A Multi-Level Health Assessment of Flint, Michigan

by

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Abstract

The quality of the public's general health depends on the accessibility and quality of public assets, the way that people live, work, learn, grow, struggle, and play together (Judy Kurland, 2000). Ecological theory suggests that by evaluating and altering these conditions, it is possible to influence health behavior and, thus, the health outcomes of populations and their constituent individuals.

Various aspects of one's community can either encourage or discourage public health. Accessibility and availability of products, physical characteristics and structures, inaccessible or poorly resourced health services, neighborhood socioeconomics, deteriorated neighborhoods, and the media are all examples of factors that can influence one's health.

In this study the health of the city of Flint was researched by examining the features and characteristics of zip code areas using a variety of data sources and methodologies, including secondary health and census data, neighborhood drive-thrus and photographs, documenting grocery stores prices, and through mapping neighborhood resources and health data using Geographic Information Systems (GIS). Because of the varied nature of the data collected, different data analyses techniques were used.

A focused comparison of 5 health issues in two zip codes showed that no one variable in particular stood out as a major correlate of the health differences between the two zip codes. The data suggest that numerous factors jointly influence the health of the population, including lower income, fewer job opportunities, and less desirable neighborhood environment.

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I. Introduction

The quality of the public's general health depends on the accessibility and quality of our public assets, the way that people live, work, learn, grow, struggle, and play together (Judy Kurland, 2000).

Examining public health is important because it allows one to determine the overall health of a particular population (Friis 1999). Although health indicators (e.g. infant mortality rates) are a good way to measure the public's health, they do not provide the full picture. Equally important to looking at the health indicators is exploring the characteristics and features of the environment in which the population lives. Ecological theory suggests that by evaluating and altering the conditions in which people live, work, learn, grow, struggle, and play together, it is possible to influence health behavior and, subsequently, the health outcomes of populations and their constituent individuals.

Large sums of money are spent for alleviating ill health through individual-level interventions each year (Krieger 1994, 1999; Cohen 1999). These interventions consider the individual's behavior, yet rarely do they consider other influencing factors. More time and money is spent on addressing the individuals' ill health than is spent on evaluating and addressing the larger community's well being. However, individual characteristics, including personality and behavior, may be less important in predicting health behavior and health outcomes than the conditions of life, including adequate housing, employment opportunities, and safe, low-crime neighborhoods (Cohen et al. 2000; Marmot 1991, 1998; McKinlay 1993; Thomas 1999).

Ecological theory supports analyzing both micro (individual) and macro (social) level influences. This approach balances the focus on individual's risk factors for ill health and the social and environmental structures in which they occur.

Numerous tools exist for individual-level assessment and health statistics and indicators provide an overall picture of the population's health. However, one of the obstacles faced by health professionals in utilizing macro level influences is identifying appropriate tools to analyze environmental, physical and social structures within a community. In contrast to interventions with individuals (e.g. patients with a condition or subjects with particular risk factors), higher-level interventions must be assessed through the use of higher-level factors independent of individuals and their risky behaviors (McKinlay and Marceau 1999). There are few known and validated tools available.

One promising tool, however, is the geographic information system (GIS) (Mckinlay and Marceau 1999). GIS allows researchers to capture the interaction between individual variables and the physical, social, and environmental structures of community. GIS software allows maps to be displayed and superimposed on one other to assess spatial relations among variables so that geographic regions, (e.g. census tracts), can be linked to points, such as location of health facilities. GIS technology can also provide information on social contextual factors, such as neighborhood characteristics.

The purpose of this research is twofold. First, the research is meant to present a model that analyzes macro-level influences in a community setting through various methodologies. This is in response to the recognition of the multiple-levels of influence that affect one's behavior and health. Behavior and health is influenced by individual-level attributes as well as by the conditions under which people live (Cohen et al. 2000).

Examining the characteristics and features of a community is seldom done. There have been numerous studies that focus on the physical environment such as water quality, air quality and climate on health. However, there has been little research done in assessing the relationship of social contexts and health, and in examining the differences between areas in terms of features of the places themselves (Macintyre et al. 1993). This paper will contribute to the limited research thus far.

Secondly, the paper advocates for looking at the characteristics of areas as a topic of investigation in its own right. It is important to achieve this in order to provide detailed and empirical information about the experiences of people in different class positions and in different types of areas, and to suggest avenues for social policy (Cohen et al. 2000). The methods used in this research are applicable to any defined "community setting" and are meant to be a guide for others conducting research in communities.

This research will examine the "health" of the City of Flint, Michigan by assessing the existing physical, social and environmental structures of the community through census data, health statistics, neighborhood drive-thrus, grocery store comparisons, and finally, by locating available services and resources within the area.

Geographical information systems will be used as a tool to present a visual picture of the conditions and as a mechanism to locate and map various resources within the area. Linking health outcomes with demographic, social, and health environments allows a reorientation towards more direct population-based, social, and institutional explanations for health differentials (Lang, 2000).

Literature Review

The Debate: Ecological versus Individualistic

Several authors have reviewed the continuing controversy regarding the battle between "risk factors" (or individualistic) approach and the "social epidemiology" or (ecological) approach (Krieger 1994, 1996, 1997, 1999; Susser 1996, 1998; Zierler 1997; McMichael 1998, 1999; Pearce 1996; Shy 1997; Davey 1996; Minkler 1999; Wilkinson 1996).

According to Rose (1985), the difference between these approaches can be explained by the type of question being asked; 1) "Why do some individuals have hypertension?" versus 2) "Why do some populations have much hypertension, whilst in others it is rare?" If one tries to explain the first question, individual behavior and/or genetics would be examined and, if one attempts to answer the second question, the environment in which the individual lives would be explored.

Each perspective is wrought by certain fallacies. Those who favor the individualistic approach propose the "ecological fallacy". The ecological fallacy is a logical fallacy inherent in making causal inferences from group data to individual behaviors. It is not feasible to generalize data collected at the group level to individuals (Morgenstern 1982; Schwartz 1994). However, the same can be said in inferring that risk factors for diseases in individuals can be summed to understand the causes of disease in populations, or that the health of a population can be explained entirely in terms of the characteristics of individuals; this is often called the "biomedical fallacy" and/or "atomistic fallacy" (Krieger et al. 1997; Shy 1997). A combination of both types of data, group level and individual level, might be the more effective method.

In response to the individualistic versus ecological debate, health behavior theories tend to fall on either one side of the debate or the other. For example the Health Belief, Stages of Change, the Theory of Reasoned Action and Planned Behavior, and Stress and Coping models focus primarily on individual behavior. On the other hand the Social Cognitive theory, Social Networks and Social Support, Diffusion of Innovations, and Community Building models tend to address the interactions between an individual and their surrounding environments (Sallis and Owen 1997).

The ecological model focuses on both individual and societal aspects that impact one's health. The following section will further describe the ecological and individualistic perspectives and provide evidence for the value of combining the two approaches.

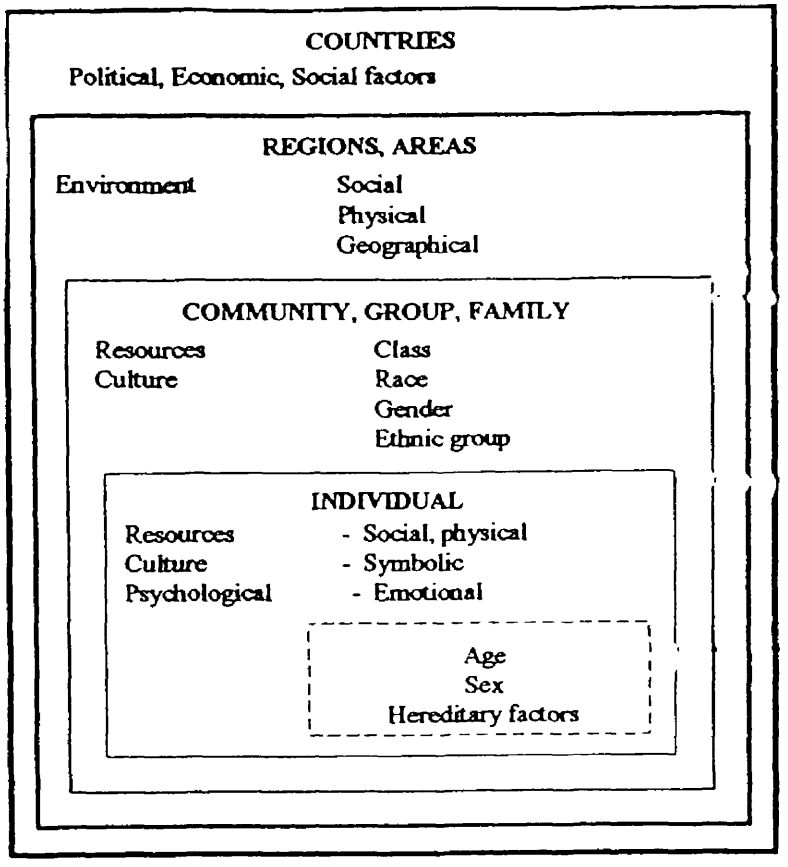
Theoretical Framework: Ecological Model

The ecological model of health promotion proposes that health is the product of the individual's continuous interaction and interdependence with his or her ecosphere-that is, the family, the community, the culture, the societal structure, and the physical environment (Bracht 1990; Minkler 1999). A major premise of ecological theory is that environmental factors are critical determinants of individual behavior.

The theory proposes that one's behavior is influenced not only by one's own personal make-up (intrapersonal), but also by the social and cultural environment (family, friends, culture), and the physical environment (climate, geography, environmental pollution, water quality, etc.) in which one lives. This aspect of exploring both proximal (near) and distal (far) environmental factors on one's behavior sets the ecological model apart from other theories of behavioral change. (Figure 1)

Figure 1

Ecological Model
Levels of Influence



(Benach 1997)

A main strength of the ecological model is that it encourages one to realize how the individual relates to the larger community and society. It brings into play very basic needs that are often taken for granted (clean water, safe neighborhoods, pollution, climate, etc.). However, these factors have a major impact on one's behavior and health. One's behavior both influences and is influenced by the environment (Moos 1996; Stokols 1992; Hovell 1994; Thompson 1990; Pappas et al. 1993; Kennedy et al. 1996; Wilkinson 1999). This basic idea of the ecological theory is defined as *reciprocal*

causation. For example, drinking unclean water can affect one's health by causing illness. The environment influences one's health. However, if individuals lobby to purify the water then those actions influence the environment. Therefore, one's behavior both influences and is influenced by the environment.

Another strength of the model is that it stresses the impact of policy decisions on health behaviors. For example, when California passed a law to ban cigarette smoking from all restaurants, this forced people to stop smoking in the restaurants and, also reduced second-hand smoke exposure to others. The impact was much larger than can be accomplished through one on one counseling with a client.

Another widely documented example dates back to the 19th century in John Snow's research. Snow was able to link a cholera epidemic to contaminated water supplies in London, England. Snow demonstrated that a disproportionate number of residents who came down with cholera used water from one water company in particular, which received polluted water, in comparison to another water company, which used unpolluted water. Once the handle on the water pump, which was receiving contaminated water was removed, the number of cholera cases dropped significantly (Friis 1999). By removing the water pump handle, people were forced to stop using that pump, which had a large effect on health outcomes.

Individualistic Model

During the 19th century, advances in the health of the population came from improvements in nutrition, sanitation, and the general living condition. Interventions focused on conditions beyond individual control, such as the social and physical environments.

However, in the 20th century, the focus shifted from the environment to individual behavior. The individualistic view emerged in the 1970s in response to a growing disenchantment with the limits of medicine, pressures to contain health care costs, and a social and political climate emphasizing self-help and individual control over health – personal responsibility (Minkler 1994,1999; Reiser 1985; Walker 1994). Ecological analysis has increasingly been seen as a second-rate way to approach individual risks because it is believed that further advances in health will come from the revolution in molecular biology and genetic approaches to combating disease (Marmot 1998).

Annually millions of dollars are spent on alleviating ill health through individual-level interventions. From this perspective, interventions center primarily on changing individual behaviors and lifestyles (Rose 1985; Krieger 1994,1999; Lomas 1998; Bunker 1997; Diez-Roux et al. 1997). Examples of interventions that use an individual-level approach to change behavior include counseling and education. These types of interventions attempt to influence knowledge, attitudes, skills, and beliefs of the individual. These interventions tend to focus on those with the high-risk behavior and attempt to move the individuals toward practicing lower-risk behaviors. For example, an individual-level intervention to reduce the chances of cardiovascular disease counsels persons with high-risk behaviors to lower fat intake, exercise regularly and stop smoking. For individuals at risk for the transmission of AIDS, interventions counsel people to reduce the number of sex partners, to be abstinent or use condoms, and not to share needles.

McGinnis and Foege (1993) compiled the leading causes of death for Americans under 75, not by disease, but rather by "actual" cause; tobacco, diet, alcohol, firearms,

sexual behavior, illicit use of drugs, motor vehicles, microbial agents, toxic agents and exercise. These individual behavior factors were found to constitute the greatest causes of premature death.

It is true Americans do not have the healthiest lifestyles in the world. The United States has record rates of obesity and eating disorders, and fully 35% of all Americans and 21% of teenagers were overweight in the mid-1990s. Tobacco accounts for over 400,000 deaths per year and more than 60% of adults are not physically active on a regular basis (Minkler, 1999). There is a great deal of evidence supporting the importance of individual responsibility for health (Kayman 1990; Berkman 1983; McGinnis 1993; Callahan 1986; Center for Disease Control 1997).

However, the individual-level approach has been called the Theory of Bad Apples (Cohen et al. 2000). It places the blame and/or responsibility of disease and health on the individual, i.e. individual behavior is in a large part responsible for the health problems we face in society. Although individual behavior choices do contribute to one's disease or health state, the social context in which those choices are made must also be taken into account.

Critique of Individualistic Approach

Mckinlay and Marceau (2000) questioned the extent to which individual behavior contributes to health. The authors cited the ongoing Massachusetts Male Aging Study that has data on 36 of the purported 60 individual risk factors for prostate cancer. The likely contribution of the 36 risk factors to the total explanation of prostate cancer is only 18%. Even when accounting for the 60 risk factors, the model only accounted for 30% of the variance. Almost two-thirds of the contributors to prostate cancer remain

unidentified. This suggests that individuals and their health cannot be understood only by looking inside their bodies and brains; one must also look inside their communities, their networks, their workplaces, and their families (Lomas 1998). It has also been found that despite the intense efforts concentrating on individual-level interventions for weight loss, the rate of obesity in the general population has increased 8% so that more than 35% of all Americans are now considered obese (Kuczmarski et al. 1994).

Based on these examples, one then questions what other factors are influencing the individual beside their own behavior? Could the availability of high-fat foods, high-calorie foods in fast food outlets and vending machines and the low price of these foods in comparison with low-fat foods, fruits, and vegetables likely be reasons why so many Americans are overweight? (Kuczmarski et al. 1994 and Jeffery and French 1998) Consider the example of tobacco and tobacco taxes. The Nation's Health report (2000) stated that tax increases are very effective in reducing tobacco use. Raising cigarette taxes could prevent about 10 million tobacco-related deaths and a 10% increase in cigarette prices would motivate about 42 million people to stop smoking. This is a clear example of how policy level decisions can have a significant impact on the populations' behaviors and health.

Macro Influences

Various aspects of one's community can either encourage or discourage the public's health. Accessibility and availability of products, physical characteristics and structures, inaccessible or poorly resourced health services, neighborhood socioeconomics, deteriorated neighborhoods, and the media are all factors that can influence one's health.

An example of the impact of the availability and accessibility of products and services involves access to healthy food. If the grocery stores in a community do not carry fresh fruits and vegetables then one's ability to eat nutritiously may be hampered. In fact, one study has shown that the cost of the same healthy foods was higher in a low socioeconomic-class neighborhood than in a higher-socioeconomic-class neighborhood (MacIntyre et al. 1993).

Diex-Roux and colleagues (1997) showed that cardiovascular heart disease might be related to neighborhood environments through a variety of mechanisms, such as differences in the availability and costs of various types of foods, in the distribution of recreational spaces, and in publicity for cigarettes. In addition, neighborhood characteristics may shape the stressors to which individuals are exposed, the resources available to deal with these stressors, patterns of social interactions, attitudes, and life expectations.

Physical characteristics of structures may inherently either reduce or increase opportunities for healthy behaviors and healthy outcomes. Examples are well-lit streets, safety bars on apartment building windows, and parks in city neighborhoods that increase the opportunity to exercise. The quality and appearance of physical structures communicate a message that can also influence behavior.

Cohen and colleagues (2000) examined the relationship between neighborhood conditions and gonorrhea. Their research was based on the broken window theory – the appearance of the physical environment provides direct messages that regulate individual behavior. A disordered physical environment is not only a consequence of neglect but also a signal to others that behaviors that are usually prohibited are tolerated. The results

of the study found that the broken window index explained more of the variance in gonorrhea rates than did a poverty index measuring income, unemployment, and low education. Several other studies that have focused on littering (Reno et al. 1993; Cialdini 1990) have come to similar conclusions: people are more likely to litter in environments that are already filled with litter.

Inaccessible or poorly resourced local health services may be an additional stressor for people already stressed by other personal circumstances. The decision of when and where to seek health care is known to be affected by the geographical distribution of resources, hence, the importance of geographic accessibility in seeking timely medical care (Fortney 1995, 1998).

