/pid195.php)
Crystal, City of
(http:/ /www.ci.crystal.mn.us/index.asp?Type=B_BASIC\&SEC=\{8BBE8BB0-6422-43A0-B4C6B557693594FD\})

## Edina, City of

(http://www.ci.edina.mn.us/citycode/L5-01_CityCodeSect0721.htm)
(http://www.ci.edina.mn.us/citycode/l5-01_citycodesect1230.htm)

## Hopkins, City of

(http://www.hopkinsmn.com/permits/general.html)
(http://www.hopkinsmn.com/permits/food.html)
(http://www.hopkinsmn.com/inspections/envhealth.html)
Food Establishment - Level One
Food Establishment - Level Two, Tier One
Food Establishment - Level Two, Tier Two
Food Establishment - Level Three, Tier One
Food Establishment - Level Three, Tier Two
Food Establishment - Level Three, Tier Three

## Maplewood, City of

http:/ /www.ci.maplewood.mn.us/index.asp?Type=B_BASIC\&SEC=\{0BBF30E4-06DF-4CC1-B1C2-30AE09B52249\}\&DE=\{45CBFCA5-861D-4397-AB7A-E3690D637574\}

Environment Health Officer: 651.249.2308

## Minneapolis, City of, FBL Licensing Information

General Information: 612-673-2080
Business License \& Consumer Service: 612-673-2564
License Inspectors:
Phil Schliesman (612) 673-3907
Julie Casey (612) 673-3905
Dan Niziolek (612) 673-3543
Dan Jacobs (612) 673-3909
Linda Roberts (612) 673-3908
Leanne Selander (612) 673-3910
Rich Tuffs (612) 673-3911
(http://www.ci.minneapolis.mn.us/environmental-health/) Check this link too

## Minnetonka, City of

(http://minnetonka.govoffice.com/index.asp?Type=B_BASIC\&SEC=\{9734A345-6D50-
4DBD-8B94-BB2AAF1794C8\%7D)
http://www.eminnetonka.com/index.asp?Type=NONE\&SEC=\{EC6E6A62-BACE-40F0-823B8D6119A321C2\}
http://www.eminnetonka.com/index.asp?Type=B_BASIC\&SEC=\{C4553BE3-BEB5-4310-
8A3A-74B3BCD71CB6\%7D
952.939.8274

## New Brighton, City of

(http://www.ci.new-brighton.mn.us/vertical/Sites/\{2CF34F28-6DFB-45DA-AF59-
36896254F224\%7D/uploads/\%7BE2DBB190-BD7F-4872-9C21-AF0CDA62EBF9\%7D.pdf)

## St. Louis Park, City of

(http://www.stlouispark.org/city_hall/permits.htm)
http://www.stlouispark.org/city_hall/permit_contact.htm\#597

## St. Paul, City of, FBL Licensing Information

Contact: Don Cheney (Information Technology Manager) Donald.Cheney@ci.stpaul.mn.us

- Have current license and inspection database for food retail, Restaurant and liquor
- Can easily get data dump (should be no-cost)


## Restaurant Licences:

(http://www.ci.stpaul.mn.us/depts/liep/licensing/food/restaurant.html)

Retail Food Establishment Licenses:
(http://www.ci.stpaul.mn.us/depts/liep/licensing/food/retailfood.html)
Food Vending Machine License
(http://www.ci.stpaul.mn.us/depts/liep/licensing/food/foodvending.htm)

## Wayzata, City of

http://www.wayzata.org/index.asp?Type=B_BASIC\&SEC=\{82734867-9347-4130-B2B211BE07987842\}

## Appendix 1C; Food, Beverage, and Lodging (FBL) Contacts

For the 7 County TREC study area. a contact list is available from the January 2006 document "STATE AND LOCAL ENVIRONMENTAL HEALTH CONTACTS" Compiled by: Minnesota Department of Health (MDH), Division of Environmental Health, Environmental Health Services 651/201-4500, Well Management 651/201-4600 (Also available on the web at http://www.health.state.mn.us/divs/eh/food/license/locals.pdf)

## Appendix 1D: Dun and Bradstreet Data

The 2006 data contained the following (Krizek et al. 2007):

- Records for 135,928 Metro area businesses (10 Counties)
- Detailed business data includes:
- Location
- Industry classification (NAICS and SICS)
- Sales
- Employees


## Sample Document

Source: http://ds.datastarweb.com/ds/products/datastar/sheets/dbus.htm
Duns Number \& update
DUNS NO: 19-550-5177 D-S UPDATE: 199402.
Company name
American Biological Technologies, Inc.
Address
940 Crossroads Blvd.
Seguin.
Texas (TX) 78155-7801
USA.
Telecommunications
Telephone: 210-372-1391
County: Guadalupe
MSA: 7240 (San Antonio, TX).
Company history
Latest year organized: 1988
Date of incorporation: 27 October 1988 (19881027)
State of incorporation: Texas (TX)
This is:
A single location
A Corporation
A small business
A Manufacturing location.
Management
President:
Michael Schrage Pres
Line of business
Activities:
Mfg Serums.
US SIC codes
US SIC:
PRIMARY: 2835 Diagnostic substances, nsk
Employees
Employees here: 83
Employees total:
Latest year: 83

Trend year (1992): 83
Base year (1990): 60
Employment growth: 38 \%.
Financial information
Sales:
Latest year: USD 1,000,000
ECU 889,570
Annual sales revision date: 13 January 1994 (940113).
Accomodation information
Square footage: 25,000 Occupancy type: Owned.
Professional advisors
Banking: Seguin State Bank \& Trust Co (DUNS NO.: 00-895-3283).

# Appendix 1E: Notes on SIC and NAICS coding 

By Ed D'Sousa

This appendix documents the SIC/NAICS codes that were used for the Twin Cities Walking study and highlights some of the quality and usability issues of ESRI's Business Analyst infoUSA database.

The SIC/NAICS codes used in our analysis were based on a best match of the NQLS Survey categories to the 4 digit Industry SIC Description and refined using the 6 digit extended codes when necessary. While the SIC 4 digit Industry code is standardized, the 6 digit extended codes appear to vary between data providers and are not defined as part of the national standard. To complicate matters, the transition from SIC to NAICS, and how the SIC codes are mapped to the new NAICS codes is not always clear, and again, may vary between the various data providers. It is important to note that private data providers (such as infoUSA and Dun \& Bradstreet) databases are not based on the US Census Bureaus classifications.

Our use of the infoUSA database required we have a definitive listing of the 6 digit extended codes used by infoUSA. We also desired to know the mapping between the 6 digit SIC code and 8 digit NAICS codes in the database. The codes and descriptions were not part of the delivered documentation with Business Analyst, but were provided by the ESRI Business Analyst support group. Currently the Codes and Descriptions can be found at http:// forums.esri.com/Thread.asp?c $=154 \& f=1667 \& t=185984 \# 550618$

## Assignment of businesses/institutions to SIC/NAICS Categories

As noted above, both the SIC and NAICS are standardized (4 digits for SIC and 6 digits for NAICS). The North American Industry Classification System (NAICS) is the current classification system used by the US Office of Budget and Management (OMB) for statistical reporting and is the official business classification standard for all US Federal agencies. NAICS replaced the Standard Industrial Classification (SIC) system in 1997, partially as a response to North American Free Trade Agreement and provides common classification system for businesses in Canada, Mexico and the United States.

