EFFECTS OF SITE DESIGN ON PEDESTRIAN TRAVEL IN MIXED-USE, MEDIUM-DENSITY ENVIRONMENTS

WA-RD 432.1

Final Report
August 1997

Washington State
Department of Transportation

Washington State Transportation Commission
Planning and Programming Service Center
in cooperation with the U.S. Department of Transportation
Federal Highway Administration

TECHNICAL REPORT STANDARD TITLE PAGE

1. REPORT NO. WA-RD 432.1	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.
4. TITLE AND SUBTITLE Effects of Site Design on Pedestrian Travel in Mixed-Use, Medium-Density Environments		5. REPORT DATE August 1997 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Anne Vernez Moudon, Paul Hess, Mary Catherine Snyder, Kiril Stanilov		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Washington State Transportation Center (TRAC) University of Washington, Bx 354802 University District Building; 1107 NE 45th Street, Suite 535 Seattle, Washington 98105-4631		10. WORK UNIT NO. 11. CONTRACT OR GRANT NO. T9903, Task 65
12. SPONSORING AGENCY NAME AND ADDRESS Washington State Department of Transportation Transportation Building, MS 7370 Olympia, Washington 98504-7370		13. TYPE OF REPORT AND PERIOD COVERED Research Report 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

This study was conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration.

16. ABSTRACT

This research project focused on whether high or low incidence of pedestrian travel in mixed-use, medium density environments is due to site design characteristics and, specifically, to the presence of direct, continuous, and safe pedestrian systems.

The study examined twelve neighborhood centers, or "sites," in the Puget Sound area of Washington. The twelve sites were selected to match in terms of gross residential density, median income, automobile ownership, and intensity and type of neighborhood commercial development. Pedestrians and bicyclists who traveled into the commercial area were recorded. A clear break emerged between urban and suburban sites. The average urban pedestrian volume was 37.7 per hour per 1,000 residents, three times higher than the 12.5 per hour per 1,000 residents in suburban sites.

These results strongly support the hypothesis that, when other variables are held constant, the urban versus suburban difference in route directness and completeness of pedestrian facilities (namely, block size and sidewalk length) affects pedestrian volumes. The results also question the common belief that people do not walk in the suburbs. Given appropriate land-use conditions, pedestrian facility improvement programs in suburban areas could support pedestrian travel and have a significant influence on mode choice.

17. KEY WORDS Pedestrian facilities, travel behavior, land use	18. DISTRIBUTION STATEMENT No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22616

19. SECURITY CLASSIF. (of this report)	20. SECURITY CLASSIF. (of this page)	21. NO. OF PAGES	22. PRICE
None	None	149	

Research Report
Research Project T9903, Task 65
Site Design Pedestrian

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Prepared for

Washington State Transportation Commission
Department of Transportation
and in cooperation with
U.S. Department of Transportation
Federal Highway Administration

August 1997

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RESEARCH CONTEXT

This project fits into the context of the Washington State Department of Transportation policy to reduce the public's dependence on motor vehicles by providing travel alternatives. The state's pedestrian transportation policy recognizes walking as an important transportation option for many trips. It requires that pedestrian facilities be integrated into comprehensive transportation planning and development programs. This project provides empirical evidence that the presence of pedestrian facilities corresponds to a higher incidence of walking as a means of transportation.

This project is also part of a comprehensive research agenda to understand and control the relationships among land use, urban form, and transportation. The overall mission of the research program is to develop ways of designing and implementing human settlement patterns that decrease total vehicle trip making, reduce the length of the typical automobile trip, and encourage the use of transportation means other than the single-occupant vehicle (Pivo and Moudon 1992).

This project falls into the category of "urban form and travel behavior" identified in the research agenda. This research category includes projects that explore the relationship between settlement patterns and travel behavior at the scale of the district and the region. Research projects on different scales of development are intended to be mutually reinforcing and to work toward developing a comprehensive understanding of the relationships between settlement patterns and transportation.

INTRODUCTION

This report consists of three parts. The first is a summary of the project's findings and recommendations. It has been placed in the beginning of this report to facilitate the readers' access to the material. The second part describes the various aspects of the method used to collect data. It begins with an overview of the methodological framework, which is followed by sections that describe the project's different phases of data collection, including the process used to select the 12 sites, the socio-demographic and physical characteristics of the selected sites, and the pedestrian volume counts. The report's third section covers the analyses of the data and includes general findings on relationships between pedestrian volumes and the characteristics of the sites, socio-demographic profiles of observed pedestrians, variability in pedestrian counts, variability in pedestrian behavior, pedestrian volumes and cordon conditions (transportation infrastructure and land-use conditions at points where pedestrians were counted), and counts of bicyclists.

I. SUMMARY OF FINDINGS AND RECOMMENDATIONS

RESEARCH DESIGN AND DEFINITIONS

This project demonstrates that pedestrian volumes are related to site design. A quasi-experimental method was used to study 12 neighborhood sites with commercial centers in the Puget Sound region. The sites selected were controlled for four basic variables that previous research has identified as factors that affect pedestrian trip volumes. These variables were as follows:

- population density (the higher the density the larger the potential "market" of pedestrians)
- income (the higher the income, the easier the access to an automobile, which acts as a disincentive to walk)
- land-use type and mix (defining appropriate origin and destination of the pedestrian trip)
- a one-half-mile radius area within which all of the above variables are spatially contained (this distance, which defines an area of approximately 500 acres, is appropriate for pedestrian travel).

Under these controlled conditions, all the 12 sites were selected for their high potential to support pedestrian travel. Each site had a gross residential density of 10 people to the acre or greater and contained all of the retail facilities necessary for daily living. In other words, each site had a concentration of commercial land uses that defines a neighborhood commercial center, as well as an average of 6,000 people living in apartments and single houses within a one-half-mile radius of the center. In all 12 sites, approximately half of the dwelling units were located within a third of a mile of the neighborhood center.

However, half of the selected sites exhibited site design characteristics that were supportive of pedestrian travel, whereas the other half of the sites did not (dependent variable). Site design characteristics that support pedestrian travel are defined by small blocks and by continuous and connected sidewalks. Site design characteristics that do not facilitate pedestrian travel are defined by large blocks and by few, often discontinuous and disconnected, pedestrian facilities.

To facilitate the discussions of site design characteristics, the six sites with supportive site design characteristics were called "urban," and the six sites whose site design was not supportive of pedestrian travel were called "suburban." The distinction between urban and suburban focused on site design characteristics that were readily measurable and related directly to the pedestrian environment: specifically, the presence or absence of sidewalks (measures of pedestrian facilities completeness) and the distribution of those sidewalks (measures of pedestrian facilities extent).

In this study, the urban sites had the following site design characteristics:

- mean block sizes of 2.7 acres (the equivalent of a 300- by 400-foot block)
- complete and continuous public sidewalk systems on both sides of all streets.

Suburban sites had the following site design characteristics:

- mean block sizes of 32 acres (the equivalent of a 1,000- by 1,300-foot block)
- incomplete and discontinuous public sidewalk systems that, on average, lined less than half of the streets of the sites.

Under this definition of "urban" and "suburban," many cities in the Puget Sound actually exhibit "suburban" characteristics. For example, more than half of the residential areas of Seattle do not have sidewalks and could, therefore, be classified as suburban according to our definition. However, to ensure the clarity of research results given the small 12-site sample, the sites selected reflected only the two extremes of urban and suburban site design characteristics; that is, there were no sites with mixed characteristics, such as sites with small or medium-sized blocks but no sidewalks. As a result, all 12 sites selected could be readily classified as either urban and suburban. They also exhibited other features that commonly distinguish between urban and suburban design characteristics, such as buildings oriented toward and situated next to streets in the case of urban sites, and buildings considerably set back from the streets and often oriented toward parking lots in suburban sites.

Finally, only a limited number of sites in the Puget Sound region could fit within the control and independent variables. As a result, the 12 sites selected were categorized and matched according to the size of their commercial centers, with size being defined by the number of businesses and types of retail facilities provided within the one-half mile pedestrian catchment area. There were four groups of sites: two groups of two sites with a large commercial center, one group of five sites with a medium-sized commercial center, and one group of three sites with a small commercial center. Areas defining the commercial center varied in size from 21 to 122 acres. All had at least one traditional grocery store. In urban sites, retail facilities lined one main street in single-story structured or mixed-use multi-story buildings. In suburban sites, retail facilities were spread through large blocks of private land dominated by parking at grade.

Pedestrians were counted as they left residential areas to enter the neighborhood commercial area.

FINDINGS

Table 1 summarizes the site characteristics and pedestrian volumes found.

1. Relationship Between Pedestrian Volumes and Site Design

Pedestrian Volumes Are Related to Site and Pedestrian Facilities Design

This project showed that the three measures traditionally employed to predict pedestrian volumes—population density, income, land-use distribution and intensity—are, individually and together, insufficient to explain pedestrian volumes; site design,

Table 1. Summary of Site Characteristics and Pedestrian Volumes

Site	Population, (complete site)[1]	Gross Population Density	Number of businesses within cordon	Median Income	Length of Streets (mi)[1]	Length of Sidewalks (mi)[1]	Sidewalk completeness[2]	Mean block size (acres)	Mean distance between entry points (ft)[3]	Median Airline Distance (mi)[4]	Mean Route Length (mi)	Route Directness[5]	Observed Pedestrians per hour	Pedestrians per hour per 1,000 residents	Pedestrians per hour (complete site)[1]
Urban Sites															
Ballard	5,936 (7,050)	14.1	205	16,500 - 27,000	28.0	40.4	100%	2.5	633	0.33	0.40	1.24	299	50	355
Madison Park	3,647 (7,100)	14.2	46	38,500 - 135,000	23.3	30.4	100%	3.7	483	0.20	0.31	1.23	152	42	296
Proctor	4,343 (4,800)	9.6	63	20,500 - 44,000	35.2	32.9	83%	2.6	632	0.36	0.43	1.25	105	24	105
Queen Anne	6983 (7,350)	14.7	68	24,500 - 52,500	30.9	39.4	100%	2.1	523	0.33	0.43	1.29	360	52	379
Wallingford	7,577 (7,850)	15.7	82	24,000 - 43,500	30.9	44.4	100%	1.8	635	0.27	0.36	1.32	271	36	280
West Seattle	5,388 (5,950)	11.9	63	27,000 - 44,000	30.7	38.0	100%	2.7	397	0.36	0.44	1.28	118	22	130
Urban Average	5,629 (6700)	13.4	88	-	29.8	37.6	97%	2.7	551	0.31	0.40	1.27	217	38	257
Suburban Sites															
Crossroads	7,037 (6,150)	12.3	96	23,000 - 38,000	7.9	7.7	63%	45.5	1,124	0.36	0.54	1.49	112	16	98
Juanita	5,294 (6,450)	12.9	44	33,000 - 71,500	13.3	10.1	45%	15.3	820	0.27	0.49	1.76	41	8	50
Kent East Hill	7,332 (6,800)	13.6	110	33,000 - 71,500	6.5	6.1	57%	48.6	1,210	0.45	0.66	1.57	85	12	79
Kingsgate	6,028 (5750)	11.5	30	34,000 - 55,500	14.1	16.0	64%	15.1	640	0.29	0.47	1.57	54	9	52
Mariner	4,932 (6,500)	13.0	55	31,000 - 34,000	8.4	5.7	44%	29.8	919	0.29	0.54	1.80	78	16	103
Oakbrook	2,930 (6,200)	12.4	70	33,000 - 71,500	9.4	1.1	9%	35.8	1,345	0.28	0.50	1.77	40	14	85
Suburban Average	5,592 (6,300)	12.6	68	-	9.9	7.8	47%	31.7	1,010	0.32	0.53	1.66	68	12	78
Average All Sites	5,611 (6,500)	13.0	78	-	19.9	22.7	72%	17.2	780	0.32	0.5	1.5	143	25	168

1. Measured for a "complete site," that is a hypothetical site developed at the same densities and with the same physical characteristics over an area of 500 acres.
2. Sidewalk completeness is measured as a ratio of the length of the sidewalk system to the length of all public street frontage.
3. Mean distance between pedestrian entrances into commercial center at cordon boundry.
4. Fifty percent of housing units are within this distance of the "100 percent" location of each commercial center.
5. Route directness is measured as the ratio of average route length to average airline distance.

Sources: U.S. Census of Population and Housing, 1990; field data.

specifically block size and the extent of pedestrian facilities provided, must also be considered.

- All urban sites studied had a higher volume of pedestrians than the suburban sites studied. On average, urban sites had three times as many pedestrians as suburban sites.
- The urban sites with the lowest pedestrian volumes had over twice as many pedestrians as the suburban sites with the lowest pedestrian volumes, and 40 percent more pedestrians than the suburban sites with the highest pedestrian volumes.
- The suburban sites with the highest pedestrian volumes fewer than a third the number of pedestrians than the urban sites with the highest volume of pedestrians.

People Do Walk in Suburban Areas

Contrary to popular belief, a substantial number of people walk to suburban neighborhood centers; between 50 and 102 pedestrians per hour were observed entering suburban centers. This translates to 8 to 16 people walking into the local commercial center per hour for every 1,000 residents living within one-half mile of the center (figures adjusted for comparability purposes).

Pedestrian Volumes Are Not Related to the Size of Neighborhood Commercial Center

In urban sites, both the lowest and highest pedestrian volumes corresponded to sites with medium-sized commercial centers. In suburban sites, the lowest pedestrian volumes were found in the sites with the smallest commercial centers. However, the largest site had fewer pedestrians than any of the medium-sized center sites.

The Distinction Between Urban (U) and Suburban (S) Carries the Most Explanatory Power in Defining Pedestrian Volumes

Variations within site design and pedestrian facilities measures used do not, in and of themselves, explain variations in pedestrian volumes within either urban or suburban site categories. Measures such as block size, total length of street and of sidewalk systems, the completeness of the sidewalk systems, and the directness of pedestrian routes are not linearly related to pedestrian volumes. Other variables come into consideration, such as variations in population density, income, and size of retail center, none of which are linearly related to pedestrian volumes, either. In this study, the combination of variables that described the distinction between urban (U) and suburban (S) site and pedestrian design characteristics was the best predictor of differences in pedestrian volumes. As a result, further analyses of the 12 sites divided them accordingly. (See summary table below.)

2. Profiles of Pedestrians

Many Young Pedestrians in Suburban Areas

The distribution of pedestrians by age was closely related to the census population in urban sites. In suburban sites, however, a disproportionate number of young people (under 18) was walking. On average, the proportion of young people walking to all people walking was 180 percent higher than the proportion of young people in the census population living in suburban sites. An average of 41 percent of the suburban pedestrians were young in comparison to 16 percent in urban sites, and in three of the suburban sites, young people constituted the majority of pedestrians counted.

Many Pedestrians of Color in Urban and Suburban Areas

A disproportionate number of people of Color was walking in both urban and suburban sites, with averages of more than 200 and 240 percent of the corresponding census populations in urban and suburban sites, respectively. On average, urban pedestrians of Color constituted 10 percent of the total number of pedestrians, versus 29 percent in suburban sites.

The uneven distribution of young pedestrians and pedestrians of Color in suburban sites raises serious questions regarding the safety of people who cannot or do not want to drive. Furthermore, pedestrian with impairments were found in three of the suburban sites. These figures point to the importance of providing facilities that support safe pedestrian travel in suburban areas.

3. Where People Walk

Most People Walk on Streets with Sidewalks

Seventy-eight percent of all pedestrians entered the commercial center on a street with sidewalks. In urban areas, 98 percent of the pedestrian trips were on streets with sidewalks, versus 60 percent in suburban areas. Streets with sidewalks constituted only 43 percent of the possible entry points into suburban commercial centers, indicating that many people choose to use sidewalks.

Most People Walk along Wide "Main" Streets

In urban sites, 41 percent of the pedestrians entered the commercial area on streets wider than 48 feet--those representing only 26 percent of the possible points of entry into the commercial center. In suburban sites, 71 percent of the pedestrians used streets wider than 36 feet, representing 55 percent of the possible entry points.

High Incidence of Jaywalking

Only 38 percent of the pedestrians entering a suburban commercial center crossed a street, versus 56 percent in urban sites, reflecting the different site design characteristics of the sites. Of those pedestrians who crossed a street at the point of entry into the commercial area, 32 percent were jaywalking in suburban sites, whereas 20 percent jaywalked in urban sites. Although jaywalking is relatively safe in urban sites, where most streets are narrow and automobile traffic is tamed, it represents substantial risk-taking on the part of the suburban pedestrian; suburban jaywalking is often across wide, heavily trafficked streets. The high incidence of jaywalking in suburban sites points to a major safety problem and indicates that pedestrians lack options in their walking routes.

Of those pedestrians who crossed a street as they entered the commercial center, 14 percent used a marked crosswalk in urban sites versus 60 percent in suburban sites, again reflecting the fact that people prefer safe pedestrian facilities whenever they are available. (Suburban intersections are so wide that a marked crosswalk is needed to protect pedestrians.)

Schools Generate Pedestrian Traffic

The presence of schools corresponded to high volumes of pedestrians in all of the three suburban sites and two of the five urban sites that had a school located near the commercial center.

Apartments and Grocery Stores Generate Pedestrian Traffic

In both urban and suburban sites, the distribution of pedestrians entering the commercial center showed a positive relationship between pedestrian volumes and dense housing and commercial activity. This relationship was especially strong when dense housing directly adjoined a grocery store. It appears, therefore, that, contrary to popular belief, a significant amount of grocery shopping is done on foot.

4. Land-Use, Site and Pedestrian Facilities Design Characteristics of Suburban Sites

The Small Suburban Center as a Significant Element of Future Transportation Planning

This project unexpectedly identified some 50 small concentrations of activity spread throughout parts of the region that have been developed since the 1960s. Although many of these concentrations do not appear to host the mixes of land uses necessary to make viable neighborhood commercial centers, the relatively high population densities or densities of retail and office development all call for further research regarding the potential of these concentrations to support a balanced transportation policy.

Compact Suburban Centers

Within the pool of selected sites, suburban sites were as compact as their urban counterparts, with, on average, 50 percent of the dwellings units falling within a third of a mile or less of the 100 percent corner in the commercial center. This indicates that land-use distribution and intensity in suburban sites are potentially as conducive to pedestrian travel as those in urban sites.

Indirect Pedestrian Travel Routes in Suburban Areas

The average actual route length traveled by pedestrians was approximately 600 feet longer in suburban than in urban sites. In urban sites, 50 percent of the residential dwellings were within a travel distance of 2,100 feet of the commercial center, versus more than 2,700 feet in suburban sites. Pedestrian travel routes between residential and commercial uses were 27 percent longer than airline distance in urban sites, whereas they were 66 percent longer in suburban sites. This indicates that site design and facilities are inefficient for pedestrians in suburban sites. The reasons behind these inefficiencies are explained below.

Inefficient Transportation Infrastructure in Suburban Areas

The size of suburban blocks was inversely related to the intensity of land uses contained by those blocks. The largest blocks contained the highest intensity land uses, such as apartment complexes and commercial areas. Thus, the blocks that generated the most trip making and were used by the highest numbers of people had the fewest streets and sidewalks. Instead of taking into account the number of people who will use the streets, suburban blocks correspond to the size of the properties they serve: blocks for single-family development are relatively small at less than ten acres (a 200- or 300-foot wide and 600- to 1,000- foot long block), whereas blocks for multi-family and commercial development vary from 40 to 100 acres (corresponding to blocks that are more than 2,100 feet on a side, or more than 30 times the size of an equivalent urban block). Clearly, suburban block size does not to address transportation demand for either motorized or non-motorized modes.

Sidewalks

Sidewalk systems in suburban sites were only one-fifth of the length of systems found in urban sites. Furthermore, sidewalks in suburban sites did not generally correspond to areas of concentrated residential or commercial activity. They were found along many of the streets that serve single-family dwellings and along arterials. However, because arterials form very large blocks, the sidewalk network that they provided was too coarsely distributed for pedestrian travel. On average, sidewalks in suburban sites were present along only half of public streets.

Distance Between Points of Entry into the Commercial Center

The mean distance between points where pedestrians could enter the commercial center was twice as long in suburban than in urban sites. The longer this distance, the fewer the points of entry into the commercial areas. At 550 feet in urban sites, this distance is already too long to provide efficient travel options for the pedestrian.

The inefficiencies of pedestrian facilities in suburban sites can be remedied as outlined in the recommendations below.

RECOMMENDATIONS

This study's findings show that it is imperative to address pedestrian safety issues and to improve the infrastructure supporting pedestrian travel in suburban areas by providing appropriate facilities. Specifically, the following findings are significant:

- the comparatively high numbers of people walking in these areas
- the disproportionately high number of young pedestrians and pedestrians of Color
- the comparatively high numbers of pedestrians using streets with sidewalks in spite of the low incidence of such streets
- the high numbers of pedestrians jaywalking in spite of the dangerous conditions found on the wide, automobile-oriented streets found in suburban areas.

The provision of additional pedestrian facilities in suburban areas also may increase pedestrian volumes and help reduce local auto congestion by encouraging people to substitute walk trips for auto trips. Because the vast majority of transit riders access public transportation by foot, developing appropriate pedestrian facilities is also relevant to supporting the use of public transportation.

Our recommendations fall into two categories: the need to identify suburban areas where land uses already exhibit characteristics that are conducive to pedestrian travel, and the need to apply site design guidelines to support the development of safer and shorter pedestrian travel routes.

Need to Identify Location and Type of Small Suburban Concentrations of Activity

The analysis of the Puget Sound Region undertaken in the site selection phase of this project pointed to many suburban areas that have population density higher than 12 people per acre, and which, as a result, have a potentially large "latent" pedestrian market. There is a need to identify these areas, which are not commonly recognized by planning authorities, and to improve their pedestrian facilities.

Need to Devise Site Design Guidelines to Support Pedestrian Travel

New guidelines and regulations need to address the retrofitting of existing areas as well as new development. The goal of the guidelines and regulations would be to provide safer and shorter routes for pedestrians to use between major land uses—residential, commercial, and school facilities. The two principal impediments to short and efficient pedestrian travel in suburban centers are the large size of blocks and the lack of sidewalks or safe pedestrian pathways. Sites with a concentration of mixed land uses and activities need to offer a continuous network of safe walkways that allow people to walk between those land uses and activities. Given this study's findings, this network should build on existing arterials as well as on the informal paths that pedestrians have already established. The following simple measures will help to develop this network and to improve considerably the pedestrian environment in suburban centers within reasonable costs.

- Provide sidewalks along all arterials and streets in and around the commercial center and the ring of apartments surrounding the center itself. Sidewalk width needs to recognize that most pedestrians prefer to use sidewalks. They must be commensurate with the width of the street or arterial, and protective elements should be placed whenever the speed of traffic constitutes a danger to the pedestrian.

- Provide marked crosswalks at all street and arterial intersections. Where traffic lights are included, provide pedestrian push buttons, and adjust pedestrian green light time to the width of the street and arterial.

Marked crosswalks should occur at least every 500 feet along streets and arterials that serve concentrations of apartments, commercial development, and schools to discourage and reduce the incidence of jaywalking. Crosswalks must be accompanied with the appropriate signage to make drivers aware of the presence of pedestrians.

- Provide gates in fences surrounding apartment complexes and schools. Because they act as de facto "street intersections," these gates should occur at regular intervals, likely every 200 feet, especially when the fence is located along the edge of the commercial center or along the arterials bordering the complex. The gates can be locked and keyed to the apartment complex entryways for security purposes.
- Provide marked pedestrian walkways leading people in and out of the gates, on both the apartment and the commercial center sides, to ensure a safe environment for the pedestrian.

Marked walkways in both apartment complexes and commercial centers should form a continuous network, identifying the shortest and most practical distances between residential and commercial building entries. The walkway network should connect to gates in fences and to sidewalks along arterials. It should be designed as a de facto pedestrian street network within the outdoor area of apartment complexes and within the parking lots of commercial areas. The network should form a simple grid adapted to the topography that connects every building entrance to the rest of the system. A 200-foot grid is appropriate for pedestrian travel. This grid can be adjusted to correspond to parking lot design and to support drivers within either the apartment complexes or the commercial center.

It is important that the grid of pedestrian pathways continue to the sidewalks along the arterials that surround the commercial center. Shoppers on foot need to be able to reach the sidewalks along the streets or arterials at small, regular intervals, not only at curb cuts designed for automobile traffic.

The network should take into account the fact that grocery stores tend to attract pedestrian traffic. It should also include safe and direct pedestrian routes between schools facilities and commercial land uses, especially as older school children tend to gravitate to these facilities.

II. METHODOLOGY

1. OVERVIEW

A quasi-experimental method was used to explore the relationship between site design and pedestrian trip volumes. It was applied to 12 study areas located in the greater Puget Sound urbanized area. The methodology was based on two pilot studies of two study areas, Wallingford (a neighborhood of Seattle) and Crossroads (a neighborhood and shopping center of Bellevue) (Hess, 1994, Saxen 1994). The following variables were used in the site selection process. For further reference, detailed discussion of this project's methodological approach is available in Moudon, et al. forthcoming.

Control Variables

All sites selected had a high potential to support pedestrian travel, including

- a mix of residential and commercial land uses contained within a one-half mile "walkable" area
- residential densities that were relatively high, approximately 10 persons per acre or higher.

Sites were matched to control for the following:

- population density
- income
- auto ownership
- neighborhood commercial land use types
- "walkable" area contained within a half-mile radius of the neighborhood center.

Independent Variables

Half of the sites chosen exhibited "low connectivity in pedestrian facilities" or site and pedestrian facilities design characteristics that were not conducive to pedestrian travel, whereas the other half of the sites exhibited "high connectivity in pedestrian facilities." In other words, sites had either high or low

- extent and completeness of potential and actual pedestrian facilities
- pedestrian route directness between homes and neighborhood commercial center.

Dependent Variable

Pedestrians were counted crossing between residential and commercial land uses; volumes were established for all sites.

2. SITE SELECTION

Methodological Framework

The first task was to select six to ten study areas in addition to the two that had been identified in the pilot studies. For ease of communication, study areas with high levels of pedestrian connectivity in their site design were called "urban sites (U)," while study areas with low levels of connectivity were called "suburban sites (S)." Given this definition, it was possible to find what we termed suburban sites in urban areas—for example, many neighborhoods within the City of Seattle would be characterized as suburban under our definition because there are no sidewalks along the streets. The goal of the site selection process was to match urban and suburban study areas into groups with similar gross population densities, similar median incomes, similar auto ownership rates, and a similar number and range of retail services.

Potential study areas were identified to meet the following criteria:

1) Residential and commercial land uses are contained within one-half-mile distance from the center of the study area—one-half mile being a commonly cited measure of "reasonable" walking distance in the literature on pedestrian travel.

(2) Within this half-mile radius, study areas have a mix of retail stores that cater to daily shopping needs—supermarkets, drugstores, restaurants, cafes, video stores, dry cleaners, hair and barber shops, and hardware stores—as components of a

commercial center that can support walking trips. Although supermarkets are not considered to be conducive to pedestrian trips (except for fill-in shopping), they often create a "retail anchor" for other stores that offer convenience services conducive to walking.

(3) Within this half-mile radius, study areas have a gross residential density of 10 or more persons per acre. This density level has been associated with pedestrian activity, given supportive pedestrian facilities and nearby shopping opportunities. While this density is similar to those found in pre-1940s urban neighborhoods, it is twice as much as average densities in the Puget Sound region.

(4) Study areas do not have any major barrier that can clearly limit pedestrian travel. Barriers that would exclude a site from consideration include very steep slopes, freeways, and other large physical elements separating housing from commercial services.

(5) Study areas have either high or low levels of pedestrian connectivity. High levels were defined as areas with extensive, complete, and direct pedestrian networks. Low levels of pedestrian connectivity were defined as areas with non-extensive, incomplete, and indirect pedestrian networks. Because the total number of study areas was limited to 12 or less, sites with mixed characteristics such as some sidewalks but with an urban street grid, were excluded from consideration so that we could focus on major differences in the site design characteristics.