The density of retail alcohol sites has been linked to local rates of alcohol abuse, rates of traffic fatalities, assaultive violence, and homicides (Mackinnon et al. 1995; Scribner et al. 1994, 1995; Gruenewald et al. 1996; Cook and Moore 1993). It has also been found that alcohol outlets and alcohol and tobacco advertising are most highly concentrated in low-income neighborhoods that also have a large percentage of African American residents (Moore et al. 1996; Garner 1996).

Malmstrom and colleagues (1999) examined whether neighborhood socioeconomic environment helps to explain the proportion of community members with self-reported poor health status. Results indicated that both neighborhood socioeconomic environment and individual education status are associated with self-reported poor health. Macintyre and colleagues (1993) concluded that over and above the individual-level attributes of deprivation, people of low socioeconomic status have poorer health because they tend to live in areas that in one way or another have a detrimental effect on health. Haining and

colleagues (1994) found a relationship between material deprivation and the rates of colorectal cancer.

Another example of the neighborhood conditions affecting health outcomes is the higher rates of asthma that occur among low-income urban youth believed to be related to increased exposure to cockroaches (Rosenstreich et al. 1997; Sarpong et al. 1996). Other examples of how environment has been associated with health and health behaviors is the strong relationship noted between crime, juvenile delinquency, tuberculosis, AIDS, teen pregnancy, and drug use in inner-city neighborhoods that are deteriorated (Wallace 1990). The media is yet another powerful influence on behaviors and is known to increase or decrease the consumption of products associated with negative health outcomes, such as tobacco, alcohol, and high-fat foods (Garner 1996; Pierce 1998).

As indicated, there is considerable evidence that macro-level factors can negatively impact health status. A major limitation of individual-level approach is that it does not consider macro-level factors influences on one's choices and behavior. It ignores the social context in which individual decision making and health-related action takes place (Minkler 1994; Neubauer 1981; Allegrante 1981; Crawford 1977). Additionally, because it targets primarily high-risk individuals, these interventions rarely reach potentially high-risk persons and thus do not prevent others from becoming at risk.

Ecological Model: Integration

Increasing evidence suggests that a balance between the micro and macro level assessments and interventions would provide the best opportunities for improving health on a larger scale (Syme 1987; Diez-Roux et al. 1997; Krieger et al. 1997; Macintyre et al. 1993; Kaplan 1996).

When a public health problem is studied only in individual terms (e.g., tobacco smoking, eating habits, alcohol consumption,) rather than in population terms (e.g., tobacco, alcohol, and fatty food production, advertising, distribution, social and economic influences on consumption), then it is likely that the solution will also be defined in individual terms and will ignore major factors contributing to one's behavior and health, which in turn, will fail to solve the problem (Pearce 1996).

The ecological model incorporates multiple levels of influence on one's health and proposes developing interventions that also impact multiple levels. For example, smoking cessation programs in combination with limited tobacco advertisements and policies that ban smoking in certain locations would have a far greater impact than a smoking cessation program alone. Another example is combining individual education for school age children on diet and exercise, with a healthy school lunch program, and an after school activities programs. The concept of merging these two levels of analyses is to ensure that various aspects of the person and the societal context in which they live are considered and addressed.

GIS

As mentioned previously, there are numerous validated tools available for individual-level assessment and overall public health assessment. However, there are few validated tools at the community-level for assessing characteristics and features of a community. These characteristics and features are essential to gain an understanding of the numerous factors and conditions that influence the populations' health. One tool, which can provide both quantifiable information and assist in presenting features of the local

environment, is the geographic information system. (An annotated bibliography on GIS is found in Appendix A).

History

The origin of geographic information systems dates back to the mid-eighteenth century with the development of cartography and the creation of the first accurate base maps. Prior to that time the graphic depiction of spatial attributes could not be accurately shown.

In 1835, technology, science, and social thought had advanced to the point that the combination of these three factors could support more comprehensive thematic mapping projects (Parent and Church 1989). The industrial revolution was actually the main catalyst in the evolution of the GIS concept. The boom in manufacturing increased the need for raw resources, brought people into crowded urban areas, and produced the need for an extensive infrastructure, both social and industrial, especially in the transportation field.

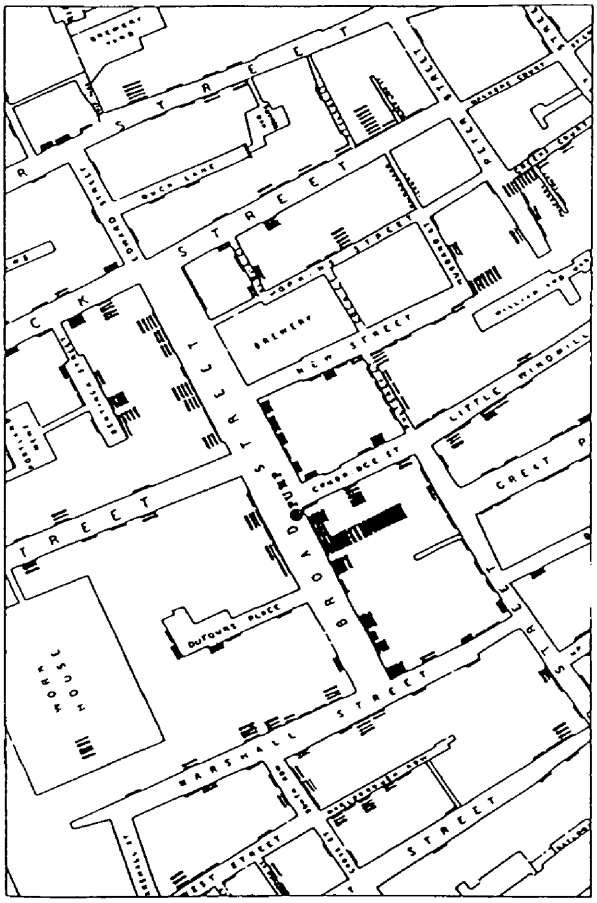
The Atlas to Accompany the Second Report of the Irish Railway Commissioners, which appeared in 1838, was the foundation of a modern, computer-based Geographic Information System. The atlas was a series of maps that depicted population, traffic flows, geology, and topography. Each base map was the same in regard to scale and country boundaries. By overlaying the different elements, the commissioners could make their recommendations as to where the best transportation routes could be sited.

One of the first major GIS efforts was the Canada Geographic Information System (CGIS), begun in 1964. CGIS was initially established to handle information gathered by the Canada Land Inventory. Its major application was to store digital map data and land-

based attributes in an easily accessible format for all of Canada. Other early systems included, Storage and Retrieval of Water Quality Control (STORET), and Map Information Assembly and Display System (MIADS).

The utilization of GIS style mapping in health care dates back to 1849 and Dr. John Snow's research into the causes of the cholera epidemic in London. The maps Snow developed showing the distribution of cholera victims represents a classic use of geographic information to draw epidemiological conclusions. The famous Snow map of 1854 (Figure 2) effectively ameliorated a public health crisis by pinpointing a contaminated water-well as a source of cholera (Friis 1999).

Figure 2



Cholera deaths in the neighborhood of Broad Street, August 19th to September 30th, 1849. *Source:* Reprinted from *Snow on Cholera* by J Snow, Map 1, Harvard University Press, © 1965

Modern GIS

Modern GIS evolved from the combination of increased computational capabilities (the computer revolution), refined analytical techniques (the quantitative revolution), and a renewed interest in environmental/social responsibility (Parent and Church 1989). Currently, there is increasing interest in the GIS tool by various groups, governmental organizations and commercial organizations. At the federal level, the number of agencies reporting widespread use of GIS has doubled, from 18 in 1990 to 44 in 1992 and since this time the number has increased dramatically (Garson and Biggs 1992). In the past few years, several books have been published on how people in specific industries utilize GIS as a tool to manage their activities and assist them in decision-making.

The use of graphic presentation of map data is demonstrated in the Crime Analysis Mapping System (CAMS) of the City of Tacoma, Washington. CAMS allows police and other users to view data on burglaries, rape, and other crimes in conjunction with census data. Data may be viewed at street, census block, district, and sub-district levels. Using a data entry screen, police can select the level of analysis, type of crime and conditions (e.g., dates), then view the pattern of crime. CAMS provides a clearer analysis of such management decisions as assigning police patrols, interpreting case patterns, targeting education efforts, and planning facilities or services such as lighting.

Some other examples of GIS applications include, tracking earthquake fault lines in relation to property data for loss-risk assessment in Utah (Firestone 1987); flood hazard mapping in Washington, D.C. (Cotter and Campbell 1987); emergency preparedness functions in Los Angeles regarding evacuation routing, shelter allocation, and identification of probable disaster locations (Johnson 1987); helping Portsmouth, New

Hampshire, preserve its supply of clean water (Lee and Douglass 1988); and tracking the spread of infectious and environmentally caused diseases (Lang 2000).

GIS in Public Health

In the field of public health one important use of GIS is to target health resources to places where they are most in need (Larimore and Davis 1995; Geronimus et al. 1996). GIS programs have also been used to study lead exposure, cardiovascular disease, trypanomiasis, Lyme disease, infant mortality, and alcohol-related injuries and violence. Scribner and colleagues (1995) found that among 74 cities in the Los Angeles region, higher levels of alcohol outlet density were geographically associated with higher rates of assaultive violence. The "Broken Windows" study conducted by Cohen, examined gonorrhea cases using geographic information systems software. Cases of gonorrhea in New Orleans were geocoded and aggregated to block group level.

In a study by Glass and colleagues (1995), GIS was utilized to identify and locate residential environmental risk factors for Lyme disease. Glass and colleagues concluded that combining a geographic information system with epidemiologic methods could be used to rapidly identify risk factors of zoonotic disease over large areas. Andes and Davis (1995), provide another example of the potential of the geographical information system. In this study, researchers applied GIS techniques to infant mortality in Alaska in order to illustrate spatial and statistical strategies useful in linking vital statistics with census data.

In an exploratory study by English and colleagues (1999), GIS techniques were used to explore whether childhood residence near busy roads was associated with asthma in low-income population in San Diego County, California. The study utilized existing

health and traffic data from an ongoing geographic information system study of environmental, demographic, and health characteristics in the California/Baja California border region.

GIS as a tool for Public Health

The recent interest in GIS by various groups is due to the tool's strengths. It has the ability to see how data relates in space and time. With the GIS, observations regarding the social, economic, political, and physical environments can be referenced to a common geospatial data framework allowing varying organizations to share spatial data regarding these phenomena (Rushton et al. 2000).

Particularly in health care, spatial techniques can facilitate the linkage of vital statistics, census, and health systems databases gathered by different administrative units each using their own regional boundaries (Andes and Davis 1995). Spatial location is also important in health care because geographical patterns of health data are one way to infer social inequalities. GIS also has the potential to change the way in which geographical resource allocations are made to facilitate the establishment of preventive health services and to control the burden of disease in patients (Rushton et al. 2000). GIS in health care is far more than a mapping tool. It is an analytic system that brings together in geographic context information on disease incidence, health services availability and access, demographic characteristics, and environmental factors.

With all its many strengths, GIS is not without weakness. One of the major limitations of GIS in health care is the ability to obtain data that is spatially referenced, accurate, up to date and disaggregated. The majority of existing health statistics are not currently collected in this format, which makes it difficult to utilize.

Another weakness that hampers the utility of GIS in health care is the poor ability of commercial GISs to handle multi-temporal geographic information or the movement of people. This limits the value of GIS in understanding health problems with long latency periods, such as many forms of cancer. With mobile populations the location of the patient at the time of diagnosis or mortality may have little relation to the location of the exposure to toxic substances or other environmental risks (Rushton et al. 2000). A third weakness is the temptation to infer individual risk based on aggregate GIS analysis, inviting the potential of the ecological fallacy as mentioned earlier.

The purpose of this research is to present a model that utilizes several macro-level methodologies to conduct a community assessment. This paper will demonstrate the capabilities and limitations of GIS as a macro-level methodology by utilizing it to analyze various characteristics and features in the city of Flint, Michigan.

II. Methodology

Case Study: Flint, Michigan

In order to demonstrate the process for utilizing these various macro-level methodologies, the City of Flint, Michigan was chosen as a case study. However, this process and these methodologies can be applied to any defined "community" area. Flint, Michigan is located approximately 60 miles northwest of Detroit in Genesee County and is best known for its automobile and parts manufacturing industries. In the immediate post-World War II period, Flint had the highest average industrial wage and among the highest rates of home ownership, car ownership and per capita retail sales of any city in the country (Buss 1999). The city was booming largely due to General Motors (GM). However, by 1987, MONEY magazine listed Flint, as the worst place to live in America.

In the 1980's General Motors began closing plants. Nearly 30,000 GM employees lost their jobs. Flint's unemployment rate during the early 80s had risen to 27% (Moore 1996). GM steadily slashed employment for 20 years, from a high of 76,800 jobs in 1978, providing 40 percent of the jobs in Genesee County, to just 33,000 in 1999 and it is projected the number will fall to fewer than 22,000 GM jobs in the next few years (Buss 1999).

In addition to the bleak employment conditions that Flint has suffered, the health statistics for the area are also alarming. For example, the infant mortality rate in Genesee County over the period 1996-98 has averaged 12.2 infant deaths per 1,000 live births, which was the highest rate among the most populous counties in Michigan. For the same three-year period, Flint had the highest rate, 15.7 infant deaths per 1,000 live births. Not only is infant mortality higher in Flint than most other cities in Michigan but Flint also has one of the highest incidence rates for sexually transmitted diseases in the state.

Today the city of Flint and associated zip code areas has a total population of 184,268 (1999 estimated population). The city has eight colleges and universities in close vicinity and is served by three major hospitals in the area. The major employers in the area are the three major health care facilities, General Motors, Mott Community College, United States Post Office, and various banking institutions.

In this study the health of the city of Flint was researched by examining the features and characteristics of zip code areas using a variety of data sources and methodologies. Including secondary health and census data, neighborhood drive-thrus and photographs, documenting grocery stores prices, and through mapping neighborhood resources and health data using GIS.

These various methods were selected because they each provide a certain layer of detail about the community and when combined represent the multiple levels of influencing factors. The health statistics and census data provide an overall picture of the community and identify areas of concern. This data is derived from aggregated individual information.

The drive-thrus allow the researcher to gather first hand information about the community. Various resources and hazards can be identified through drive-thrus along with information in regard to the areas appearance and condition. Photographs provide a visual picture to accompany the description. This method focuses on the community-level and regional-level influences in one's life.

Conducting an in-depth investigation (e.g. grocery store comparison) provides even further details on the community factors, which may be influencing health. These types of in-depth exploration provide the researcher with an understanding of the barriers the population faces in the community.

Finally, locating and mapping various resources throughout the area is an excellent way of visually examining the quantity and location, (in comparison to populations), of these facilities. This method also provides information on the policy-level of influence on one's health and behaviors. The placement of resources within a community can have a large impact on those living in the community. Quality factors of these facilities could be obtained through an in-depth investigation method.

Combined, these methods provide a comprehensive picture of the community's health and the multiple levels of influence, which may be affecting that health. In addition,

utilizing multiple methods provides a mechanism to check one's findings. If similar results are found with each method this will add to the validity of the findings.

Health Statistics/Census Data

The first step of the research was to obtain health statistics and census data for the City of Flint. These statistics are not centrally collected (see appendix B for a listing of various sources of data used). The Genesee County Health Department (GCHD) provided data on infant mortality for the time period of 1996 through 1998. GCHD also provided data on lead referrals (1996-present), and asthma cases (1992-1996). The State of Michigan's Vital Statistics Department shared data on gonorrhea and chlamydia (1999). Ideally, the data collected from these various sources would have been for the same time period, however, the availability of health data in zip code format is limited in Flint. Therefore, the rates that are presented may be less than accurate due to the limitations of the denominator data used. The 1990, 1997 and 1999 census data were obtained by zip code area from the Census Bureau website.

The actual number of cases by zip code was given for the health events. Rates were calculated for each health event by dividing the actual number of cases by the total population in each zip code using the estimated 1999 census population. The exception was the infant mortality rate, which was calculated as number of infant deaths divided by the number of live births (x 1,000) in each zip code area for the 1996-1998-time period.

The 1999 estimated census population was utilized because estimated population numbers for the years corresponding with the data were not available. Thus, if the population varied greatly from the 1999 estimated population, rates may be either over or

under estimated. Tables 1-5 display the complete data set and calculations for the six Flint zip codes for each of the five health events identified.

Table 1
Infant Mortality Rates per 1000 live births for City of Flint
1996-1998

Zip code	Infant Deaths	Live Births	Rate
48502	1	13	76.9
48503	19	1002	19.0
48504	17	1357	12.5
48505	43	1676	25.7
48506	13	1125	11.6
48507	13	996	13.1

Table 2
Chlamydia Rates per 10,000 people for City of Flint
1999

Zip code	Chlamydia cases	1999 Population	Rate
48502	67	1120	598
48503	83	32493	25
48504	143	40321	35
48505	154	40577	37
48506	29	34473	8
48507	54	35284	15

Table 3
Gonorrhea Rates per 10,000 people (1999) for City of Flint
1999

Zip code	Gonorrhea cases	1999 Population	Rate
48502	9	1120	80
48503	102	32493	31
48504	163	40321	40
48505	244	42968	60
48506	32	34473	9
48507	33	35284	9

Table 4
Lead Rates per 10,000 people >20 mg/d1 for City of Flint
1996-2000

Zip code	Lead referrals	1999 Population	Rate
48502	1	1120	8.92
48503	8	32493	2.46
48504	14	40321	3.47
48505	23	40577	5.67
48506	0	34473	0
48507	2	35284	.56

Table 5
Asthma Rates per 10,000 people as reported by Hurley Medical Center for City of Flint
1992-1996

Zip code	Asthma cases	1999 Population	Rate
48502	16	1120	143
48503	308	32493	94
48504	475	40321	117
48505	752	40577	185
48506	132	34473	38
48507	124	35284	35

Once the rates were calculated they were entered into the GIS Arcview mapping system.