Both the SIC and NAICS appear to have a large set of 4 and 6 digit codes (respectively) for industry classifications and the assignment of businesses to the 4 digit SIC / 6 digit NAICS within the infoUSA database appears to be fairly reasonable. infoUSA (and other data providers) has extended both SIC and NAICS with 2 (or more) additional digits which allows for greater resolution of different business types within an category. Unfortunately, these extended coding can differ significantly between the various private data providers and do not translate well when mapping SIC to NAICS. In many cases, these extended codes are not consistently applied, often do not reflect a businesses activity and add little to the ability to isolate focused business activities. Understanding how businesses are assigned their SIC/NAISC is a key issue. For higher quality data requirements, the list may need to be cross reference against other sources, a possibly expensive and time consuming task. The cross referencing may only provide a marginal increase in data quality, but for certain categories, this may be desirable.

As an example, infoUSA data for Food Services (SIC 5812 - NAICS 7221/7222/7223) has nearly $85 \%$ of the Food Services restaurants (SIC 581208) as Limited service restaurants (NAICS 72221105). This appears to be a catch all that includes businesses that would appear to fit better in other categories. SIC 581208 includes pizza places, cafés, full service restaurants, McDonald's/Burger King, etc. While it is a reasonable to extract all restaurants in a study area from the infoUSA database using SIC 5812, it is not possible to isolate fast-food from the full service, sit down restaurants. Additionally, some of the mappings between SIC and NAICS seem unreasonable (Table 5D-1), such as Cafes (SIC 581214) mapped to Cafeterias (NAICS 72221202) or Box Lunches (SIC 581215) to Full Service Restaurants (NAICS 72211002).

Table 5D-1: Restaurant and Food Services SIC/NAICS Classification mappings and feature counts for the Study Area

| SIC Code | SIC Description | NAICS Code | NAICS Description | Count |
| :---: | :---: | :---: | :---: | :---: |
| 581203 | ICE CREAM PARLORS | 72221313 | SNACK \& NONALCOHOLIC BEVERAGE BARS | 142 |
| 581206 | FOODS-CARRY OUT | 72221104 | LIMITED-SERVICE RESTAURANTS | 21 |
| 581208 | RESTAURANTS | 72221105 | LIMITED-SERVICE RESTAURANTS | 3254 |
| 581209 | DELICATESSENS | 72221103 | LIMITED-SERVICE RESTAURANTS | 57 |
| 581212 | CATERERS | 72232001 | CATERERS | 158 |
| 581214 | CAFES | 72221202 | CAFETERIAS | 20 |
| 581215 | BOX LUNCHES | 72211002 | FULL-SERVICE RESTAURANTS | 5 |
| 581219 | SANDWICHES | 72211020 | FULL-SERVICE RESTAURANTS | 7 |
| 581220 | RESTAURANT MANAGEMENT | 72231009 | FOOD SVC CONTRS | 10 |
| 581222 | PIZZA | 72211016 | FULL-SERVICE RESTAURANTS | 114 |
| 581223 | BANQUET ROOMS | 72231001 | FOOD SVC CONTRS | 46 |
| 581224 | BARBECUE | 72221101 | LIMITED-SERVICE RESTAURANTS | 3 |
| 581225 | BEVERAGES-NON-ALCOHOLIC-RETAIL | 72221320 | SNACK \& NONALCOHOLIC BEVERAGE BARS | 3 |
| 581226 | THEATRES-DINNER | 71111006 | THEATER COMPANIES \& DINNER THEATERS | 1 |
| 581227 | ITALIAN FOOD PRODUCTS | 72211011 | FULL-SERVICE RESTAURANTS | 1 |
| 581229 | DELI-BAKERY | 72221102 | LIMITED-SERVICE RESTAURANTS | 4 |
| 581230 | RESTAURANTS-FOODS DELIVERY | 49221004 | LOCAL MESSENGERS \& LOCAL DELIVERY | 1 |
| 581231 | FOOD SERVICE-INDUSTRIAL | 72231004 | FOOD SVC CONTRS | 1 |

Additionally, a very small set of businesses are listed more than once in the database, often within the same category. Usually the business name is spelled differently (Di Napoli Café vs Dinapoli Café), and / or the address is slightly different ( 814 Main St. vs 816 Main St.). While this is a relatively rare occurrence, it does represent a source of noise in the database.

## Data Quality

For the 7 counties in the Twin Cities Metro area, 93,695 records exist in the InfoUSA database. The following database description is from the Business Analyst InfoUSA documentation:
"Description: InfoUSA collects information on approximately 11 million private and public US companies. Individual businesses are located by address geocoding-not all will have an exact location. Businesses can be retrieved by their Standard Industrial Classification Code (SIC) as well as by North American Industry Classification System (NAICS) Code and Location. The infoUSA Business File can be used for locating both competitors and marketing opportunities. This data is current as of January 2005.

## Enhancements for 2005:

With the 2005 infoUSA business listings data, a collection of geocoding processes were incorporated into the process to help improve the overall geocoding match rate. This included several passes through different geocoders. Overall, 90 percent of the businesses are coded at the address level; 99.8 percent are assigned to a census block group."

Geo-coding and Positional Accuracy

As stated in the documentation, the business listings are processed through several geocoders, with $90 \%$ of the data geocoded at the address level with the majority of the remaining businesses located at the census block group. Each feature is coded with it's geocoding status, so those features located at the address level can be separated from the other, "less accurate" locations. While the geocoding status can help indicate the level of positional accuracy the feature was processed to, it does not completely describe how well individual, address level features are placed. In general, business located in strip malls and other complexes that cover large areas may be off by several hundred meters. Businesses in individual buildings along public roads are generally located within 10 meters or so.

## Completeness

For most categories, the data was assumed to accurate and complete enough for the analysis purpose. For categories, such as libraries, were very few locations (less than 100) existed in the database, the analysis could be significantly impacted if one or two key locations were missing. For categories where a relatively large number of locations exist (greater than 100) the list was reviewed to see if it was reasonable. For categories with greater than 500 locations, the list was assumed to be sufficient without any review.

Several examples can help illustrate the types of errors and the approach used to verify the data produced reasonable analysis results.

Ninety libraries were extracted from the infoUSA database for the 7 counties in the Twin Cities Metro area. The library locations were verified against a listing from MELSA (an alliance of public libraries in the Twin Cities). Overall, $13 \%$ of the libraries were missing from the infoUSA database. $26 \%$ of the infoUSA listings were deleted for a variety of reasons (duplicates, incorrect listings, incorrect address). In the City of St. Paul, which covered the heart of the study area, 5 of the 12 library locations ( $>40 \%$ ) were not in the InfoUSA database. The missing libraries were geocoded and combined with the other, verified infoUSA libraries.

While libraries represent a critical neighborhood asset that people may walk to, post office locations were deemed to be less critical, as many of the functions that can be performed at a post office can also be performed elsewhere. For example, stamps can be purchased from ATM's and super markets, mailmen collect letters for delivery from residences and private businesses that specialize in mailing and shipping services. 142 post office locations were extracted for the metro area. Three post offices were removed from the Business Analyst dataset, as they were deemed not to be actual post offices.