(6) The study areas selected would be distributed in Snohomish, King, and Pierce counties. In particular, urban sites outside of Seattle were deemed desirable.

Step One: Use of GIS Maps

Regional maps were created to show concentrations of population densities based on 1990 census data on the tract level, and concentration of retail employment based on Washington State data supplied by the Puget Sound Regional Council on the transportation analysis zone (TAZ) level.

TAZ data were not adequate for identifying small retail centers. As shown in Figure 1, employment densities calculated for TAZs in the Kirkland-Redmond area poorly match the striped polygons representing areas in actual commercial development mapped from aerial photographs. This map highlights the following shortcomings of TAZ level data to recognize small or even medium-sized retail centers:

- Areas in commercial development are broken into several TAZs.
- TAZs combine areas in commercial development with areas without commercial development, thus averaging employment density across large areas.
- Small areas of commercial development are grouped with larger areas of commercial development within one TAZ.

The limitations of TAZ boundaries mask the location of small centers potentially capable of supporting pedestrian travel. Figure 1 shows how two of our eventual study areas were not readily identifiable. Kingsgate, a small retail center with about 30 businesses, is split between two large TAZs; Juanita, a small center with about 40 businesses, is split between three TAZs, one of which contains Totem Lake, a very large, automobile-oriented commercial center to the east. These problems are compounded further when retail job data are revised; because the number of retail jobs is smaller than total employment figures, neighborhood retail centers are not identifiable at the TAZ level.

Similar problems were encountered when population densities were examined through -tract level data. Figure 2 shows census tracts with population densities of above 10 persons per acre in the three-county area considered. On the basis of these data, the region appears to be monocentric, with most tracts at these density levels located in the central part of Seattle. A handful of other tracts show up in Tacoma and Everett, along with a few tracts in suburban areas. Two of these suburban tracts eventually ended up as our study sites of Juanita and Crossroads. However, the other four suburban study areas cannot be identified at the census-tract level.

Figure 3 shows the same density ranges on the census-block-group level. Only three of our eventual six suburban case study sites can be identified. Figure 4 shows the same density ranges at the census-block level. In this case, all of the study areas selected can be identified. Many other areas also show up as being developed at medium-density ranges—reflecting the fact that in western King County (as defined by the map, and excluding Seattle) about 30 percent of the population lives in census blocks above this 10 person per acre range. Problems in identifying areas of concentrated residential densities still arise in some suburban areas, where blocks tend to be very large. It is further compounded because census block size tends to increase dramatically around suburban retail centers.

Step Two: Use of Aerial Photographs in Combination with Census Data to Identify Suburban Sites

Because of these problems with census and TAZ boundaries, aerial photographs (1:400 scale, 1995) were used to supplement data for identifying concentrations of suburban populations. Density maps at the census-block-group and census-block level were used to focus the reading of aerial photographs on areas with population densities high enough to support pedestrian travel. Photographs served to examine areas for concentrations of multi-family housing, because such concentrations are necessary to achieve density ranges of 10 persons per acre in suburban locations where low-density, single-family development prevails.

Table 2 shows some 60 concentrations that this method identified in the three-county region. However, the photographs were not useful in older, urban areas where differences in land uses are less discernible because they are not necessarily reflected in the massing of buildings—where, for example, small office buildings cannot be discerned from small apartment buildings. The method used to identify urban sites is discussed under Step Three below.

Census data were then examined for population density, number of multi-family housing units, and ranges of median incomes for block groups covering the population concentrations identified in the aerial photographs. In many cases, block groups did not match well with the areas identified. However, this level of data collection had to be used because block-level data are very limited.

Block-level data served to more precisely measure population density for the more promising areas. In a few cases where census-block geography did not correspond to the layout of the actual area, density computations were adjusted by, for example, excluding areas in undeveloped land outside of a one-half-mile distance from study areas. Some possible study areas were eliminated because they did not generate the gross density necessary to match those found in urban neighborhoods. This process permitted us to eliminate such sites as Mill Creek in Snohomish County and Redmond in King County. Although these locations include large numbers of apartments, population densities within the one-half-mile distance of the center were below 4 persons to the acre. Figure 5 shows that in Redmond, most of the 2,400 apartments are located just beyond the one-half-mile walking distance from the city center.

Photographs were then reexamined to eliminate areas with no nearby commercial development or with major physical barriers. Examples of these types are shown in figures 6 and 7. Figure 6 shows the area of Mountlake Terrace in Snohomish County with about 1,100 apartment units, yet no nearby commercial development. Figure 7 represents the northern part of Southcenter in King County. Its approximately 1,700 apartment units are not only located on a very steep hillside but are also separated from one of the region's largest retail centers by a major freeway.

Further investigation of the range of retail services available entailed calling local businesses for information about adjacent stores. Actual visits to the remaining sites yielded a precise inventory of businesses and a means to check general site conditions, including topography.

Step Three: Identification of Urban Sites

As mentioned earlier, the search for urban sites was necessarily limited to areas developed before the Second World War, when streets were consistently constructed with sidewalks along them and city blocks were relatively small. For urban sites, census data were used to identify appropriate population densities and were combined with a survey of supermarket location as the primary anchor for a potential neighborhood center. Figure 8 shows the location of major supermarkets drawn from telephone directories. Aerial photographs were also used to check the size and completeness of street grids and sidewalks, and to identify the general distribution and type of commercial and residential structures. As in suburban areas, telephone surveys helped to identify the types of retail businesses existing in promising sites, and the most promising sites were visited to inventory businesses and to check topography and general site conditions.

Step Four: Matching Urban and Suburban Sites

Urban and suburban sites were matched on the basis of gross population densities, the range of median income measured at the census-block-group level, and the numbers and ranges of businesses of each site's retail district. Table 3 summarizes the list of suburban and urban sites used for matching pairs. Putting together true pairs proved to be impossible, given the limited number of sites available within the density ranges, medium income ranges, and concentration of land-use mixes in the one-half-mile walking radius. The final matching process recognized that the urban sites available in this region that fall into a range of relatively low population densities similar to those found in suburban areas have commercial centers of different sizes. As a result, sites were categorized according to the size of commercial centers. Four groups of matched urban and suburban sites emerged: two groups of sites with large commercial centers, one group of sites with medium-sized commercial centers, and one group of sites with small commercial centers. Table 4 shows the 12 sites matched. Table 5 outlines census data for the 12 sites. Figure 9 shows the location of the 12 sites in the Puget Sound region.

Table 6 records all the businesses found in the sites as of Summer 1996. The number of businesses, as well as the range of retail services offered, are comparable in the different groups of sites. The larger number of businesses found in Ballard with respect to Kent reflects Ballard's turn-of-the-century origins and its related small industrial and office facilities. Figures 10 through 21 show the general land uses for the 12 study areas. (See next section for explanation of how these maps were created.)

Site Socio-Demographic Profiles

The socio-economic characteristics of the sites selected are summarized in Table 7.

Actual population figures for the sites vary from less than 2,900 people in Oakbrook (S) to more than 7,500 in Wallingford (U). These variations correspond not only to slight variations in densities found in the individual sites, but also to the relative "completeness" of the individual areas contained in the half-mile walking radius, including topography and regional elements such as freeways that define different boundaries for the study areas. Adjusted for a "complete" 500-acre site, population figures vary from 4,800 in Proctor (U) to 7,800 in Wallingford (U). Gross residential density within the half-mile study area varies from 9.6 person per acre in Proctor (U) to 15.7 in Wallingford (U). Mean incomes vary from $26,000 in Ballard (U) to $75,000 in Madison Park (U). This greater variation in income stems from the data source being at the census-block-group level and hence not always corresponding to the actual geography of the study area. Automobile ownership per person varies between 0.6 in Proctor (U) and Oakbrook (S) to 0.8 in Madison Park (U), with the nine other sites at 0.7 autos per person.

Lessons from Site Selection

The following lessons were learned from the site selection process. First, the process demonstrated that conventional methods for land-use and transportation analysis, based on census and TAZ geographies, are inadequate to identify small-sized centers in suburban areas. Both the large size and the boundary definition of conventional analytic units average the land-use characteristics of small centers with either low intensity land uses or with much larger nearby centers, thereby masking their existence. Yet because these small centers can have concentrations of several thousand people, they should be recognized as important to planning for all transportation modes, including transit, bicycling, and walking.

Small centers are an important component of the overall urbanization of suburban areas. The development of large numbers and concentrations of multi-family housing has produced suburban concentrations of population that are comparable to those found in older neighborhoods in the region's central cities. The densities are high enough to support pedestrian travel if land-use and site design characteristics also support walking. However, the appropriate population densities of many of these suburban population concentrations are not matched with the such mixed land-use characteristics. Many concentrations of population are not near commercial services, and, likewise, many concentrations of services are not near housing.

Second, the largest suburban employment and retail centers seem to be the most dysfunctional in support of walking. Although these commercial centers tend to be surrounded by large numbers of apartments, these areas of low intensity commercial land are so large that the walking distance between the services and housing are beyond a half-mile.

Finally, there are relatively few good pedestrian neighborhoods in the Puget Sound region. Despite targeting areas outside of Seattle in our search for sites with highly connected pedestrian networks, five of the six eventual urban sites were in Seattle. No sites were identified in Everett, and only one site was found in Tacoma. We relaxed our density requirement in order to include that Tacoma neighborhood. Only three neighborhoods in Seattle were excluded from consideration because their densities were too high to match those found in suburban areas. Rather, there are few neighborhoods in the region that have the combined characteristics of medium population densities, highly connected pedestrian systems, and reasonably compact commercial centers offering a range of convenience services. Many neighborhoods, however, have two of these three characteristics and could be made more supportive of pedestrian travel if the third piece were improved.

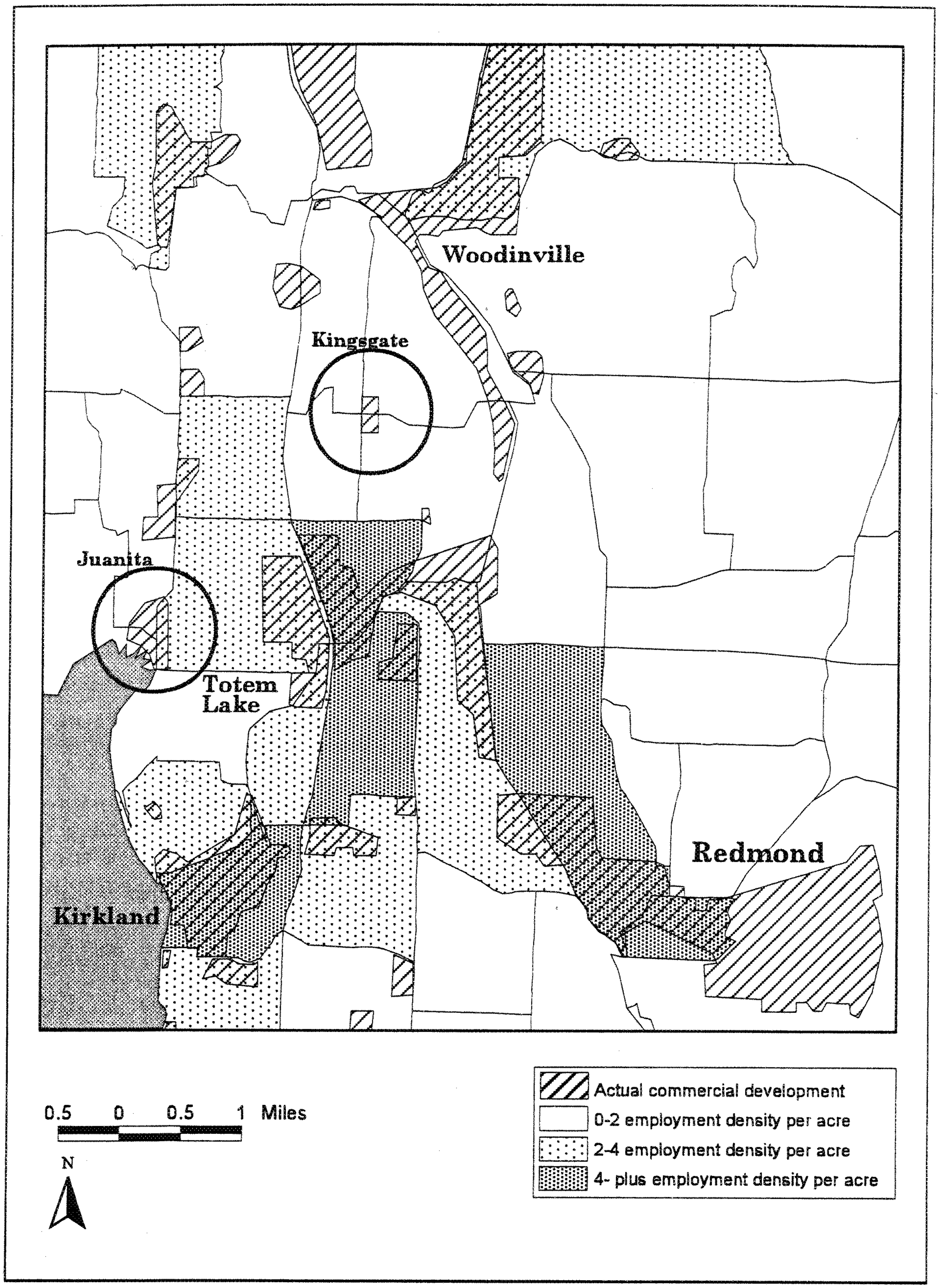


Figure 1. Kirkland-Redmond TAZ Employment Densities and Areas of Commercial Development

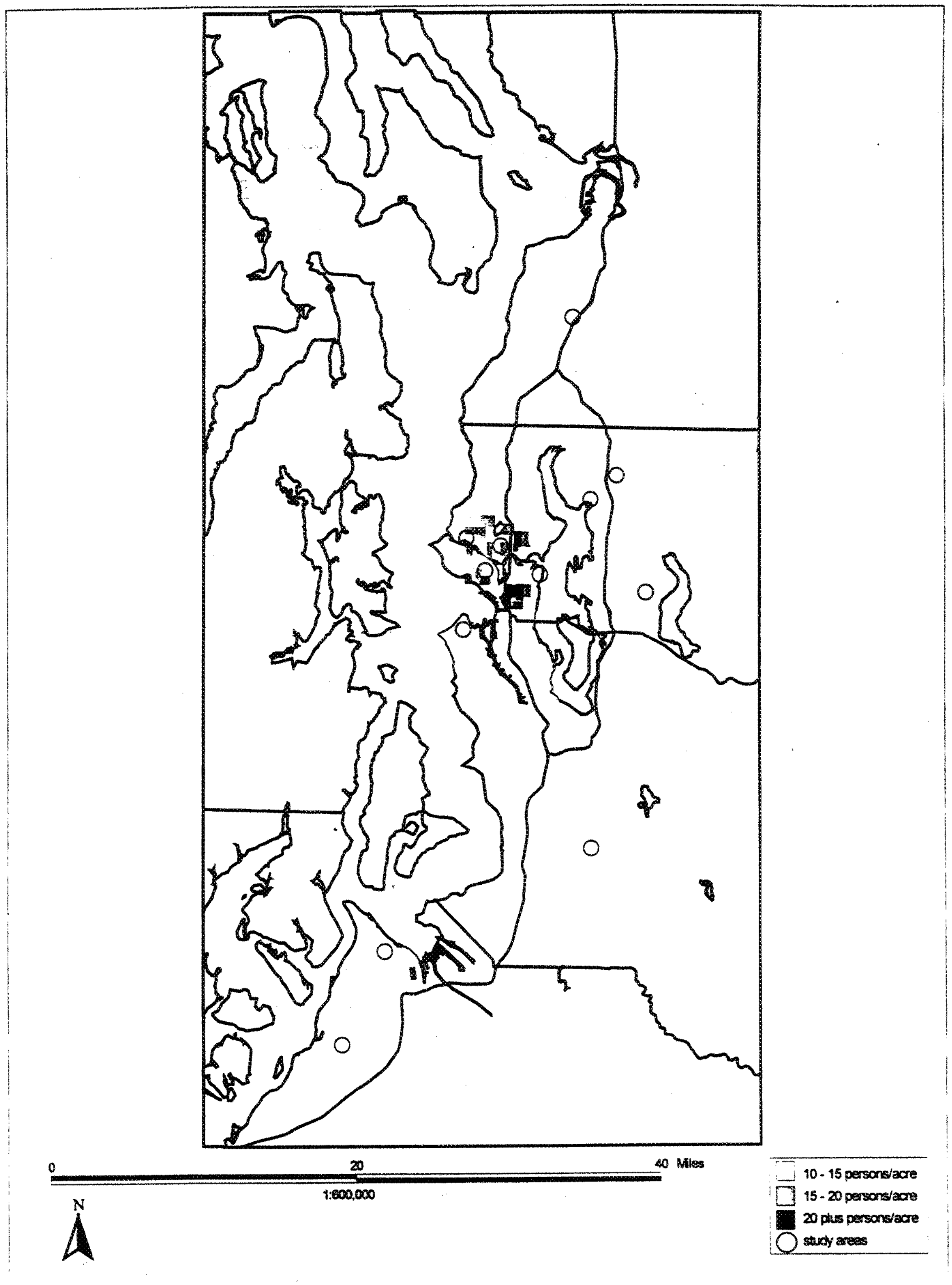


Figure 2. Population Density: Census Tracts with Greater than 10 Persons per Acre

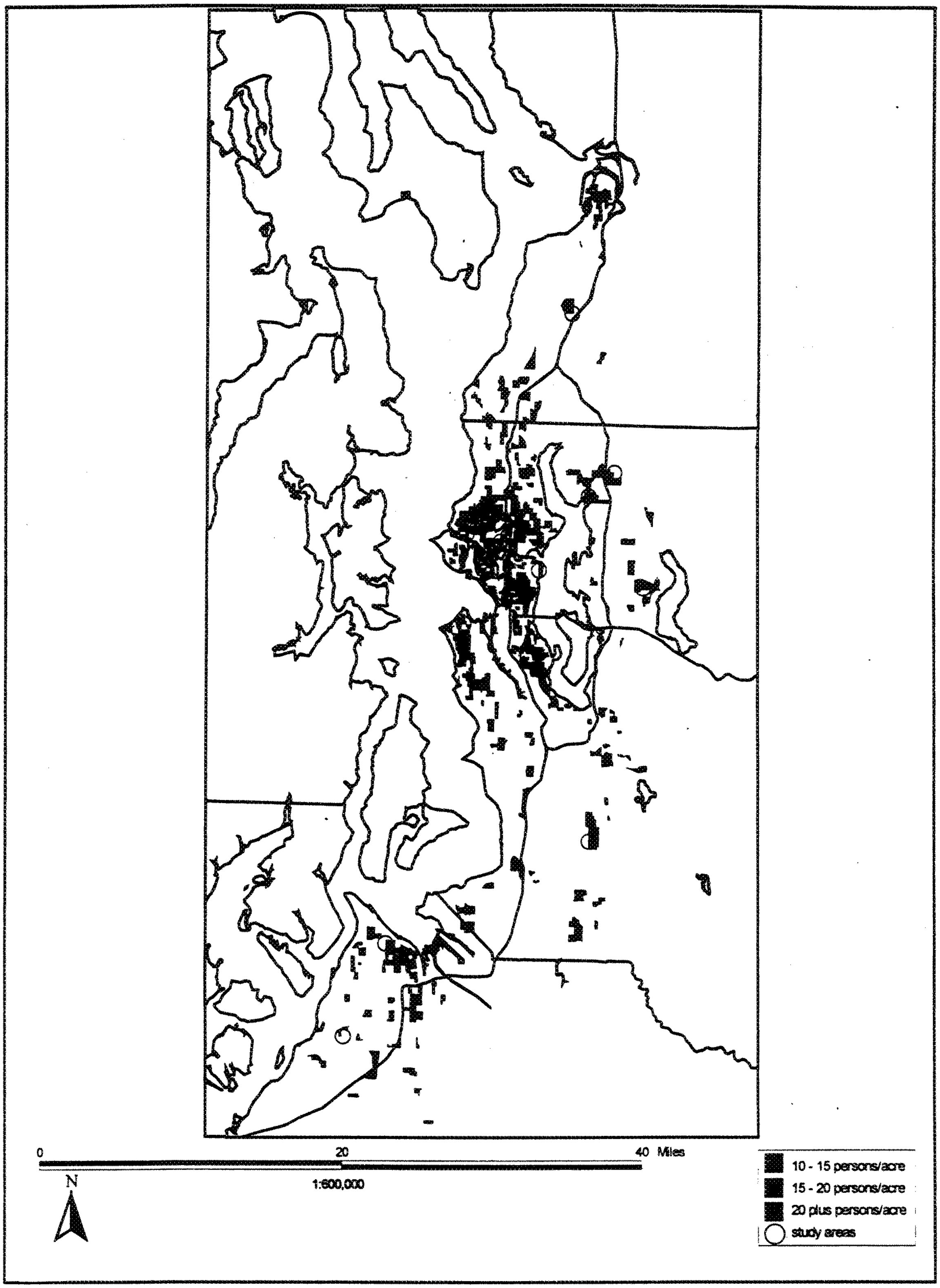


Figure 3. Population Desntiy: Census Block groups with Greater than 10 Persons per Acre

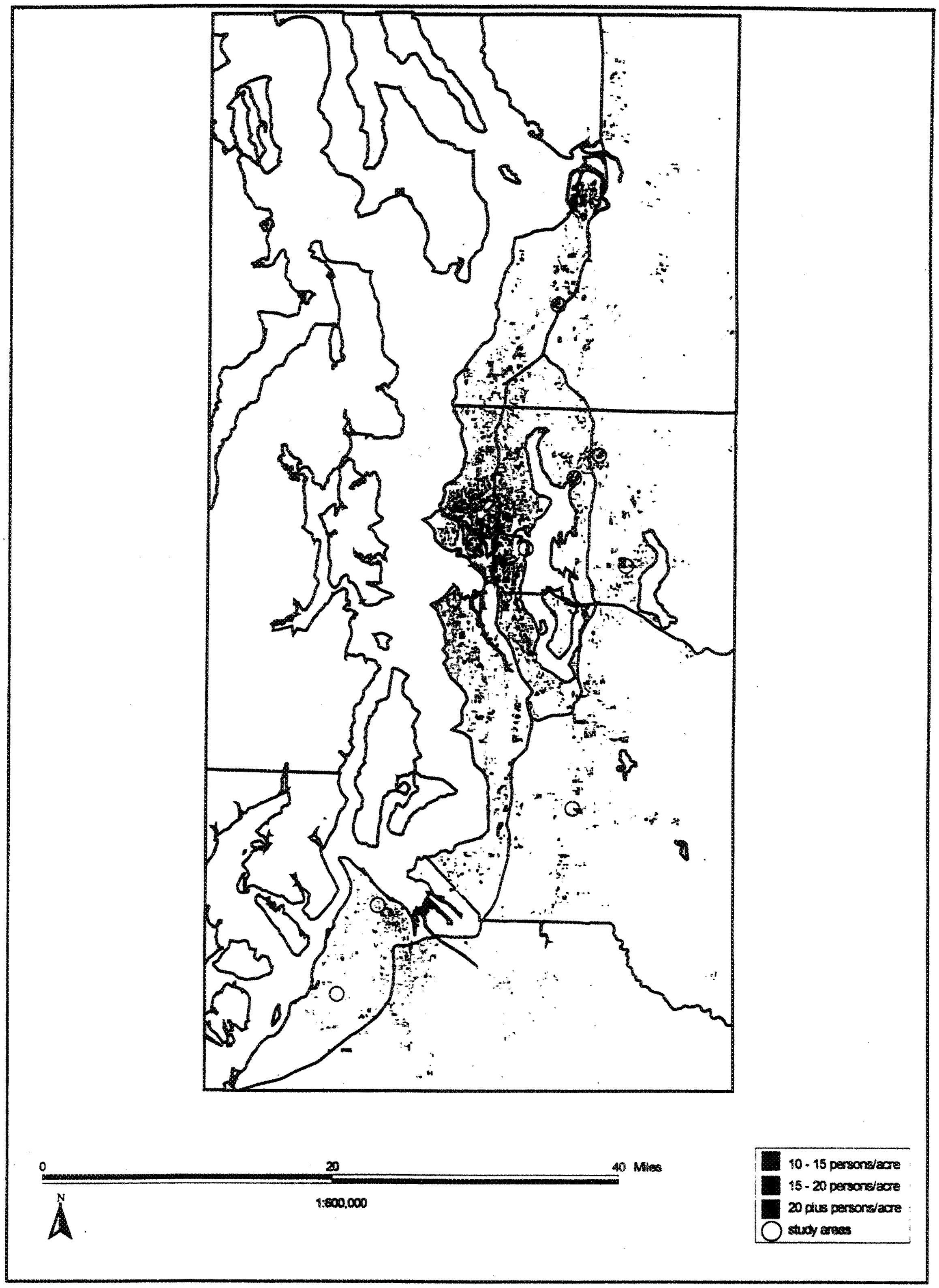


Figure 4. Population Density: Census Blocks with Greater than 10 Persons per Acre

Figure 5. Aerial photo showing apartments outside of the center of Redmond. A large concentration of apartments is highlighted by a thick black line. The white circle is a one-half mile radius and is centered on a shopping area.

Figure 6. Aerial photo of apartments in Mountlake Terrace isolated from commercial development. The thick black line surrounds the apartments.

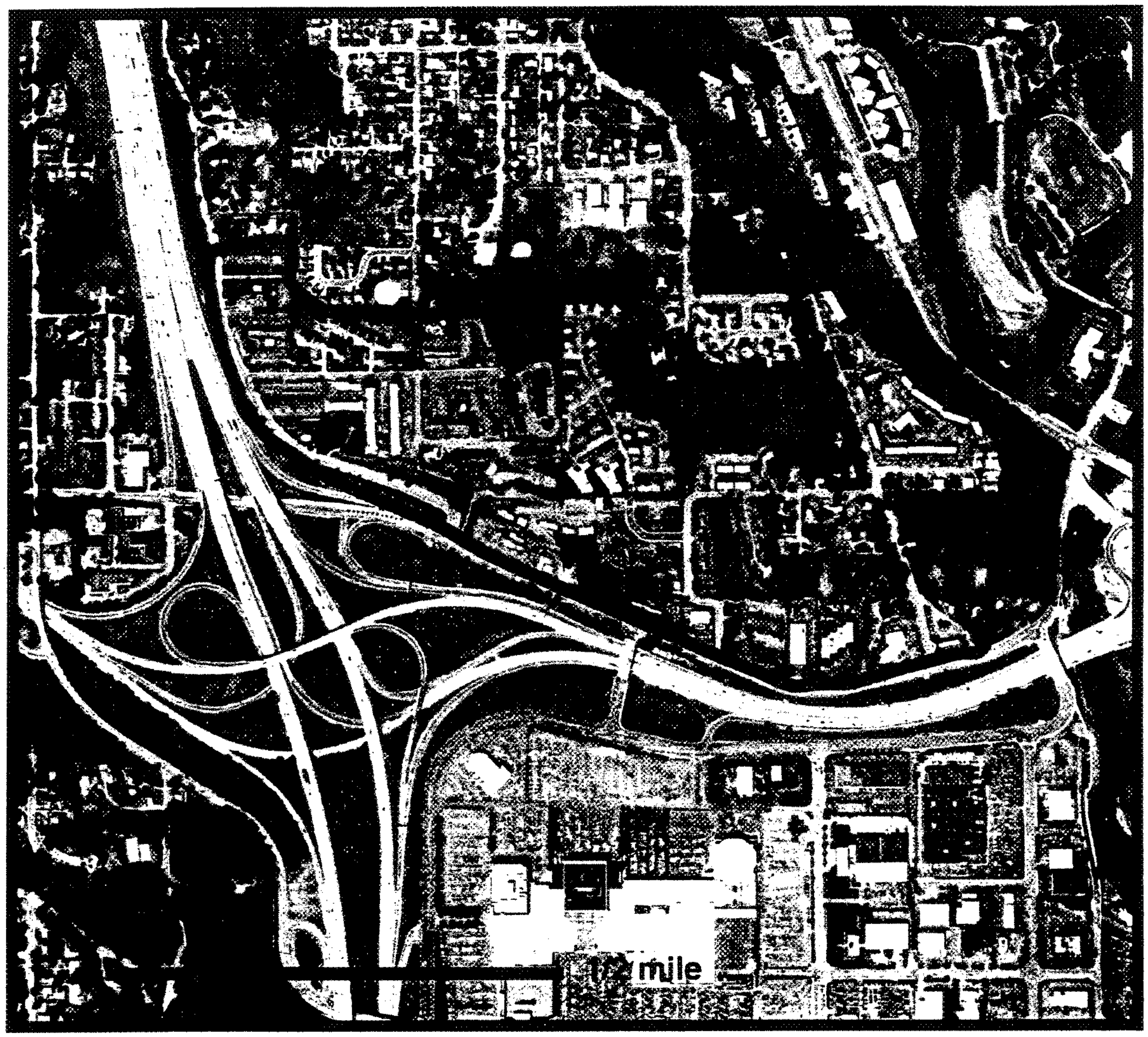


Figure 7. Aerial photo showing apartments near to, but separated from, Southcenter shopping center. The thick black line surrounds a concentration of apartments. The white structure at the bottom of the photograph is part of the mall.