GIS Mapping

A view of the City of Flint labeled by zip code was developed and then the data were inputted into the GIS and results were mapped out allowing the researcher to compare the spatial distribution of health statistics and census data by zip code areas. GIS was also used to locate various resources within each zip code area (see under Observational Data). Geocoding adds point locations defined by street address, or other address information to a map. First, one must obtain a reference theme showing the streets of interest. Street data that can be added to a view and used as a reference theme for geocoding is available from several companies and also from the US Bureau of the Census. Once the reference theme is in place, data containing addresses can be loaded into the GIS as a table and is then geocoded by matching them to the address data in the reference theme.

Not all addresses may be valid, (e.g. incorrect spelling, non-specified as a street or a road; or the address may be outside the area covered by the reference theme). In such invalid cases, GIS tallies the number of unmatched addresses and displays them for the user to check. If there is no obvious reason why the address was rejected, one can pinpoint the location visually and manually map the address.

Health statistics and census data results identified two zip code areas as having the worst health outcomes, 48502 and 48505. Zip code area 48506 had the best health outcomes for the city. Based on these results, areas 48505 and 48506 were selected for exploration as to the reasons for the health differences. Although these two zip codes are

geographically adjacent, the health differences between them are remarkable. [The 48502 zip code, although an area with poor health statistics, was not chosen due to the small geographical area and small population size, (estimated 1999 census population of 1120 persons).]

Observational Data

In order to get a better idea of why the health is better in 48506 than in 48505, further exploration was conducted using several methods. Drive-thrus allow the researcher to observe and experience the community first hand. The data collected is from the researcher's own observations, rather than from word of mouth or generalized information. It was important to make systematic comparisons (e.g. consider similar aspects) between the two areas in order to reveal fewer differences than expected or differences in the opposite direction to that anticipated.

Two neighborhood drive-thrus were conducted in each zip code area. The first drive-thru consisted of gathering initial impressions of the neighborhoods and obtaining a sense of what resources exist in the area. The second set of drive-thrus consisted of locating various parks in each area, and once again, obtaining further information on the types and condition of resources in the areas.

Conditions that were considered when examining the neighborhoods and parks, included garbage accumulation, graffiti, abandoned cars, billboards and signs, general upkeep of parks, playgrounds, and number of vacant lots. Photographs were taken of the parks and areas.

Information on other resources in the area was gathered through various available listings. The addresses of businesses, churches, schools, and bars/party stores for each

zip code were obtained from the Community and Business Partnership – University of Michigan-Flint. A community coalition, Programs to Reduce Infant Deaths Effectively (PRIDE) provided the addresses of health and social services. The data were geocoded using the ArcView mapping system as mentioned previously.

Grocery Stores

A survey was conducted of availability and price of food. This involved the researcher going into a sample of grocery stores in both zip code areas and checking on availability and price of a list of food items. As mentioned previously, recent studies have demonstrated that lower income neighborhoods are subject to higher food prices in grocery stores. Higher prices and limited availability of food items can be a barrier to healthy eating. The purpose of the survey was to find out if there were differences between 48505 and 48506.

A list of grocery stores located in each zip code area was obtained from the Michigan Agricultural Department – Food and Dairy Division. The initial plan was to divide each zip code area into four different quadrants and then randomly select grocery stores from each quadrant. However, in some quadrants there was an overwhelming number of mini-marts and few to no grocery stores, thus a random sample was not feasible. It was decided instead to visit the large grocery stores (e.g. Meijer, Kroger, Kessel) in each zip code and then visit other smaller mini-marts (e.g. 7-Eleven) located in different geographical sectors (NW, SW, NE, SE) of each zip code area.

A list of fourteen different food items was used for comparison between zip codes. Both availability and price of the item was recorded during the visit to each store. Substitutions were not made because one of the objectives of the survey was to measure

availability of food items. However, it is recognized that if a certain brand of food item or quantity is not available then people may make substitutions, which is a potential limitation of this approach. For instance, a 2% gallon of milk was on the food list; if there was no 2% gallon of milk available it was listed as not available in that store even if a 1% gallon of milk or a ½ gallon of 2% was available.

Disallowing substitutions however, allowed for more direct and systematic comparisons between stores, despite of the aforementioned limitation. Once all the data were gathered, a table was prepared which calculated the average price and availability for each food item in each zip code area.

A subjective measurement of the environment was conducted for each store. The cleanliness of the store and surroundings and the quality and assortment of fruit and vegetables available were documented. Cleanliness was categorized by, swept floors, mopped and free of debris, inside appearance including odor, and presence of insects in the store. Quality of fruit was gauged from poor, average to good. An example of good fruit included no brown spots, fresh produce. Average would consist of some brown spots, slightly wilted, and poor consists of brown spots and/or rotten, and wilted.

III. Results

Demographics

Figure 3 shows the City of Flint divided into its six zip code areas. Figure 4 represents the estimated 1999 census population for each zip code area. The overall estimated 1999 population for the city of Flint is 184,268. Zip code area 48502 has the smallest population estimated at 1120 and zip codes 48504 and 48505 have the largest

populations estimated between 35,000 and 41,000. The estimated 1999 population for 48505 is 40,577 and for 48506 it is 34,473 with a difference of 6,104 persons.

Figure 5 presents the median income for 1990 by zip code area. Zip code 48505 has the lowest median income for 1990 at $13,321 and zip code area 48507 has the highest at $30,346. The difference in median income between 48505 ($13,321) and 48506 ($25,122) is $11,801.

Health Data

Figures 6 – 10 show the various health conditions by zip code for the City of Flint. There are wide variations in health status by zip code area. This pattern is consistent across the different health issues. As one can see from the maps, zip code areas 48506 and 48507 have the lowest rates of selected disease, among the zip codes. Zip code areas 48502 and 48505 have the highest rates of disease. The 48502 zip code area has the highest rate of sexual transmitted diseases (STDs) followed by 48505. The pattern is consistent across all the diseases except for asthma where the zip code 48505 has a higher rate than 48502. The health status differences between 48505 and 48506 are remarkable, e.g. the infant mortality is almost 2 fold greater between 48505 and 48506 and lead referrals are 5 fold greater.

Initial Drive-Thru

48505

The first impression of the 48505 zip code area was the stark contrasts within the area. Throughout the area, there is new development next to abandoned buildings, well-maintained houses next to boarded up houses (see appendix C -pictures 1 and 2). The close proximity of these contrasts seemed to be consistent throughout the area. There