- HITCHING POST (2 occurrences)
- POST FACTO INC

The post offices locations were not checked against an authoritative source (i.e. the USPS list of locations).

## ESRI Business Analyst

It is important to note the infoUSA dataset shipped with Business Analyst is stored in a nonstandard, proprietary data file that can only be accessed if a Business Analyst license is available. The point locations for business can be exported to other formats (shapefile, Geodatabase) but the business address will not be accessible. Only the business's name, city, state/zip, SIC/NAICS, sales volume, number of employees and geocoding status are stored in tables accessible without a Business Analyst license. Address information is stored in an
encrypted data file that can only be accessed using Business Analyst tools. Additionally, only one address can be displayed at a time. For our study, the location and business classification were the primary concern. If we had required the businesses addresses, a different data source would probably have been chosen.

## Sources for SIC and NAICS Code Lists

InfoUSA listing of SIC codes - includes the 6 digit versions. This is the most complete version found that lists descriptions for the extended SIC codes.
http://list.infousa.com/cgi-
bin/abicgi/abicgi.pl?bas elements=4\&bas vendor=190000\&bas type=LC\&bas page=6999\&bas action=AboutOurData\#
-Note: the alphabetically sorted list on the web site appears to be incorrect, the numeric appears correct.

US Census NAICS Listings
http://www.census.gov/epcd/www/naics.html
NAICS.COM has listing of 2002 NAICS codes, same info as on US Census web site
http://www.naics.com/
NIACS.NET has outdated (1997?) NAICS codes, but has extended listings Http://www.naics.net/
infoUSA Business Analyst Data
Notes on characteristics

- locations are approximate - for small store fronts located on streets, locations may be better than those located in strip malls or other locations where the business occupies a suite number in a building.

Appendix 1F: Protocol/Geography/Data Matrix
Matrix complete as of version 1.0.

| Draft TREC-IDEA Measures | Geographies |  |  |  |  | Data |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 5-Feb-07 | straig ht line buffer S | netwo <br> rk <br> buffer <br> s | home to schoo densit y | straight <br> line <br> distance | network distance | D\&B/ Govt using NAIC S | D\&B/ Govt using name | $\begin{aligned} & \text { Land } \\ & \text { usel } \\ & \text { Met } \\ & \text { Coun } \\ & \text { cil } \\ & \text { data } \end{aligned}$ | Cens us/ road data |
| 2. FUNDAMENTAL PROTOCOLS AND PROCEDURES |  |  |  |  |  |  |  |  |  |
| 2.1 Net Land Area (without water): See TCWS GIS Protocol 2.1. |  |  |  |  |  |  |  |  |  |
| 2.2 Gross Area (including water): See TCWS GIS Protocol 2.2. |  |  |  |  |  |  |  |  |  |
| 2.3 Measurement Geography <br> Type 1: Straight Line or Airline Buffer; See TCWS GIS Protocol 2.5. | x |  |  |  |  |  |  |  | x |
| 2.4 Measurement Geography <br> Type 2: Network or Street Distance Buffer |  | x |  |  |  |  |  |  | x |
| 2.5 Measurement Geography Type 3: Straight Line or Airline Distance to Nearest Feature; See TCWS GIS Protocol 2.7. |  |  |  | x |  |  |  |  | x |
| 2.6 Measurement Geography <br> Type 4: Network or Street Distance to Nearest Feature |  |  |  |  | x |  |  |  | x |
| 2.7 Measurement Geography <br> Type 5: Home to School Route Buffer |  |  | x |  |  |  |  |  | x |
| 3. FOOD SERVICES A.K.A. RESTAURANTS |  |  |  |  |  |  |  |  |  |
| 3.1 Distance to Nearest Restaurant |  |  |  | X | x | x |  |  | x |
| 3.2 Restaurant Density | x | x | x |  |  | x |  |  |  |
| 3.3: Distance to Limited Service or Fast Food Restaurants |  |  |  | x | x | x | x |  | x |
| 3.4 Limited Service of Fast Food Restaurant Density | x | x | x |  |  | x | x |  |  |
| 3.5 Distance to Fast Food Restaurants Subtypes (See below for subtypes) |  |  |  | x | x | x | x |  | x |
| 3.6 Density of Fast Food Restaurant Subtypes | x | x | x |  |  | x | x |  |  |
| 3.7 Distance to Non Fast Food Restaurants. |  |  |  | x | x | x |  |  | x |
| 3.8 Density of Non Fast Food Restaurants | x | x | x |  |  | x |  |  |  |


| 4. FOOD STORES |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 4.1 Distance to any Retail Food Outlet--All Stores Selling Food (not restaurants) |  |  |  | x | x | x |  |  | x |
| 4.2 Density of all Retail Food Outlets-All Stores Selling Food (not restaurants) | x | x | x |  |  | x |  |  |  |
| 4.3 Distance to Groceries, Supermarkets, or Super Centers |  |  |  | x | x | x | x |  | x |
| 4.4 Density of Groceries, Supermarkets, or Super Centers | x | x | x |  |  | x | x |  |  |
| 4.5 Distance to Large Supermarket or Super Center |  |  |  | $\mathbf{x}$ | x | x | x |  | x |
| 4.6 Density of Large Supermarkets or Super Centers | x | x | x |  |  | x | x |  |  |
| 4.7 Type of Nearest Retail Food Outlet |  |  |  | x | x | x | x |  | x |
| 4.8 Distance to Nearest Convenience Store Including Gas Stations |  |  |  | x | x | x |  |  | x |
| 4.9. Density of Convenience Stores Including Gas Stations | x | x | x |  |  | x | x |  |  |
| 5. YOUTH AND UTILITARIAN OR RECREATIONAL PHYSICAL ACTIVITY |  |  |  |  |  |  |  |  |  |
| DENSITY |  |  |  |  |  |  |  |  |  |
| 5.1 Raw Population per Unit Land Area: See TCWS GIS Protocol 3.1 | x | x | x |  |  |  |  |  | x |
| 5.2 Population per Unit Land Area (without water): See TCWS GIS Protocol 3.2 | x | x | x |  |  |  |  |  | x |
| 5.3 Residential Population in Residential Parcels (Residential Density) (without water): See TCWS GIS Protocol 3.3 | x | x | x |  |  |  |  |  | x |
| 5.4 Employment Per Unit Land Area: See TCWS GIS Protocol 3.6 | x | x | x |  |  | x |  |  |  |
| PEDESTRIAN INFRASTRUCTURE |  |  |  |  |  |  |  |  |  |
| 5.5 Distance to Nearest Transit Stop: See TCWS GIS Protocol 4.10 |  |  |  | x | x |  |  | x |  |
| 5.6 Transit Stop Density: See TCWS GIS Protocol 4.11 | x | x | x |  |  |  |  | x |  |
| LAND-USE MIX |  |  |  |  |  |  |  |  |  |
| 5.7 Percentage of Total Parcel Area in Major Land Uses (residential, commercial, office, industrial, institutional, park and recreation, vacant): See TCWS | x | x | x |  |  |  |  | X |  |


| GIS Protocol 5.1 |  |  |  |  |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| 5.8 Percentage of Land Area in <br> Retail Uses (a subset of the major <br> land uses): See TCWS GIS <br> Protocol 5.4 |  |  |  |  |  |  |  |  |  |

Note: Buffers will be at $200 \mathrm{~m}, 400 \mathrm{~m}, 800 \mathrm{~m}$, and 1600 m from home or school; other distances are possible.