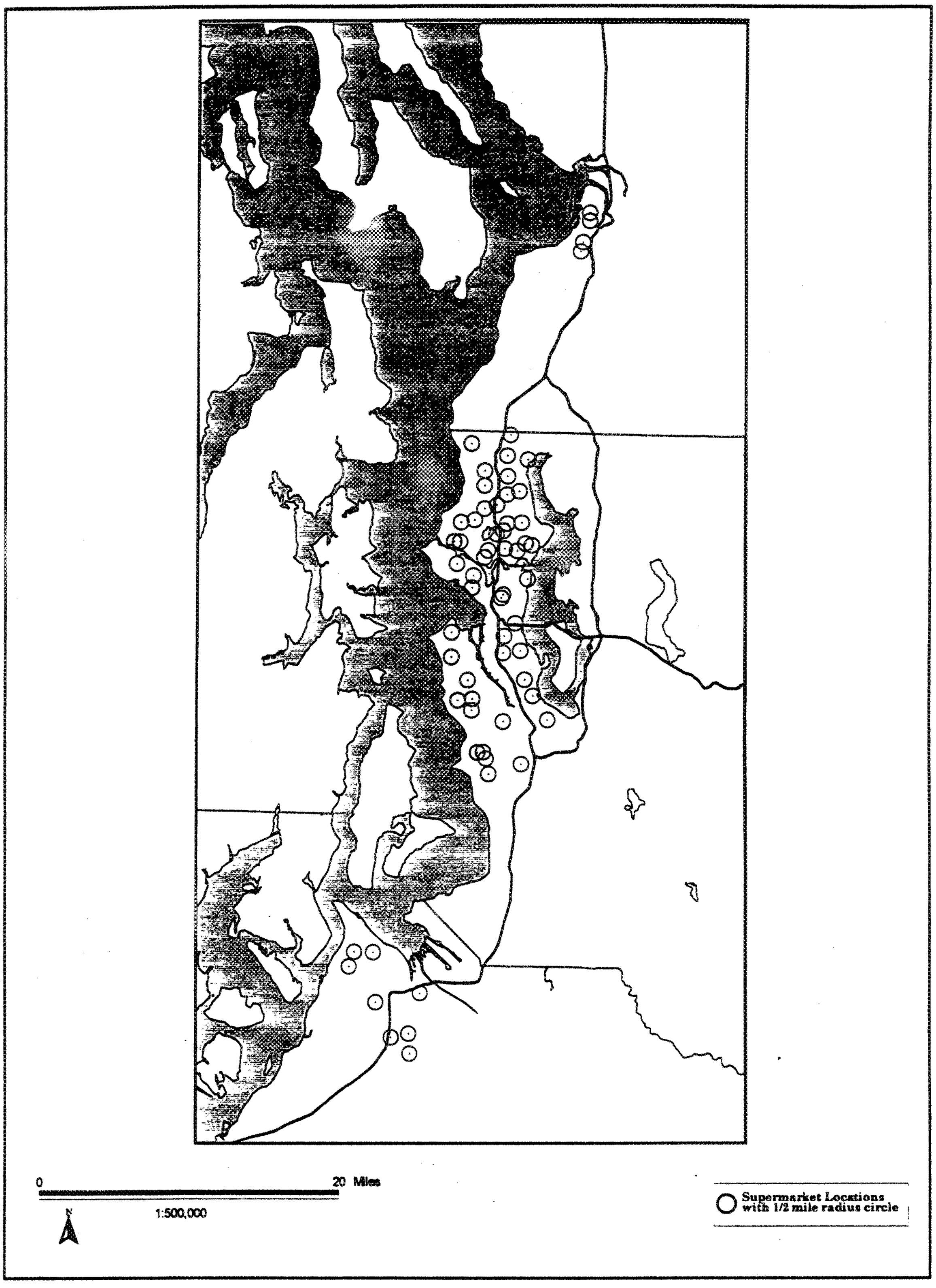


Figure 8. Major Supermarket Locations in Urban Areas with 1/2-Mile Radius Circles

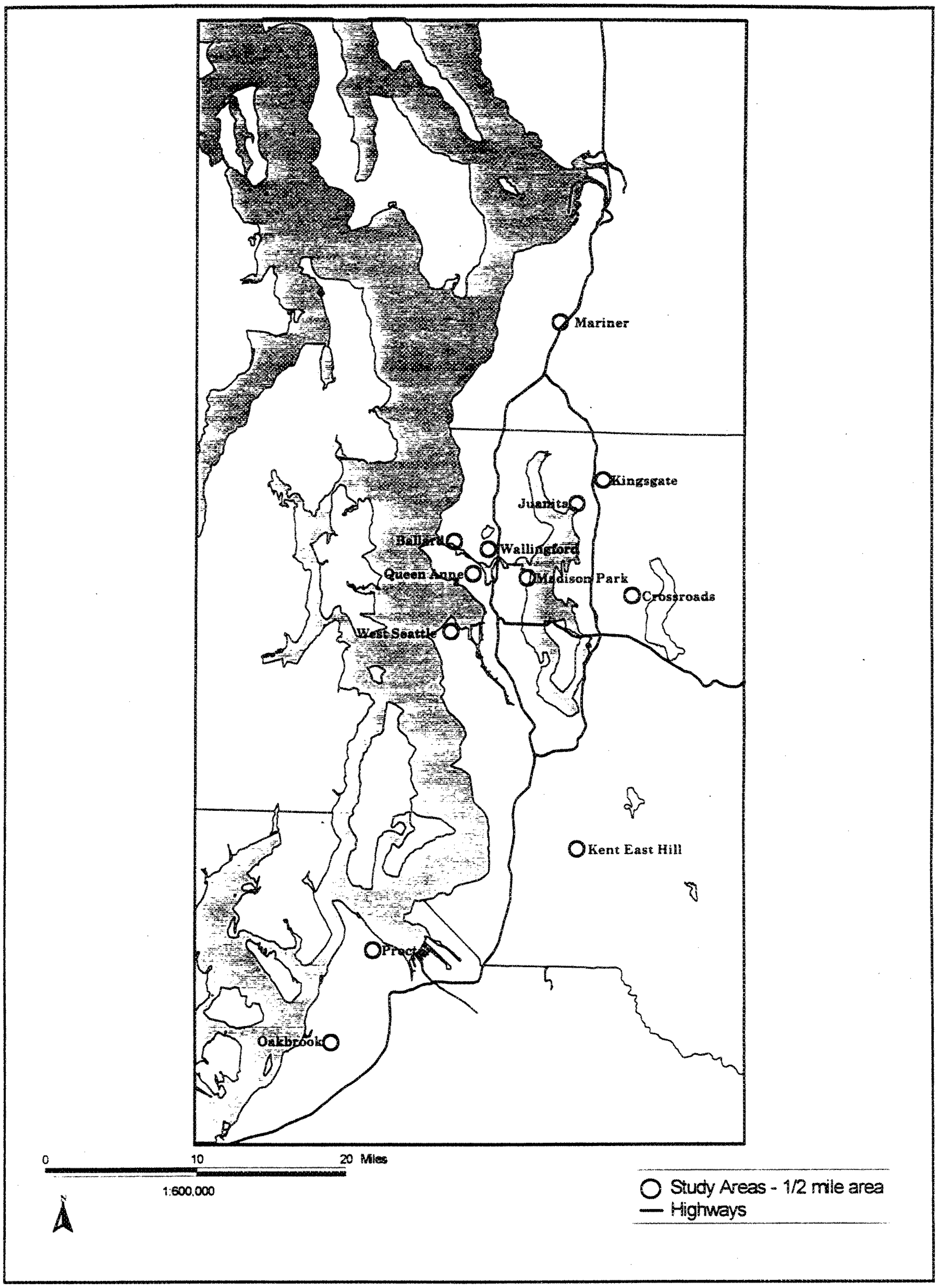
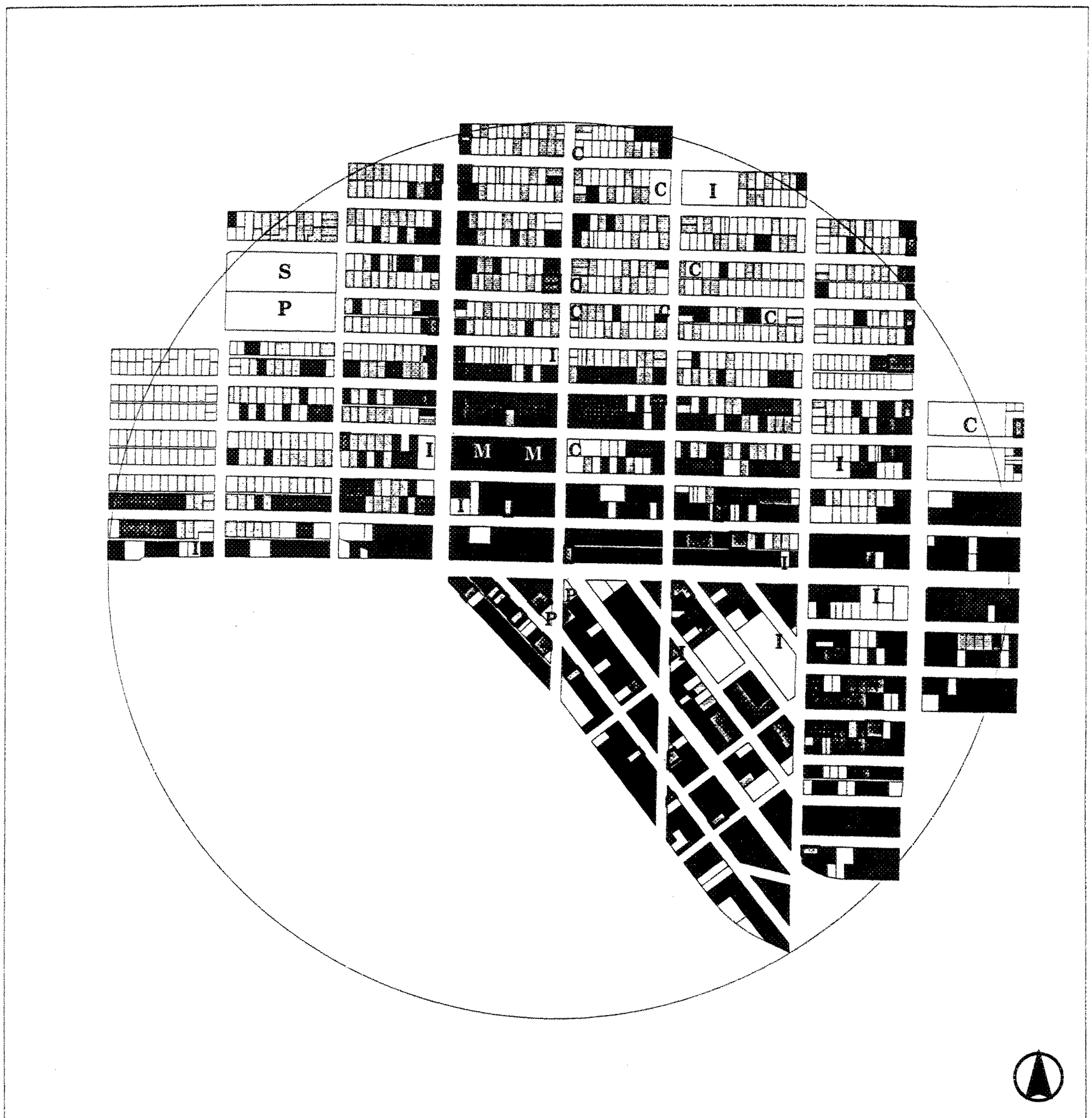


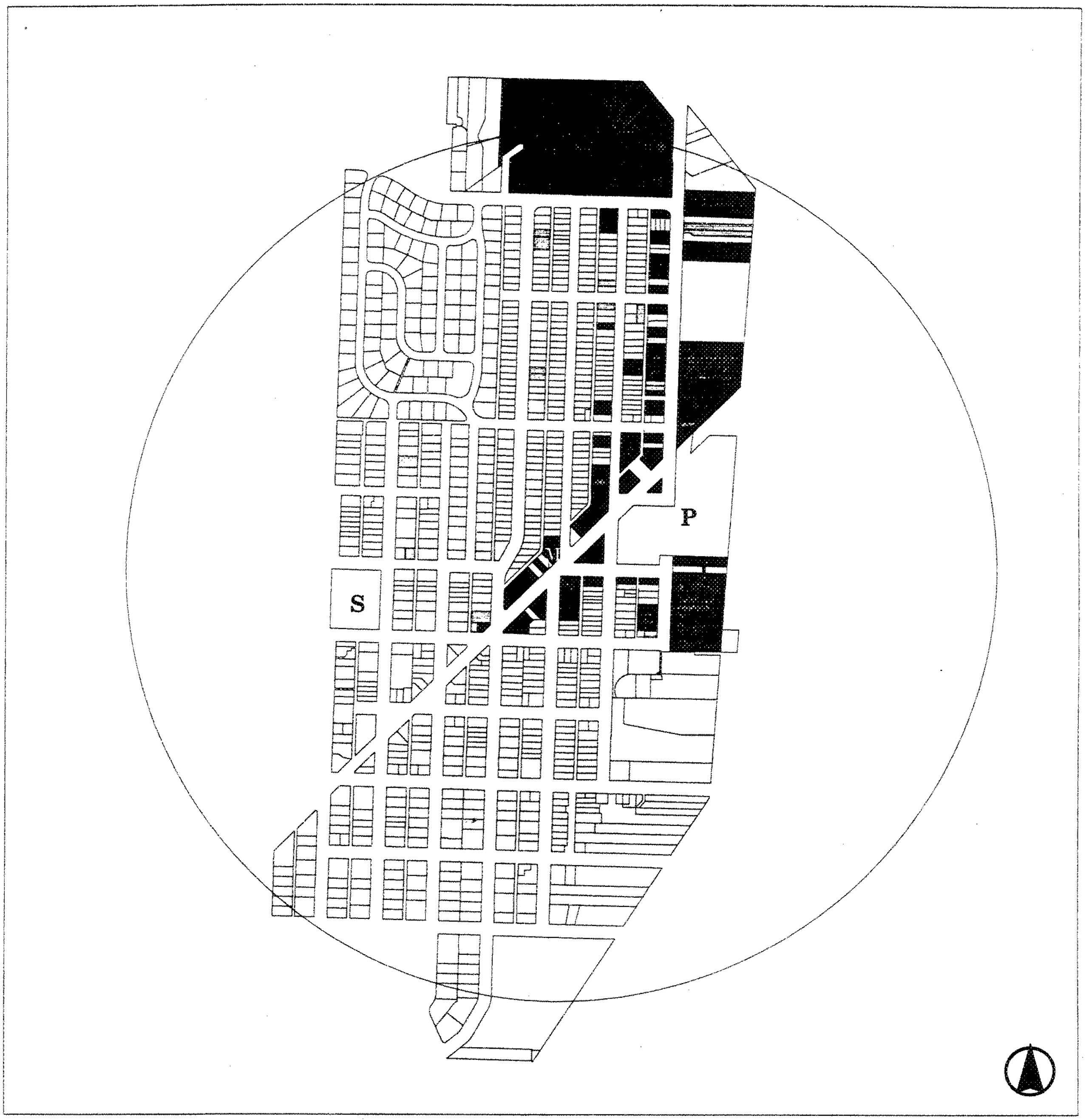
Figure 9. Locations of the 12 Sites (Study Areas)



- Vacant, Parking, Unknown Use
- Single Family Residential
- Mobile Homes
- Duplex, Triplex Residential
- Multi-Family Residential, Townhouses (4 plus units)
- Mixed Use Commercial/Residential
- Retail, Office, Industrial, Other Commercial

C - Church
I - Other Institutional
M - Supermarket
P - Park
S - School

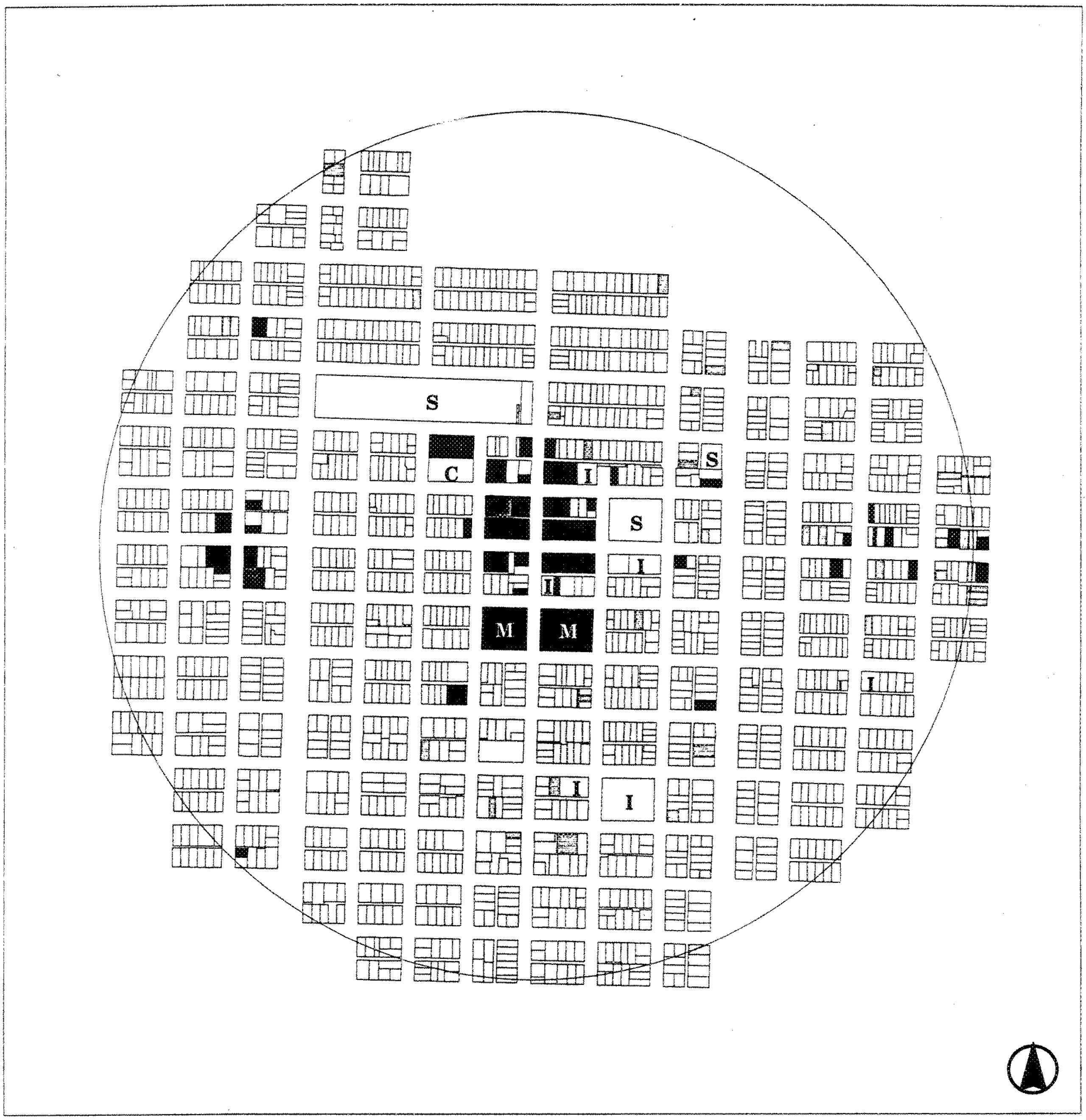
Figure 10. Ballard (U) Land Use



Vacant, Parking, Unknown Use
Single Family Residential
Mobile Homes
Duplex, Triplex Residential
Multi-Family Residential, Townhouses (4 plus units)
Mixed Use Commercial/Residential
Retail, Office, Industrial, Other Commercial

C - Church
I - Other Institutional
M - Supermarket
P - Park
S - School

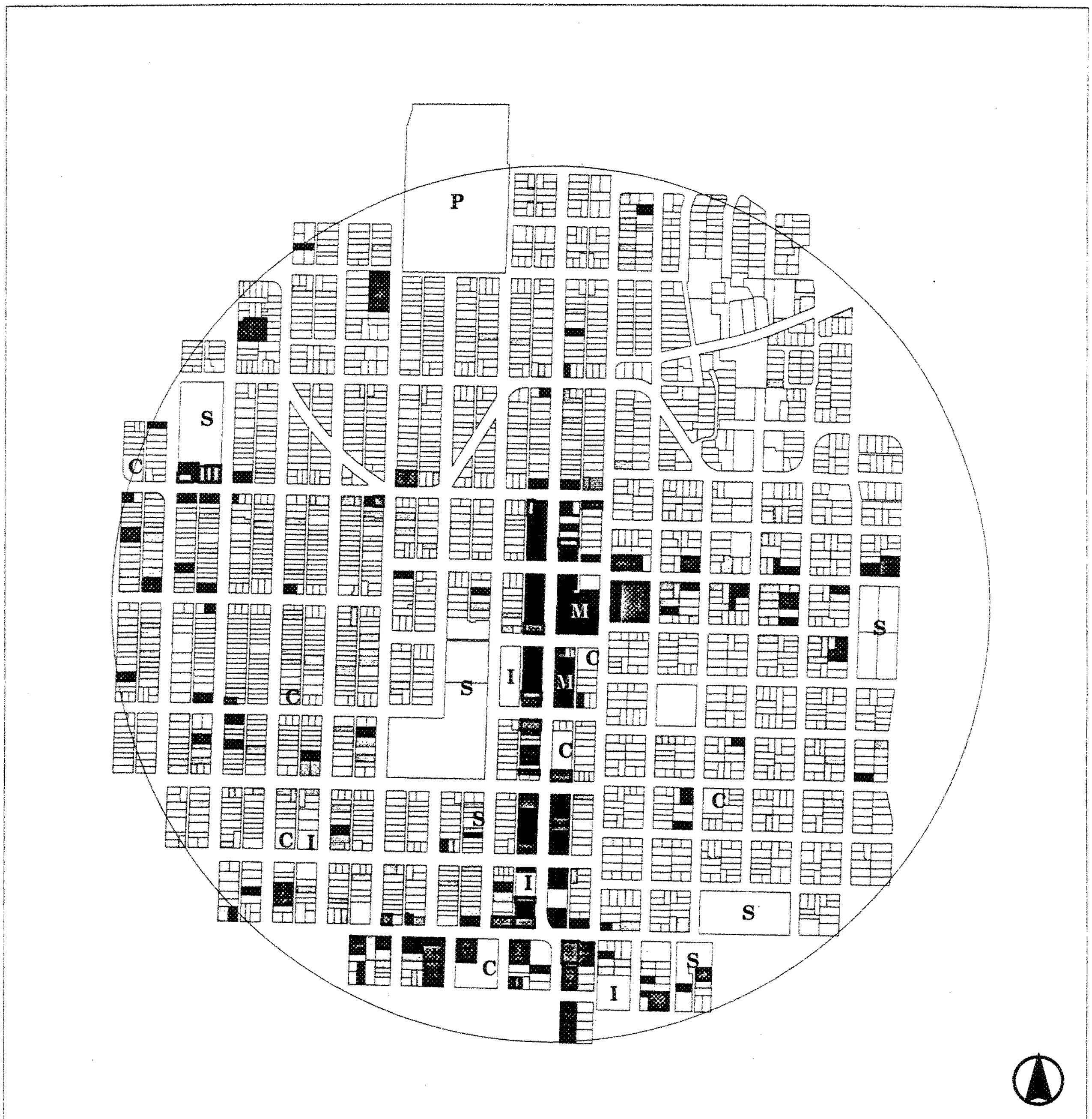
Figure 11. Madison Park (U) Land Use



Vacant, Parking, Unknown Use
Single Family Residential
Mobile Homes
Duplex, Triplex Residential
Multi-Family Residential, Townhouses (4 plus units)
Mixed Use Commercial/Residential
Retail, Office, Industrial, Other Commercial

C - Church
I - Other Institutional
M - Supermarket
P - Park
S - School

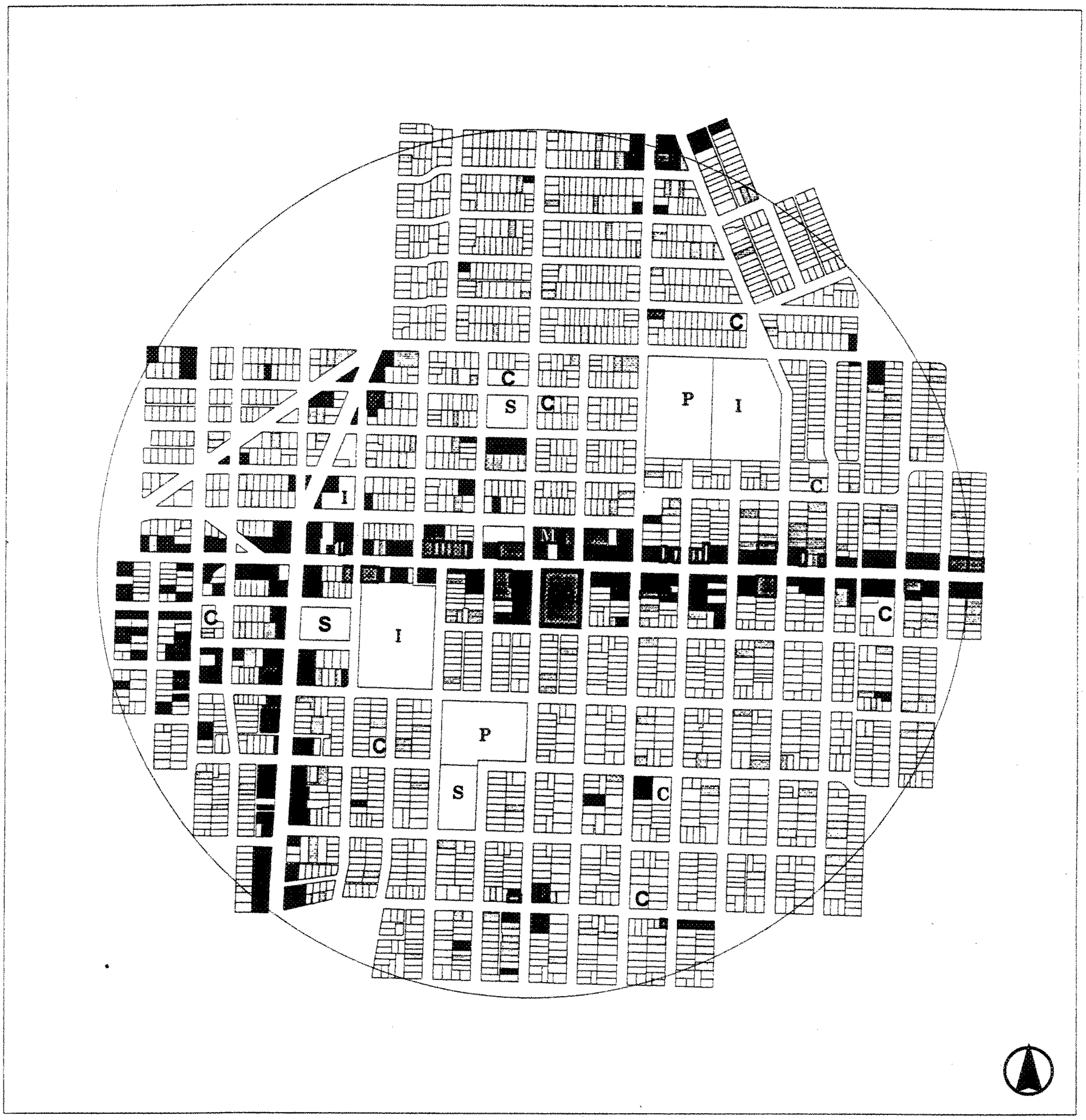
Figure 12. Proctor (U) Land Use



Vacant, Parking, Unknown Use
Single Family Residential
Mobile Homes
Duplex, Triplex Residential
Multi-Family Residential, Townhouses (4 plus units)
Mixed Use Commercial/Residential
Retail, Office, Industrial, Other Commercial