Figure 3: Flint Zip Code Areas

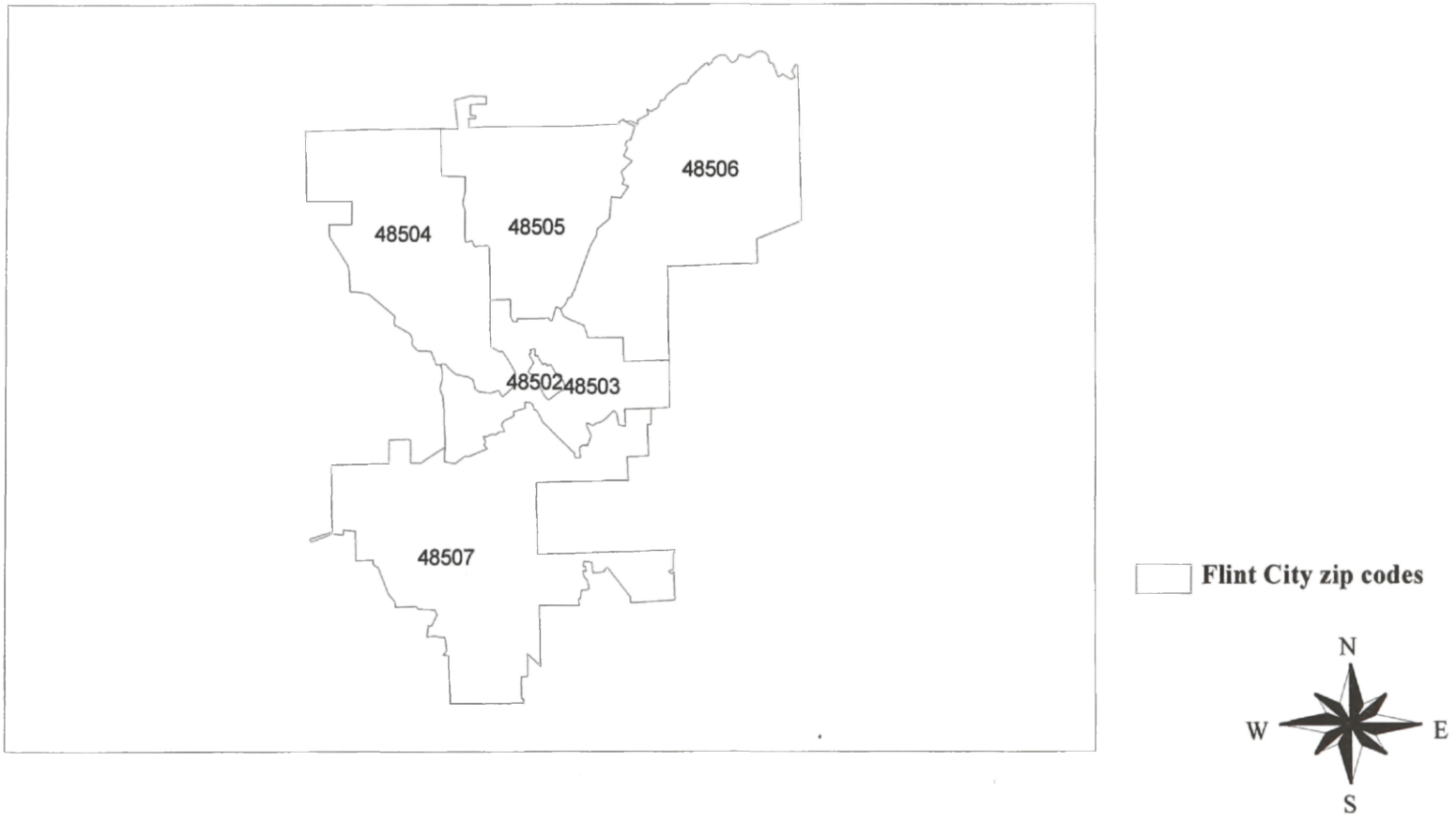


Figure 4: 1999 Estimated Population

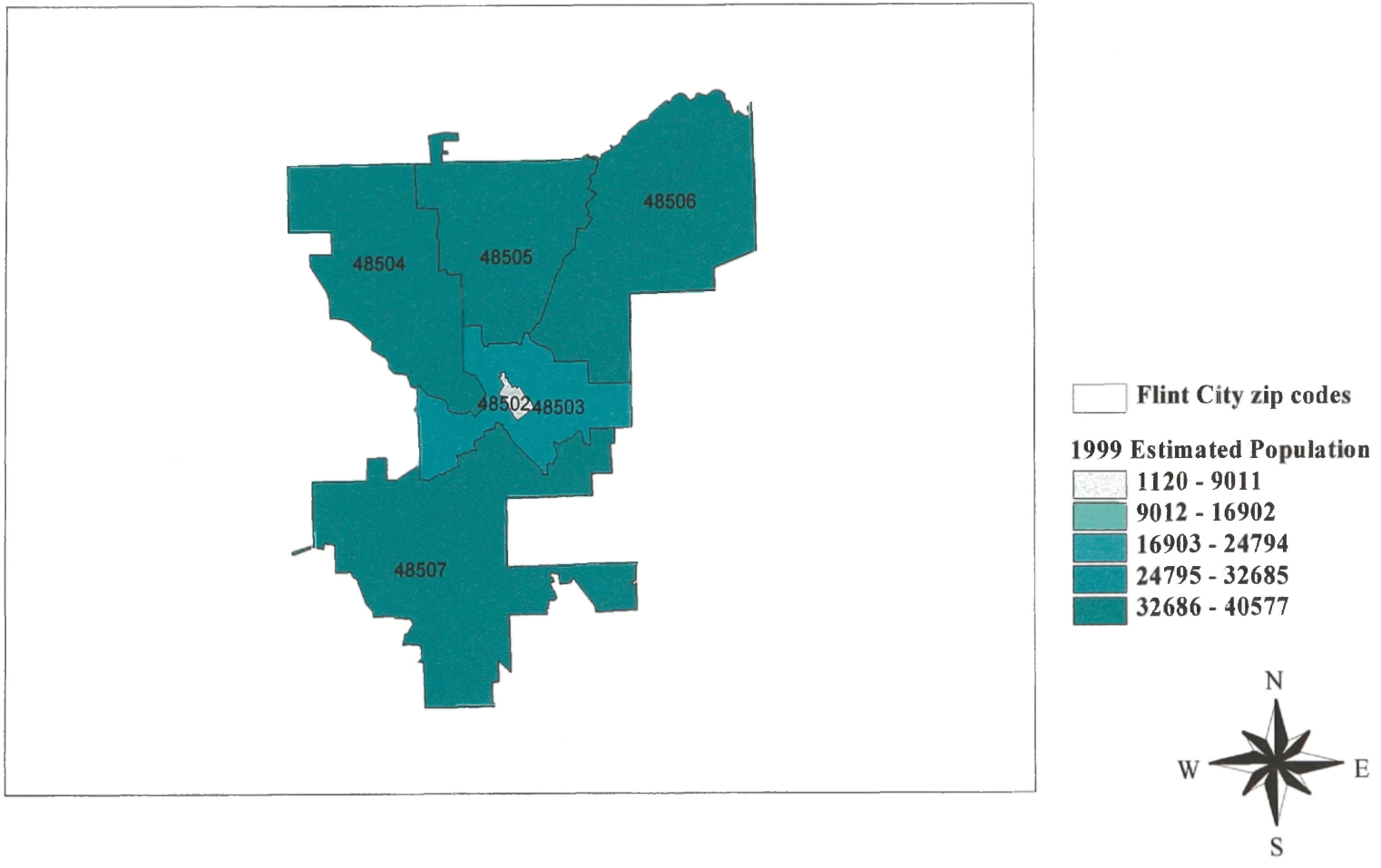


Figure 5: 1990 Median Income

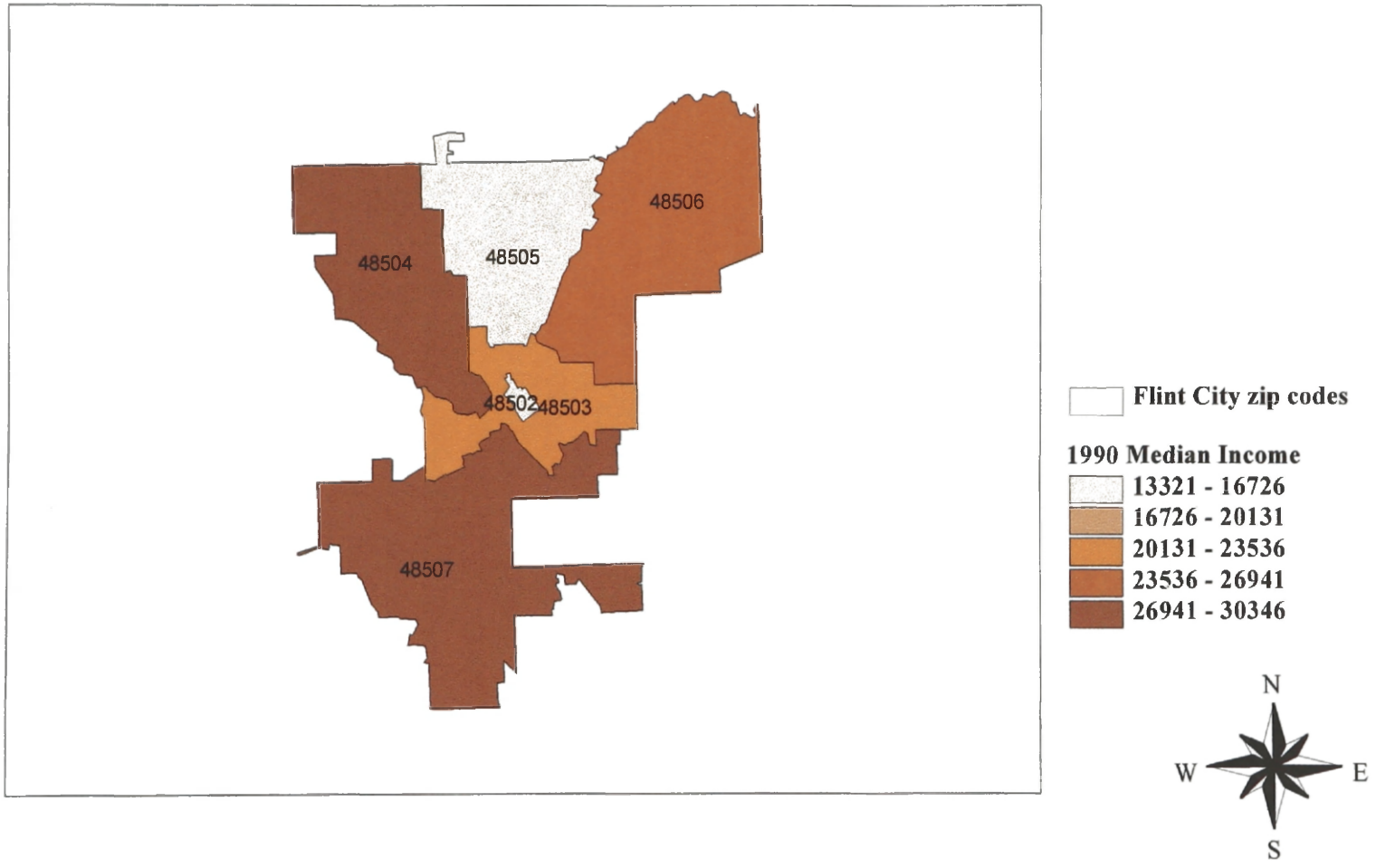


Figure 6: Infant Mortality Rates

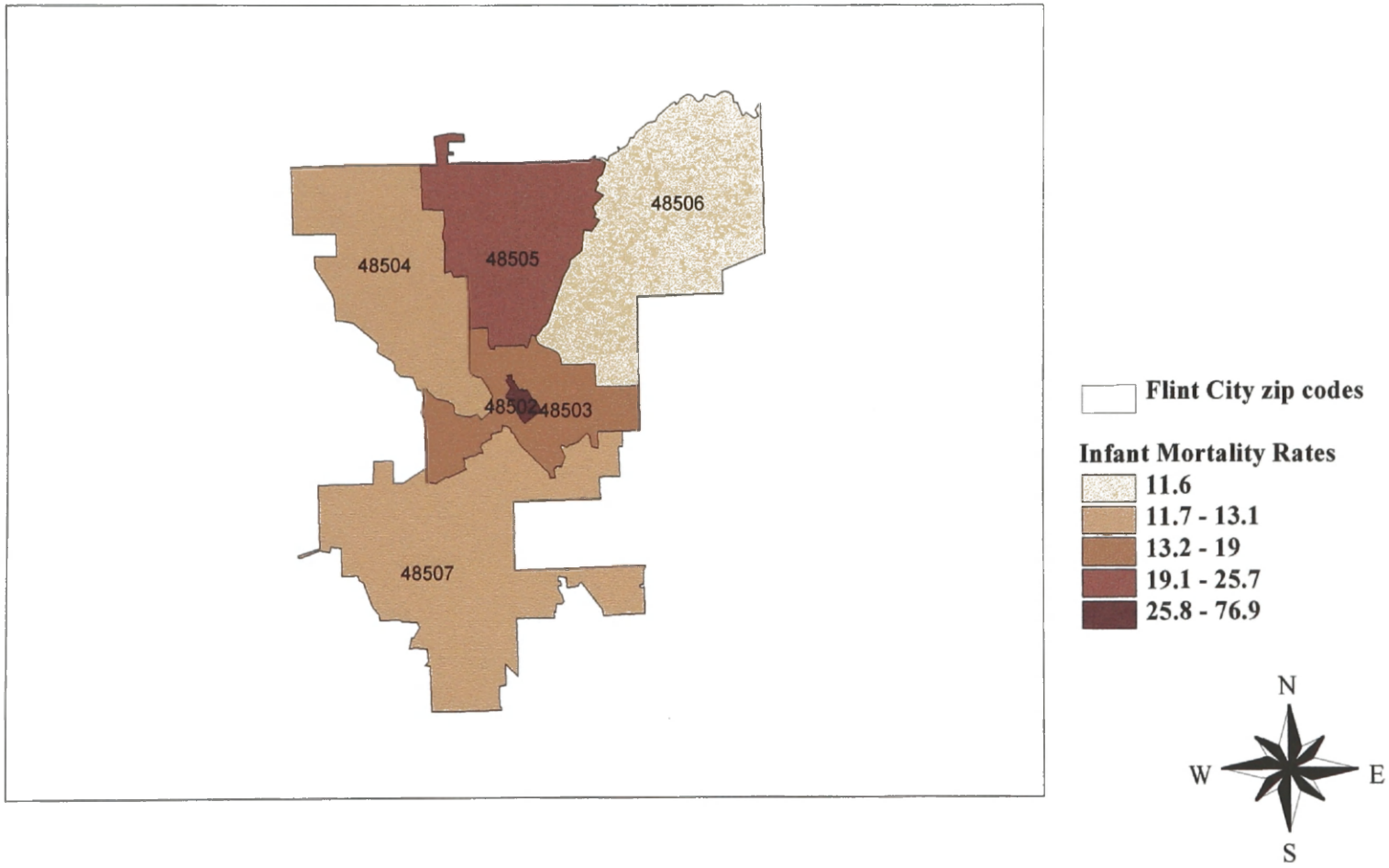


Figure 7: Gonorrhea Rates

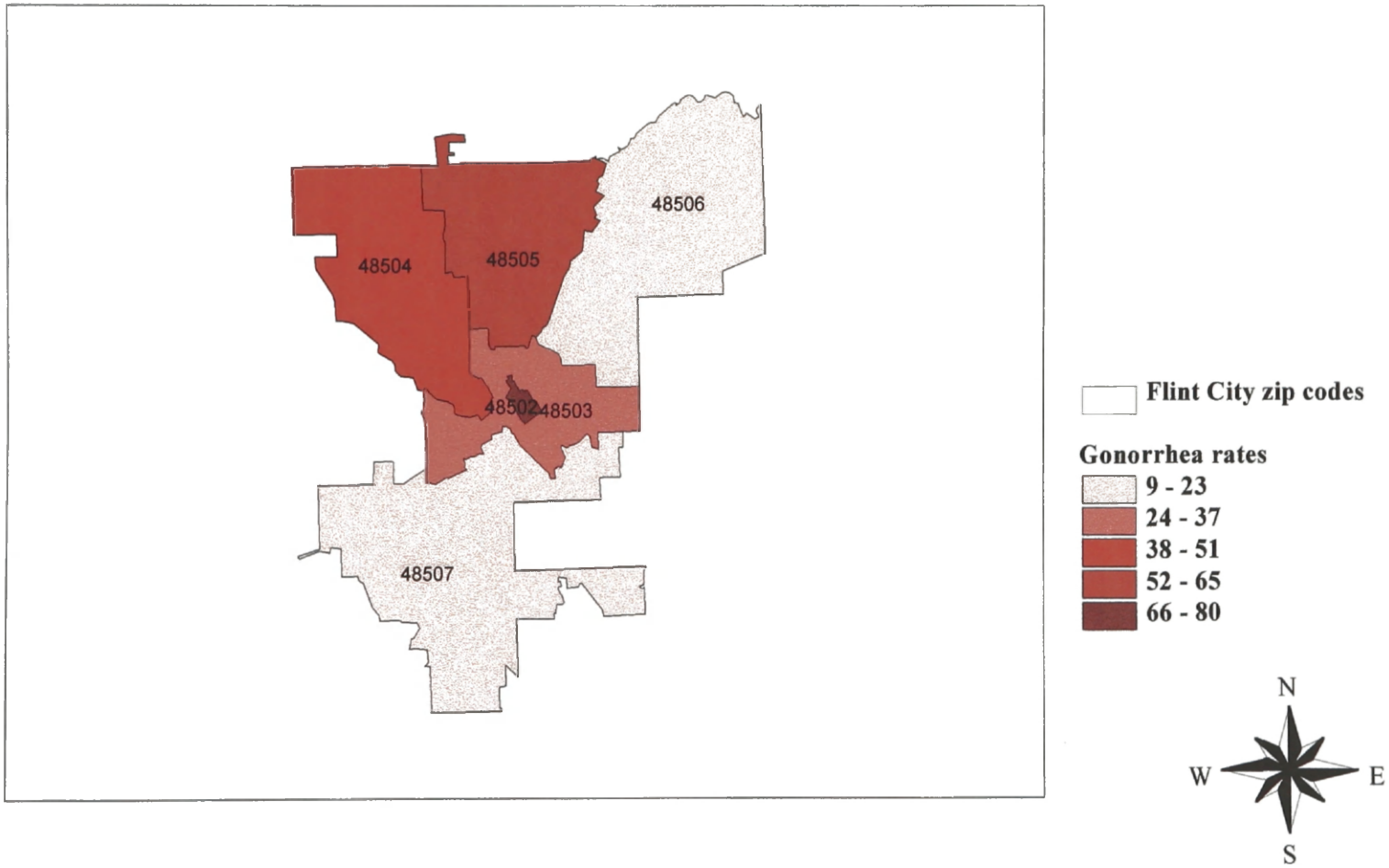


Figure 8: Chlamydia Rates

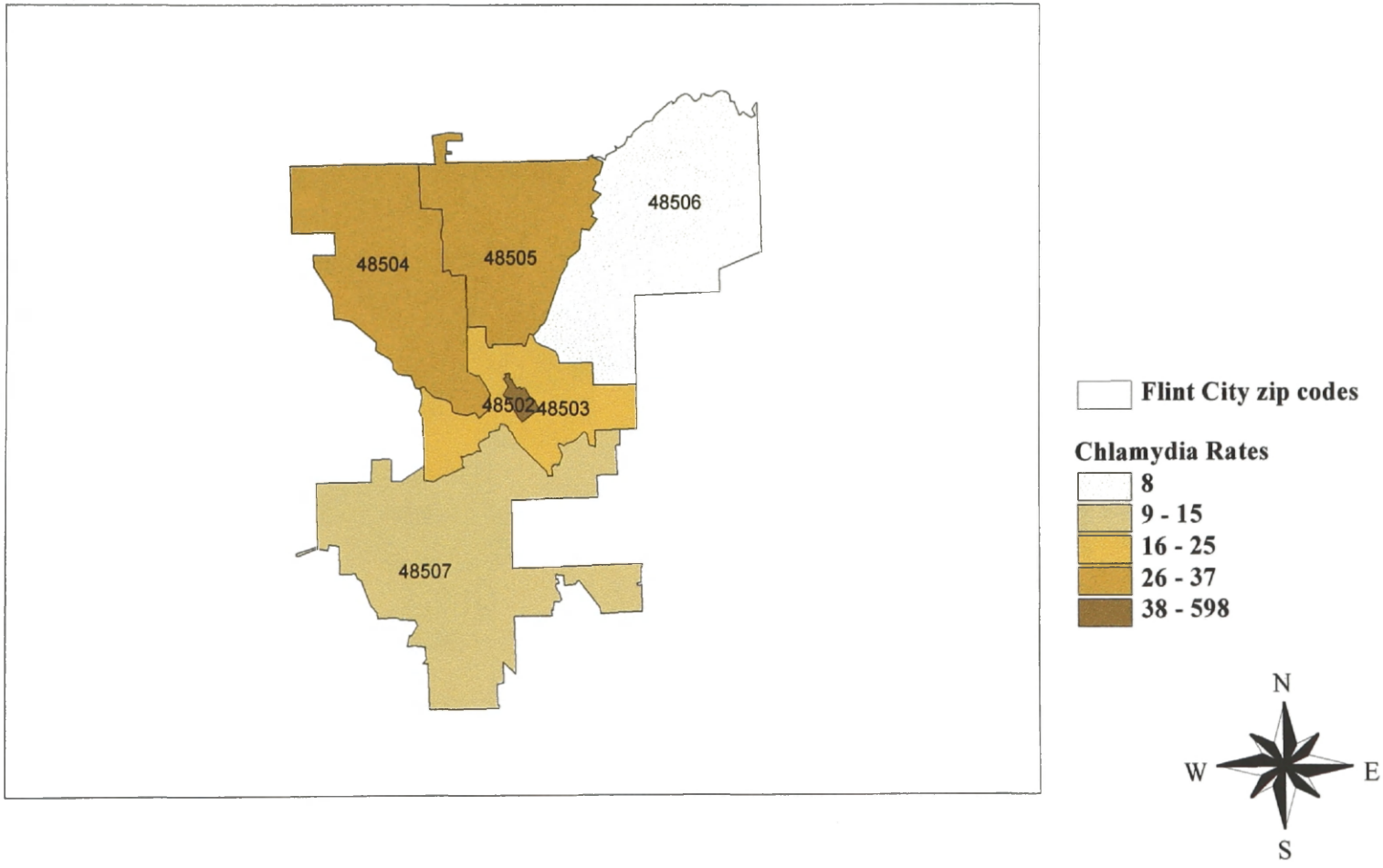


Figure 9: Lead Referrals

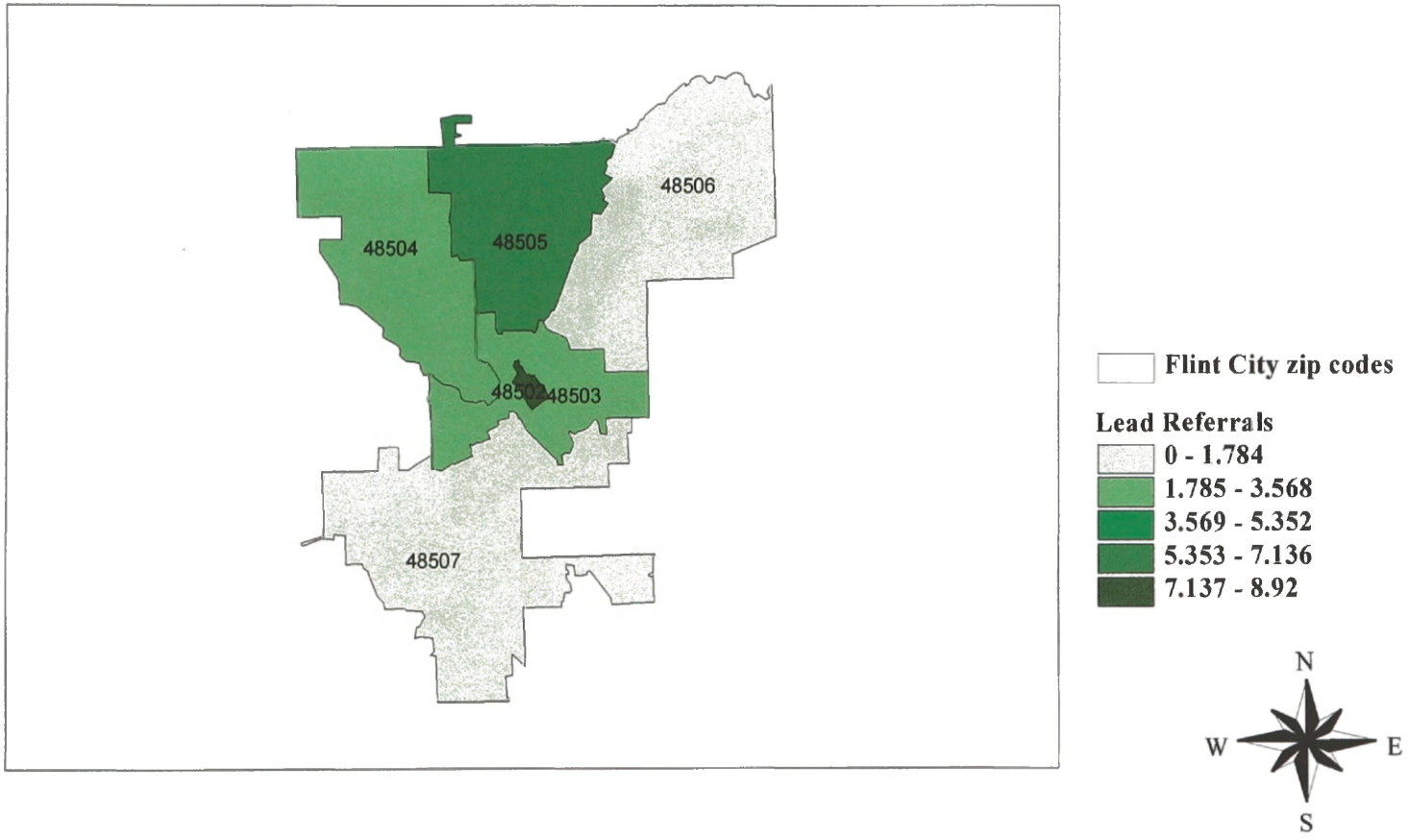
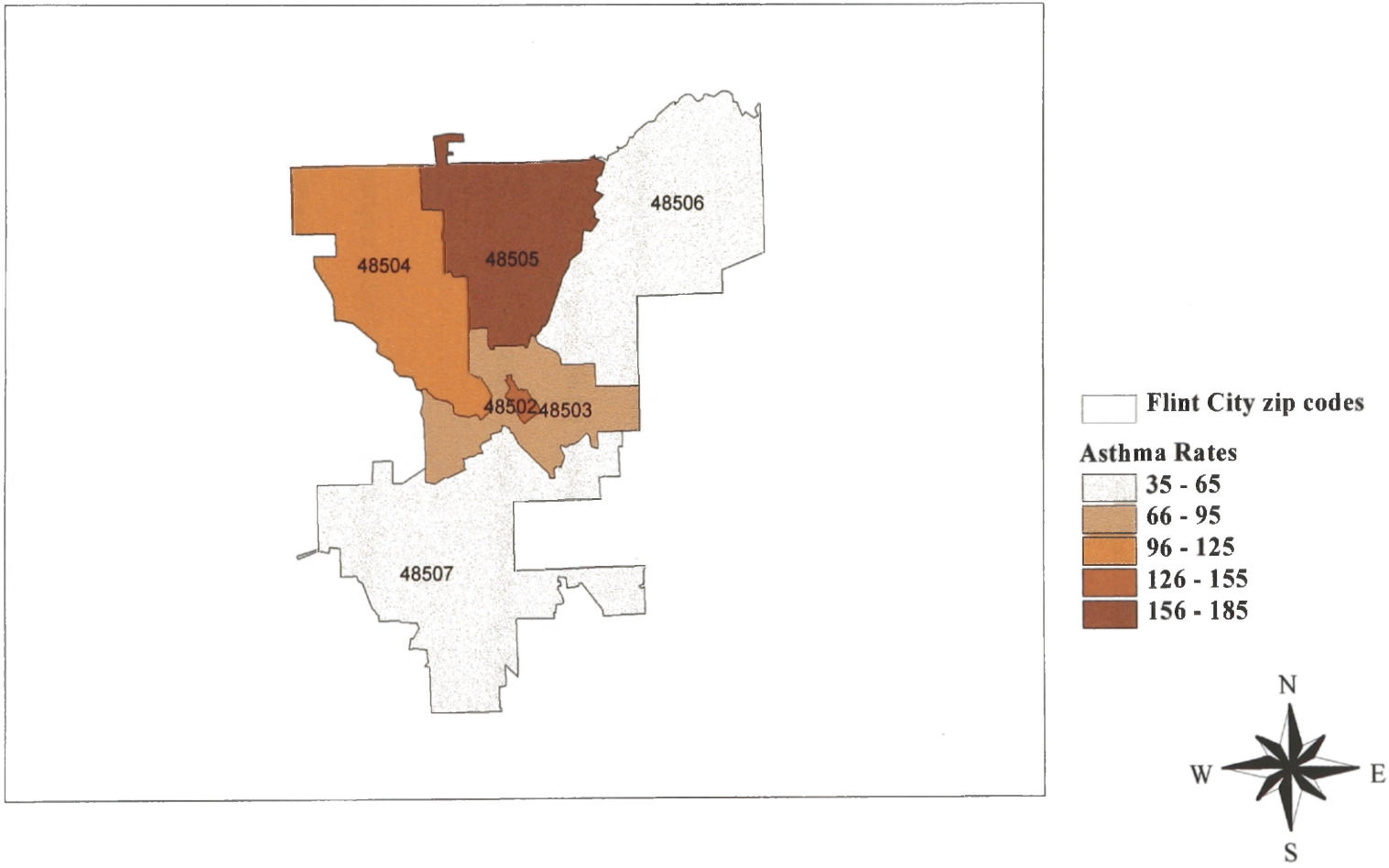