## Appendix 3A: Wikipedia and Quick Serve Restaurant Fast Food Lists

Wikipedia

| A\&W | Dunkin' Donuts |
| :---: | :---: |
| Amigos/Kings Classic | Einstein Bros. Bagels |
| Andy's | El Pollo Loco |
| Arby's | Fatburger |
| Arctic Circle Restaurants | Fazoli's |
| Arthur Treacher's | Filiberto's |
| Atlanta Bread Company | Five Guys |
| Au Bon Pain | Fosters Freeze |
| Back Yard Burgers | Fuddruckers |
| Baja Fresh | Godfather's Pizza |
| Baja Fresh Mexican Grill | Grandy's |
| Baker's Drive-thru | Green Burrito |
| Baskin Robbins | Griff's Hamburgers |
| Big Apple Bagels | Hamburger Stand with Der |
| Big Boy | Wienerschnitzel |
| Blake's Lotaburger | Happy Daz |
| Blimpie | Hardee's |
| Bojangles' | Home Run Inn Pizza |
| Boston Market | Honey Dew Donuts |
| Boston's Gourmet | Hot Dog on a Stick |
| Braum's | Hot Stuff Pizza |
| Brown's Chicken \& Pasta | In-N-Out Burger |
| Bruster's Ice Cream | Jack in the Box |
| Bud's Broiler | Jamba Juice |
| Buffalo Wild Wings | Jason's Deli |
| Bun Boy | Jimmy John's |
| Burger King | Jim's Burger Haven |
| Captain D's Seafood | Kenny Rogers Roasters |
| Carl's Jr. | Kewpee |
| Charley's Grilled Subs | KFC |
| Checkers Drive-In (also called | Krispy Kreme |
| Rally's Drive-In) | Krystal |
| Chester's | L\&L Hawaiian Barbecue |
| Chick-fil-A | La Salsa |
| Chipotle Mexican Grill | Lenny's Sub Shop |
| Chuck E. Cheese's | Little Caesars Pizza |
| Church's Chicken | Long John Silver's |
| CiCi's Pizza | Maid-Rite |
| City Barbeque | McDonald's |
| Cold Stone Creamery | McDonald's |
| Cosi | Milio's Sandwiches |
| Cousins Subs | Milo's Hamburgers |
| Crown Burgers | Moe's Southwest Grill |
| Culver's | Mr. Chicken |
| Culver's | Mr. Sub |
| Dairy Queen | Mrs. Winners Chicken |
| Del Rancho | Nathan's Famous |
| Del Taco | Noah's Bagels |
| Denny's | Ollie's Trolley |
| Dick's Drive-In | Orange Julius |

Papa Murphy's PizzaTake ' N
Bake
Peter Piper Pizza
Pioneer Chicken
Pizza Hut
Pizza Ranch
Popeyes Chicken \& Biscuits
Portillo's
Potbelly Sandwich Works
Qdoba Mexican Grill
Quiznos Subs
Raising Cane's Chicken Fingers
Rally's Hamburgers
Rax Restaurants
Red Burrito
Roy Rogers Family Restaurants
Rubio's
Runza
Sbarro
Schlotzsky's Deli
Shakey's Pizza
Simple Simon's Pizza
Skipper's
Sonic Drive-In
Sonny's Real Pit Bar-B-Q
Starbucks
Starbucks
Steak 'n Shake
Stewart's Drive-In
Submarina
Subway
Taco Bell
Taco Bueno
Taco Cabana
Taco Del Mar
Taco John's
Taco Mayo
Taco Tico
Taco Time
Tastee-Freez
Teriyaki Boy
The Daily Bagel
The Great American Bagel
The Great Steak \& Potato
The Hat
Tim Hortons
Togo's Eateries
Tudor's Biscuit World
Una Mas!
Wendy's

| Dog n Suds | Original Tommy's | Wetzel's Pretzels |
| :--- | :--- | :--- |
| Domino's Pizza | Pal's Sudden Service | Whataburger |
| Donatos Pizza | Panda Express | White Castle |
| Drive-In/Rally's | Panera Bread | Wienerschnitzel |
| Duchess Restaurants | Papa John's Pizza | Winchell's Donuts |
|  |  | Winsteads |
|  |  | Yello Sub |
|  |  | Yum-Yum Donuts |
|  |  | Zaxby's |

Quick Serve Restaurant Magazine online's National Chain Restaurants--QSR 50 (ranked by system-wide sales). The list (with their rank) is as follows:

| Arby's | 11 | Domino's Pizza | 10 | Panera Bread | 18 |
| :--- | :--- | :--- | :--- | :--- | :--- |
| Baja Fresh Mexican Grill | 48 | Drive-In/Rally's | 32 | Papa John's Pizza | 16 |
| Baskin-Robbins | 34 | Dunkin' Donuts | 9 | Papa Murphy's PizzaTake 'N |  |
| Blimpie Subs | 50 | Einstein/Noah's Bagels | 46 | Bake | 42 |
| Bojangles' | 41 | El Pollo Loco | 39 | Pizza Hut | 6 |
| Boston Market | 27 | Fazoll's | 47 | Popeyes | 19 |
| Buffalo Wild Wings | 29 | Hardee's | 17 | Quiznos Classic Subs | 20 |
| Burger King | 2 | Hot Stuff Pizza | 51 | Sbarro | 40 |
| Captain D's Seafood | 36 | In-N-Out Burger | 45 | Sonic Drive-In | 12 |
| Carl's Jr. | 21 | Jack in the Box | 13 | Starbucks | 7 |
| Checkers | 31 | Jason's Deli | 49 | Steak n Shake | 28 |
| Chick-fill-A | 15 | KFC | 8 | Subway | 4 |
| Chipotle | 30 | Krystal | 43 | Taco Bell | 5 |
| Church's Chicken | 24 | Little Caesars Pizza | 26 | Wendy's | 3 |
| CiCi's Pizza | 37 | Long John Silver's | 23 | Whataburger | 22 |
| Cold Stone Creamery | 44 | McDonald's | 1 | White Castle | 33 |
| Culver's | 38 | Panda Express | 25 |  |  |
| Dairy Queen | 14 |  |  |  |  |
| Del Taco | 35 |  |  |  |  |