C - Church
I - Other Institutional
M - Supermarket
P - Park
S - School

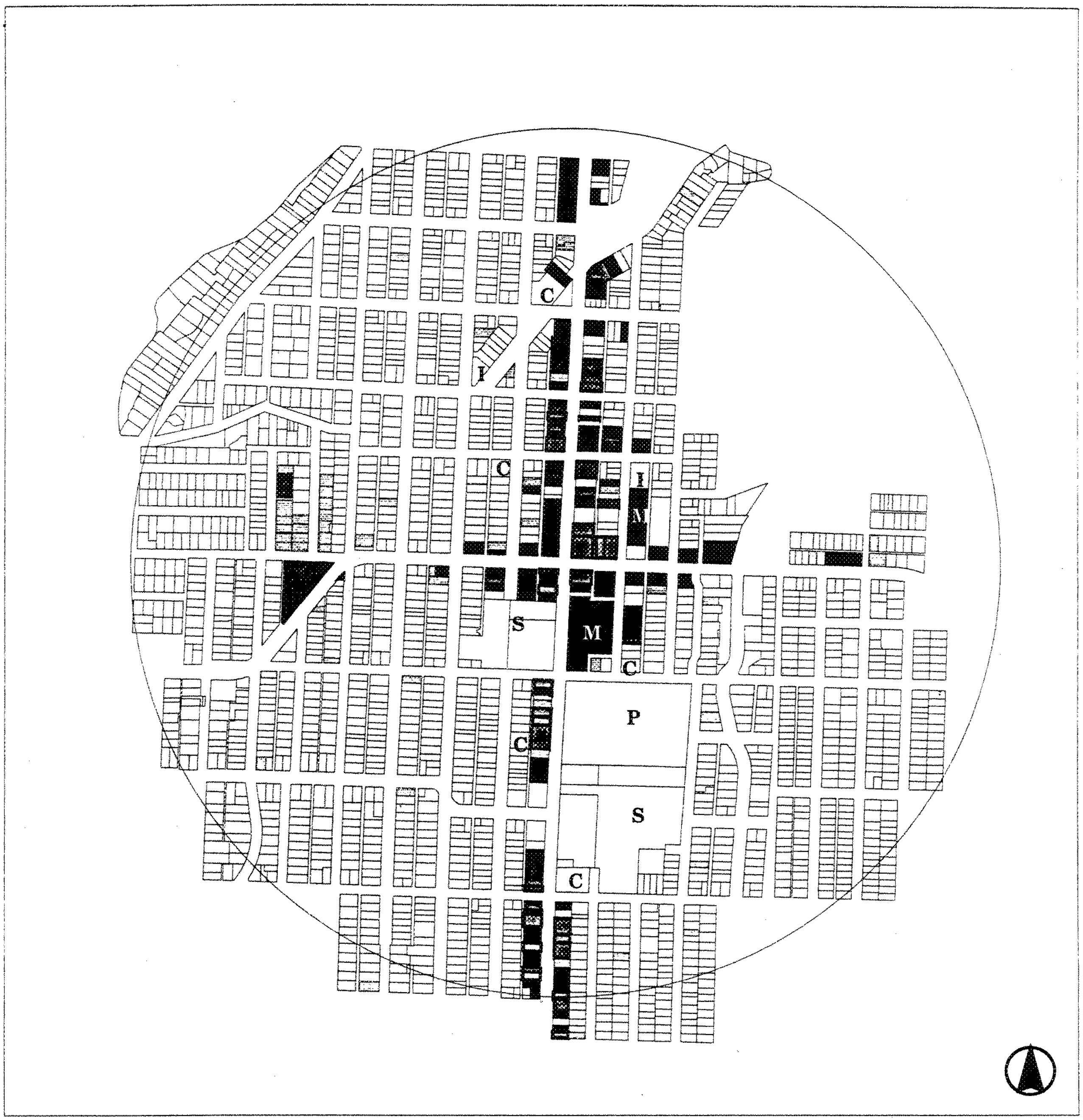
Figure 13. Queen Anne (U) Land Use



Vacant, Parking, Unknown Use
Single Family Residential
Mobile Homes
Duplex, Triplex Residential
Multi-Family Rsedential, Townhouses (4 plus units)
Mixed Use Commercial/Residential
Retail, Office, Industrial, Other Commercial

C - Church
I - Other Institutional
M - Supermarket
P - Park
S - School

Figure 14. Wallingford (U) Land Use



Vacant, Parking, Unknown Use
Single Family Residential
Mobile Homes
Duplex, Triplex Residential
Multi-Family Residential, Townhouses (4 plus units)
Mixed Use Commercial/Residential
Retail, Office, Industrial, Other Commercial

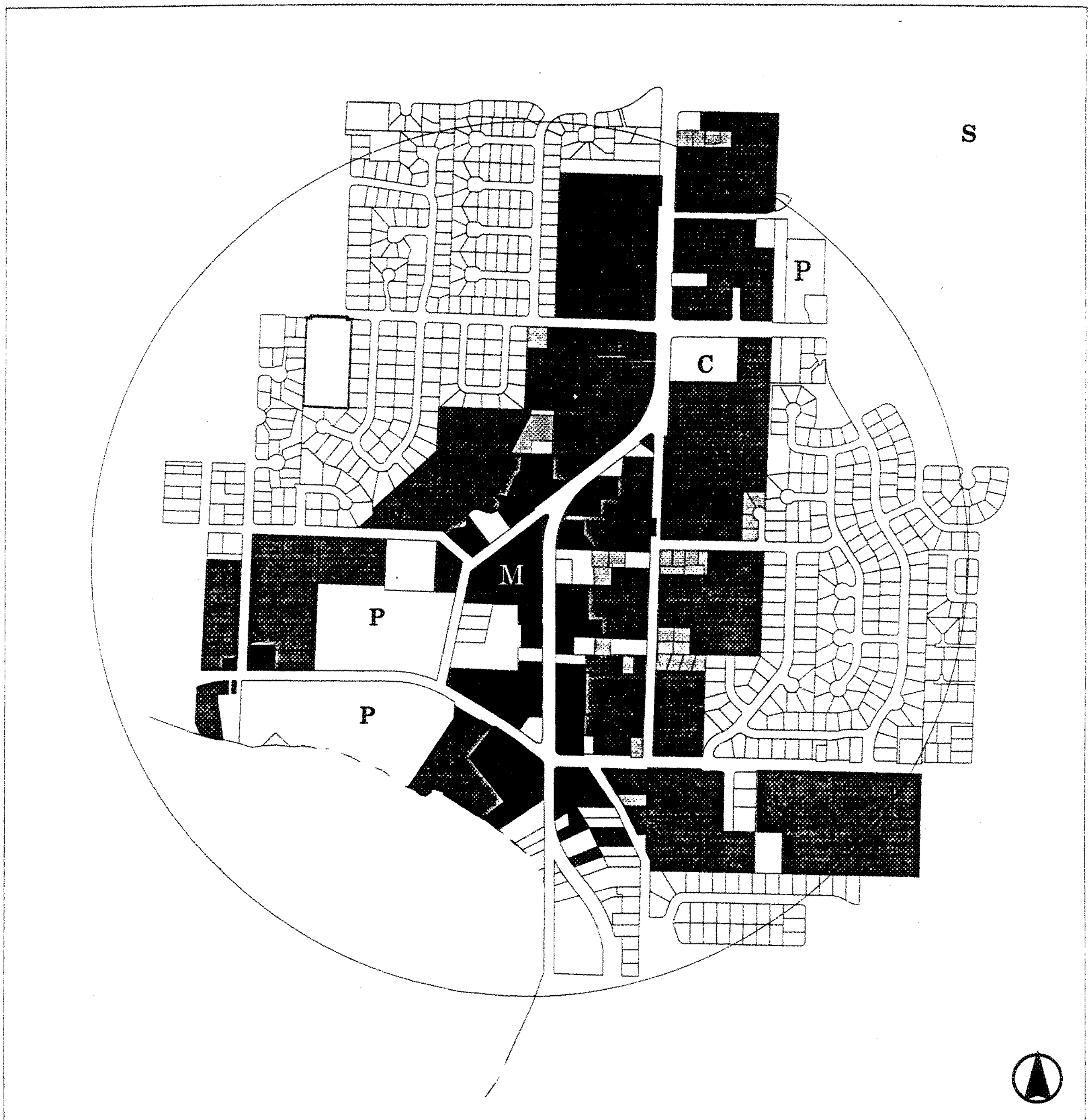
C - Church
I - Other Institutional
M - Supermarket
P - Park
S - School

Figure 15. West Seattle (U) Land Use

- Vacant, Parking, Unknown Use
- Single Family Residential
- Mobile Homes
- Duplex, Triplex Residential
- Multi-Family Residential, Townhouses (4 plus units)
- Mixed Use Commercial/Residential
- Retail, Office, Industrial, Other Commercial

- C - Church
- I - Other Institutional
- M - Supermarket
- P - Park
- S - School

Figure 16. Crossroads (S) Land Use



Vacant, Parking, Unknown Use	C - Church
Single Family Residential	I - Other Institutional
Mobile Homes	M - Supermarket
Duplex, Triplex Residential	P - Park
Multi-Family Residential, Townhouses (4 plus units)	S - School
Mixed Use Commercial/Residential	
Retail, Office, Industrial, Other Commercial	

Figure 17. Juanita (S) Land Use

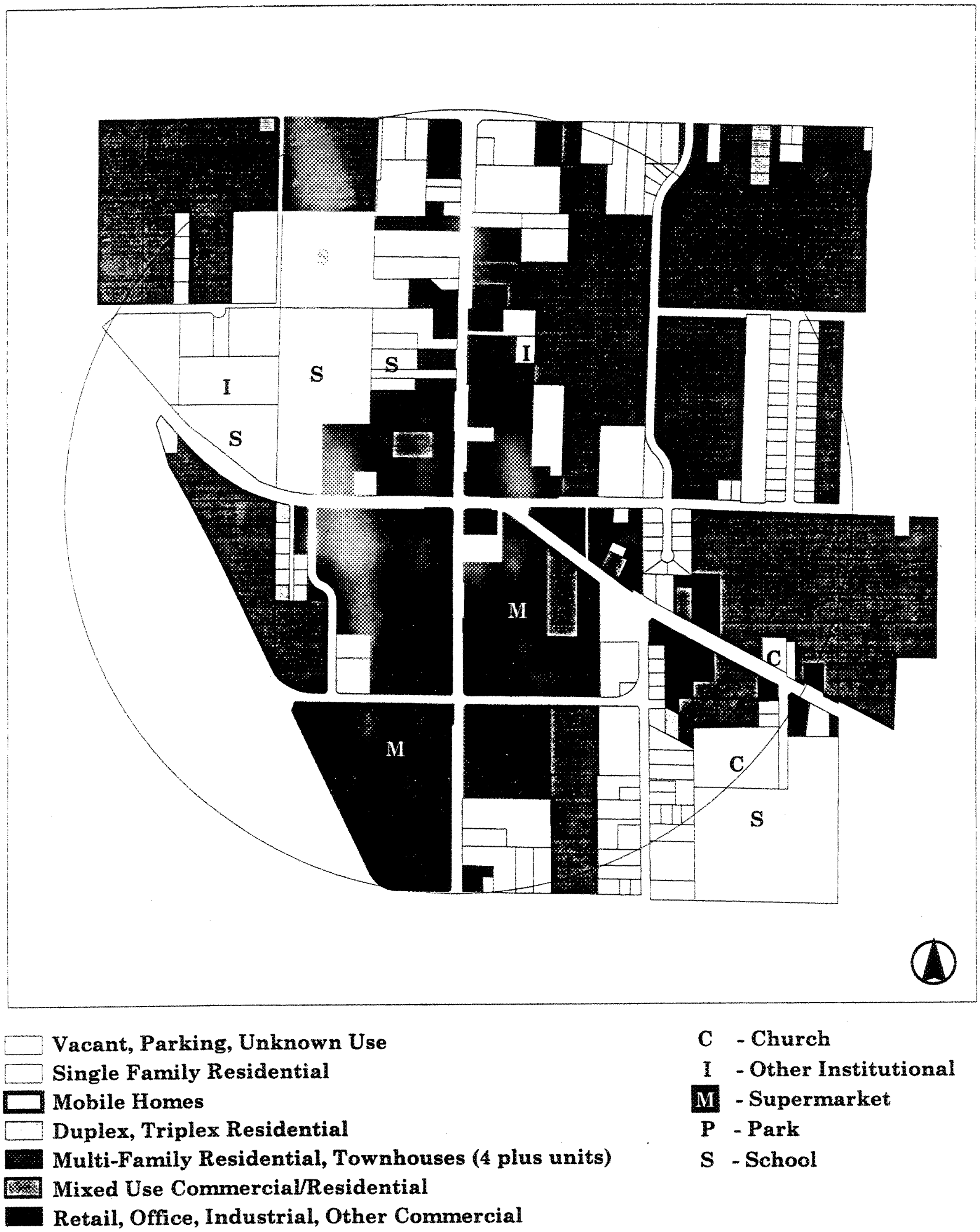
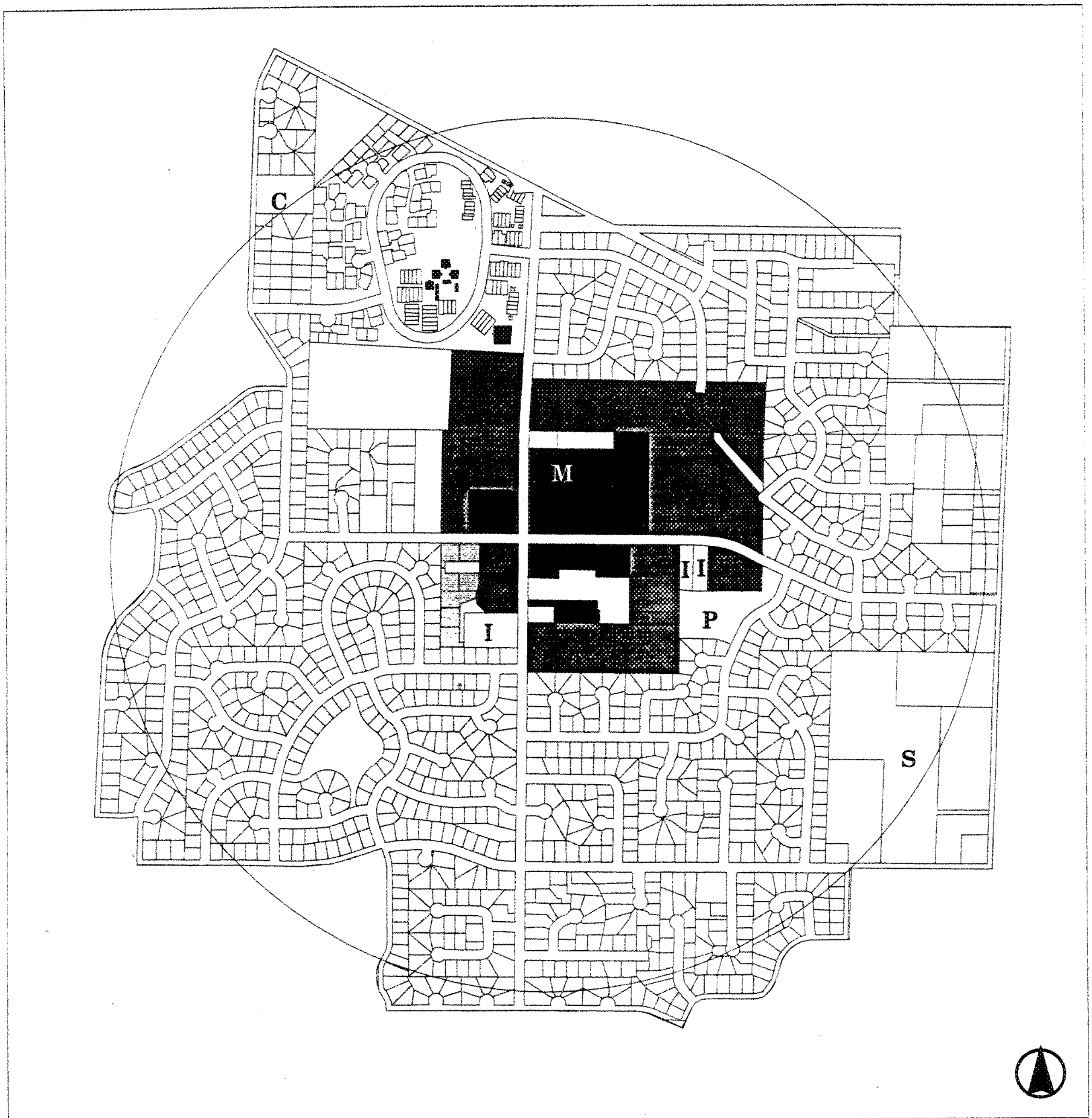


Figure 18. Kent East Hill (S) Land Use



Vacant, Parking, Unknown Use
Single Family Residential
Mobile Homes
Duplex, Triplex Residential
Multi-Family Residential, Townhouses (4 plus units)
Mixed Use Commercial/Residential
Retail, Office, Industrial, Other Commercial

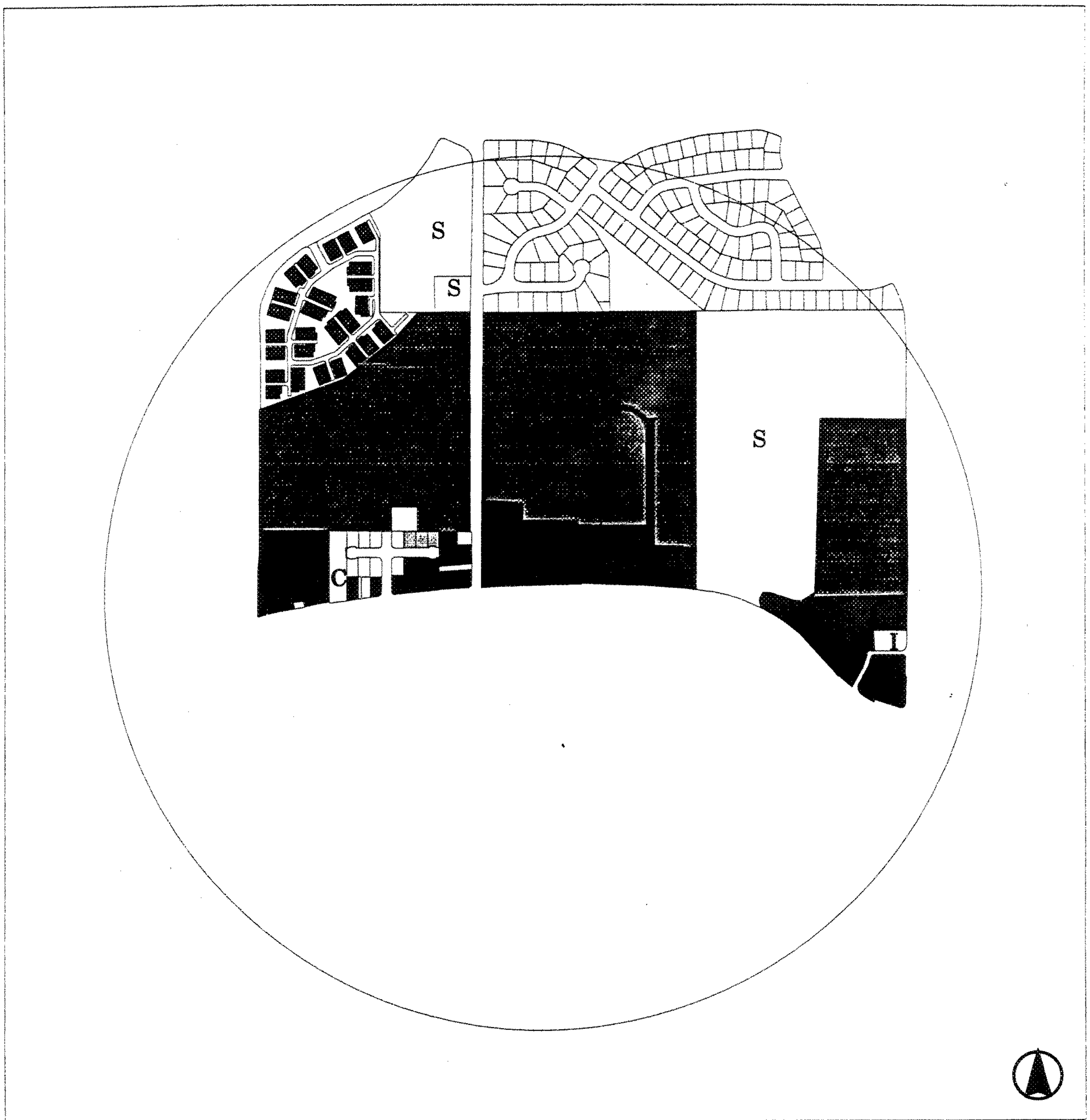
C - Church
I - Other Institutional
M - Supermarket
P - Park
S - School

Figure 19. Kingsgate (S) Land Use

Vacant, Parking, Unknown Use
Single Family Residential
Mobile Homes
Duplex, Triplex Residential
Multi-Family Residential, Townhouses (4 plus units)
Mixed Use Commercial/Residential
Retail, Office, Industrial, Other Commercial

C - Church
I - Other Institutional
M - Supermarket
P - Park
S - School

Figure 20. Mariner (S) Land Use



Vacant, Parking, Unknown Use
Single Family Residential
Mobile Homes
Duplex, Triplex Residential
Multi-Family Residential, Townhouses (4 plus units)
Mixed Use Commercial/Residential
Retail, Office, Industrial, Other Commercial

C - Church
I - Other Institutional
M - Supermarket
P - Park
S - School

Figure 21. Oakbrook (S) Land Use

Table 2. List of Potential Sites Examined in Initial Site Selection Process

County	Site name
King	Ballard
King	Ballinger Terrace
King	Central Redmond
King	Crossroads
King	Downtown Burien
King	Downtown Kirkland
King	Factoria
King	Juanita
King	Kent East Hill
King	Kent Plains
King	Kingsgate
King	Lake City
King	Madison Park
King	Maplewood
King	North City Terrace
King	North Highlands
King	North Tacoma
King	Northgate
King	Sea-Tac Airport, northwest
King	Paramont Park
King	Petrovitsky
King	Poverty Bay
King	Queen Anne
King	Redondo
King	Richmond Beach
King	Sea-Tac
King	South Des Moines
King	Southcenter
King	Sunset Hills
King	Thorndyke
King	Totem Lake
King	Twin Lakes
King	Wallingford
King	West Seattle
King	White Center
King	Windsor Hills
King	Woodinville

County	Site name
Pierce	Fernhill
Pierce	Fircrest
Pierce	Larchmont
Pierce	Menlo Park
Pierce	North Highland Hills
Pierce	Oakbrook
Pierce	Proctor
Pierce	South Highland Hills
Pierce	Westgate
Snohomish	Alderwood Interchange E.
Snohomish	Alderwood Manor
Snohomish	Casino Corner
Snohomish	Chennault Beach
Snohomish	College Place
Snohomish	Lake Ballinger
Snohomish	Mariner
Snohomish	Meadowdate
Snohomish	Mill Creek
Snohomish	Naketa Beach
Snohomish	North Mountlake Terrace
Snohomish	Scribner Lake
Snohomish	SE Mountlake Terrace

Table 3. Sites Used for Matching Urban and Suburban Site Characteristics

Urban (U) Sites	Suburban (S) Sites
Ballard, Seattle	Crossroads, Bellevue
Capital Hill, 15th East, Seattle	Downtown Burien
Fremont, Seattle	Downtown Kirkland
Greenlake, Seattle	Fircrest, Tacoma
Northgate, Seattle	Kent East Hill, Kent
Phinney Ridge, Seattle	Kent Plains, Kent
Proctor District, Tacoma	Kingsgate, King County
Queen Anne, Queen Anne Ave., Seattle	Lake City Way at 125th St., Seattle
Roosevelt, Seattle	Mariner, Snohomish County
Wallingford, Seattle	Menlo Park, Tacoma
West Seattle, California St at Admiral Way, Seattle	Oakbrook, Pierce County
West Seattle, West Seattle Junction, Seattle	Sea-Tac, Burien

Table 4. Summary of the 12 Selected Sites

Sites	*Urban Site Design Characteristics (U)*	*Suburban Site Design Characteristics (S)*
Group 1: Large Centers	Ballard (Seattle)	Kent East Hill (Kent)
Group 2: Large Centers	Wallingford (Seattle)	Crossroads (Bellevue)
Group 3: Medium Centers	Queen Anne (Seattle)	Mariner (Snohomish County)
	Proctor District (Tacoma)	Oakbrook (Pierce County)
	West Seattle (Seattle)	
Group 4: Small Centers	Madison Park (Seattle)	Juanita (Kirkland)
		Kingsgate (King County)