Figure 10: Asthma Rates



was one completely abandoned apartment complex of at least 3 to 4 different buildings (see pictures 3 and 4). The windows were boarded up and the building looked to have been vandalized. Despite these empty buildings, new developments for housing were evident nearby.

Along with the number of abandoned buildings, there were many vacant buildings and lots that were not well maintained. Many of the buildings were covered with graffiti and the windows were boarded over. On the larger industrial buildings, glass windows had been broken.

In contrast to this, there were many houses and yards that were well maintained. A community member stated that there have been government programs to encourage people to buy some of the run down houses for low cost on the condition that they keep it for at least two years and fix it up.

Driving through the area, the main businesses seemed to be auto related, small industrial, liquor mini-marts, and fast food restaurants. Accompanying the many liquor mini-marts, were an abundance of liquor advertisements. One Rite-Aid in the area had liquor posters on every light post in its parking lot (see picture 5). These advertisements can be seen throughout the main streets in the area (see pictures 6-9), including on some billboards. Litter, broken glass, and trash was prevalent in much of the area, particularly around abandoned buildings and houses.

In addition to the identified blight, several resources existed in the area. There is a job corps training center (see picture 10) next to the UM-Flint Business and Community Partnership Office, which provides training and offers expertise to small business and organizations in the area. There were several parks in the area, (see Other Resources

section for quality and condition of parks) shelters, a soup kitchen, a health facility, and a dental office, as well as other various resources in the area. There were many churches in the area. There were also billboards advertising different universities throughout the area.

48506

In the zip code area **48506** much of the lower southwestern part of the zip code was very similar to the 48505 zip code area, with abandoned houses, boarded up windows, empty buildings, trash and litter (see pictures 11 and 12). Again there were a number of liquor marts and liquor advertisements in the area. Other businesses in the area seemed similar to that seen in 48505, fast food, liquor/mini-marts, automotive, light industrial businesses. However, as one drove further northeast in 48506, the area began to change.

The area became more rural with the housing spread out. The houses were well maintained and had larger yards (see picture 13-15). There was a golf course and a bowling alley. In this section of 48506 the liquor/mini-marts were fewer and more recreational resources appeared.

Overall the condition and appearance of 48505 and the majority of 48506 were similar. Both of these areas consisted of boarded up houses, abandoned buildings and empty lots. Additionally, there were well-maintained houses and yards amidst the abandoned houses in both areas. The types of businesses and other resources seemed to be consistent throughout most of the two areas. The condition of the parks in the areas was also comparable (see Other Resources section).

However, the northeastern section of the 48506 zip code area was significantly different than the rest of 48506. The housing and lots were better maintained. There

were fewer liquor/mini-marts in the area, fewer liquor advertisements posted and as mentioned previously the area seemed to have more recreational resources (e.g. golf course, bowling alley).

Grocery store comparison

The following table reports the average price of each food item and the availability of that item in the stores. The table is broken down by zip code area (see figure 11 for location of grocery stores). There are a total of 25 grocery stores in 48505 and 16 in 48506. Eight stores in each area were visited.

48505

Food Item	**Average Price Range**	**# of stores carrying item (8 stores total)**
2% gallon milk	$2.97 (2.59-3.29)	8
Ground hamburger	$1.35 (.99-1.59)	5
Wheat bread	$1.20 (.99-2.09)	6
Whole fryer chicken	$ .87 (.69-1.12)	4
Tomatoes per lb	$ .99 (.69-1.39)	4
Lettuce-iceberg	$1.17 (.99-1.49)	5
10oz. Box cheerios	$3.28 (2.99-3.50)	6
Red delicious apples (3 lbs)	$1.76 (1.50-1.99)	3
10 lbs potatoes	$2.79 (2.49-3.00)	4
Country Crock butter (3 lbs)	$2.69 (2.59-2.79)	2
Dozen grade A large eggs	$1.19 (.99-1.49)	6
Campbell chicken noodle soup	$1.13 (.85-1.39)	7
2½ oz. Gerber banana baby food	$ .55 (.49- .69)	4
Gallon drinking water	$ .91 (.69- .99)	4
Total Bill	**$22.85**	**68**

48506

Food Item	**Average Price Range**	**# of stores carrying item (8 stores total)**
2% gallon milk	$2.87 (2.69-2.99)	6
Ground hamburger	$1.36 (.89-1.29)	3
Wheat bread	$1.74 (.89-2.19)	6
Whole fryer chicken	$ .89 (.79- .89)	3
Tomatoes per lb	$ .94 (.59-1.29)	2
Lettuce-iceberg	$ .99 (.99)	4
10oz. Box cheerios	$3.61 (2.69-4.55)	7

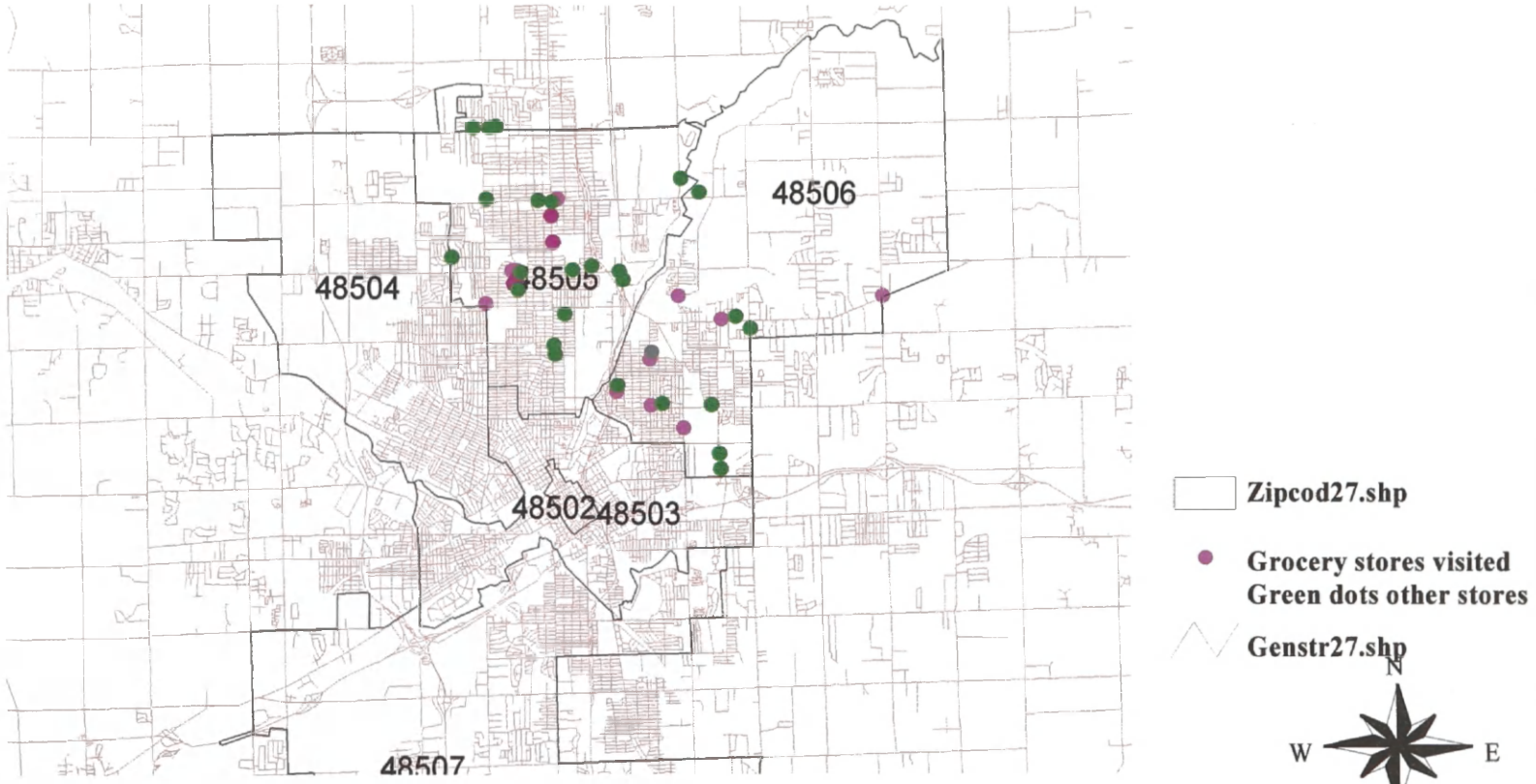
Red delicious apples (3 lbs)	$ unavailable	0
10 lbs potatoes	$2.92 (2.49-2.99)	3
Country Crock butter (3 lbs)	$2.45 (2.43-2.49)	3
Dozen grade A large eggs	$1.42 (1.09-1.99)	3
Campbell chicken noodle soup	$1.20 (.89-1.29)	7
2½ oz. Gerber banana baby food	$ .50 (.49- .53)	3
Gallon drinking water	$ 1.07 (.79- 1.79)	5
Total Bill	**$21.96**	**55**

As the table shows, the average difference in grocery bills is .89 cents less in the 48506 zip code. However, a 3 lb bag of red delicious apples could not be found in any of the grocery stores visited in the 48506 zip code area. No substitutions were made when searching for food items. The price range in both zip code areas, are fairly similar. There were fewer food items available in the 48506 zip code (55) as compared with 48505 (68).

Overall, it was surprising to find the lack of availability of certain food, in either zip code, especially 48506. There were very few so-called "grocery stores" that actually sold groceries (fruits & vegetables). The majority of the stores in each zip code area were mini marts, which sold liquor, chips and pop. In fact one of the mini-marts visited had absolutely no food items on the list. Another had only one loaf of white bread left on the shelf and another store had no milk, but large quantities of beer in the cooler. Most of the exterior and interior of the mini-marts were covered with liquor advertisements and/or pictures of women on the walls.

The larger grocery stores were spacious and fairly clean, although one did have several puddles of water throughout the store. The assortment of fruits and vegetables seemed to improve with the size of the store. The quality of fruit and vegetables ranged from average to good (some brown spots, slightly wilted to fresh with no brown spots) in

Figure 11: Grocery Stores



the larger stores and was usually fair to poor (brown spots, wilted to rotten) in the smaller mini-marts that sold fruits and vegetables.

Two comments were made by store clerks, which are worth noting for further investigation. In the 48505 zip code area one store clerk commented when asked about a price "the prices are high in here because we accept WIC coupons". In the 48506 zip code area a store clerk stated, "malt liquor is what sells". He said that he wasn't from the Flint area and if he had a store in his area he would offer "more food items". This particular location was covered with beer and liquor advertisements inside and out.

Other Resources

Both zip code areas have several parks. Zip code 48505 has fifteen park facilities, while those in 48506 have nine. The condition of the parks did not vary much by zip code area. Both areas had many parks that were not maintained, with uncut lawns, litter on the ground, broken toys, missing basketball hoops, etc. (see pictures 16-18). The Riverside Park in 48505 appeared to be in poor condition. The park was used as a dumping ground and had discarded mattresses along the walking path (see picture 19). However, there were also some well-kept parks in each area (see pictures 20-22). The drive-thrus were conducted during the day hours prior to the beginning of the school year and only on two occasions were people observed using the park facilities.

Figures (12-17) show the location of other resources in the zip code areas. The location of churches, businesses, schools, bars/party stores, and health and social services have been plotted out using geocoding in ArcView. The zip code area 48505 has approximately 110 churches, 27 schools, 21 bars/party stores, 303 businesses, and 17 health and social services within the area. In comparison 48506 has approximately 43

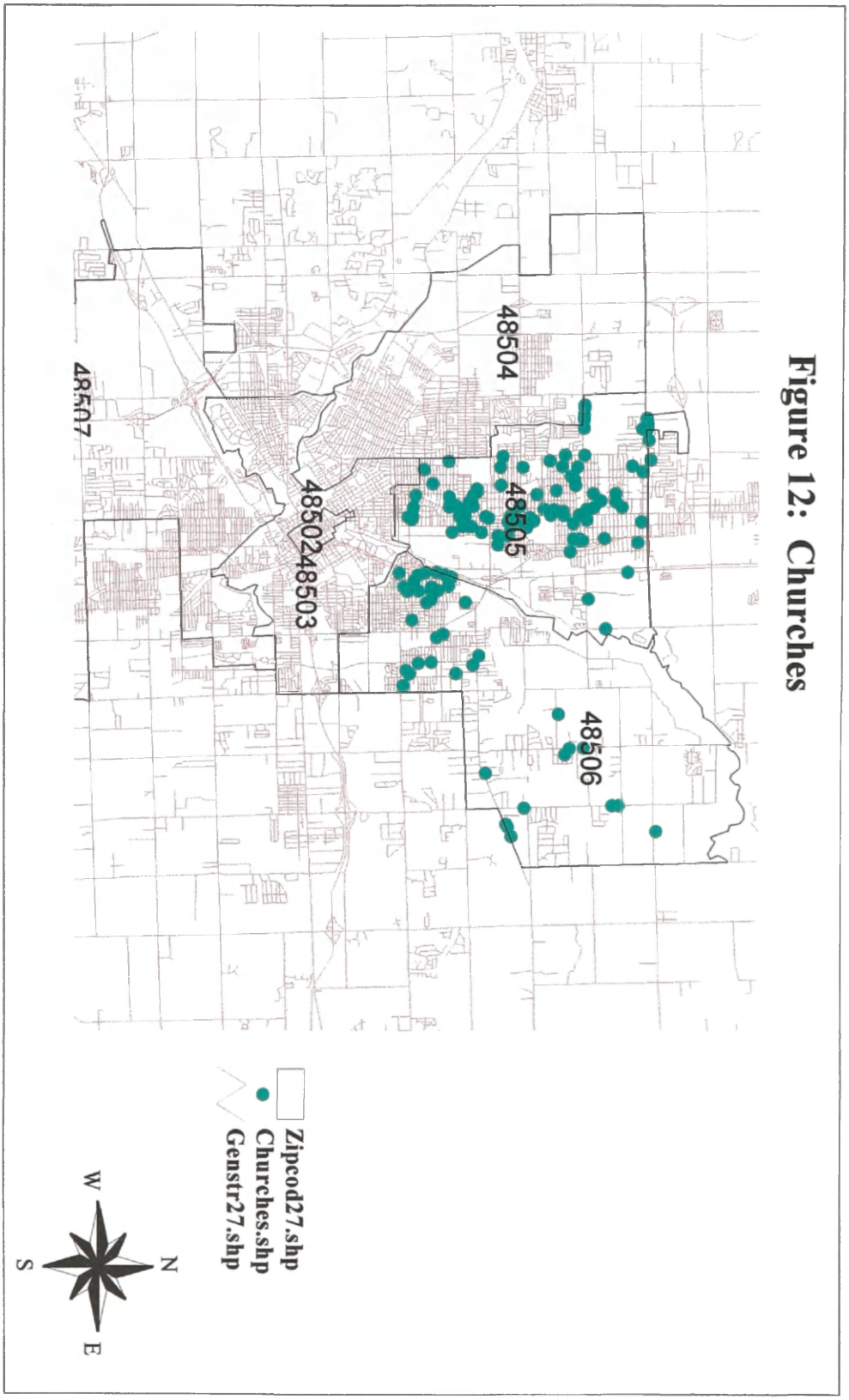


Figure 12: Churches
48504
48505
48506
48502
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48507
Zipcod27.shp
Churches.shp
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Figure 13: Businesses