## Appendix 4A: Wikipedia Supermarket List

| 99 Ranch Market - The largest Asian American supermarket chain on the West Coast. <br> Ai Hoa Supermarket - Formerly a large Chinese- | Asian |  |
| :---: | :---: | :---: |
| Vietnamese American chain in southern California, now operates one store in Chinatown, Los Angeles | Asian |  |
| Diho Supermarket - Chinese American Hong Kong Supermarket - Chinese American | Asian |  |
| supermarket chain. <br> Island Pacific Supermarket - Filipino American chain | Asian |  |
| in California and Nevada | Asian |  |
| Marukai - Japanese American supermarket. <br> Mitsuwa - Japanese American supermarket chain of | Asian |  |
| Southern California. | Asian |  |
| Seafood City - Filipino American supermarket chain. Shun Fat Supermarket - Chinese American | Asian |  |
| supermarket. <br> Uwajimaya - Asian American supermarket chain in | Asian |  |
| the Pacific Northwest. | Asian |  |
| Aldi (the US operations of a German group) | discount chains |  |
| Food 4 Less | discount chains |  |
| Grocery Outlet (west) | discount chains |  |
| Marc's | discount chains |  |
| Price Chopper (New York and Pennsylvania) | discount chains |  |
| PriceRite (Connecticut, New York, Massachusetts, |  |  |
| Rhode Island and Pennsylvania--Owned by Wakefern) Supervalu (midwest, mixed franchiser and directly- | discount chains |  |
| owned stores, uses banners: Cub Foods, Save-A-Lot and more ) | discount chains |  |
| WinCo Foods (west) | discount chains |  |
| Fiesta Supermarket - Mexican-American, primarily |  |  |
| in Texas | Hispanic/Latino |  |
| Publix Sabor - Hispanic, operated by Publix. | Hispanic/Latino |  |
| Superior Warehouse - Mexican American | Hispanic/Latino |  |
| Supermercados Gigante - Mexico-based supermarket |  |  |
| chain with locations in the US. | Hispanic/Latino |  |
| Acme | National chains | supervalu |
| Albertsons | National chains | supervalu |
| Albertsons LLC | National chains |  |
| Baker's | National chains | Kroger |
| bigg's | National chains | supervalu <br> Delhaize Group (Belgian company's US |
| Bloom | National chains | subsidiaries) |
| Bristol Farms | National chains | supervalu |
| Carrs | National chains | safeway |
| Costco | National chains |  |
| County Market | National chains |  |
| Cub Foods | National chains | supervalu |


| Dillon's | National chains | Kroger |
| :---: | :---: | :---: |
| Dominick's | National chains | safeway |
| Farm Fresh | National chains | supervalu |
| Farmer Jack | National chains | A and P |
| Food 4 Less | National chains | Kroger |
| Food Emporium | National chains | A and P Delhaize Group (Belgian company's US |
| Food Lion | National chains | subsidiaries) |
| FoodsCo | National chains | Kroger |
| Fred Meyer | National chains | Kroger |
| Fry's Food | National chains | Kroger |
| Genuardi's | National chains | safeway <br> Ahold (Dutch company's |
| Giant Food (Maryland) | National chains | US subsidiaries) <br> Ahold (Dutch company's |
| Giant Food (Pennsylvania) | National chains | US subsidiaries) Delhaize Group (Belgian company's US |
| Hannaford | National chains | subsidiaries) |
| Harris Teeter | National chains |  |
| Harvey's | National chains | Delhaize Group (Belgian company's US subsidiaries) |
| Henhouse | National chains |  |
| Hornbacher's | National chains | supervalu |
| Jay C | National chains | Kroger |
| Jewel/Jewel-Osco | National chains | supervalu <br> Delhaize Group (Belgian company's US |
| Kash n' Karry | National chains | subsidiaries) |
| King Soopers | National chains | Kroger |
| Kmart | National chains |  |
| Kroger | National chains | Kroger |
| Lazy Acres | National chains | supervalu |
| Lucky Stores (used to be Max Foods) ( 3 locations |  |  |
| Alhambra, El Centro, and Montebello, CA) | National chains | supervalu |
| Pavilions | National chains | safeway |
|  |  | Ahold (Dutch company's |
| Peapod | National chains | US subsidiaries) |
| Piggly Wiggly | National chains |  |
| QFC | National chains | Kroger |
| Ralphs | National chains | Kroger |
| Randalls | National chains | safeway |
| Safeway | National chains | safeway |
| Save-A-Lot | National chains | supervalu |
| Scott's Food \& Pharmacy | National chains | supervalu |
|  |  | Ahold (Dutch company's |
| see also: Giant-Stop \& Shop | National chains | US subsidiaries) |
| Shaw's | National chains | supervalu |
| Shop 'n Save | National chains | supervalu |

Shop 'n' Save (Singapore, not the Shop 'n Save owned by SuperValu)
Shoppers Food \& Pharmacy
Smiths
Star Market
Stop \& Shop
Sunflower Market
Super Saver Foods
SuperValu
Target Stores
Tom Thumb
Tops
Vons
Waldbaum's
Wal-Mart
Whole Foods
WinCo Foods
Winn-Dixie
Acme Fresh Market, operating in the Akron, Ohio area
Andronico's (California)
Bashas' (Arizona)
Big Y Foods (New England)
Bi-Lo Foods
Brookshire Brothers (Texas) A brother of the
Brookshires mentioned above.
Brookshire's Also runs Super1 Foods in East Texas and Shreveport, LA (Texas \& Louisiana)
Buehler's Buy-Low (Indiana, Illinois, Kentucky)
Byerly's
Cannata's Family Market (southern Louisiana)
Clemens (PA)
Copps Food Center
Copps Food Center (Wisconsin)

National chains
National chains
National chains
National chains

National chains
National chains
National chains
National chains
National chains
National chains

National chains
National chains
National chains
National chains
National chains
National chains
National chains
Regional/local chains
Regional/local chains
Regional/local chains
Regional/local chains
Regional/local chains

Regional/local chains

Regional/local chains
Regional/local chains
Regional/local chains
Regional/local chains
Regional/local chains
Regional/local chains
Regional/local chains Roundy's

| County Market | Regional/local chains |
| :--- | :--- |
| C-Town | Regional/local chains |
| D\&W Food Centers (Michigan) | Regional/local chains |
| D'Agostino's (New York) | Regional/local chains |
| DeMoulas' Market Basket (New England - | Regional/local chains |
| Massachusetts/New Hampshire) | Regional/local chains |
| Fareway (Iowa) | Regional/local chains |
| FasChec (Charleston, West Virginia area) | Regional/local chains |
| Felpausch (Michigan) |  |
| Fiesta Food Stores (Houston, Dallas \& Austin, Texas) | Regional/local chains |
| Hispanic and International foods. | Regional/local chains |
| Food Basket |  |