Table 5. Census Data Examined for Each Site, by Block Groups

	GROUP 1		GROUP 2		GROUP 3					GROUP 4		
Site	Ballard (U)	Kent (S)	Wallingford (U)	Crossroads (S)	Proctor (U)	Queen Anne (U)	West Seattle (U)	Mariner (S)	Oakbrook (S)	Madison Park (U)	Kingsgate (S)	Juanita (S)
CNTY	King	King	King	King	Pierce	King	King	Snohomish	Pierce	King	King	King
BLKGRP	32-2, 32-3, 32.99-3, 33-3, 33-4, 47-4, 47-5, 47-7	295.01-2, 295.01-9	46-3, 46-4, 50-1, 50-2, 50-3, 50-4, 51-1, 51-2, 51-3, 51-4, 51-5, 52-4, 54-1, 54-5	232-1, 232-3, 232-4, 232-5	605-3, 605-4, 605-5, 607-5, 607-6, 608-1, 608-2, 608-3, 608-4	59-6, 60-2, 60-3, 67.98-4, 68.98-1, 68.98-2, 68.98-3, 68.98.7, 69-1, 69-2	96-2, 96-3, 96-4, 97-1, 98-1, 98-8	418.03-2, 418.03-3, 418.03-9, 418.04-4	721.06-3, 721.06-4	63-1. 63-2, 63-3, 63-6	219.01-2, 219.01-3, 219.03-3, 219.04-1	220.04-3, 220.04-4, 222.02-2, 222.98-3, 222.98-9
POP	7010.0	9284.0	10148.0	8041.0	7792.0	7945.0	5269.0	10850.0	3304.0	3884.0	8392.0	7311.0
POP/ACRE	13.45	8.24	13.83	11.24	10.72	14.38	11.83	7.30	11.70	13.05	6.13	10.36
TOTAL UNITS	4273	4588	4960	4014	2689	4030	2551	5546	1692	2205	2996	3305
UNITS/ACRE BG	8.2	4.1	6.8	5.6	3.7	7.3	5.7	3.7	6.0	7.4	2.2	4.7
PCT OWN OCC	0.17	0.14	0.49	24.79	76.62	0.57	0.59	38.70	0.24	0.52	0.66	0.52
PCT MF	0.81	0.89	0.38	0.83	0.09	0.40	0.36		0.82	0.60	0.43	0.64
PCT WHT	91.5	89.6	89.2	81.9	96.3	92.9	95.7	92.0	75.8	95.0	90.0	89.0
PCT BLK	1.4	5.1	1.2	4.3	0.9	2.0	1.2	3.0	13.2	3.1	2.1	2.3
PCT ASIAN PACIFIC	3.7	3.4	5.9	12.7	2.7	3.8	1.1	3.0	3.5	2.1	6.5	5.5
PCT OTHER RACE	2.8	2.8	3.1	0.9	2.1	1.1	1.2	2.0	2.8	1.0	2.1	2.1
PCT HISP ORIG	3.5	3.4	4.3	3.8	2.8	1.0	1.7	3.0	5.8	0.8	3.5	2.5
PCT POP UNDER18	7.9	24.2	11.5	18.3	18.9	15.1	15.0	22.0	19.4	12.5	29.9	19.6
PCT POP 65 PLUS	20.2	5.0	9.4	9.9	11.1	12.6	22.7	9.0	10.2	28.0	4.9	11.9
MEAN HSHLD SIZE	1.7	2.2	2.1	2.1	3.0	2.1	2.1	2.3	2.2	1.8	2.9	2.3
MEAN MF HSHLD SIZE	1.5	1.9	1.5	1.8	1.6	1.4	1.3	1.8	1.7	1.3	2.3	1.7
MEDIAN INC RANGE	16,566-27,292	29,095-32,000	24,355-43,750	23,233-38,051	20,694-44,013	24,750-52,635	27,083-44,375	31,136-34,086	20,581-22,955	38,500-135,080	34,128-52,553	33,015-71,630
MEAN INC	26,013	34,089	37,874	35,465	39,165	45,965	41,141	35,000	26,911	75,685	45,228	44,927
AUTO/HH	1.2	1.6	1.6	1.5	1.9	1.4	1.6	1.7	1.4	1.5	1.9	1.7
AUTO/PRS	0.7	0.7	0.7	0.7	0.6	0.7	0.7	0.7	0.6	0.8	0.7	0.7
PCT COMMUTE SOV	54.6	81.5	54.2	68.4	70.3	63.5	65.3	78.0	74.7	75.2	74.7	78.8
PCT COMMUTE BUS	21.9	3.5	18.0	11.2	1.9	13.6	12.1	2.0	2.9	8.4	9.4	6.0
PCT COMMUTE WALK	6.3	2.9	5.9	3.6	11.5	7.1	2.5	3.0	2.4	1.3	1.7	2.1
MEAN COMMUTE TIME	22.0	25.2	19.3	20.3	17.6	18.2	22.1	22.0	21.6	18.9	24.9	24.6

Table 6. Land Use Survey at Urban (U) and Suburban (S) Sites within Cordon Area

	GROUP 1		GROUP 2		GROUP 3					GROUP 4		
Site	Ballard (U)	Kent (S)	Wallingford (U)	Crossroads (S)	Proctor (U)	Queen Anne (U)	West Seattle (U)	Mariner (S)	Oakbrook (S)	Madison Park (U)	Kingsgate (S)	Juanita (S)
Bakery/Food specialty	2	2	2	3	2	1	1	1		1	4	3
Bank	11	3	2	4	2	1	3	2	1	4	1	1
Bookstore	2		5	2	2	1				1		
Clothes-related	11	4	6	5	3	2	1		1	3		
Coffee shop	6		4	1	1	4	3			3		1
Convenience	2	4				1	2	2	2		1	1
Day care		1		1			1	2	2			
Drugstore	3	3	2	1		1				1	1	
Dry Cleaners	2	3	2	2	3	3	2	2	5	3	2	4
Gas & Auto-related	12	8	3	2		1	5	8	6		2	3
Grocery	2	1	2	2	2	2	3	1	2	1	1	1
Hair/nail salon	10	12	3	5	4	2	6	1	6	3	3	2
Hardware	2	3	1		1	2			1	1		
Health club	1	2				1			1		1	1
Home/Discount	26	10	4	13	1		2	4			1	
Hotel/motel								2				
Miscellaneous/General	46	25	9	17	22	20	7	7	13	10	1	2
Movie theater	1	1	1	1	1		1					
Entertainment/Night Cl	2				1						2	2
Post Office				1	1				1			
Professional Office	38	6	6	3	2	6	7	8	10	2	3	15
Religious		2			1	2	1		1			
Restaurant/taverns	24	17	26	26	8	16	13	12	14	8	6	8
School-related	1	1			2	1	1	1	1	1		
Travel/Insur/R. Estate		2	3	4	3		1		1	4		
Video	1		1	3	1	1	3	2	2		1	
TOTAL	**205**	**110**	**82**	**96**	**63**	**68**	**63**	**55**	**70**	**46**	**30**	**44**

Table 7. Socio-economic Characteristics of the 12 Sites, within 1/2-Mile Area

Site	Actual Population	Population "Complete Site"	Population Density	Number of Businesses	Median Income	Autos per Person	Percent Population Caucasian	Percent Population Under 18	Percent Population Over 65
Ballard (U)	5,936	7,050	14.1	204	16,500 - 27,000	0.7	91.5	7.9	20.2
Kent East Hill (S)	7,332	6,800	13.6	109	33,000 - 71,500	0.7	89.6	24.2	5.0
Wallingford (U)	7,577	7,850	15.7	82	24,000 - 43,500	0.7	89.2	11.5	9.4
Crossroads (S)	7,037	6,150	12.3	96	23,000 - 38,000	0.7	81.9	18.3	9.9
Proctor (U)	4,343	4,800	9.6	63	20,500 - 44,000	0.6	96.3	18.9	11.1
Queen Anne (U)	6,983	7,350	14.7	68	24,500 - 52,500	0.7	92.9	15.1	12.6
West Seattle (U)	5,388	5,950	11.9	62	27,000 - 44,000	0.7	95.7	15.0	22.7
Mariner (S)	4,932	6,500	13.0	54	31,000 - 34,000	0.7	92.0	22.0	9.0
Oakbrook (S)	2,930	6,200	12.4	69	33,000 - 71,500	0.6	75.8	19.4	10.2
Madison Park (U)	3,647	7,100	14.2	45	38,500 - 135,000	0.8	95.0	12.5	28.0
Kingsgate (S)	6,028	5,750	11.5	30	34,000 - 55,500	0.7	90.0	29.9	4.9
Juanita (S)	5,294	6,450	12.9	43	33,000 - 71,500	0.7	89.0	19.6	11.9

3. SITE LAND USE AND DESIGN CHARACTERISTICS

Each of the 12 sites selected was studied for its detailed land-use and site design characteristics. GIS maps served to describe these conditions, to measure the different elements of the pedestrian facilities, and to relate the social attributes of the areas studied to their physical characteristics.

GIS Maps

GIS maps were developed for each site to help define and analyze the physical environment of each area in relation to its pedestrian facilities. Data came from a variety of sources: parcel-based maps from local jurisdictions, county tax assessor's files, census information, aerial photographs (specifically Washington State Department of Natural Resources Air Photo Series NW-95), and field work. Access to GIS databases was in many cases difficult, with many jurisdictions reluctant at first to provide the information. Also, the type and quality of data available varied greatly by jurisdiction, with most requiring extensive follow-up field work. Table 8 summarizes the types and sources of data obtained for the different sites.

All data relating to pedestrian facilities were verified by field measurements to include roadway width, public sidewalks, crosswalks, bus stops, and traffic signals. When original databases did not include buildings, those located in and near the commercial center were traced from aerial photographs. Data on the location and amount of commercial parking are being collected as part of a separate study of parking utilization in medium-sized neighborhood commercial centers (Snyder, forthcoming).

The data for each site are available in Arc/Info and ArcView in a number of separate layers, shown in Table 9.

Matching Databases: Study Area Definition

For each site, GIS maps combined several geographical areas that corresponded to different sources of data and different analytical requirements. The largest area was approximately one-and-one-half mile square, and the smallest area delineated the "cordon" surrounding the neighborhood commercial center. In between these two areas were the half-mile-radius pedestrian "catchment" area and what we called the "study area." Figure 22 and Figure 23 illustrate the different geographical areas for Queen Anne (U) and Mariner (S), respectively.

The purpose of the large, square area (approximately two-mile square) was to depict the overall context of the neighborhood selected. Variability in this area's size came from the process of matching GIS tiles to the site's context. The cordon area refers to the area defined as the neighborhood commercial center proper and served to establish where counts were made of pedestrians entering the neighborhood center. The one-half-mile radius area framed the territory within which people were likely to walk to the center.

The defined study area was important for computational purposes: it was the area for which final gross population density had been established, and from which site design or urban form measurements were made. The area was defined by a combination of (a) census-block geography (to establish population density), (b) the half-mile-radius pedestrian catchment area, and (c) the specificity of each site—excluding bodies of water, freeways, large parks, and areas beyond the reach of pedestrians because of topography. While a perfectly balanced study area would include the 500 acres contained in a one-mile circle, actual study areas for the 12 sites ranged from 350 to 550 acres. In suburban sites, where census blocks often extend well beyond the half-mile circle, we performed what we called "surgery," cutting the size of the census block to conform with the half-mile circle area. Surgery was performed only on those census blocks that were homogeneous in development pattern or that included open space. Adjustments were then made accordingly to compute densities and total population figures.

Cordon Definition

As the smallest area, the cordon was an imaginary line encircling each one of the neighborhood commercial centers. The cordon was established for the purposes of counting pedestrians entering the commercial center (see Section 4, Pedestrian Volumes Counts). It was drawn as a line separating the primarily residential zones from the primarily commercial zones of the neighborhoods studied. (See figures 10 through 21 regarding maps of the 12 study areas' land uses.)

In suburban sites, we placed office development located within the study area outside of the cordon as a way to capture as much of the pedestrian traffic into the center as possible. Most people will drive to their office, but they may walk to the commercial center during the day for errands, lunch, or other purposes. In urban sites, fine-grained distribution of land uses in the commercial zone are likely to include some office uses, thereby putting these urban sites at a slight disadvantage with respect to their suburban counterparts. However, the cordons in several urban sites excluded some of the area's commercial uses which often spread over large, and mostly elongated, areas—reflecting their origins as streetcar suburbs. Schools were also kept outside of the cordon, for the simple reason that these institutions are traditionally kept at a substantial distance from neighborhood commercial centers.

Matched sites had similarly sized cordon areas, though their shapes varied considerably. Urban cordons tend to be elongated (following the old street car lines), and suburban cordons tend to be concentric (in effect, more center-like).

Possible points of entry by pedestrians into the cordon were established from field surveys, which included a detailed description of the conditions around the cordon (See Section 4). These conditions vary considerably in suburban sites, where the commercial center is usually isolated from its neighbors. In urban sites, points of entry correspond to public streets.

Definition of Measurements of Site and Pedestrian Facilities Design

A central concern of this project was to establish simple, yet effective measures of site design that describe the characteristics of the pedestrian environment. Our work called for distinguishing between high and low connectivity in the pedestrian system. This was a difficult task for several reasons. First, even when land-use type and intensity were controlled for, defining a site involves many variables that interact in a complex fashion. Sites are made of different physical elements, such as streets with or without sidewalks, and these elements come in different dimensions, such as wide and narrow streets. Second, pedestrian routes within a site cannot readily be modeled, as pedestrians are small, highly mobile "entities" who can use a great number and types of facilities, or "paths," within a site. Modeling pedestrian travel is especially difficult in suburban sites, where a loose pattern of development with open land, undeveloped space, and parking lots allows many route options. Keeping these difficulties in mind, we concentrated on measures of what we termed the "potential" and the "actual" public pedestrian facilities. We also measured routes that pedestrians can travel using both "formal" and "informal" pathways. These terms are described below.

The "potential" public network relates to the streets, roadways, and their networks, which may or may not contain actual pedestrian facilities. This network is particularly important in suburban sites, where actual pedestrian facilities are few. Public streets provide the primary connection between land uses and, being in the public realm, are most easily available for the addition of pedestrian facilities.

The potential public network is measured in terms of its total extent and distribution. Extent is defined by the total length of the street system in each study area. Distribution is measured by the average size of blocks in each study area. Both measures are important because it is possible to have an extensive network that is badly distributed, and hence restricts, or does not facilitate, pedestrian access to some locations.

The actual public pedestrian facilities are measured in terms of the extent of the sidewalk system and the completeness of this system. As with streets, the extent of the sidewalk system is defined as the total length of sidewalks in each study area. Completeness is defined as the ratio of the length of the total existing sidewalk system to the length of the potential sidewalk system, where all streets have sidewalks on both sides of roadways. Another measure of the actual network is the mean distance between entry points into commercial center. This measure indicates the *de facto* block size for the pedestrian network and illustrates network distribution and permeability. In urban sites, points of entry correspond to the street and cross-street network. In suburban sites, where entry points may be through parking lots, they serve as *de facto* streets for pedestrians entering the commercial center.

These measures of the potential and actual pedestrian system can be computed as "actual" and "adjusted" numbers. Adjusted measures are as follows:

- actual measures adjusted to the number of residents in the study area to reflect the relationship between the amount of facilities and the population to be served
- actual measures adjusted to a "complete" 500-acre area within one half-mile of the center
- actual measures adjusted to the 128 acres that fall within a one-quarter mile radius of the site's center—approximately 25 percent of the study area

Actual figures were useful for comparing and understanding the characteristics and potential of each specific site as is. Adjusted figures helped to compare sites, generalize the findings, and analyze the effects of the different independent variables considered.

Another set of measures was developed to define routes that pedestrians use between housing units and their commercial center. Routes selected for travel were assumed to contain both formal and informal pathways. Formal paths include those pedestrian pathways that are publicly accessible, reserved or clearly marked, and legally protected for pedestrian use. Thus sidewalks, intersections, and marked crosswalks are part of the formal network, but road shoulders and routes through parking lots do not qualify as formal pedestrian pathways. However, because these informal paths are common parts of the pedestrian network in suburban sites, they were included in the selected routes. These routes were used to measure airline distances between housing units and commercial centers, actual traveled route distances, and a calculated ratio of these two measures to establish the pedestrian route directness.

Measures taken for the 12 sites are described in the following pages. Table 10 summarizes actual and adjusted measures of pedestrian facilities, within one-half mile study area. Table 11 summarizes actual and adjusted measures of pedestrian facilities completeness for one-quarter mile center of the study area. Figures 24 and 25 diagram total sidewalk length (in miles), total street length (in miles), and mean block size (acres) for a one-half mile and one-quarter mile around the center, respectively.

Measures of Potential Pedestrian Facilities

Total Length of Streets at Center Line

This measure indicated the extent of the roadway system and the potential for pedestrian facilities in a given study area, assuming that it was most practical to link pedestrian facilities with roadways. Figures 26 a, b, c show actual street networks for the 12 study areas. The total length of streets adjusted to a 500-acre site varied from more than 35 miles in urban areas (Proctor) to 6.5 miles in suburban areas (Kent). Clearly, the total length of streets in the 12 sites selected was neither related to density of development (Proctor being the urban site with the lowest density) nor to the size of the commercial center (Kent being the largest suburban center studied). The measures of street networks showed that in suburban areas, actual development patterns do not follow the most elemental rule of infrastructure planning: infrastructure should relate positively to the density and intensity of activities to be served.

In urban sites, the portion of streets allocated to the quarter-mile area in and near the commercial center was on average slightly lower than the 25 percent that the area would justify, because blocks in and near the commercial center were slightly larger. In suburban sites, the portion of streets in and near the commercial center was lower for all sites except Kent, with Crossroads, Juanita, and Kingsgate recording less than 18 percent of their streets in the one-quarter-mile area.

Mean Block Size

This measure complemented the total street length measure above to project the distribution of streets in a given area. Consistent with the measures of street length, mean block size for the half-mile study area were 2.7 acres for urban sites (approximate size of a 300- by 400-foot block) and 31.7 acres for suburban sites (approximate size of a 1,000- by 1,300- foot block). In the quarter-mile area, this variation was even larger, with a mean urban block of 3 acres and a mean suburban block of 55 acres. This measure most powerfully illustrated the dysfunctional nature of the suburban street infrastructure at the site level for both pedestrians and motor vehicles; there is an inverse relationship between roadway provision and the development's density and intensity. Indeed, Kent and Oakbrook had block sizes of 100 acres within one-quarter-mile of their commercial centers (approximate size of a 1,400 by 3,000 feet block).

Measures of Actual Pedestrian Facilities

Total Length of Public Sidewalks

This measure indicated the extent of the public sidewalk system as the most basic and formal pedestrian facility that can be provided. Figures 27 a, b, and c show the actual sidewalk networks for the 12 study areas. Networks varied considerably between urban and suburban sites, with the longest public sidewalk system adjusted to a 500-acre site measuring 44 miles (Wallingford) and the shortest measuring 1.1 miles (Oakbrook) within the half-mile study area. The mean length of sidewalks for urban sites was 37.6 miles, versus 7.8 miles in suburban sites. Sidewalks in urban sites were distributed evenly throughout the study area, with approximately 25 percent of the total length found in the quarter-mile area for all urban sites. In large and medium-sized suburban sites with few sidewalks, 40 percent of the total length of sidewalks were found in and near the commercial centers (Kent and Mariner). In small suburban sites (Juanita and Kingsgate) less than 18 percent of the sidewalks were in the quarter-mile surrounding their center. Generally, sidewalks in suburban areas were only found along arterials and streets in single-family areas. Hence suburban sites with relatively large amounts of single-family development had by far the longest sidewalk network. This measure showed that as important pedestrian facilities, sidewalks in suburban areas are not related, as they should be, to density or intensity of development.

Sidewalk Completeness Ratio

This measure was a ratio of the length of the existing public sidewalk system to the length of the potential system, where sidewalks line both sides of all roadways. The ideal ratio is 1:1, indicating that a system is complete. A complete system is necessarily continuous, but an incomplete system may not be continuous. To illustrate, an area with a ratio of 0.5:1 would need to double the number of sidewalks to have a complete system. However, this area might have sidewalks on one side of all roadways, making a continuous but not complete system. It might also have sidewalks concentrated on both sides of some streets with other streets having no sidewalks. This latter case creates a discontinuous system and is common in suburban sites, where sidewalks are found along arterials and in single-family developments but not in multi-family developments.

With respect to the 12 study sites, the ratios of sidewalk completeness for urban sites was 1.0, with the exception of Proctor at 0.9. All suburban sites had ratios of sidewalk completeness of less than 1.0, with a mean ratio for all suburban sites of 0.47. Suburban sites would need to more than double the length of their sidewalks to have a complete system on existing streets.

Mean Distance between Entry Points into Cordon

This measure was calculated as the average distance between possible pedestrian entry points into commercial centers. Mean distance between entry points in urban sites is 551 feet, versus 1,010 feet in suburban sites. Note that these figures do not take into account the significant difference in the quality of the pedestrian environment created by streets as the principal entry points in urban sites, versus gates, locked gates, and small passages as entry points in suburban sites. However, while the distribution of pedestrian paths in suburban sites was appropriately more fine-grained than the street network, the network was far too coarse to respond to the needs of pedestrians. This fact as confirmed by the numerous informal paths found in suburban sites, which showed that pedestrians take it upon themselves to improve the system's permeability.

Measures of Routes Traveled

Measures of routes traveled depend on how the origin and the destination of the pedestrian trip are defined. In all cases, destination was defined using the 100 percent corner of each study area. Since services may be distributed differently around this location in different commercial centers, this is an imperfect assumption. In a center with clustered services, most services will be close to the 100 percent location. However, in a center organized around a lengthy shopping street, as is common in the urban sites, some services may be located one-quarter-mile away from the 100 percent location. The effects of these differences in the spatial distribution of commercial services on route travel measurements, and on pedestrian travel in general, are not always evident and are worth additional study.

Two methods were used to define the trip origin. In the pilot study, the selection of points of origin was based on geometrical considerations by using cardinal points and fractions thereof. This method is appropriate for sites where dwellings, and therefore people, are distributed in a regular pattern throughout the geographical area under consideration. This was the case in most of the urban sites. However, this method does not provide an adequate measure of route directness for sites where the housing units are distributed in irregular clusters. This was the case in suburban sites, where residential densities were concentrated in the apartment developments scattered irregularly around the site, usually around the edge of the commercial center.

In this study, therefore, points of origin of the pedestrian trip were selected on the basis of a random sample of dwelling units in each study area to capture differences in their spatial distribution of land uses. Tax assessors data provided the basis for the selection. The greater of 35 dwelling units, or every hundredth unit in a study area, was chosen as a point of origin. These origins and destinations were used to measure average airline distances, average route distances, and route directness ratios for the 12 sites. Figures 28 and 29 show examples of sampled origins and destinations, pedestrian routes, and airline distances for an urban and suburban site. Table 12 summarizes these measures for the sites.

Airline Distance

Airline distance was measured as the straight-line distance between sampled origins and the 100 percent corner of each study area. The average (mean or median) airline distance of all sampled origins is a measure of the compactness of each site. Both the distribution of residential land in a site and the distribution of housing units within the area with residential development will affect compactness. Residential land with high dwelling-unit densities that immediately adjoin the commercial center decreases airline distances and hence increases a site's compactness. Dense concentrations of housing at the site's edge rather than at the center decreases compactness. Commercial areas with large geographic extents also increase airline distance and decrease compactness. So does land in non-residential uses such as parks, large institutional uses, and parking lots separating residential land and the commercial center. Given the same directness of travel routes (see below), a longer airline distance lengthens walking distances for most residents, and will, therefore, likely decrease the incidence of walking.

The compactness of the 12 sites is shown in Figure 30. The sites are ordered from the least compact to the most compact site. Madison Park (U) was the most compact site, with both mean and median airline distances between housing and the 100 percent corner at about one-quarter mile. Thus, about one-half the housing units in Madison Park were within one-quarter mile of the commercial center. This result was a function of the entire site's small size, the commercial area's small size, and the immediate adjacency of housing and commercial land uses. On the other hand, Kent (S) was by far the least compact site, with an average airline distance of about four-tenths of a mile. In this case, commercial land uses covered a large geographic area that pushed most residential land uses to the site's edge. As a result, half of Kent's dwelling units were within slightly less than half a mile from the 100 percent location.

Because this study was designed to have all urban and suburban sites as compact as possible, there was not a simple split between urban and suburban average airline distances. Between the two extremes of Madison Park (U) and Kent (S) were a mixture of urban and suburban sites with average airline distances of about one-third mile.

Travel Distance

Travel distance in this study was measured as the shortest "formal" route that a pedestrian could use between sample origins and the commercial center. Travel through gates between an apartment complex and the commercial center was defined as a formal travel route. However, trespassing through someone else's property was not considered, even if it was likely that some pedestrians would take such a route. Pedestrians were assumed to cross streets at a marked or unmarked legal crosswalks. Pedestrian routes in parking lots only considered travel along the principal driveways into the parking lots. Parking lots were principally used as travel routes in suburban apartment complexes and in some suburban commercial centers.

Travel distance establishes how many people can actually walk one-half mile or less between their house and the neighborhood commercial center. As such, this measure can be used to determine how many people or housing units fall within a half-mile catchment area as defined by actual travel routes. In Hess's pilot study (1994), this measure was termed the site's "effective" density and was depicted as the "distance contour" of the study area—the distance contour being the area of the site that includes all the dwellings within a one-half-mile travel distance to the commercial center. Hess established that Crossroads' (S) effective density was 49 percent of the density of units within the one-half mile geographic area—meaning that only half of the dwellings fell within a half-mile travel distance of the center. In Wallingford (U), this number was 73 percent.

In this study, travel distance was expressed as an average route length between the sampled origin and destination. Mean and median travel distances are shown in Figure 31. Each one-hundredth of a mile increase in travel distance represents approximately an additional 50 feet. Unlike in the airline distance measure, a break existed between urban sites with shorter travel distances and suburban sites with longer travel distances. Kingsgate (S) had the shortest suburban mean travel distance, although it was approximately 150 feet longer than the longest urban mean travel distance (West Seattle). It is known that pedestrians are very sensitive to walking distances and that there are thresholds over which people are much less likely to walk. It is not known exactly where the thresholds are, but clearly the longer walking distances in suburban sites discourage pedestrian travel. Most suburban sites have average travel distances of one-half mile or more, the outside limit of "reasonable" walking distances for most people.

Route Directness Ratio

Route directness is measured by a ratio of travel distances to airline distances. A hypothetical ideal ratio of 1:1 indicates that all routes in a site are straight paths between housing units and the center. On the other extreme, a ratio of 2:1 would indicate that travel routes are twice as long as straight line distances. Figure 32 shows the actual route directness ratios for the 12 sites.

As with travel distances, a break existed between urban and suburban measurements. Reflecting similarly fine-grained street networks with small block sizes, urban sites had similarly direct travel routes, ranging from 1:1.23 in Madison Park (U) to 1:1.32 in Wallingford (U). Large block sizes, especially around commercial centers, affected the directness of suburban routes. Mariner (S), with a ratio of 1:1.80, had the least direct suburban pedestrian routes, and Crossroads (S), with a route directness ratio of 1:1.49, half the most direct suburban travel routes. The indirectness of suburban pedestrian routes explains why all suburban sites had longer walking routes than urban sites, even though some suburban sites were more compact than their urban counterparts.

Measures of average airline distance, average route length, and route directness could clearly be refined, taking into account the actual time distance between origins and destinations (including signalization and specific route characteristics). In addition, these measures could reflect the quality and relative safety of the pedestrian trip, as defined by the characteristics of the sidewalks.