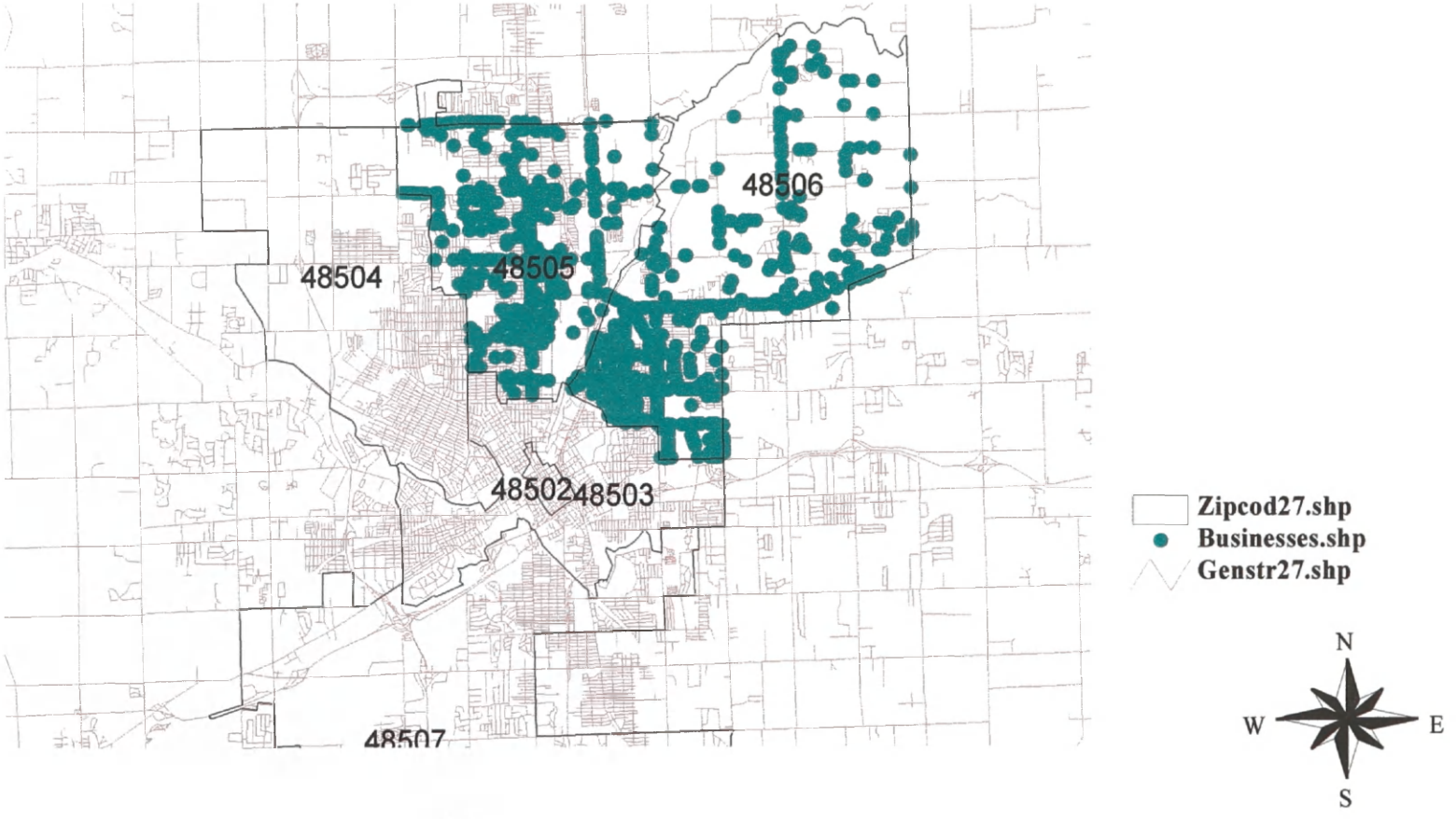


Figure 14: Schools

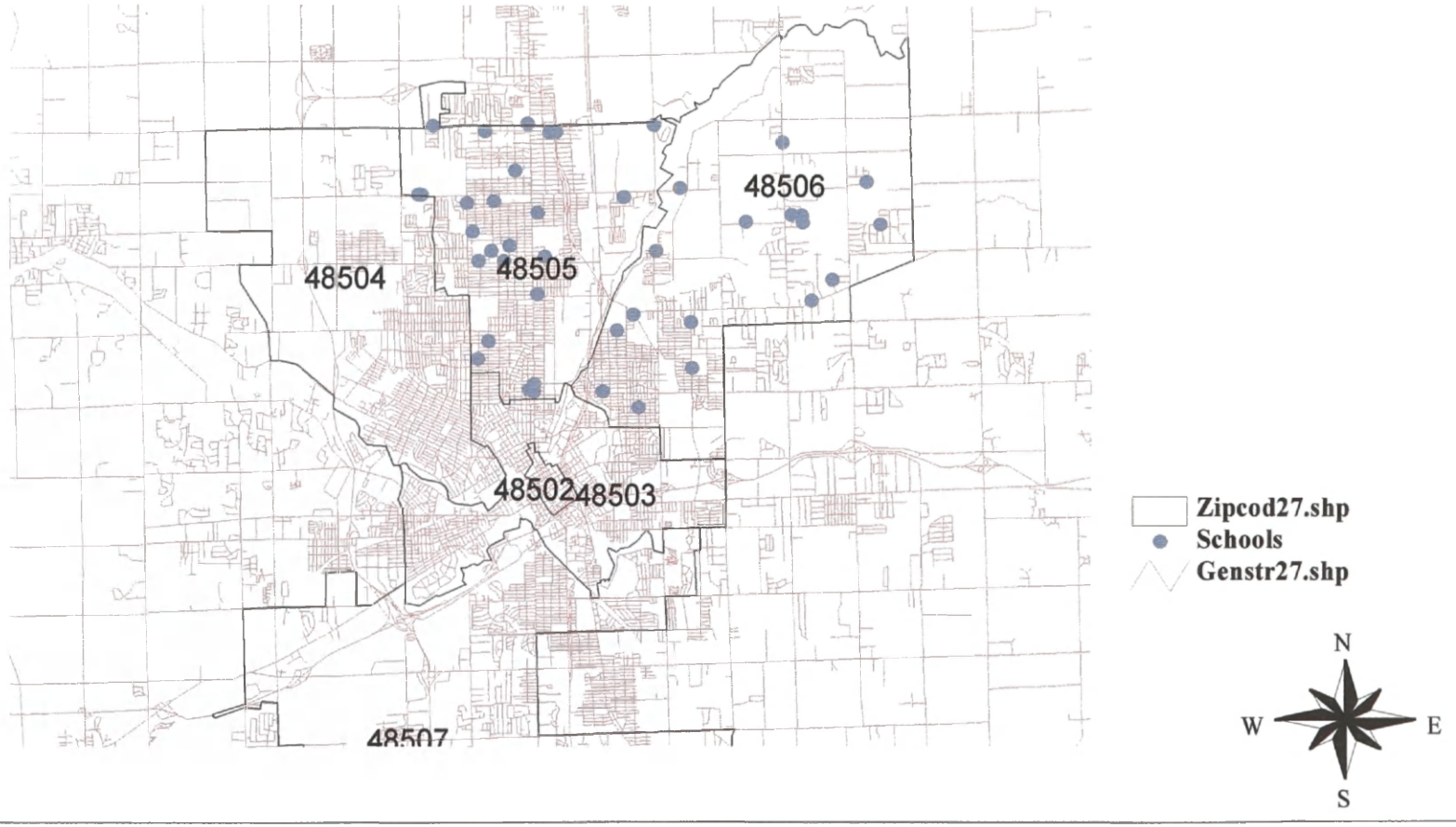


Figure 15: Bars and Party Stores

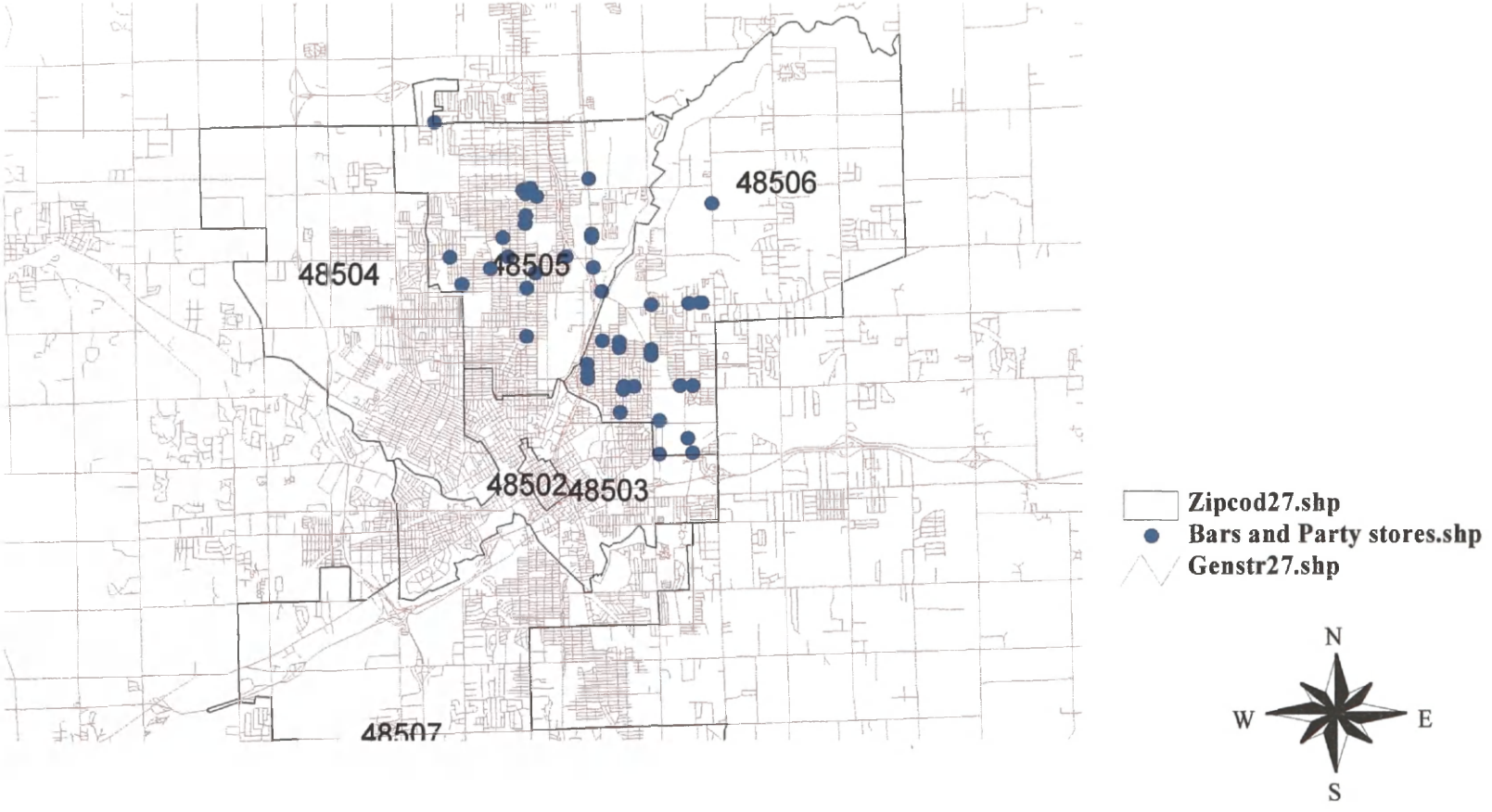
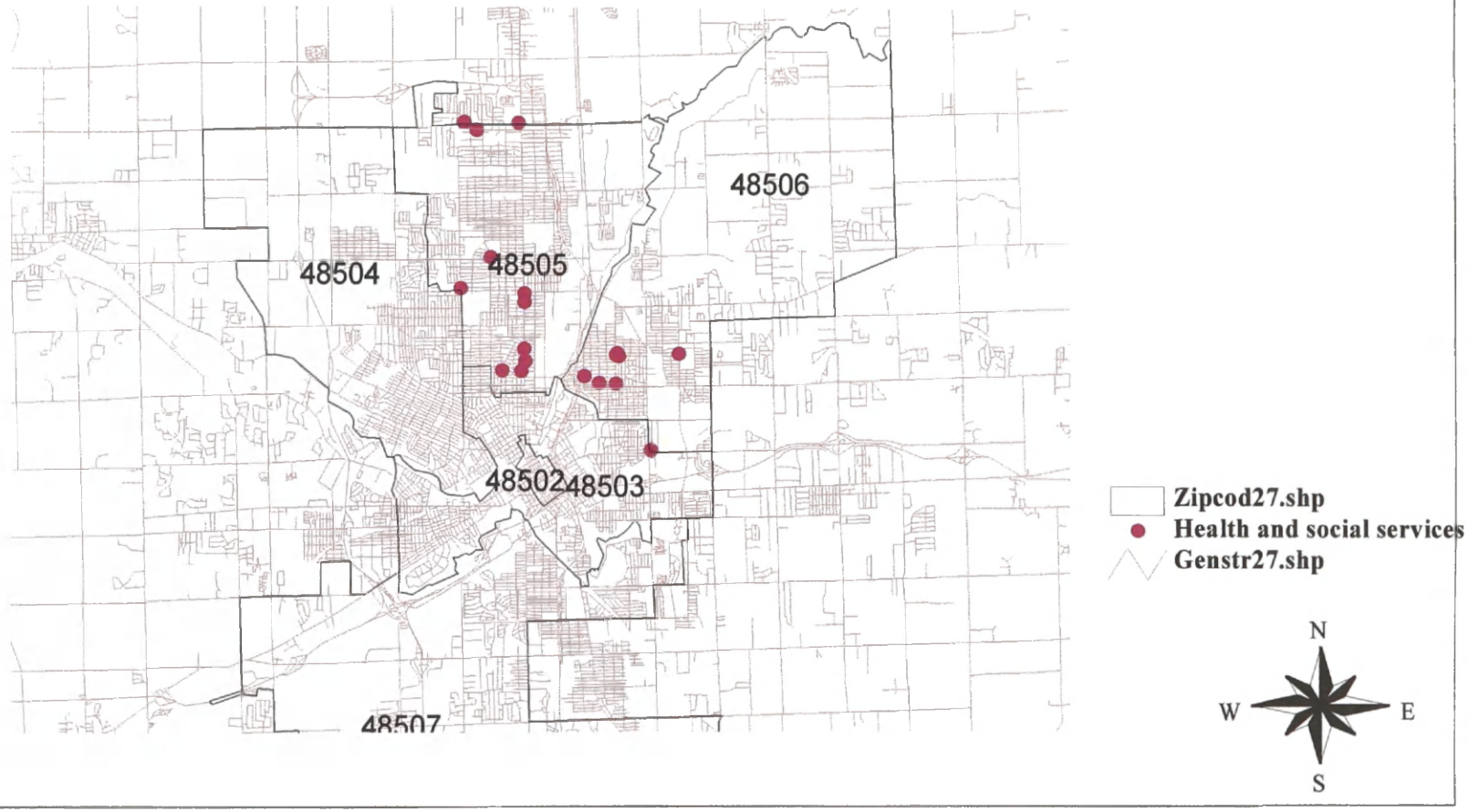
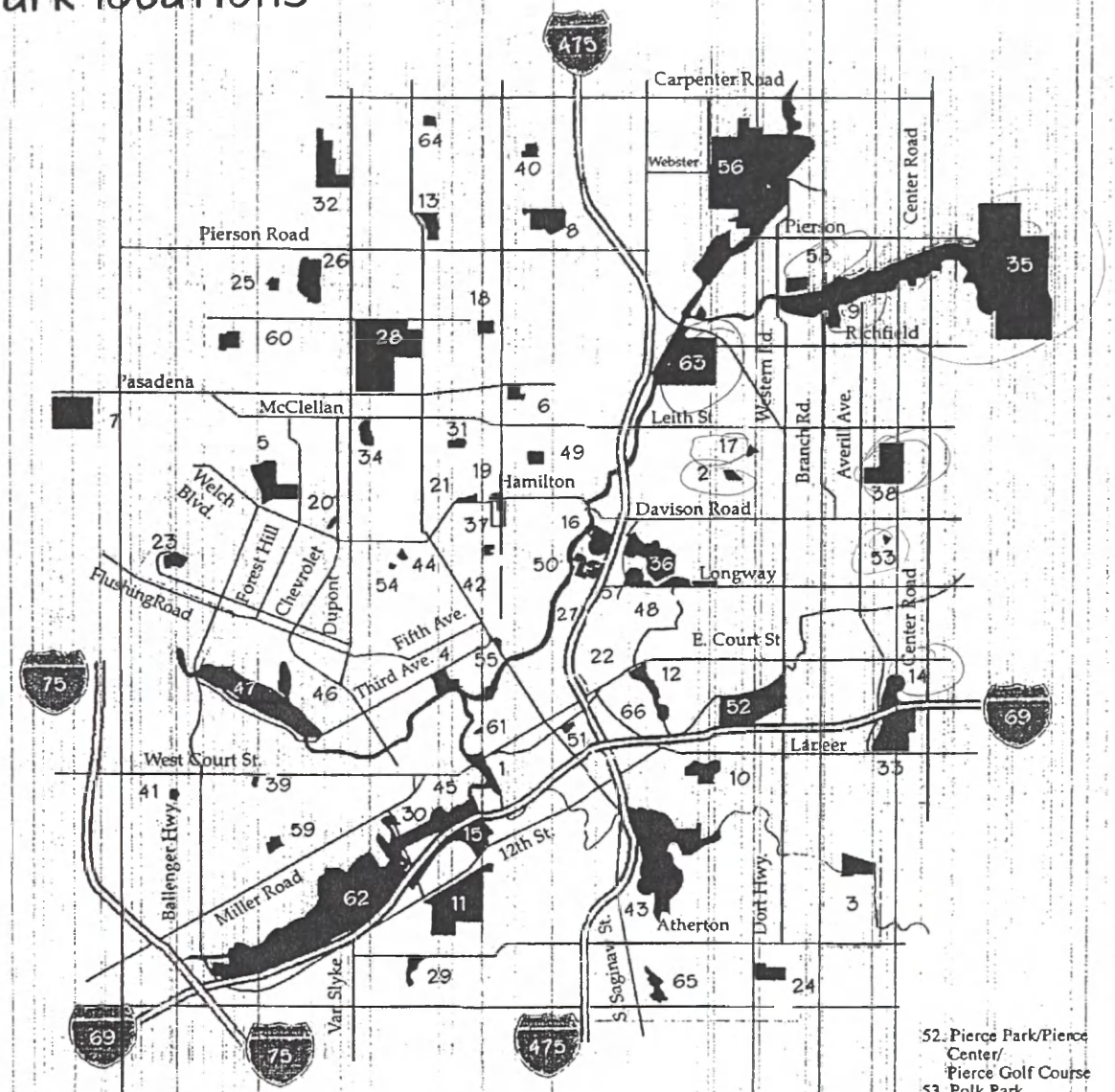