|  | Food City (Kentucky, Virginia, Tennessee) |
| :---: | :---: |
|  | Food Giant |
|  | FoodFair (Southeast Ohio, Eastern Kentucky, and |
|  | FoodLand (Hawaii) |
|  | FoodLand Supermarkets(Western Pennsylvania) |
|  | Foodtown (Northeast, mainly New Jersey) (a similarly named store, "Food Town", operates in the Houston, Texas area) |
|  | Gerland's (Houston) |
|  | Giant Eagle (eastern United States) |
|  | Glen's (Northern Michigan) |
|  | Grand Union (AKA GU Family Markets) |
|  | Haggen Top Food \& Drug (Washington, Oregon) |
|  | Harding's Friendly Markets (Southwest Michigan) |
|  | H-E-B (Texas) Has expanded in to Mexico and soon |
|  | Louisiana. H-E-B Central Market is a competitor to |
|  | Whole Foods (Health) Largest grocer in Texas. |
|  | Heinen's Fine Foods (Greater Cleveland) |
|  | Hugo's (North Dakota, Minnesota) |
|  | Hy-Vee Food Stores (Hundreds of stores in 7 states) |
|  | Ingles (south) |
|  | Jons (Los Angeles inner-city) |
|  | Karns Foods (Central Pennsylvania) |
|  | Key Food |
|  | King Kullen (Long Island) |
|  | Kowalski's (Minnesota) |
|  | Lowes Foods (North Carolina) |
|  | Lund's (Minnesota) |
|  | Magruder's (Washington, DC region) |
|  | Market Basket (SE Texas and SW Louisiana) |
|  | Mars (Greater Baltimore area) |
|  | Marsh (Indiana and Ohio, includes O'Malia's and LoBill chains) |
|  | Martin's Super Food Stores (New York) |
|  | Martin's Super Markets (Indiana) |
|  | Mayfair |
|  | Meijer (midwest) |
|  | Minyard's (Dallas/Fort Worth Metroplex, operates also under the names "Carnival", an ethnic-oriented line, and "Sack and Save", a discount line) |
|  | Nash Finch Company (Upper midwest) |
|  | Nugget Markets (Northern California) |
|  | Omni Foods (Massachusetts and New Hampshire) |
|  | P\&C Foods |
|  | Pathmark (eastern United States) |
|  | Penn Traffic (Pennsylvania, New York, Vermont, New Hampshire) |
|  | Pick 'n Save (Wisconsin, Illinois) |
|  | Publix (southeast United States) |

Regional/local chains
Regional/local chains
Regional/local chains Regional/local chains Regional/local chains

Regional/local chains Regional/local chains Regional/local chains Regional/local chains Regional/local chains Regional/local chains Regional/local chains

Regional/local chains Regional/local chains Regional/local chains Regional/local chains Regional/local chains Regional/local chains Regional/local chains Regional/local chains Regional/local chains Regional/local chains Regional/local chains Regional/local chains Regional/local chains Regional/local chains Regional/local chains

Regional/local chains Regional/local chains Regional/local chains Regional/local chains Regional/local chains

Regional/local chains Regional/local chains Regional/local chains Regional/local chains Regional/local chains Regional/local chains

| Regional/local chains | Penn traffic |
| :--- | :--- |
| Regional/local chains | Roundy's |
| Regional/local chains | Penn traffic |

lunds

Penn traffic

Penn traffic

Penn traffic

| Publix (southeastern US) | Regional/local chains |  |
| :---: | :---: | :---: |
| Quality Markets | Regional/local chains | Penn traffic |
| Quality Markets (New York and Pennsylvania) | Regional/local chains |  |
| Rainbow Foods (Minnesota) | Regional/local chains | Roundy's |
| Raley's (western U.S., own Nob Hill and Bel Air) | Regional/local chains |  |
| Rice Supermarkets Also *Rice Epicurean Markets (Houston) | Regional/local chains |  |
| Riverside Markets | Regional/local chains | Penn traffic |
| Robèrt's Fresh Market* (New Orleans, Louisiana Metro area) | Regional/local chains |  |
| Roundy's | Regional/local chains | Roundy's |
| Rouse's Supermarket (Louisiana) | Regional/local chains |  |
| Safeway (aka Preston-Safeway, unrelated to Safeway |  |  |
| Inc.; Central Indiana) | Regional/local chains |  |
| Save-Mart (California) | Regional/local chains |  |
| Schnucks (Missouri, Illinois, Indiana) | Regional/local chains |  |
| Scolari's Food and Drug (California, Nevada) | Regional/local chains |  |
| Sears Grand (nationwide) | Regional/local chains |  |
| Sendik's Food Market (Wisconsin) | Regional/local chains |  |
| Sentry Foods (Wisconsin) | Regional/local chains |  |
| Simon Delivers (Minneapolis/St. Paul, |  |  |
| Minnesota/Wisconsin online grocery) | Regional/local chains |  |
| Spartan Stores (Michigan) | Regional/local chains |  |
| Stater Brothers (California) | Regional/local chains |  |
| Stew Leonard's (New York City metropolitan area) | Regional/local chains |  |
| Stewart's Shops (New York and Vermont) | Regional/local chains |  |
| Strack and Van Til (Northwestern Indiana) | Regional/local chains |  |
| Sullivan's Foods (Northern \& Central Illinois) | Regional/local chains |  |
| Sunshine Foods (Upper Mid-west) | Regional/local chains |  |
| Turco's (New York) | Regional/local chains |  |
| Ukrop's (central Virginia) | Regional/local chains |  |
| United (West Texas) | Regional/local chains |  |
| Victory (soon to be defunct, Massachusetts \& New |  |  |
| Hampshire) | Regional/local chains |  |
| Wade's (Virginia) | Regional/local chains |  |
| Wegmans (Northeast) | Regional/local chains |  |
| Weis Markets - Mid-Atlantic (Pennsylvania, Maryland, New York, New Jersey, West Virginia) | Regional/local chains |  |
| Westborn Market (Southeast Michigan) | Regional/local chains |  |
| Whitefront - California (defunct) | Regional/local chains |  |
| Wilson Farms (Upstate New York) | Regional/local chains |  |
| Woodman's Food Market (Wisconsin, Northern Illinois) | Regional/local chains |  |
| Affiliated Food Stores | Retailers cooperatives |  |
| Affiliated Foods Midwest | Retailers cooperatives |  |
|  |  | Associated Wholesale |
| Apple Market | Retailers cooperatives |  |
| Associated Food Stores | Retailers cooperatives |  |
| Associated Grocers | Retailers cooperatives |  |
| Associated Grocers of Florida | Retailers cooperatives |  |
| Associated Grocers of the South | Retailers cooperatives |  |


| Associated Wholesale Grocers |  | Associated Wholesale <br> Associated Wholesalers |
| :--- | :--- | :--- |
| Retailers cooperatives <br> Cash Saver | Retailers cooperatives | Retailers cooperatives |
| Central Grocers Cooperative | Retailers cooperatives <br> Grocers | Associated Wholesale |
| Country Mart | Retailers cooperatives <br> Retailers cooperatives | Grocers |
| IGA | Retailers cooperatives | Associated Wholesale |
| Grocers |  |  |