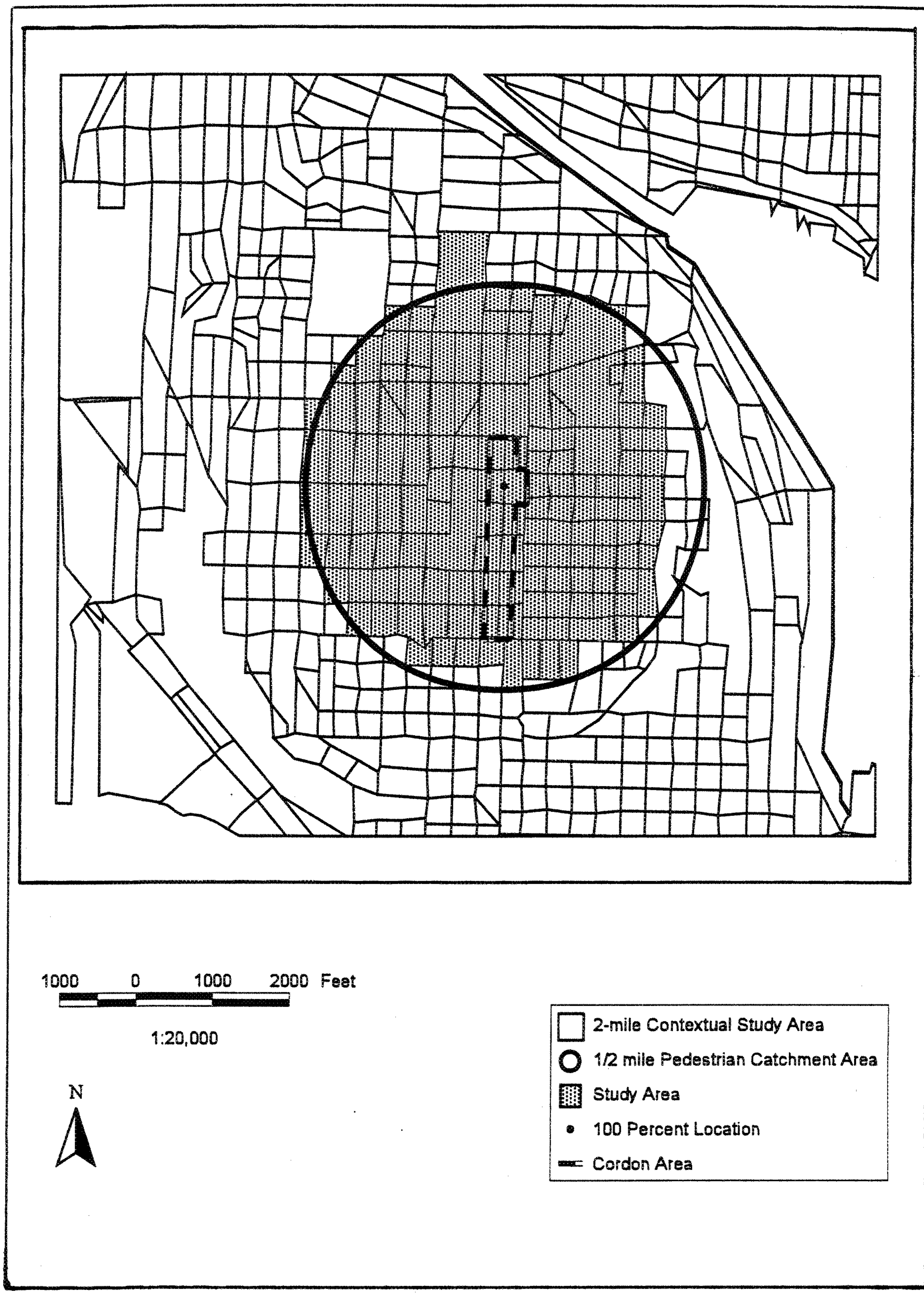


Figure 22. Study Area Boundaries for Queen Anne (U)

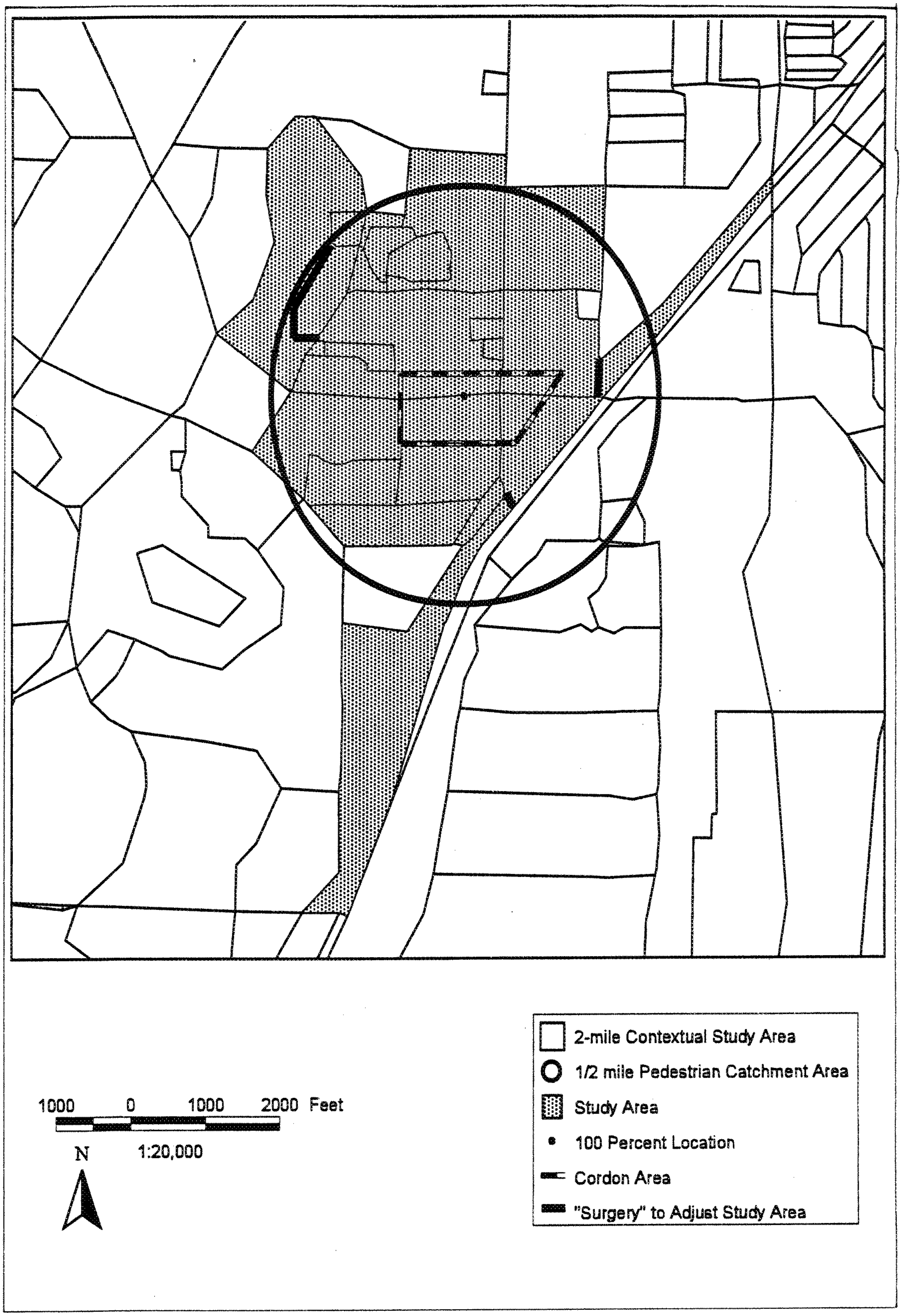


Figure 23. Study Area Boundares for Mariner (S)

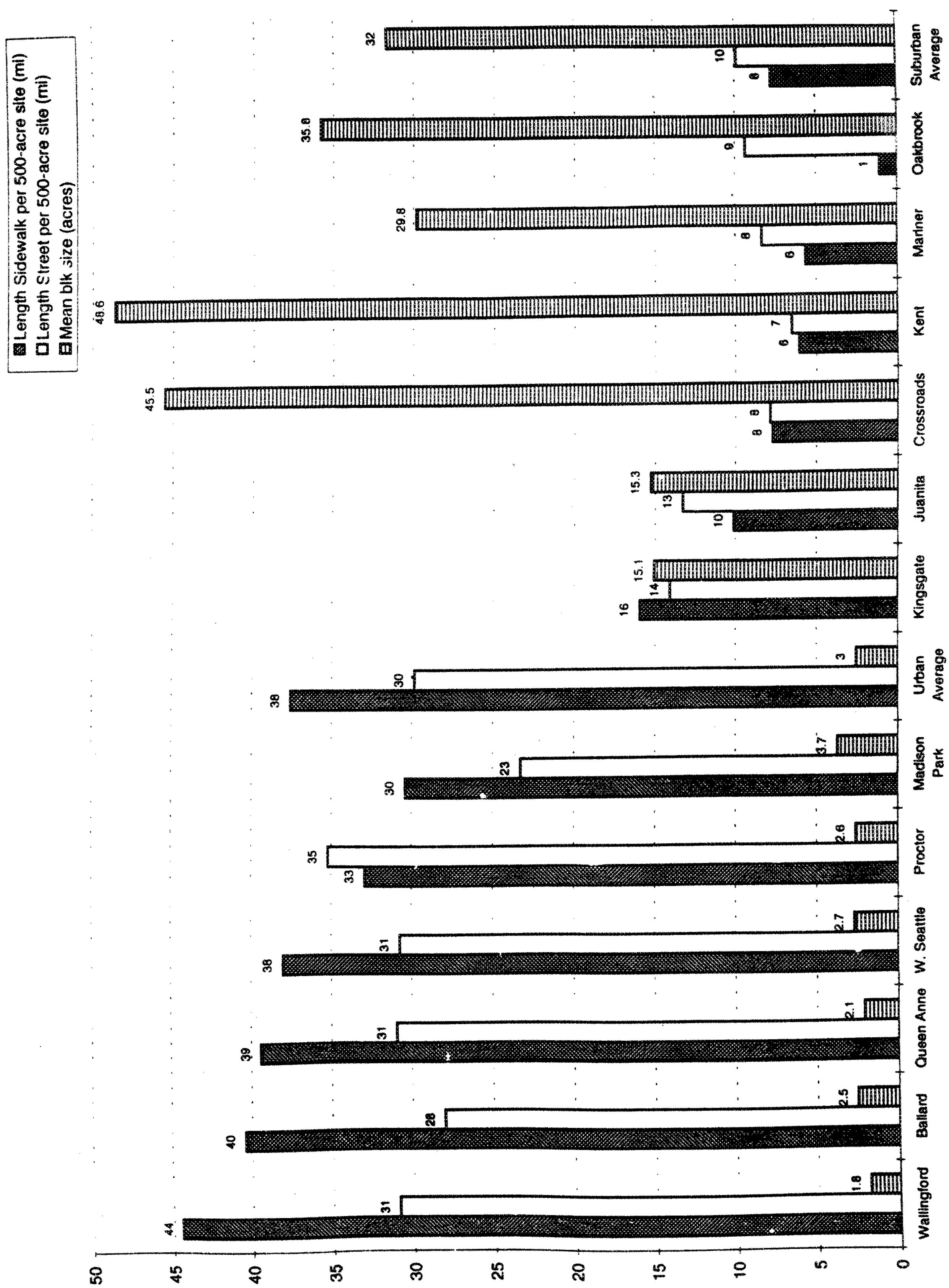


Figure 24. Length of Sidewalks, Streets, and Mean Block Size, within 1/2-Mile Area