Figure 16: Health and Social Services



Park locations



1. Aldrich Park
2. Amos Park
3. Atherton Park
4. Atwood Stadium
5. Basset Park/Haskell Community Center,
6. Berston Park/Berston Field House,
7. Black Memorial Forest City Cemetery
8. Bonner Park
9. Branch-Carr Park
10. Brennan Park/Brennan Community Center
11. Broome Park
12. Burroughs Park
13. Clara Hilborn Park
14. Cook Park
15. Crohin Derby Downs
16. Dayton Park
17. Delaware Park
18. Dewey Park
19. Dort Park
20. Dougherty Park
21. Durant Park
22. East Street Park
23. Eldorado Vista Park
24. Farnumwood Park
25. Flemming Park
26. Flint Park Lake
27. Flint River Parkway
28. Forest Park
29. Gerholz Park
30. Happy Hollow
31. Hardenbrook
32. Hasselbring Park and Hasselbring Community Center
33. IMA Sports Arena
34. Iroquois Park
35. Kearsley Lake Golf Course
36. Kearsley Park
37. Kennedy Park
38. Longway Park
39. Mann Hall Park
40. Martin Park
41. McCallum Park
42. McFarlan Memorial
43. McKinley Park/ McKinley Center/Thread Lake
44. Metawaneence Park
45. Mobley Park
46. Mott Park
47. Mott Park Golf Course
48. Mott Triangle
49. Oak Park
50. Park and Forestry Headqrts
51. Park and Recreation Headqrts/ City Hall
52. Pierce Park/Pierce Center/ Pierce Golf Course
53. Polk Park
54. Ramona Park
55. Riverbank Park
56. Riverside Park
57. Robert T. Longway Greenbelt
58. Rollingwood Park
59. Sarginson Park
60. Sarvis Park
61. Stockton Park
62. Swartz Creek Golf Course/Kellar Tennis Courts
63. Whaley Park
64. Wilkins Park
65. Windiate Park
66. Woodlawn Park

churches, 18 schools, 26 bars/party stores, 548 businesses, and 8 health and social services within the area.

As one can see from the maps, a higher concentration of resources in 48506 are located in the southwestern part of the area as opposed to the northeastern section. For example, the number of bars and party stores are higher in 48506 than in 48505, however, their location is primarily in the lower western section of the zip code. The same holds true for the number of churches and health and social services. Schools and businesses appear to be nearly evenly distributed throughout both zip code areas. As reported earlier, the type of businesses in 48505 and 48506 observed during the drive-thrus appeared to be primarily small industrial, automotive related, fast food restaurants and mini-marts. According to 1997 business census data, there were 303 business establishments in 48505 and 548 in 48506. Table 6 indicates the number and types of businesses in each area.

Table 6

Zip Code	**48505**	**48506**
Number of establishments	303	548
Number of employees	6,228	11,295
Annual payroll in $1,000	$230,434	$387,706
Types of Business		
Agricultural Services Forestry/Fishing	0	6
Mining	0	1
Construction	17	61
Manufacturing	17	28
Transportation Public Utilities	13	18
Wholesale Trade	26	47
Retail Trade	110	185
Finance, Insurance Real Estate	13	27
Services	105	167
Unclassified	2	8

48505

Of the 303 establishments in 48505 110 of those were in retail trade (43 grocery stores, 13 eating places, 7 drinking places, 5 gasoline service stations, 5 used merchandise stores, 4 auto and home supply stores, 4 drug stores and proprietary stores and a variety of other miscellaneous types).

The next largest business sector in 48505 was the service sector with 105 business establishments (28 religious organizations, 6 data processing and preparation, 6 individual and family services, 4 dry-cleaning plants, 4 top and body repair and paint shops, 3 general automotive repair shops, 3 offices and clinics of medical doctors, 3 offices and clinics of dentists, 3 health and allied services, 3 civic and social associations, etc.)

The wholesale trade sector had 26 establishments (7 scrap and waste materials, 3 plumbing and hydronic heating supplies, 2 petroleum bulk stations, 2 warm air heating and air-conditioning, and 2 motor vehicle parts, used, etc.).

48506

There were a total of 548 business establishments as reported by the 1997 business census data in the zip code 48506 area. Of the 548 businesses, 185 were in retail trade (44 eating places, 26 drinking places, 23 grocery stores, 8 drug stores and proprietary stores, 7 lumber and other building materials, 5 hardware stores and 5 miscellaneous retail, 5 used merchandise stores, 5 florists, 3 liquor stores and a small number in various other areas).

The next largest segment was in Services with 167 establishments. As follows: 18 religious organizations; 12 top and body repair and paint shops, 10 general automotive

repair shops, 7 offices and clinics of medical doctors, 7 offices and clinics of dentists, 7 beauty shops, 6 child day care services, 6 automotive repair shops, 5 car washes, 5 repair services, 5 accounting, auditing, and bookkeeping; and a small number in a variety of other establishments.

The next largest sector was Construction with 61 establishments, (11 electrical work, 10 general building contractors, 10 plumbing, heating, air-conditioning, 6 roofing, siding, and sheet metal work, 5 carpentry work, and a variety of others).

Summary of Results

Table 7 provides a summary of the results by zip code areas. Including population, income, health statistics, grocery stores comparison, neighborhood conditions, and other resources and businesses.

Table 7: Summary of Results	**48505**	**48506**
Population	40,577	34,473
Median Income	$13,321	$25,122
Health		
Infant Mortality	High	Low
Gonorrhea	High	Low
Chlamydia	High	Low
Lead	High	Low
Asthma	High	Low
Neighborhood Conditions	Boarded up houses Liquor advertisements Vacant lots	Similar except for NE section More rural
Grocery Stores		
Price	$22.85	$21.96
Availability	68	55
Number of Parks	15	9
Number of Churches	110	43
Number of Schools	27	18
Number of Businesses	303	548
Annual Payroll	$230,434	$387,706
Number of Employees	6,228	11,295
Number of Bars/Party Stores	21	26
Number of Health/Social Services	17	8

IV. Discussion

This study focused on an assessment of the macro-level influences within a community that are either health promoting or health threatening. Numerous assessments have been conducted at the individual level and of the physical environment such as water quality, air quality and climate. However, those assessments neglect to consider the factors within one's community that can either promote or inhibit one's health and health behaviors. This study examined some of those aspects within the city of Flint.

The selected methods were chosen because each method provides a certain layer of detail that is needed in order to fully understand the factors influencing health and health behaviors. No method alone is able to portray the complete picture. But when utilized in combination with other methods, they build upon one another and provide a great deal of insightful information.

The first method consisted of gathering health statistics and census data by zip code areas. This level of analysis provides a general picture of health in the city of Flint and assists in identifying areas of concern. Results found a wide variation in health status between the zip code areas. Distinct patterns in five health issues were observed with zip codes 48505 and 48502 having the worst health outcomes and 48506 and 48507 having the best health outcomes. Although zip codes 48505 and 48506 are adjacent and share the same macro-environmental influences, i.e. climate, terrain and water supply, the health patterns were very different, for every health issue examined. Based on this knowledge, the zip codes 48505 and 48506 were chosen for further exploration.

Census data provided the demographic data of the City of Flint, which provided another layer of pertinent information. Data showed differences in the 1990 median

income between the two areas in favor of 48506 and in the racial composition with 48506 predominately White and 48505 predominately African American. Data also showed a difference between the two zip codes in overall population size as estimated by the 1999 census. The zip code 48506 is smaller in population than 48505 by approximately 6,104 people.

The results of the in-depth investigation of grocery stores were similar for both zip code areas, in terms of prices, quality and availability of food items. However, as was learned from the census data, the median income in 48506 is higher and therefore those living in that area are more able to purchase the food at that price.

The in-depth investigation of grocery stores provided yet another layer of detail. This method was an excellent way to observe factors that directly impact one's health and health behaviors. The availability and quality of various food items can either promote or hinder one's eating behaviors. Similar results were found in both areas with the exception of availability, i.e. fewer food items were found in zip code 48506. Overall the lack of large grocery stores and the availability of food items were surprising.

It is also interesting to note that there are no major grocery store chains, such as Meijer, Super K-Mart, or Farmer Jack in either area. (Further research into the zoning regulations might be an interesting to study).

The next method for gathering information consisted of neighborhood drive-thrus and using GIS to locate and map out resources in each zip code. The drive-thrus and resource mapping provide another vital piece of information. Drive-thrus allow one to examine the area visually, which then provides information on the conditions, appearance and other aspects. The drive-thru method was essential in gaining information on resources.

hazards, and health promoting and health threatening characteristics in the areas. For example, by driving through the areas, a high number of alcohol-related messages and liquor/min-marts were identified throughout the 48505 zip code area and in the southwestern area of 48506. Only going into the area and observing the surroundings can provide this type of information.

Results gathered through the drive-thrus indicated that the neighborhood environment, (cleanliness, up-keep, overall appearance), was similar between the southwestern section of 48506 and 48505. Much of these areas consisted of a mixture of well-maintained housing and abandoned housing and buildings. Businesses were similar in the area with a large number of liquor/mini-marts, fast food restaurants, churches, auto related services, etc. However, the exception was the northeastern section of 48506, which appeared to be better maintained, with fewer abandoned houses and buildings, less litter and with more recreational resources available (bowling alley, golf course).

Resource mapping through GIS assisted in gathering information on the allocation of resources in the areas. GIS maps visually presented the results, which allowed for comparisons of resources between the two zip code areas. The 1997 census business data also provided valuable information on the number and type of business establishments in each location.

The location, accessibility, and quantity of health and social services, schools, parks, businesses, churches, and human services can impact one's health. The types of businesses in the area not only provide a possible source of income, but also have an effect on the make-up of the surrounding environment.

As mentioned previously, the 1999 estimated census data showed that 48506 had a smaller population as compared to 48505. However, when examining resources in the community, results indicated that zip code 48506 has a larger share of business establishments and a greater variety of businesses.

Looking at the overall results there was not one feature in particular that stood out as a major cause of the health differences between the two zip codes. However, there were numerous factors that could be influencing the health of the population in 48505. For example, lower income, fewer job opportunities, less desirable neighborhood environment (as compared to the northeast section of 48506). Because there are multiple levels of causation of health multiple levels of investigation are desirable. Future research could explore policy level (city, county, and state) decisions, i.e. resource allocations, which may be affecting the health of the population.

V. Implications of Research

The methodologies utilized in this research are applicable to any defined "community setting" and are meant to be a guide for others conducting research. This type of research in larger "community settings" might be limited by the amount of time, manpower, and resources one has available. However, this is a factor that could be overcome with the participation of the community members themselves. Involving community members in neighborhood drive-thrus, grocery store comparisons, locating resources, and taking photographs is an excellent technique to raise awareness among community members, empower the community as a whole, and enhance the findings of one's research.

The type of information gathered through the community assessment is relevant not only for the sheer importance of understanding health problems in different areas and

involving community members, but also for policy and decision-making. The allocation and placement of resources in a community needs to be strategically planned. Because structural and social factors are often manipulatable through the political process, they offer promising approaches to improving the health status of our communities.

Instead of encouraging individuals to eat more healthily or exercise more, perhaps it would be more useful to try to improve the availability, quality and prices of healthy foodstuffs in poor localities, or to improve the availability of and quality of parks and recreation area. It might be helpful to advocate for research that focuses on the health promoting or health threatening features of social and physical environments, and establishing local and national health policies, which take into account features of places as well as features of people.

GIS is a valuable tool in presenting the data. The maps provided a visual picture, identified areas of concern, and made for an easy comparison between the different areas. The geocoding component of GIS is invaluable. With valid addresses, GIS can locate any number of resources within minutes. These aspects are extremely beneficial when working with the community and decision-makers.

Unless one tries to explore more systematically the ways areas differ, one is left with few suggestions for social or public health policies that might improve the health of those in the worst areas, other than those relating to individual improvements in lifestyle (Macintyre, 1993).

VI. Limitations

There are several limitations to this study. First the familiarity of the researcher with the city of Flint may have biased expectations. Ideally, the research would be conducted

blindly with no former knowledge or formed impressions of the area. This could provide greater objectivity to the study.

Additionally, the rates for the health indicators, as mentioned previously, are not for different time periods due to the lack of available data in this format. Ideally, all data would be for the same time period. Quality demographic data for small geographic areas, particularly publicly available data, is often not available or in the form one wants, especially during inter-census periods. Efforts are underway in Flint to develop better data systems.

The information in this study was analyzed at the zip code level to enable comparisons. It is recognized that people are mobile and are not limited by their zip code area. For example, one is not limited to the grocery stores, health facilities, parks, etc. only found in their zip code area. This factor plays a role when considering a group's health as related to social context.

Finally the study was limited by resources and time constraints set by the researcher. Ideally, all grocery stores and other resources in the community would have been explored, not just a sample.

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Appendix A
GIS Annotated Bibliography

Geographic Information Systems (GIS)
Annotated Bibliography

Throughout the history of the development of geographic information systems (GIS) the primary goal has been to take raw data and transform it, via overlays and other analytical operations, into new information which can support the decision making process (Parent and Church, 1987).

The ancestry of geographic information systems dates back to the mid-eighteenth century with the development of cartography and the creation of the first accurate base maps. Up until that point, the graphic depiction of spatial attributes could not be accurately shown.

In 1835, technology, science, and social thought had advanced to the point that the combination of these three factors could support more comprehensive thematic mapping projects (Parent and Church, 1987). The industrial revolution was the main catalyst in the evolution of GIS. The boom in manufacturing increased the need for raw resources, brought people into crowded urban areas, and produced the need for an extensive infrastructure, both social and industrial, especially in the transportation field.

The Atlas to Accompany the Second Report of the Irish Railway Commissioners, which appeared in 1838, was the first framework of a Geographic Information System. The atlas was a series of maps that depicted population, traffic flows, geology, and topography. For each sheet the base map was the same in regard to scale and country boundaries. By overlaying the different elements, the commissioners could make their recommendations as to where the best transportation routes could be sited.

One of the first major GIS sites was the Canada Geographic Information System (CGIS), begun in 1964. CGIS was initially established to handle information gathered by the Canada Land Inventory. Its major application was to store digitized map data and land-based attributes in an easily accessible format for all of Canada. Other early systems included, Storage and Retrieval of Water Quality Control (STORET), and Map Information Assembly and Display System (MIADS).

The utilization of GIS in health care dates back to 1849, and Dr. John Snow's research into the causes of the cholera epidemic in London. The maps he made showing the pattern of cholera victims represents a classic use of geographic information to draw epidemiological conclusions. The famous Snow map of 1854 effectively solved a public health crisis by pinpointing a contaminated water-well as a source of cholera.

Modern GIS evolved from the combination of increased computational capabilities (the computer revolution), refined analytical techniques (the quantitative revolution),

and a renewed interest in environmental/social responsibility (Parent and Church, 1987). Currently, there is increasing interest in the GIS tool by various groups, governmental organizations and commercial organizations. At the federal level, the number of agencies reporting widespread use of GIS has doubled, from 18 in 1990 to 44 in 1992 (Garson & Biggs, 1992). In the past few years, several books have been published on how people in specific industries utilize the geographic information system as a tool to manage their activities and assist them in decision-making.