## REFERENCES

Alexander, Ernest. 1993. Density measures: A review and analysis. Journal of Architectural and Planning Research 10, 3: 181-202.
Andersen, R. E., T. A. Wadden, S. J. Bartlett, B. Zemel, T. J. Verde, and S. C. Franckowiak. 1999. Effects of lifestyle activity vs. structured aerobic exercise in obese women: a randomized trial. Journal of the American Medical Association. 281, 4:335-40, Jan. 27.
Audirac, Ivonne. 1999. Stated preference for pedestrian proximity. Journal of Planning Education and Research. 19: 53-66.
Austin, SB, SJ Melly, BS Sanchez, A Patei, S. Buke, and S. Gortmaker. 2005. Clustering of fastfood restaurants around schools: A novel application of spatial statistics to the study of food environments. American Journal of Public Health 95, 9: 1575-1581.
Badland, Hannah and Grant Schofield. 2005. Transport, urban design, and physical activity: an evidence-based update. Transportation Research Part D: 177-196.
Ball, Kylie, Adrian Bauman, Eva Leslie, and Neville Owen. 2001. Perceived environmental aesthetics and convenience and company are associated with walking for exercise among Australian adults. Preventive Medicine 33: 434-440.
Block, J.P., R.A. Scribner, and K.B. DeSalvo. 2004. Fast Food, Race/Ethnicity, and Income: A Geographical Analysis. American Journal of Preventive Medicine 27, 3: 211-217.
Boarnet, M. G., and S. Sarmiento. 1998. Can land-use policy really affect travel behavior? A study of the link between non-work travel and land-use characteristics. Urban Studies 35(7):1155-1169.
Boarnet, Marlon, and Kristen Day. 2004a. Assessing built environment features linked to physical activity. Presentation at Active Living Research Annual Conference, San Diego, January.
Booth, Katie, Megan Pinkston, Walker Poston. 2005. Obesity and the Built Environment. Journal of the American Dietetic Association 105: S110-117.
Burdette, H. and R.C. Whitacker. 2003. Neighborhood playgrounds, fast food restaurants, and crime: relationships to overweight in low-income preschool children. Preventive Medicine 38: 57-63.
Cervero, R., and R. Gorham. 1995. Commuting in transit versus automobile neighborhoods. Journal of the American Planning Association; 61:210-225.
Cervero, Robert, and Kara Kockelman. 1997. Travel demand and the 3 Ds: Density, diversity, and design. Transportation Research; D, 2, 3: 199-219.
Cervero, Robert, and Michael Duncan. 2003. Walking, bicycling, and urban landscapes: Evidence from the San Francisco Bay area. American Journal of Public Health 93(9): 14781483.

Chung C. and S.L. Myers. 1999. Do the poor pay more for Food? An analysis of grocery store availability and food price disparities. Journal of Consumer affairs 33, 2: starts at page 276.
Churchman, Arza. 1999. Disentangling the concept of density. L Plan Lit 13, 4: 389-411.
Crane, Randall, and Richard Crepeau. 1998. Does neighborhood design influence travel? Behavioral analysis of travel diary and GIS data. UCTC Working Paper. Berkeley: University of California Transportation Center.
Crane, Randall. 2000. The influence of urban form on travel: An interpretive review. Journal of Planning Literature 15, 1: 3-23.

Day, Kristen, and Mariela Alfonzo. 2004. Measuring urban design features related to walking and bicycling. Presentation at the Assoc. of Collegiate Schools of Planning Conf., Portland, October.
Day, Kristen, Marlon Boarnet, Mariela Alfonzo, Ann Forsyth, 2006. The Irvine Minnesota Inventory to Measure Built Environments: Development. American Journal of Preventive Medicine 30, 2: 144-152.

Day, Kristen, Marlon Boarnet, Mariela Alfonzo, Ann Forsyth. 2005. The Irvine-Minnesota Urban Design Inventory (inventory, training package and instructions). Irvine: University of California Irvine.
Day, Kristen,, Marlon Boarnet, Mariela Alfonzo, Ann Forsyth, J. Michael Oakes, 2006. The Irvine Minnesota Inventory to Measure Built Environments: Reliability Tests. American Journal of Preventive Medicine 30, 2: 153-259.
Dill, Jennifer. 2003. Measuring network connectivity for bicycling and walking. July 17 draft. Presented at the Joint Cong. of ACSP-AESOP, Leuven, Belgium.
Duncan, O. D., and B. Duncan. 1955. A methodological analysis of segregation indexes. American Sociological Review 20: 210-217.
Dunphy and Fisher. 1996. [Citation to add.]
Ewing, Reid, Tom Schmid, Richard Killingsworth, Amy Zlot, and Stephen Raudenbush. 2003. Relationship between urban sprawl and physical activity, obesity, and morbidity. American Journal of Health Promotion 18, 1: 47-57.
Forsyth, Ann ed. 2005. Environment and Physical Activity: GIS Protocols. Versiona 3.1 and following. Minneapolis: Design Center.
Forsyth, Ann, Kathryn H. Schmitz, Michael Oakes, Jason Zimmerman, and Joel Koepp. 2006 Standards for Environmental Measurement using GIS: Toward a Protocol for Protocols. Journal of Physical Activity and Health 3, S1: 241-s257
Forsyth, Ann, Michael Oakes, and Kathryn H. Schmitz. 2004a. Observational measures of the physical environment: Testing and modifying the Boarnet-Day Inventory. Revised after presentation at the Assoc. of Collegiate Schools of Planning Conf., November.
Forsyth, Ann. 2000. Analyzing public space at a metropolitan scale: Notes on the potential for using GIS. Urban Geography 21, 2: 121-147.
Forsyth, Ann. 2003. Measuring Density: Working Definitions for Residential Density and Building Intensity. Design Brief 9. Minneapolis: Design Center.
Forsyth, Ann. 2004a. Community Design: A Toolkit for Building Physical Activity into Daily Life. Minneapolis: Design Center.
Forsyth, Ann. Forthcoming. Density. Encyclopedia of the City. Edited by Roger Caves. New York: Routledge.
Frank, Lawrence D., and Gary Pivo. 1994. Impacts of mixed use and density utilization of three modes of travel: Single-occupant vehicle, transit, and walking. Transportation Research Record 1466:44-52.
Frank, Lawrence D., and P. O. Engelke. 2001. The built environment and human activity patterns: Exploring the impacts of urban form on public health. Journal of Planning Literature;16, 2: 202-218.
Giles-Corti, Billie, and Robert J. Donovan. 2003. Relative influences of individual, social environmental, and physical environmental correlates of walking. American Journal of Public Health 93, 9: 1583-1589.
Grant, Jill. 2002. Mixed use in theory and practice. Journal of the American Planning Association 68, 1: 71-84.
Handy, Susan, Marlon G. Boarnet, Reid Ewing, and Richard E. Killingsworth. 2002. How the
built environment affects physical activity: Views from urban planning. American Journal of Preventive Medicine 23, 2S: 64-79.
Handy, Susan. 1992. Regional versus local accessibility: Implications for nonwork travel. Transportation Research Record 1400:58-66.
Handy, Susan. 1996a. Methodologies for exploring the link between urban form and travel behavior. Transportation Research Record 1, 2:151-165.
Handy, Susan. 1996b. Urban form and pedestrian choices: Study of Austin neighborhoods. Transportation Research Record 1552:135-144.
Handy, Susan. 1996c. Understanding the link between urban form and nonwork travel behavior. Journal of Planning Education and Research 15, 3: 183-198.
Handy, Susan. 2003. Critical assessment of the literature on the relationships among transportation, land use, and physical activity. Paper prepared for the TRB and the Institute of Medicine Committee on Physical Activity, Health, Transportation, and Land Use; Nov. 24. Draft.
Hess, Paul M., Anne Vernez Moudon, Mary Catherine Snyder, and Kiril Stanilov. 1999. Neighborhood site design and pedestrian travel. Transportation Research Record, 1674:919.