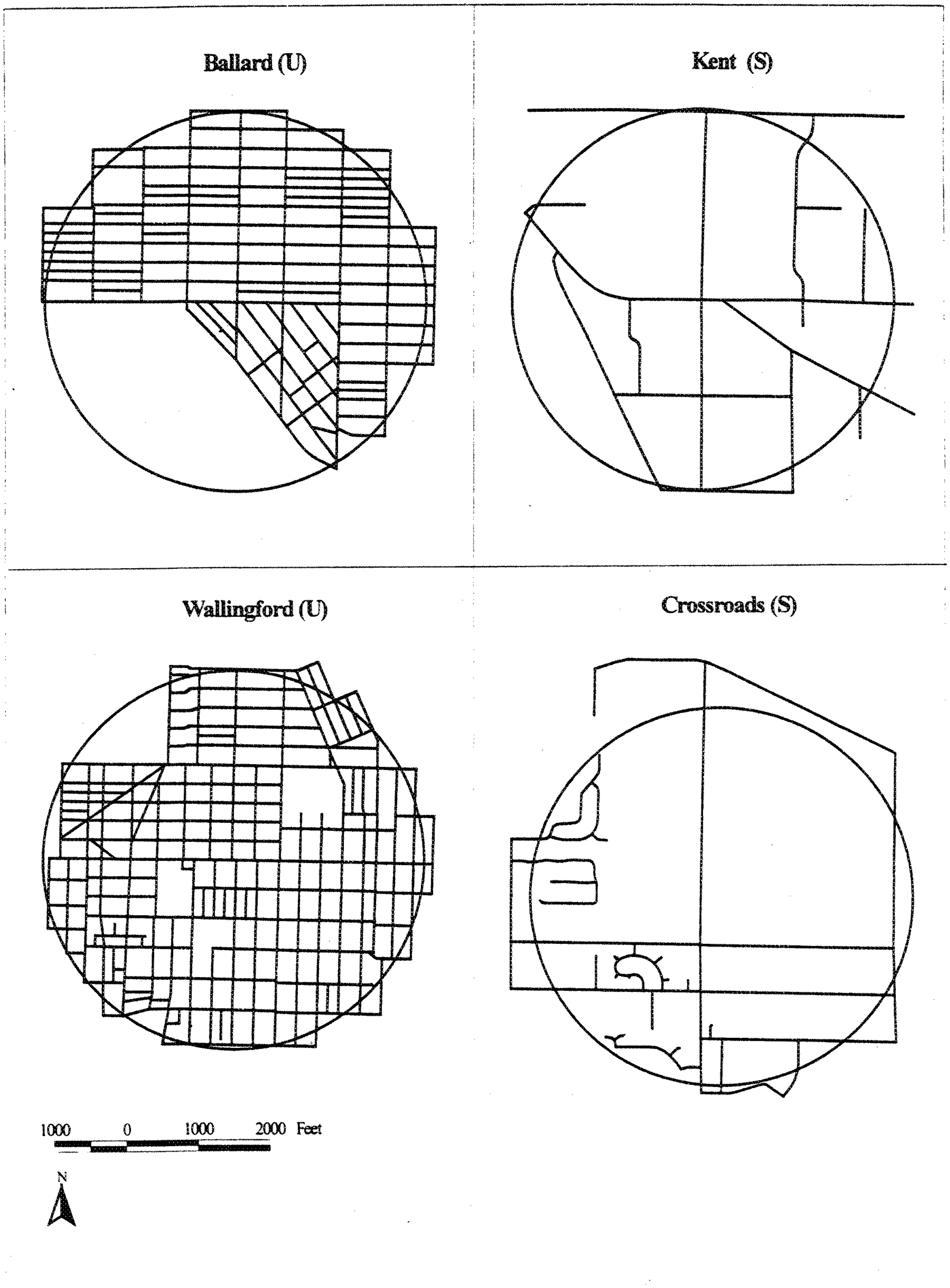


Figure 26a. Street Networks for Ballard, Kent, Wallingford, and Crossroads

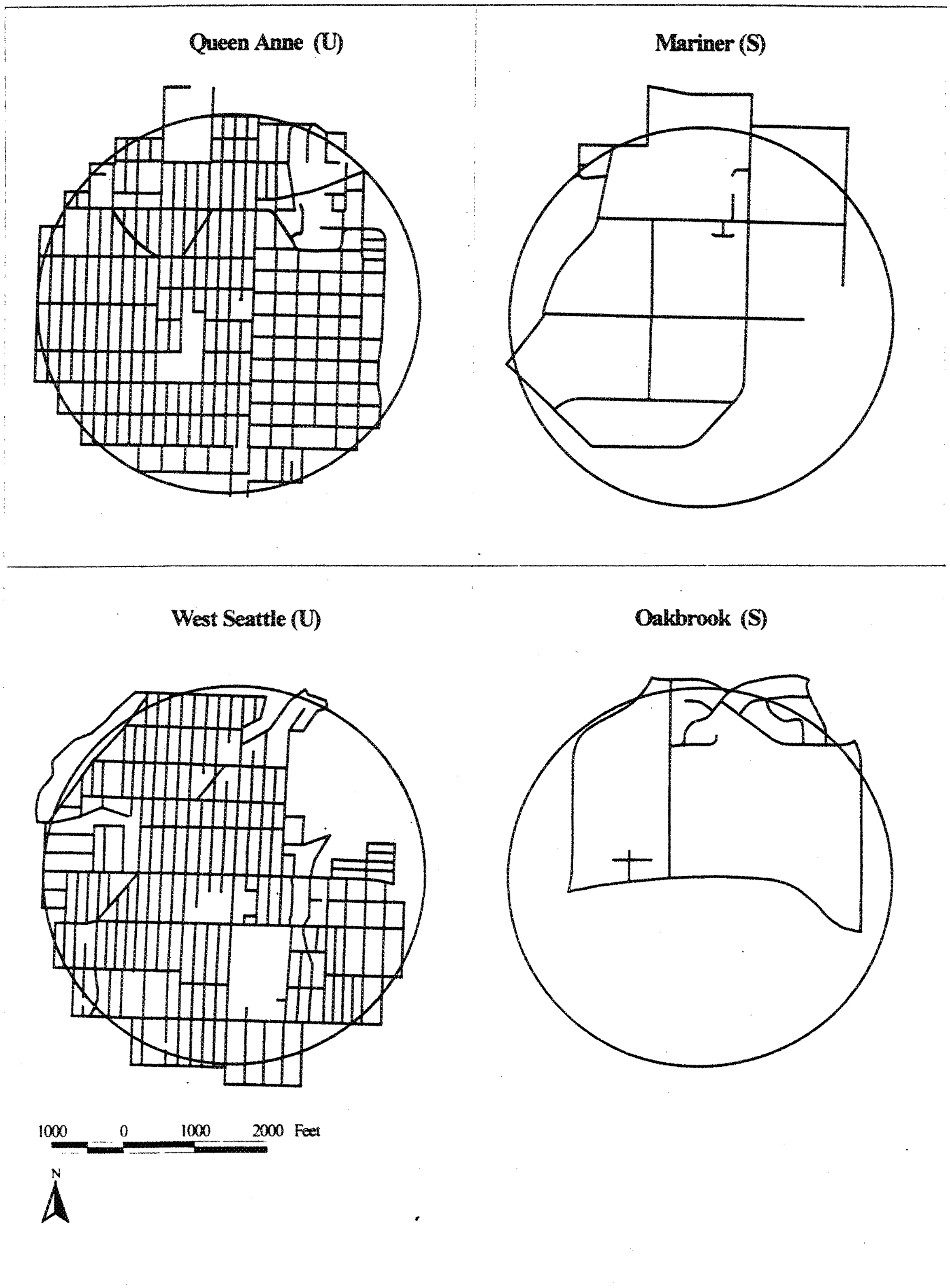


Figure 26b. Street Networks for Queen Anne, Mariner, West Seattle, and Oakbrook

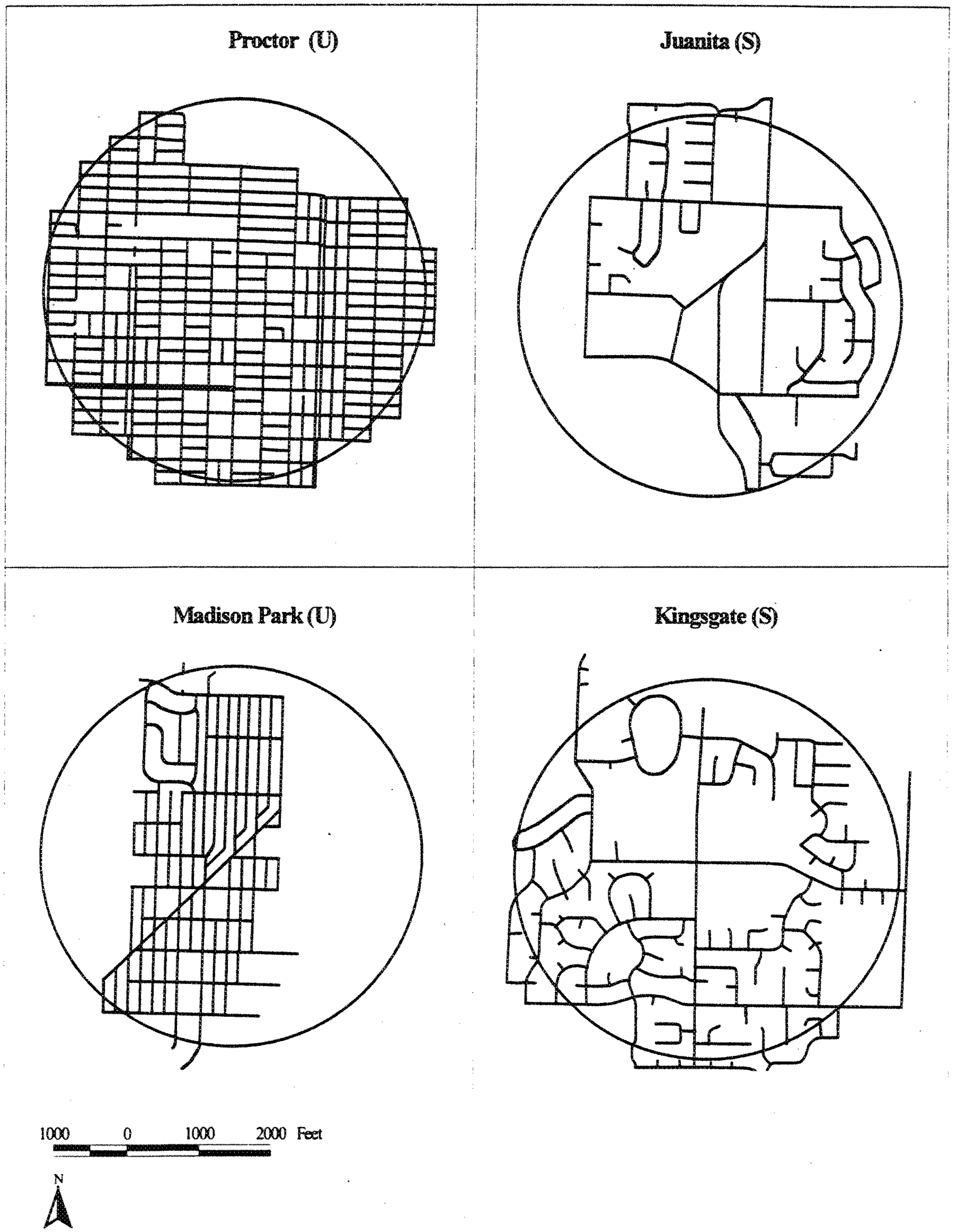


Figure 26c. Street Networks for Proctor, Juanita, Madison Park, and Kingsgate

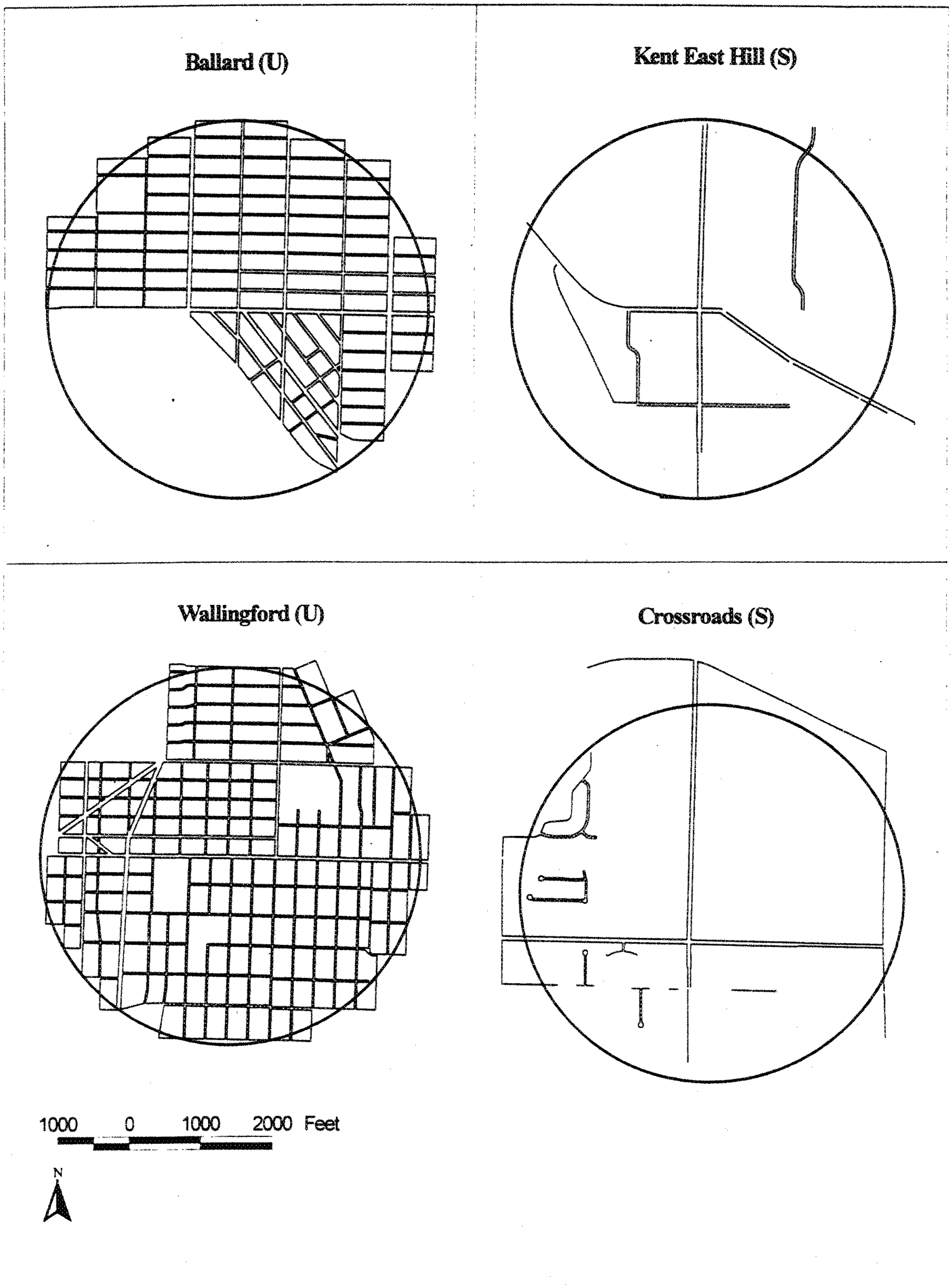


Figure 27a. Sidewalk Networks for Ballard, Kent, Wallingford, and Crossroads

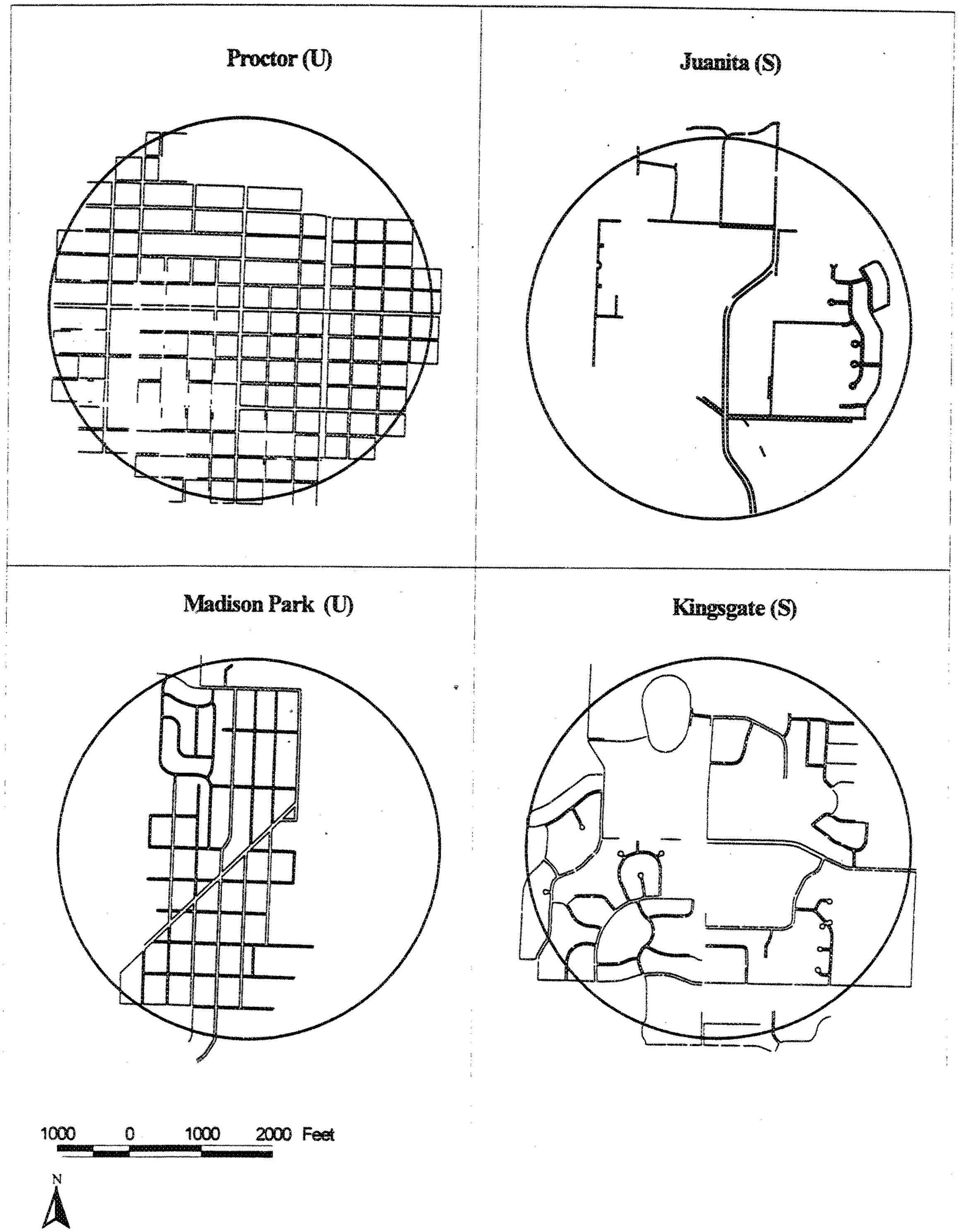


Figure 27b. Sidewalk Networks for Proctor, Juanita, Madison Park, and Kingsgate

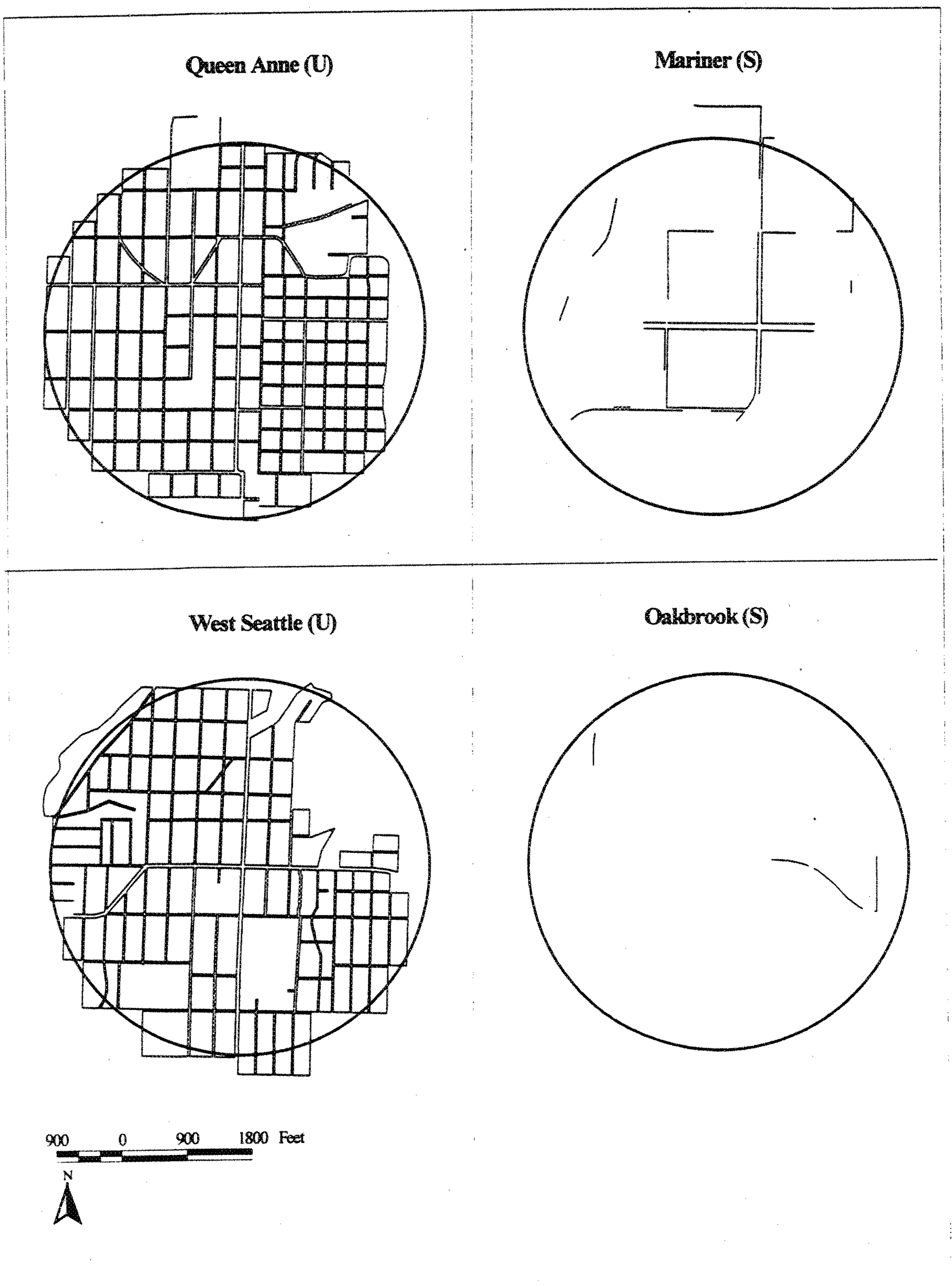


Figure 27c. Sidewalk Networks for Queen Anne, Mariner, West Seattle, and Oakbrook

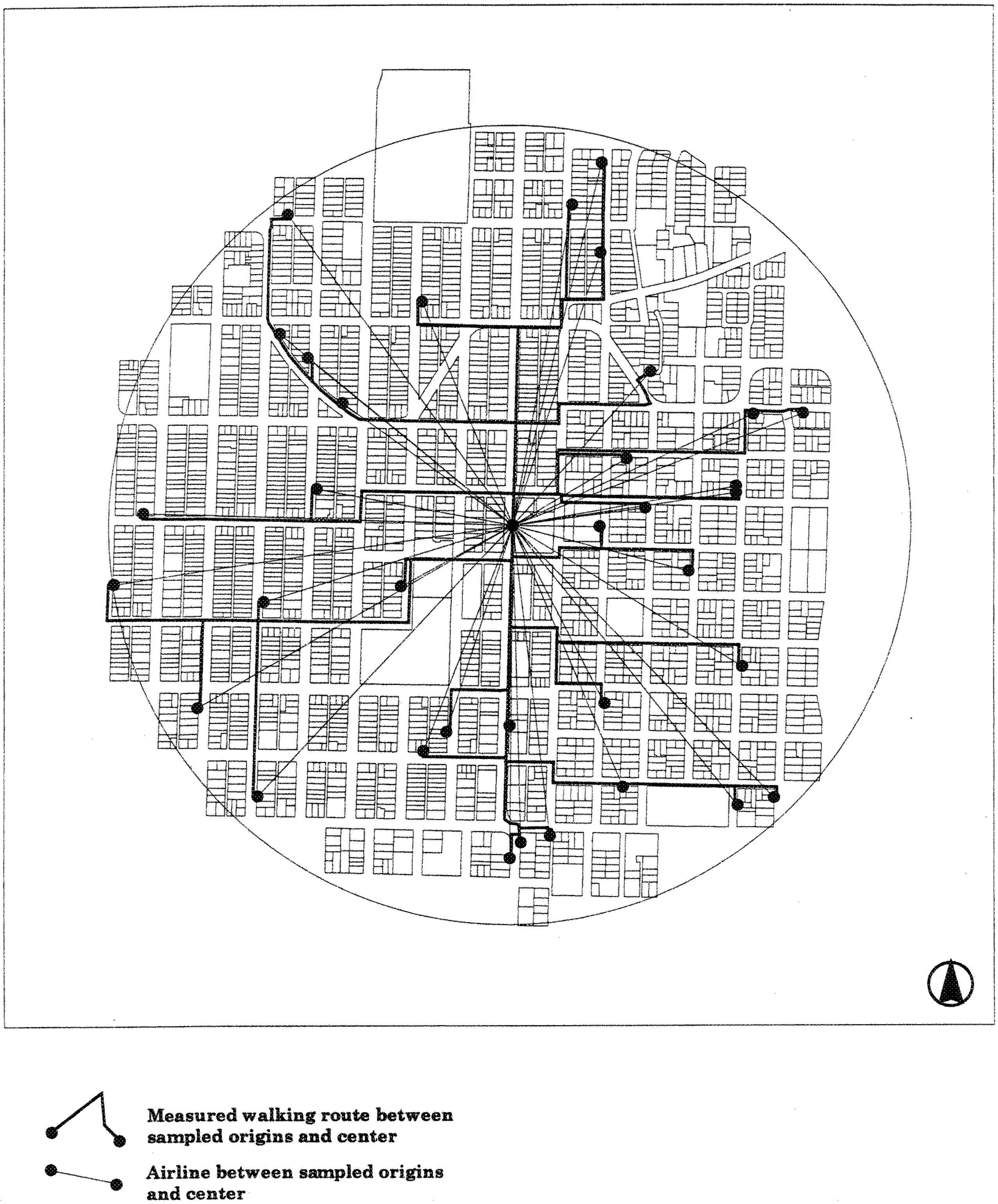
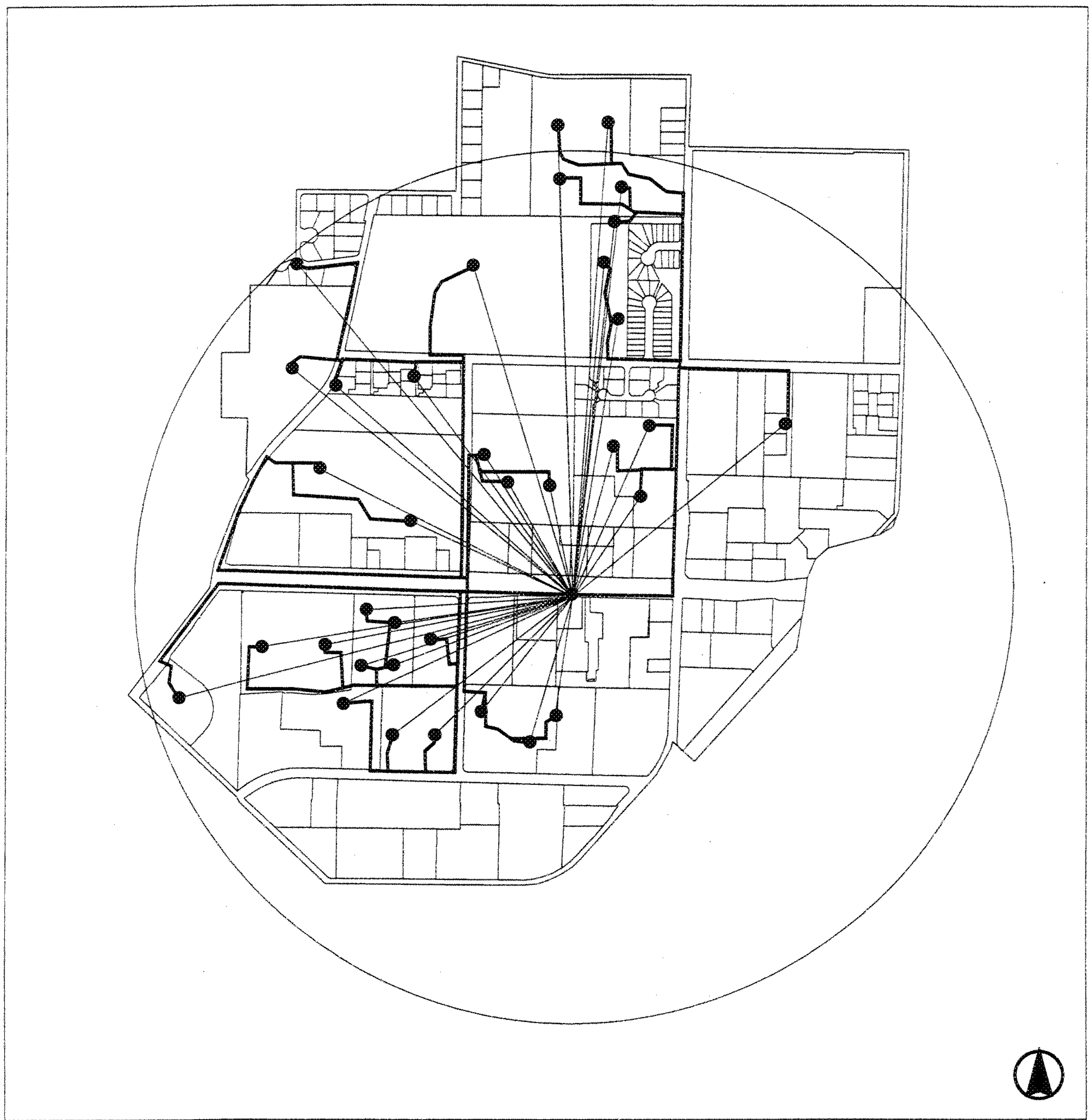


Figure 28. Sampled Origins, Destinations, and Pedestrian Routes for Queen Anne (U)



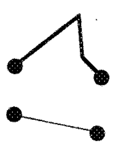


Figure 29. Sampled Origins, Destinations, and Pedestrian Routes for Mariner (S)

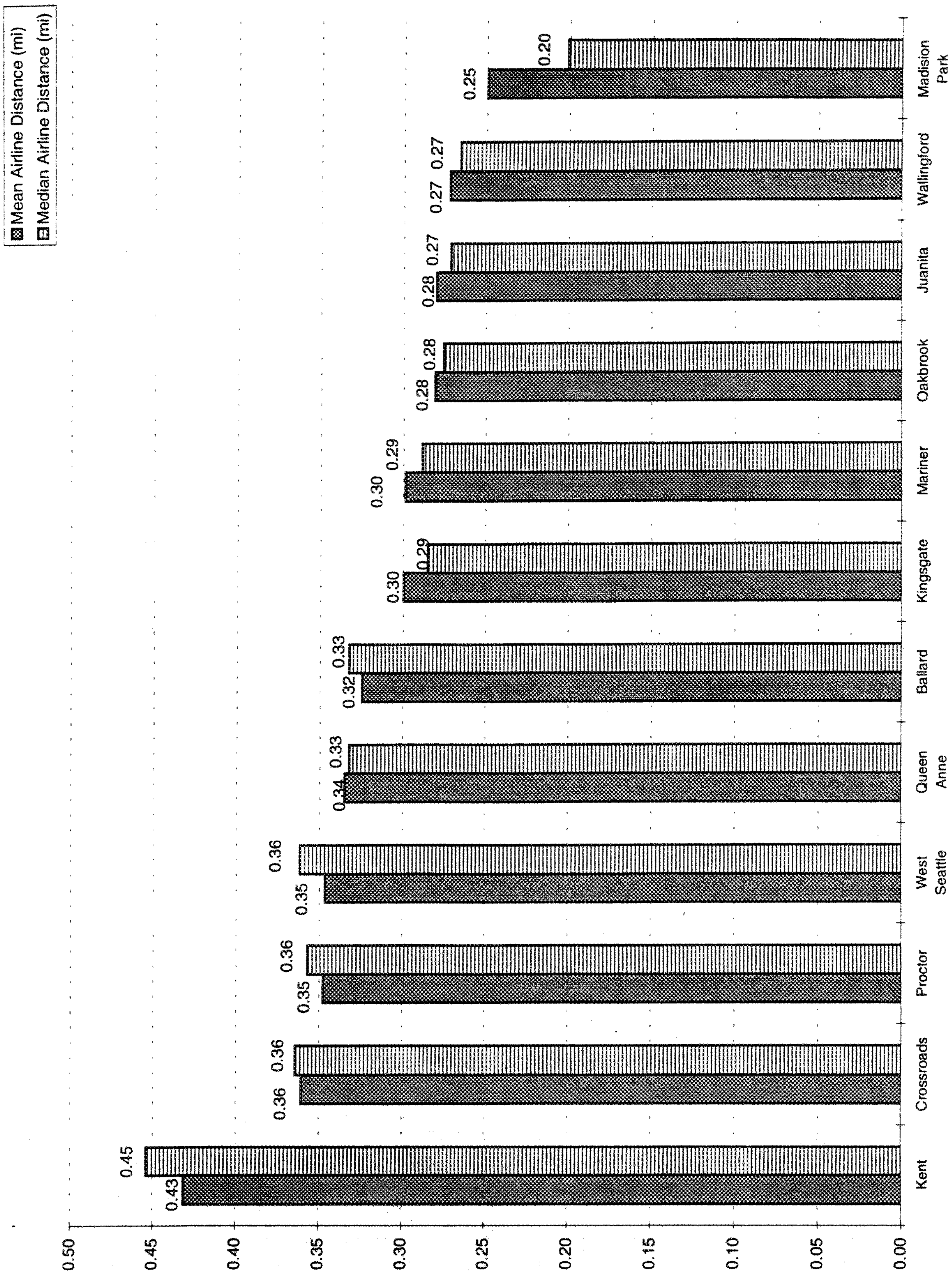


Figure 30. Average Airline Distance for Sampled Housing Units and Commercial Centers

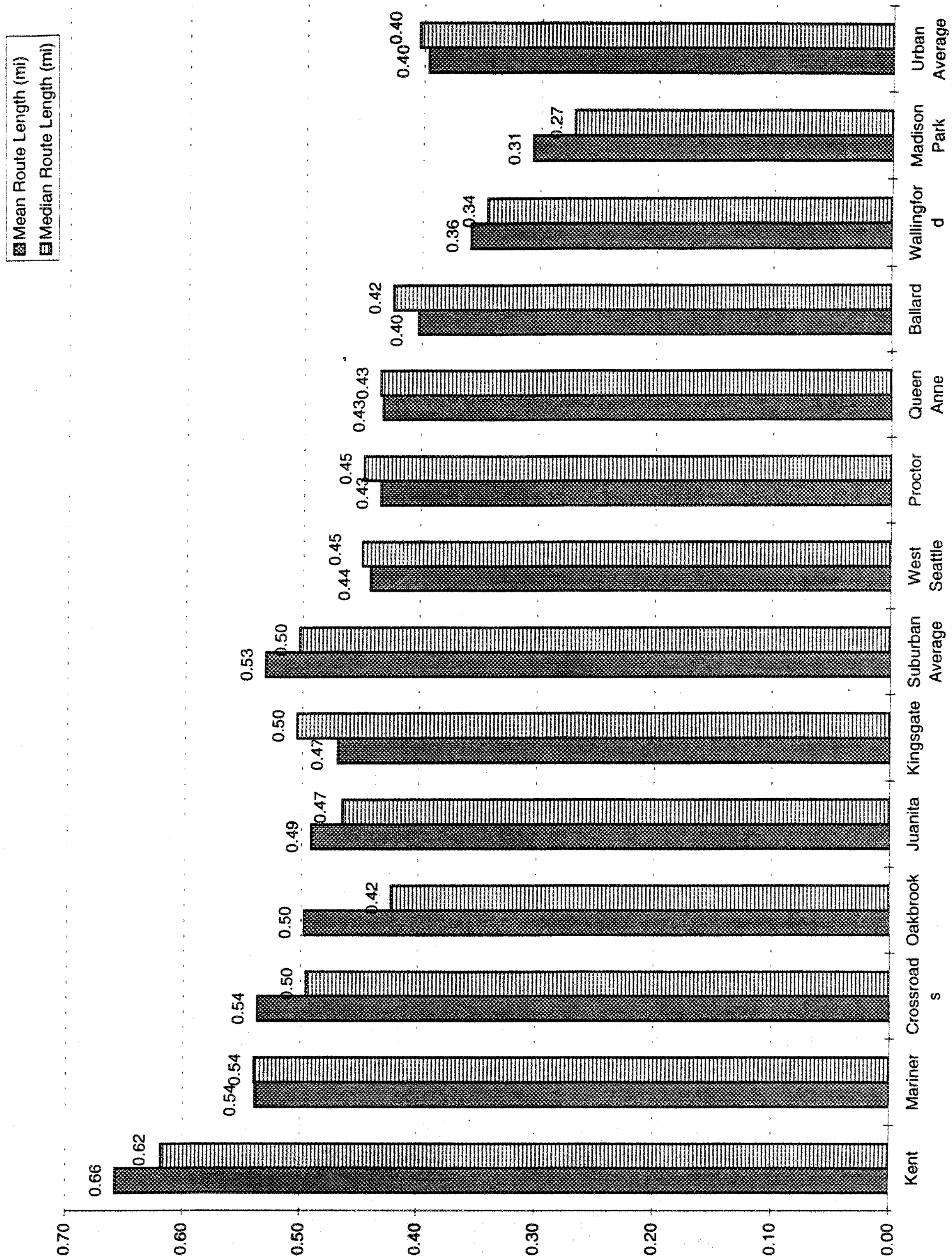


Figure 31. Average Pedestrian Route Length for Sample Housing Units and Commercial Centers

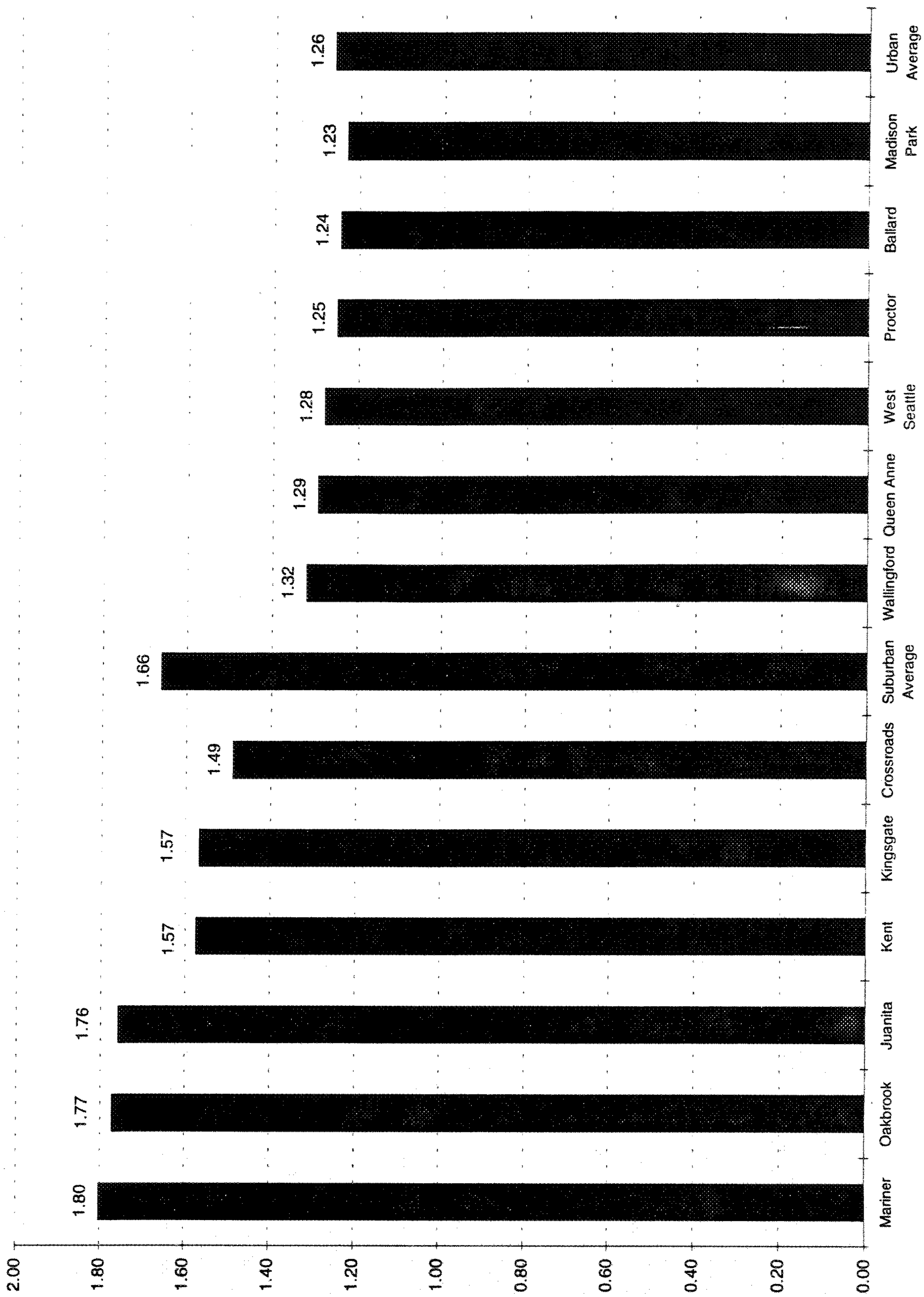


Figure 32. Average Pedestrian Route Directness for Sampled Housing Units and Commercial Centers

Table 8. Data Sources for GIS Layers

Site	Data Sources
Ballard, Madison Park, Queen Anne, Wallingford, West Seattle	City of Seattle: Arc/Info coverages of parcels and buildings; King County Tax Assessor parcel data
Kent East Hill	City of Kent: DXF files of parcels and buildings
Crossroads	City of Bellevue: Arc/Info coverages of parcels and sidewalks
Proctor	City of Tacoma: AutoCad files of roadways, sidewalks, buildings, and parking; Arc/Info coverages of parcels
Mariner	City of Everett: Arc/Info coverages of parcels and buildings; Snohomish County Tax Assessor parcel maps
Oakbrook	Pierce County: Tax Assessor parcel maps
Kingsgate	King County: Arc/Info coverages of parcels and street centerlines
Juanita	City of Kirkland: Arc/Info coverages of parcels and sidewalks

Table 9. GIS Layers Created for All 12 Sites

GIS Layers
buildings
bus stops
census block groups
census blocks
cordon
cordon entry points
cordon observation points
crosswalks
half-mile distance circle
land uses
off-street parking
parcels
public sidewalks
roadways
street center lines
street rights-of-way
study area boundaries
traffic and pedestrian signals

Table 10. Study Area Characteristics within the 1/2-Mile Area

Site	Density (people per acre)	Cordon area (acres)	Cordon Perimeter (feet)	Study area (acres)	Length of Streets (miles)	Length of Streets (mi) per 500-acre site	Length of Sidewalks (miles)	Length of Sidewalks (mi) per 500-acre site	Sidewalk complete-ness	Mean block size (acres)	Mean distance btw entry points (feet)
Ballard	14.1	87.9	9,488	365.4	20.5	28.0	29.5	40.4	1.00	2.5	633
Madison Park	14.2	13.4	3,860	293.9	13.7	23.3	17.9	30.4	1.00	3.7	483
Proctor	9.6	27.0	5,056	461	32.5	35.2	30.3	32.9	0.83	2.6	632
Queen Anne	14.7	21.6	6,280	470.9	29.1	30.9	37.1	39.4	1.00	2.1	523
W. Seattle	11.9	20.8	5,083	448.7	27.6	30.7	34.1	38.0	1.00	2.7	635
Wallingford	15.7	31.2	5,557	485.8	30.0	30.9	43.2	44.4	1.00	1.8	397
Urban Avg.	13.4	33.6	5,887	421.0	25.6	29.8	32.0	37.6	0.97	2.7	551
Crossroads	12.3	42.1	5,620	550.6	8.7	7.9	8.5	7.7	0.63	45.5	1,124
Juanita	12.9	22.6	4,099	348.7	9.3	13.3	7.0	10.1	0.45	15.3	820
Kent	13.6	122.4	12,098	540.3	7.1	6.5	6.6	6.1	0.57	48.6	1,210
Kingsgate	11.5	18.8	3,842	520.9	14.7	14.1	16.6	16.0	0.64	15.1	640
Mariner	13.0	50.3	7,351	369.4	6.2	8.4	4.2	5.7	0.44	29.8	919
Oakbrook	12.4	33.8	10,764	239.4	4.5	9.4	0.5	1.1	0.09	35.8	1,345
Suburban Avg.	12.6	48.3	7,296	428.2	8.4	9.9	7.2	7.8	0.47	31.7	1,010
All Sites Avg.	13.0	41.0	6,592	424.6	17.0	19.9	19.6	22.7	0.7	17.1	780

Table 11. Study Area Characteristics within the 1/4-Mile Area

Site	Length of Streets (miles)	Length of Streets (mi) per 500-acre site	Street Percent of 1/2 mile Area	Length of Sidewalks (miles)	Length of Sidewalks (mi) per 500-acre site	Sidewalk percent of 1/2 mile Area per 500-acre site	Sidewalk completeness	Mean block size (acres)
Ballard	5.2	5.6	18.6%	8.6	9.3	23.0%	1.00	3.0
Madison Park	6.4	6.9	27.5%	8.1	8.8	28.9%	1.00	3.2
Proctor	7.7	6.4	18.2%	8.5	8.5	25.8%	0.90	2.7
Queen Anne	7.6	7.6	24.6%	10.4	10.4	26.4%	1.00	2.5
W. Seattle	7.1	7.1	23.1%	9.0	9.0	23.7%	1.00	4.2
Wallingford	6.4	6.4	20.7%	11.1	11.1	25.0%	1.00	2.4
Urban Avg.	6.7	6.5	23.2%	9.3	9.5	25%	1.0	3.0
Crossroads	1.1	1.1	17.7%	1.8	1.8	23.4%	0.80	101.7
Juanita	2.2	2.2	13.9%	1.7	1.7	16.8%	0.40	22.1
Kent	1.4	1.4	24.5%	2.4	2.4	39.3%	0.80	54.5
Kingsgate	2.5	2.5	16.4%	2.9	2.9	18.0%	0.60	20.2
Mariner	1.7	1.7	20.2%	2.4	2.4	42.1%	0.70	32.1
Oakbrook	1.2	2.3	21.5%	0.1	0.2	18.2%	0.10	99.6
Suburban Avg.	1.7	1.7	19%	1.9	1.9	26%	0.6	55.0
All Sites Avg.	4.2	4.1	21%	5.6	5.7	26%	0.8	29.0

Table 12. Route Length, Airline Distance, and Route Directness

Site	Mean Airline Distance (mi)	Median Airline Distance (mi)	Mean Route Length (mi)	Median Route Length (mi)	Route Directness
Ballard	0.32	0.33	0.40	0.42	1.24
Madison Park	0.25	0.20	0.31	0.27	1.23
Proctor	0.35	0.36	0.43	0.45	1.25
Queen Anne	0.34	0.33	0.43	0.43	1.29
Wallingford	0.27	0.27	0.36	0.34	1.32
West Seattle	0.35	0.36	0.44	0.45	1.28
Urban Average	0.31	0.31	0.40	0.40	1.27
Crossroads	0.36	0.36	0.54	0.50	1.49
Juanita	0.28	0.27	0.49	0.47	1.76
Kent	0.43	0.45	0.66	0.62	1.57
Kingsgate	0.30	0.29	0.47	0.50	1.57
Mariner	0.30	0.29	0.54	0.54	1.80
Oakbrook	0.28	0.28	0.50	0.42	1.77
Suburban Average	0.33	0.32	0.53	0.51	1.66

4. PEDESTRIAN VOLUME COUNTS

The goal of this part of the project was to establish an expedient yet effective method for determining pedestrian traffic volumes into the neighborhood commercial centers. Short of conducting travel surveys, the best method for finding out how many people walk or bicycle to or from the neighborhood commercial center is to count them as they enter the area. Borrowing from Gehl's and Grønlund's extensive research in Scandinavia (Gehl 1980), we counted people entering a territory surrounding the neighborhoods' commercial centers. As explained in the previous section of this report, this territory was defined by a "cordon." Each cordon had a variety of "points of entry."