The use of graphic presentation of map data is demonstrated in the Crime Analysis Mapping System (CAMS) of the City of Tacoma, Washington. CAMS allow police and other users to view data on burglaries, rape, and other crimes in conjunction with census data. Data may be viewed at street, census block, district, and sub-district levels. Using a data entry screen, police can select the level of analysis, type of crime and conditions (e.g., dates), then view the pattern of crime. CAMS provides a clearer analysis of such management decisions as assigning police patrols, interpreting case patterns, targeting education efforts, and planning facilities such as lighting.

Some other recent examples of GIS applications include, tracking earthquake fault lines in relation to property data for loss-risk assessment in Utah (Firestone, 1987); flood hazard mapping in Washington, D.C. (Cotter & Campbell, 1987); emergency preparedness functions in Los Angeles regarding evacuation routing, shelter allocation, and identification of probable disaster locations (Johnson, 1987); helping Portsmouth, New Hampshire, preserve its supply of clean water (Lee & Douglass, 1988); and tracking the spread of infectious and environmentally caused diseases (Lang, 2000).

The recent interest in GIS by various groups is due to the strengths this tool has to offer. It has the ability to see how data relates in space and time. With the GIS, observations regarding the social, economic, political, and physical environments can be referenced to a common geospatial data framework allowing varying organizations to share spatial data regarding these phenomena (Rushton, 2000). Particularly, in health care, spatial techniques can facilitate the linkage of vital statistics, census, and health systems databases gathered by different administrative units each using their own regional boundaries (Andes & Davis, 1995). Spatial location is also important in health care because geographical patterns of health data are one way to infer social inequalities. See appendix A for examples of mapping capabilities.

With all its many strengths, GIS is not without weaknesses. One of the major limitations of GIS in health care is the ability to obtain data-spatially referenced, accurate, up to date and disaggregated. The majority of existing health statistics are not currently collected in this format, which makes it difficult to utilize. Another weakness that hampers the utility of GIS in health care is the poor ability of commercial GISs to handle multi-temporal geographic information or the movement of people. This limits the utility of GIS in understanding health problems with long latency periods, such as many forms of cancer, since with mobile populations, the

location of the patient at the time of diagnosis or mortality may have little relation to the location of the exposure to toxic substances or other environmental risks (Rushton, 2000).

The following annotated bibliography outlines a variety of texts and articles, which discuss principles, concepts, history, limitations and applications of GIS.

Johnson, Pettersson, Fulton – Editors, *Geographic Information Systems (GIS) and Mapping – Practices and Standards.* ASTM Publications, Philadelphia, PA, 1992.

The text defines GIS as an organized collection of computer hardware, software, and geographic data designed to efficiently capture, store, update, manipulate, analyze, and display all forms of geographically referenced information.

This publication provides 26 of the 31 papers presented at the International Symposium on Mapping and Geographic Information Systems in 1990. The purpose of the Symposium was to bring together an interdisciplinary and international group of scientists and engineers to provide a forum to exchange experiences and to address areas in which standardization of GIS elements could be helpful to facilitate technology.

The majority of the papers in the text address the subject of standardization. The need to identify standards not only for computer hardware and software operations but also for controlling the quality of data has been recognized within agencies concerned with implementation of large GIS programs.

The papers addressing applications of GIS include; basic technology, soil investigations and geologic explorations, and of ground water and environmental studies. There are no papers on the applications of GIS to health care.

The publication is more suited for professionals involved in integration of GIS technology in practical science and engineering project applications or involved in standards development.

Aronoff, S., *Geographic Information Systems: A Management Perspective.* WDL Publications, Ottawa, Canada, 1989.

Aronoff defines GIS as a computer-based system that provides the following four sets of capabilities to handle georeferenced data: 1) input; 2) data management (data storage and retrieval); 3) manipulation and analysis; and 4) output.

This text presents the principles and concept of GIS. It provides a complete introduction to the subject, addressing both the technical and organizational issues.

The text is aimed at both users and managers of the GIS technology and assumes the reader has no previous experience in the field. The book demonstrates the ability of the GIS to be utilized as a management tool. The text considers topics such as maintenance and analysis of spatial data, justification of system, system acquisition and start-up, and operational system.

The book contains several examples of practical GIS applications, however, not in the health field. Examples focus on; agricultural and land use planning, forestry and wildlife management, archaeology, geology, municipal applications, and global scale applications.

Ripple, W., Editor, *Fundamentals of Geographic Information Systems: A Compendium.* American Society for Photogrammetry and Remote Sensing and American Congress on Surveying and Mapping, Bethesda, MD, 1989.

The text defines GIS as an integrated system to capture, store, manage, analyze, and display information relative to concerns of a geographic nature.

This volume includes an international collection of articles dealing with GIS concepts. The articles included were obtained primarily from refereed journals in cartography, GIS, and remote sensing. The compendium is designed to be useful in university GIS courses as a textbook supplement and as a reference for individuals interested in employing GIS technology.

The main focus of the volume is on the fundamentals, principles, and issues in GIS. Particular attentions is given to such issues as entering digital data into a GIS, the assessment of errors in GIS, the development of improved spatial data structures to increase the efficiency of GIS, integration of remote sensing data, and the development of artificial intelligence techniques, and specifically expert systems, for GIS.

The volume provides an excellent overview of the definition, the history of technology and requirements and principles for GIS implementation. The volume also provides a guide to information sources on GIS literature including books, journals, symposia proceedings, and an extensive selection of newsletters.

There is a section on recent examples of GIS applications. The examples include; aquatic resource evaluation, waste disposal site selection, and geological engineering. No examples are provided for health care.

Pickles, J., Editor, *Ground Truth: The Social Implication of Geographic Information Systems.* The Guilford Press, New York, London, 1995.

The book examines the transformation of data handling and mapping capabilities that have emerged in the past two decades, and the impact they have had within the discipline of geography.

The author believes the development and deployment of sociogeographic data gathering, handling, and imaging techniques are part of a broader reconfiguration of the use of information in society.

The book represents a variety of ideas, ideologies, and social practices that have emerged with the development of new forms of data handling and spatial representation. It also places GIS as a tool and an approach to geographical information within wider transformations of capitalism in the late 20th century: as a tool to protect disciplinary power and access to funding; as a way of organizing more efficient systems of production; and as a reworking (and rewriting) of cultural codes-the creation of new visual imaginaries, new conceptions of earth, new modalities of commodity and consumer, and new visions of what constitutes market, territory, and empire.

Garson, G., Biggs, R., *Analytic Mapping and Geographic Databases: Quantitative Applications in the Social Sciences.* Sage Publications, Newbury Park, London, New Delhi, Series/Number 07-087, 1992.

The paper demonstrates how traditional difficulties in utilizing maps can be overcome. The author believes that in the social sciences, maps are neglected as analytic tool due to the common difficulties of using maps effectively and efficiently.

The authors review the many types of maps-UBC, dasymetric, block, isarithmic, to name a few-and explain summary statistics, such as geographic means, location quotients, and areal correspondence.

Martin, D., *Geographic Information Systems and Their Socioeconomic Applications.* Routledge, London and New York, 1991.

The book is a non-technical introduction to the expanding field of GIS in contrast to much of the existing material on GIS, which is either too technical or concerned with applications in the physical environment. This book is a valuable resource for students and professionals in applied socioeconomic fields, as the aim of the book is to introduce GIS within a strong framework of socioeconomic applications.

The book reviews the development and present applications of GIS technology, and presents a theoretical framework in which to understand the evolution of GIS. The reader learns about the collection, input, storage, manipulation and output of data in GIS.

Lang, L., *GIS for Health Organizations.* Published by Environmental Systems Research Institute, Inc., Redlands, CA, 2000.

This book demonstrates the uses of the GIS in health care and is one of the few resources available to health professionals. The text provides a minimal amount of background on GIS and instead has devoted much of the space to providing the reader with examples of applying GIS techniques in health care.

The book presents case studies which include, 1) pollution contributing to high rate of breast cancer, 2) preventing the spread of malaria, 3) analyzing sales territories for pharmaceutical companies, 4) comparing health care practices by region, 5) siting locations for new assisted-living centers, 6) locating rehabilitation centers, 7) uncovering the patterns of injury, 8) managing member enrollment, 9) managing information overload, and 10) modeling a toxic spill to help protect people living nearby. The details and outcomes of each project are thoroughly explained.

The author does an excellent job of demonstrating how and why GIS is a valuable management tool. The book also provides a resource of other case studies series including, Zeroing In: Geographic Information Systems at Work in the Community.

Twigg, L., *Health Based Geographical Information Systems: Their Potential Examined In The Light Of Existing Data Sources.* Social Science and Medicine, Vol. 30, No. 1, pp. 143-155, 1990.

The aim of the paper is to expand on some of the issues limiting the use of GIS within health research. The first part of the paper focuses on the functions of GIS and the possible applications in the field of medical geography and general health research. The second section considers the problems of using routine health data sets within GIS, and finally, the last section of the paper provides an example of community health services planning to integrate some of the issues raised within the paper.

The majority of the paper is devoted to the problems associated with the routine health data sets. In England and Wales, which is where the research was conducted, official health statistics are hampered by their lack of spatial detail. Without this spatial detail the utility of the data in GIS is limited. Another issue in regard to data is that, most published data sets are reported by fairly large administrative areas; there is a little disaggregation.

The paper argues that, although GIS is a potential tool for health professionals, its use is dependent upon the availability of suitable data-spatially referenced, accurate and up to date. Additionally, the conclusion is reached that the full utility of GIS can only be achieved if data is obtained at the most disaggregated level possible.

Andes, N., Davis, J., *Linking Public Health Data Using Geographic Information System Techniques: Alaskan Community Characteristics and Infant Mortality.* Statistics in Medicine, Vol. 14, pp. 481-490, 1995.

This research applies GIS techniques to infant mortality in Alaska. The article provides useful information on conducting research with multi-source data using GIS techniques. A primary goal of this paper is to encourage spatial linkage and analysis techniques for vital statistics and census data.

Information characterizing geographical locations is gathered from Alaska's vital statistics for the years 1982-91 and the 1990 Census. Geographic Information system (GIS) techniques are applied to identify, 1) spatially homogeneous regions, 2) assess spatial compatibility across databases, and 3) allocate geographical units across boundaries.

Glass, G., Schwartz, B., Morgan, J., Johnson, D., Noy, P., Israel, E., *Environmental Risk Factors for Lyme Disease Identified with Geographic Information Systems.* American Journal of Public Health, Vol. 85, No. 7, pp. 944-948, July 1995.

In this study the GIS was used to identify and locate residential environmental risk factors for Lyme disease. Data were obtained for 53 environmental variables at the residences of Lyme disease case patients in Baltimore County from 1989 through 1990 and compared with data for randomly selected addresses. A risk model was generated combining the geographic information system with logistic regression analysis. The model was validated by comparing the distribution of cases in 1991 with another group of randomly selected addresses.

This study demonstrates that a geographic information system may be useful in identifying environmental risk factors associated with vector-borne infectious diseases and that by combining a geographic information system with epidemiologic analysis, one can study the spatial patterns of disease over larger geographic areas with greater accuracy.

English, P., Neutra, R., Scalf, R., Sullivan, M., Waller, L., Zhu, L., *Examining Associations between Childhood Asthma and Traffic Flow Using a Geographic Information System.* Environmental Health Perspective, Vol. 107, No. 9, pp. 761-767, September 1999.

In this exploratory study, GIS techniques were used to explore whether childhood residence near busy roads was associated with asthma in low-income population in San Diego County, California. The study utilized existing health and traffic data from an ongoing geographic information system study of environmental, demographic, and health characteristics in the California/Baja California border region.

Researchers examined the locations of residences of 5,996 children less than or equal to 14 years of age who were diagnosed with asthma in 1993 and compared them to a random control series of non-respiratory diagnoses. Locations of the children's residences were linked to traffic count data at streets within 550 ft. The number of medical care visits in 1993 for children with asthma was also examined.

The researchers examined the capability of GIS in linking traffic volume information to asthma cases and a random control series that were gathered from routinely collected billing information. The researchers believed this would provide a more accurate exposure assessment than linking asthma cases to average exposure values in an area.

The authors mentioned several strengths in the utilization of GIS techniques in this research which included, 1) quick linkage of traffic count information to geocoded addresses, 2) GIS facilitated efficient computation of traffic counts at the nearest street to the residence of the case control and at the street with the highest traffic, and 3) GIS summed the total traffic count at all streets within a 550 ft. buffer area.

Rushton, G., Elmes, G., McMaster, R., *Considerations for Improving Geographic Information System Research in Public Health.* URISA Journal, Vol. 12, No. 2, Spring 2000.

The paper is a response to the University Consortium for Geographic Information Science 1999 Summer Assembly. The paper describes the uses of GIS in the field of public health. Unlike other recent research, this paper does not focus on GIS in epidemiology and health services research but instead focuses on the education and research needs to fulfill the potential of improving health with GIS.

The paper discusses the lack of educational training and resources in GIS for public health professionals. The majority of the GIS classes offered provide students and professionals with knowledge in the areas of GIS/GIScience, not specifically applications in public health. The CDC is currently developing distance-learning modules on GIS and public health.

The paper also addresses the lack of GIS-based research in public health. The authors prioritized and recommended the following areas for research, 1) improving disease surveillance data systems, 2) risk factors as contributors to disease and ill health, 3) ecological studies of the relationship between environmental factors and disease transmission, 4) temporal aspects of GIS and health, 5) integrate the literature of spatial choice in geography and econometrics with the literature of preventive care choices, 6) propose additional systematic studies of access, health treatment choice, and health outcomes, 7) develop methods for targeting health resources, 8) using GIS to improve ways to communicate to the public the results of research on health, and 9) maintaining the confidentiality of health records

The last section of the paper address policy implications. A major recommendation is that policy considerations should include "best practices" for spatial analysis within GIS in public health.

Welde, B., Kinman, E., Haithcoat, T., *Integrating GIS with Dispersion Software to Determine the Equity and Risk of Air Pollution in East St. Louis, Illinois.* Http://www.esri.com/library/userconf/proc99/proceed/indices/trackd3.htm, June 2000.

This paper is an overview of work conducted at the University of Missouri that examines the applicability of integrating dispersion modeling software with GIS to illuminate generalized trends of accumulative pollution and toxicity.

The paper stemmed from the need to understand the exposure risk in an area with multiple industrial facilities. The research is conducted in East St. Louis. Over 70 industrial facilities-including oil refineries, chemical companies, steel mill, commercial waste incinerator, five hazardous waste landfills, as well as copper, lead, and zinc smelters-are located within the incorporated area of East St. Louis.

The authors recommend continued exploration with other dispersion modeling software.

Banta, J., *Culturally Competent Mental Health.* Http://www.esri.com/library/userconf/proc99/proceed/indices/trackd3.htm, June 2000.

This paper discusses the use of GIS, ArcView in particular, in conducting a Cultural Competency Needs Assessment. The State of California Department of Mental Health is requiring that counties address cultural and ethnic issues in the implementation of outpatient managed care for Medicaid clients.
ArcView was used to merge census and zip code based data in order to create regionally based tables of county demographic and Medi-Cal beneficiary data. One example of information that the research produced was the languages in which each county must have linguistic capability. This type of research can assist counties in planning for services.

Balagopalan, M., *Communication of Health Risk Assessment by Integrating Geographic Information System (GIS) with Computer Dispersion Models.* Http://www.esri.com/library/userconf/proc99/proceed/indices/trackd3.htm, June 2000.

This paper considers the implications of air pollution from industrial sources and how that information is shared with the affected population. The author suggests GIS is a potential tool in communicating the risk to the affected population.

The author states that with GIS, the street layer and demographic information can be layered with the risk isopleths, to show the cumulative impacts, if any, on the community, and also the affected highest risk areas.

The paper examines the integration of GIS with a computer dispersion-modeling program, Industrial Source Complex Short Term (ISCST3). The author has included a step-by-step technical description of the process.

Appendix B
Table of Resources

Resource/Data List

Infant Mortality Rates	Genesee County Health Department
Asthma Data	Genesee County Health Department/Hurley Hospital
Lead Referrals	Genesee County Health Department
Gonorrhea Data	State of Michigan Vital Statistics
Chlamydia Data	State of Michigan Vital Statistics
Genesee County Health Statistics	www.mdch.state.mi.us/PHA/OSR
Flint Grocery stores	Department of Agriculture-State of Michigan/Food and Dairy Division
Flint Parks	Flint Parks and Recreation Department
Flint Demographics	www.venus.census.gov/cdrom/lookup
Flint Businesses	Office of Business and Community Partnerships UM-Flint
Flint Liquor Stores	Office of Business and Community Partnerships UM-Flint
Churches	FACED and Office of Business and Community Partnerships
Flint's history	http://newfirstsearch.oclc.org:80/W
Health Facilities/ Support Services	Programs to Reduce Infant Deaths Effectively (PRIDE)

Appendix C
Photographs

Pictures 1 and 2 - Contrasts between houses in 48505

Pictures 3 and 4 - Abandoned apartment complex

Pictures 5 and 6 - Liquor advertisements

Pictures 7 and 8 - Liquor advertisements

Picture 9 - Liquor advertisements

Picture 10 - Job Corps Center

Pictures 11 and 12 - Housing in southern section of 48506

Pictures 13 and 14 - Housing in northeast section of 48506

Picture 15 - Housing in northeast section of 48506

Picture 16 - Poorly maintained park

Picture 17 and 18 - Parks

Picture 19 - Riverside Park

Picture 20 - Well maintained park

Pictures 21 and 22 - Well maintained parks