Hoehner, Christine M., Laura K. Brennan, Ross C. Brownson, Susan L. Handy, and Richard Killingsworth. 2003. Opportunities for integrating public health and urban planning approaches to promote active community environments. American Journal of Health Promotion 18(1): 14-20.
Horowitz, Z, KA Colson, PL Herbert, and K Lancaster. 2004. Barriers to buying healthy foods for people with diabetes: Evidence of environmental disparities. American Journal of Public Health 94, 9: 1549-1554.
Humpel, Nancy, Neville Owen, and Eva Leslie. 2002. Environmental factors associated with adults' participation in physical activity. American Journal of Preventive Medicine 22, 3: 188-199.
Kaufman, P.R. 1999. Rural poor have less access to supermarkets, large grocery stores. Rural Perspectives 13, 3: 19-26.
Krizek, K, A. El-Geneidy, and J. Horning. 2007. Parcel Level Land Use and Determining Motorized and on-Motorized Accessibility. PowerPoint. Minneapolis: Active Communities and Transportation Research Group.
Krizek, Kevin. 2000. Pretest-posttest strategy for researching neighborhood scale urban form and travel behavior. Transportation Research Record, 1722:48-55.
Krizek, Kevin. 2003b. Operationalizing neighborhood accessibility for land use-travel behavior research and regional modeling. Journal of Planning Education and Research 22, 3: 270-287.
Krizek, Kevin. 2003a. Residential relocation and changes in urban travel: Does neighborhoodscale urban form matter? Journal of the American Planning Association 69 ,3: 265-281.
Laraia, B., A.M. Siega-Riz, J Kaufman, And S.J. Jones. 2004. Proximity of supermarkets is positively associated with diet quality index for pregnancy. Preventive Medicine 39; 869875.

Lund, Hollie. 2003. Testing the claims of new urbanism: Local access, pedestrian travel, and neighboring behaviors. Journal of the American Planning Association 69, 4: 414-429.
Massey, D. S., and N. A. Denton. 1988. The dimension of residential segregation. Soc Forces 67: 281-315.
McCann, Barbara A., and Reid Ewing. 2003. Measuring the health effects of sprawl: A national analysis of physical activity, obesity and chronic disease. Smart Growth America Surface Transportation Policy Project.

McNally, Michael G. and Anup Kulkarni. 1997. Assessment of influence of land-use transportation system on travel behavior. Transportation Research Record 1607: 105-115.
Moore, LV and AV Diez Roux. 2006. Associations of Neighborhood Characteristics with the Location and Type of Food Stores. American Journal of Public Health 96, 2: 325-331.
Morland, , S. Wing, A Diez Riux, C. Poole. 2002. Neighborhood Characteristics Associated with the Location of Food Stores and Food Service places. American Journal of Preventive Medicine, 22: 23-29.
Morland, K., S. Wing, A Diez Riux. 2002. The contextual Effect of the Local Food Environment on Residents' Diets: the Atherosclerosis Risk in Communities Study. American Journal of Public Health 92, 11: 1761-1767.
Moudon, Anne Vernez, and Chanam Lee. 2003. Walking and bicycling: An evaluation of environmental audit instruments. American Journal of Health Promotion 18(1): 21-37.
Moudon, Anne Vernez, and P. Hess. 2000. Suburban clusters: The nucleation of multifamily housing in suburban areas of the central Puget Sound. Journal of the American Planning Association 66, 3: 243-264.
Moudon, Anne Vernez, Chanham Lee, Allen Cheadle, Cheza Collier, Donna Johnson, Robert Weathers, Jean-Ives Courbois, and Phil Hurvitz. 2004. Walkable and bikable communities project: A draft report on findings from the walking models. Seattle: University of Washington Urban Form Lab.
Moudon, Anne Vernez, P. Hess, M. Snyder, and K. Stanilov. 1997. Effects of site design on pedestrian travel in mixed use, medium density environments. Report WA-RD 431.1. Olympia: Washington State Department of Transportation.
Oakes, J. M. 2004. The (mis)estimation of neighborhood effects: Causal inference for a practicable social epidemiology. Social Science and Medicine 58:1929-52 (with discussion and rejoinder).
Oakes, J. M. and P. H. Rossi. 2003. The measurement of SES in health research: current practice and steps toward a new approach. Social Science and Medicine 56:769-84.
Pereira, MA, A Kartashov, C Ebbeling, L Van Horn, M Slattery, D Jacobs, D. Ludwig. 2005. Fastfood habits, weight gain, and insulin resistance (the CARDIA study): 15 year prospective analysis. Lancet 365: 36-42.
Roman, M. 2001. Users' handbook version 1.0. Ramsey County GIS Users' Group.
Saelens, Brian, James Sallis and Lawrence Frank. 2003. Environmental correlates of walking and cycling: Findings from the transportation, urban design, and planning literatures. Annals of Behavioral Medicine 25, 2: 80-91.
Sallis, J. F., A. Bauman, and M. Pratt. 1998. Environmental and policy interventions to promote physical activity. American Journal of Preventive Medicine,15 4:379-397.
Sallis, J. F., M. Hovell, C. Hofstetter, J. Elder, M. Hackley, C. Caspersen, and K. Powell. 1990. Distance between homes and exercise facilities related to frequency of exercise among San Diego residents. Public Health Report 105:179-185.
Sallis, J. F., M.F. Johnson, K. J. Calfas, S. Caparosa, J. Nichols. 1997. Assessing perceived physical environment variables that may influence physical activity. Research Quarterly Exercise Sport 68:345-351.
Schimek, Paul. 1996. Household motor vehicle ownership and use: How much does residential density matter? Transportation Research Record 1552: 120-125.
Song, Yan, and Gerrit-Jan Knaap. 2004. Measuring urban form. Journal of the American Planning Association 70, 2: 210-225.
Southworth, M. 1997. Walkable communities? An evaluation of neotraditional communities on the urban edge. Journal of the American Planning Association, 63, 1: 28-44.

Steiner, R. L. 1994. Residential density and travel patterns: Review of the literature. Transportation Research Record, 1466:37-43.
Steiner, R., A. Bond, D. Miller, and P. Sand. Future Directions for Multimodal Areawide Level of Service Handbook: Research and Development. Florida Department of Transportation, Office of Systems Planning, Contract BC-345-78, 2004.
Takano, T., K. Nakamura, and M. Watanabe. 2002. Urban residential environments and senior citizens' longevity in megacity areas: The importance of walkable green spaces. Journal of Epidemiology and Community Health 56: 913-918.
Turner, M. G., R. H. Gardner, and R.V. O’Neill. 2001. Landscape Ecology in Theory and Practice: Pattern and Process. New York: Springer Verlag.
US Census Bureau. 2005. 2004 First Edition TIGER/Line® Technical Documentation. Washington, DC: US Census.
US Department of Transportation, Federal Highway Administration. 1999a. Guidebook on Methods to Estimate Non-Motorized Travel: Overview of Methods. FHWA-RD-98-165. McLean, VA: FHWA.
US Department of Transportation, Federal Highway Administration. 1999b. Guidebook on Methods to Estimate Non-Motorized Travel: Supporting Documentation. FHWA-RD-98-166. McLean, VA: FHWA.
Zenk, S., A Shulz, B. Israel, S. James, S. Bao, and M. Wilson. 2005. Neighborhood Racial Composition, Neighborhood Poverty, and the Spatial Accessibility of Supermarkets in Metropolitan Detroit. American Journal of Public Health 95, 4: 660-667.