Cordon Points of Entry

Points of entry included all pedestrian routes or "openings," no matter how small, that people could use to penetrate the commercial center of each site from the residential area. Points of entry into the cordon area were established by walking along the edge between commercial and residential land uses and recording any place through which pedestrians could pass.

In urban areas, points of entry are usually defined by the cross-streets leading to the neighborhood commercial centers. However, people can also move through vacant or parking lots—"missing teeth" in the urban fabric—if those are left open and unfenced. Alleyways leading to the centers are also considered points of entry. There were 8 to 20 points of entry into the cordon in our urban sites.

In the suburban sites, points of entry into the cordon area were more ambiguous because suburban commercial centers are often surrounded by parking lots that are, by definition, easily permeated by pedestrians. As a result, cordon edge conditions were studied via detailed on-site analyses to identify points of entry into the suburban sites. We found many of the suburban parking lots surrounded by "elements" that constituted more or less of a barrier across the cordon, depending on the physical ability of the person walking: e.g., a planted area, a fence, small walls (a 2-ft tall wall is relatively easily overcome by a pedestrian). In addition to a few side streets, openings into suburban cordons included gates and small passages in fences. Less formal entry points took the form of holes that people had made in fences and passages forced through hedges or bushes of all kinds. Because blocks were larger in suburban areas and because most properties were surrounded by fences, there were fewer points of entry in suburban sites than in urban ones. Suburban sites had 6 to 13 entry points.

Observation Points

Observation points were the points at which pedestrians entering the cordon could be counted. These points differed from points of entry into the cordon only in cases where two entry points could be observed at the same time. The number of observation points was smaller than the number of entry points. Observation points were established from site inspections.

Figures 33 and 34 illustrate the edge conditions, entry points, and observations points around the cordons for Wallingford (U) and Crossroads (S), respectively. Table 13 shows the number of entry points and observation points for all sites.

Pedestrian Counts

All pedestrians crossing the cordon were counted at given periods of time. To complete counts of non-motorized trips, bicyclists were counted crossing the cordon. Both pedestrians and bicyclists moving along the cordon but not entering the commercial center at that observation point were also recorded. The definition of the cordon was such that in suburban sites, most people crossing the cordon either left their car at home, at the office, or did not have access to a car. In urban centers, however, the comparatively low availability of private parking and the predominance of on-street parking made it possible for some people to cross the cordon who came by car but parked on-street outside the neighborhood center. The position of the cordon points in urban sites allowed observation of "parkers" within two blocks of the center. These people were excluded from the pedestrian counts.

Specific data about pedestrian and bicyclist socio-cultural and behavioral characteristics were also gathered to the extent possible. These data included the following:

- the person's approximate age, gender, and race
- the surface used before, during, and after crossing the cordon
- the person's travel speed
- whether people moved alone or in groups
- whether accompanied by a child or dog
- whether they were in a wheelchair or otherwise impaired.

Figure 35 shows the instrument used to record data on pedestrians entering the cordon. Field notes were also encouraged to record any unusual circumstance, as well as general impressions of the site and the people.

Protocol for Counting

Counts followed a strict protocol on each site. All points of entry into the cordon were observed for two hours each—with the total number of hours of observation for each site varying accordingly. All observations were made during good weather, taking into account the unprotected conditions of non-motorized travel. Unusually wet weather in April and May, followed by unusual hot spells and general irregularities in weather patterns throughout the summer, made the task more difficult than anticipated. Furthermore, the two hours of observation were distributed into weekdays and Saturdays (70 minutes and 50 minutes, respectively) to take into account and to provide a sense of possible differences in travel behavior between working and non-working days. To ensure high pedestrian counts, observations were also spread through important hours of the day for non-motorized travel: lunch hour (30 minutes), after school (20 minutes), early evening for the weekday (20 minutes), and late morning to mid-afternoon for Saturdays (50 minutes total).

Ideally, there should have been one observer at each point of entry for each period of observation to count all pedestrians and bicyclists entering into the cordons. Obvious limitations in the number of observers available for the study (three in most cases) led to distributing the observations into shorter periods of 15 and 20 minutes so that the observers could cover up to five points of entry for each period of the day being observed.

In summary, the three periods of observation for each site were as follows. Figure 36 shows the site protocol used for Wallingford.

Weekday:

11:00+ AM to 2:00+ PM (2 x 15 minutes for a total of 30 minutes per point of entry)

3:00 PM to 6:00+ PM (2 x 20 minutes for a total of 40 minutes per point of entry)

Weekend:

10:30 AM to 3:00 PM (2 x 15 minutes and 1 x 20 minutes for a total of 50 minutes per point of entry)

A specific observation schedule was designed to fit each site with its corresponding number of observation points.

Counts were done on warm, sunny days. However, as mentioned earlier, weather conditions varied from site to site. For example, observations on some sites took place within a long period of good weather, whereas others occurred on a "special" day in the midst of a long period of rain. In the latter cases, one could expect that more people were out walking than if the weather had been good over a longer period. Temperature also affects the number of pedestrians. Some of our observations took place on particularly hot days for the Puget Sound, when one could expect fewer people to be walking than usual. Table 14 shows the actual schedule of counts and related weather conditions.

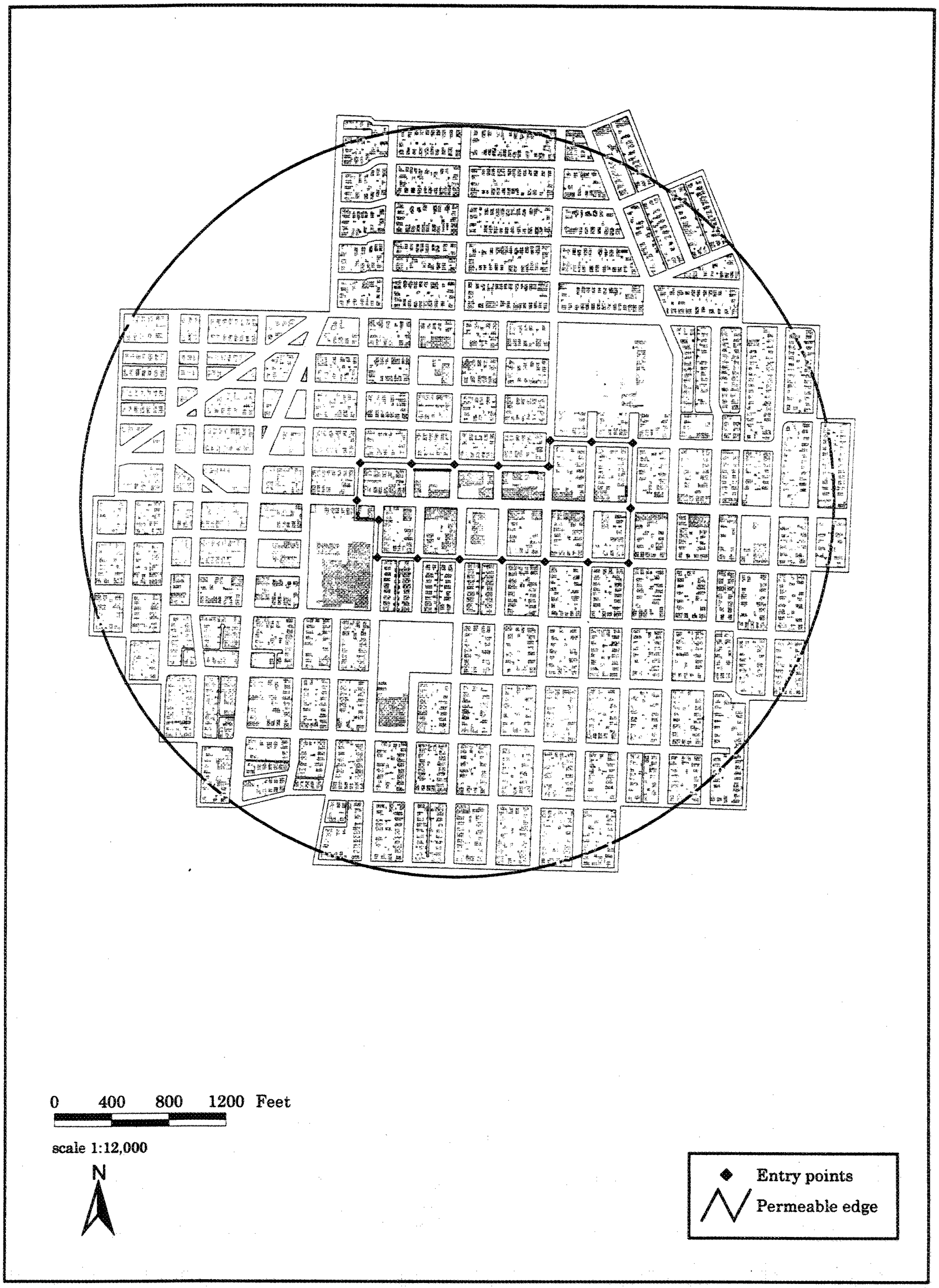


Figure 33. Edge Conditions for Wallingford (U)

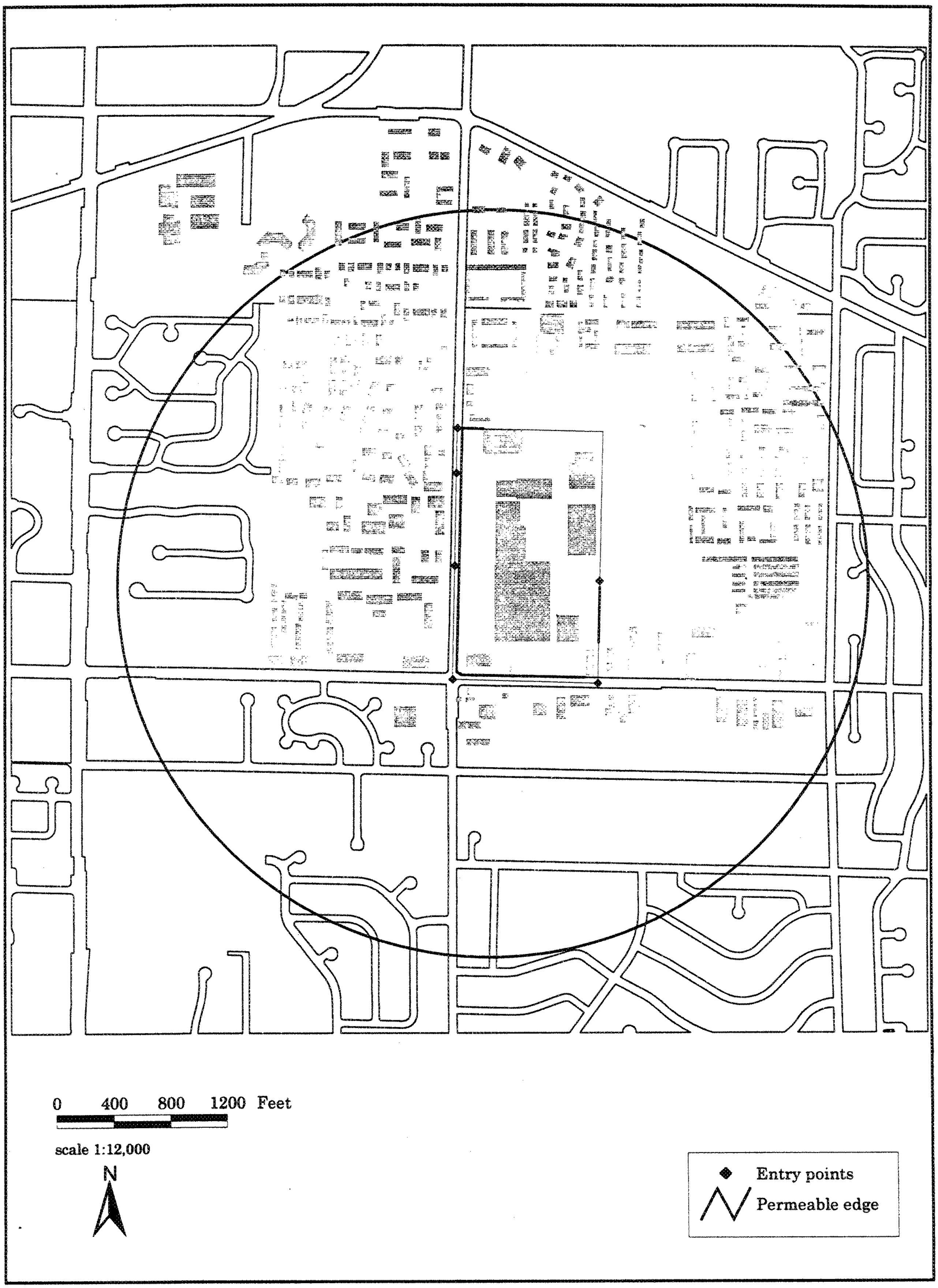


Figure 34. Edge Conditions for Crossroads (S)

Site name | Observer name

Date | Time from / to

Observation point no. | Weather: sunny clouds temp.

I. Pedestrians

1. Crossing cordon toward center

No.		X-ing surface				Going toward				Speed				Gndr		Age			Race									
	on SW	XW	Jwlk	Intsect	Impat	SW	SH	ST	P-lot	Slow	Med	Fast	Run	M	F	Y	M	O	W	A	AA	O	Grp	WLC	Impr	Dog	Rec	Cld
1																												
2																												
3																												
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Figure 35. Data Record Sheet for Pedestrian Counting

Weekday evening #2

WALLINGFORD

WALLINGFORD - 14 points, 3 observers

			WEEK			WEEKEND		
			Noon	Afternoon	Eve	Morning	Noon	Afternoon
obsrv 1	obsrv 2	obsrv 3	2x15 min	20 min	20 min	15 min	15 min	20 min
1	6	11	11:30	3:00	6 5:20	11:00	12:30	2:00
2	7	12	11:45	3:20	7 5:40	11:15	12:45	2:20
3	8	13	12:00	3:40	8 6:00	11:30	1:00	2:40
4	9	14	12:15	4:00	9 6:20	11:45	1:15	3:00
5	10		12:30	4:20	10 6:40	12:00	1:30	3:20
	break							
6	11	1	1:00					
7	12	2	1:15					
8	13	3	1:30					
9	14	4	1:45					
10		5	2:00					
observation periods			11:30-2:15	3:00-4:40	5:20-7:00	11:00-12:15	12:30-1:45	2:00-3:40

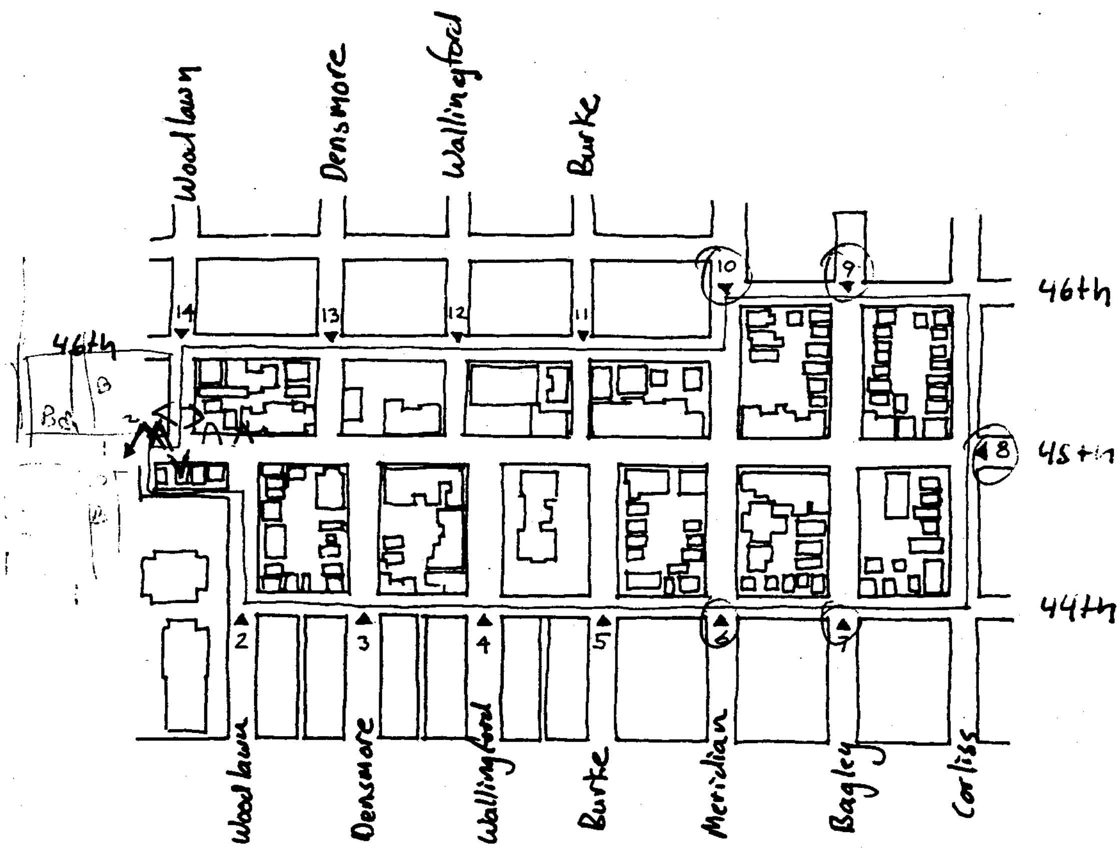

Figure 36. Pedestrian and Bicycle Count Protocol for Wallingford (U)

Table 13. Entry and Observation Points into the Cordon

	Entry Points	Observation Points
Ballard	20	15
Madison Park	13	8
Proctor	13	8
Queen Anne	17	12
Wallingford	18	14
West Seattle	12	8
Urban Average	16	11
Crossroads	6	5
Juanita	6	5
Kent	12	10
Kingsgate	6	6
Mariner	11	8
Oakbrook	13	8
Suburban Average	9	7

Table 14. Schedule of Counts Completed and Related Weather Conditions

Site	Weekday (WD)/ Weekend (WE)	Period	Date	Weather
Ballard	WD	Noon	6/12/96	Low-mid-high 60s breezy
Ballard	WD	Afternoon	6/13/96	68-70s Sunny
Ballard	WD	Noon/Afternoon	6/12/96	Sunny 70s
Ballard	WD	Noon/Afternoon	6/11/96	Partly sunny 60s windy
Ballard	WD	Evening	7/9/96	mostly sunny 80s
Ballard	WD	Evening	7/9/96	low 80s sunny breezy
Ballard	WD	Evening	7/10/96	70s-80s sunny windy
Ballard	WE	Morning/Noon/Afternoon	6/1/96	Partly sunny low 70s
Ballard	WE	Morning/Noon/Afternoon	6/1/96	Partly sunny low 70s
Ballard	WE	Morning/Noon/Afternoon	6/1/96	Thin clouds 65-70
Crossroads	WD	Noon/Afternoon	6/20/96	Sunny 70s
Crossroads	WD	Evening	6/20/96	Sunny 70s
Crossroads	WE	Morning/Noon/Afternoon	7/26/96	Sunny breezy 84
Juanita	WD	Morning/Noon/Afternoon	6/4/96	Partly cloudy 65
Juanita	WE	Morning/Noon/Afternoon	8/23/96	Sunny 80
Kent East Hill	WD	Noon/Afternoon	6/5/96	Sunny high 60s
Kent East Hill	WD	Noon/Afternoon	6/5/96	Sunny 65-70
Kent East Hill	WD	Evening	6/12/96	Sunny
Kent East Hill	WD	Evening	8/12/96	Sunny 75
Kent East Hill	WE	Morning/Noon/Afternoon	6/8/96	Some clouds 60s
Kent East Hill	WE	Morning/Noon/Afternoon	6/8/96	Sunny 70
Kingsgate	WD	Noon/Afternoon	6/5/96	Sunny 70
Kingsgate	WD	Evening	6/5/96	Sunny 70-75
Kingsgate	WE	Morning/Noon/Afternoon	7/26/96	Up to 90, Breezy very sunny
Madison Park	WD	Noon	5/9/96	Sunny 65
Madison Park	WD	Afternoon	5/30/96	Clouds
Madison Park	WD	Noon/Afternoon	6/3/96	Sunny ~70
Madison Park	WD	Evening	6/26/96	Sunny 70s
Madison Park	WD	Evening	6/27/96	Sunny 70s
Madison Park	WE	Morning/Noon/Afternoon	8/17/96	Partly sunny, 70
Madison Park	WE	Morning/Noon/Afternoon	9/28/96	Foggy 60s
Mariner	WD	Noon/Afternoon	9/10/96	Sunny 70
Mariner	WD	Noon/Afternoon	9/10/96	Sunny 70
Mariner	WD	Evening	8/5/96	Sunny 70
Mariner	WD	Evening	8/5/96	Sunny 70
Mariner	WE	Morning/Noon/Afternoon	9/28/96	Clouds to Sunny 50 - 65
Mariner	WE	Morning/Noon/Afternoon	9/28/96	Sunny 70
Oakbrook	WD	Noon/Afternoon	9/10/96	Sunny 75
Oakbrook	WD	Noon/Afternoon	9/10/96	Sunny 75
Oakbrook	WD	Evening	9/24/96	Sunny 65
Oakbrook	WD	Evening	9/24/96	Sunny ~70
Oakbrook	WE	Morning/Noon/Afternoon	9/28/96	65-70 Beautiful sunny day

Table 14 (cont.) Schedule of Counts Completed and Related Weather Conditions

Oakbrook	WE	Morning/Noon/Afternoon	9/28/96	65-70 Beautiful sunny day
Proctor	WD	Noon/Afternoon/Evening	9/11/96	Partly sunny ~70
Proctor	WD	Noon/Afternoon/Evening	9/11/96	Partly sunny ~70
Proctor	WE	Morning/Noon/Afternoon	8/10/96	Sunny 85
Proctor	WE	Morning/Noon/Afternoon	8/10/96	Sunny 85
Queen Anne	WD	Noon/Afternoon	6/6/96	Mostly sunny 70s
Queen Anne	WD	Evening	7/2/96	Partly sunny windy 75-80s
Queen Anne	WD	Noon/Afternoon/Evening	6/6/96	Partly sunny 70s
Queen Anne	WE	Morning/Noon/Afternoon	10/19/96	Sunny 60
Queen Anne	WE	Morning/Noon/Afternoon	10/19/96	Sunny 60
Wallingford	WD	Noon	9/11/96	Sunny 70
Wallingford	WD	Afternoon	6/13/96	Sunny Very HOT!
Wallingford	WD	Noon/Afternoon	6/19/96	No clouds low 70s slight breeze
Wallingford	WD	Noon/Afternoon	6/19/96	Sunny high 60s to 70s
Wallingford	WD	Evening	7/16/96	Mostly sunny 70s
Wallingford	WD	Evening	7/8/96	Sunny high 70s
Wallingford	WD	Evening	7/17/96	Sunny 80
Wallingford	WE	Morning/Noon/Afternoon	7/13/96	No Clouds 70-90s
Wallingford	WE	Morning/Noon/Afternoon	6/30/96	Sunny over 70 got HOT!
Wallingford	WE	Morning/Noon/Afternoon	7/13/96	No Clouds 70-90s
West Seattle	WD	Noon/Afternoon	9/9/96	Sunny 72
West Seattle	WD	Noon/Afternoon	9/9/96	Sunny 72
West Seattle	WD	Evening	7/30/96	Sunny 75
West Seattle	WD	Evening	7/30/96	Sunny 75
West Seattle	WE	Morning/Noon/Afternoon	10/12/96	Sunny through clouds 50 - 65
West Seattle	WE	Morning/Noon/Afternoon	10/12/96	Sunny through clouds 50 - 65

WD counts were approximately 11:15 to 2:15 for noon, 3:00 to 4:20 for afternoon, and 5:20 to 7:00 for evening.
WE counts were approximately 11:00 to 12:00 for morning, 12:30 to 1:30 for noon, and 2:00 to 3:20 for afternoon.

III. ANALYSES OF FINDINGS

1. GENERAL FINDINGS

Pedestrian volumes were recorded for each period of observation and each day (weekday and weekend) when observations took place. Pedestrian volumes were established as follows:

(1) total number of actual trips, as counted during the observation time, or total number of trips per hour of observation

(2) total number of trips adjusted to the number of residents (in the 1,000s) in the study area to reflect the percentage of the resident population walking to the neighborhood commercial center; these figures accounted for the differences in actual population density of the different sites

(3) total number of trips adjusted to a "complete" 500-acre site, equivalent to a full half-mile area site; these figures took into account the differences in the size of the study areas based on the individual sites' configurations.

As in the case of measuring the site and pedestrian facilities design characteristics, actual numbers of pedestrians reflected the actual population of pedestrians in each site. The actual volumes (pedestrians per hour) were useful to compare and understand the characteristics and potential of each site as is. Adjusted numbers helped to generalize the findings, to make the sites comparable, and to analyze the effects of the different independent variables under consideration. Table 15 summarizes the total number of trips into each site's commercial center, showing actual and adjusted figures.

Actual numbers of pedestrian trips into the commercial center were larger for the urban sites than for the suburban sites, with the exception of Crossroads (S) and Proctor (U) with 112 and 105 pedestrians per hour, respectively. However, at 551 acres, Crossroads was larger than a full 500-acre site, whereas Proctor's study area only covered

461 acres. Furthermore, Crossroads' density was 12.3 persons per acre versus 9.6 in Proctor, and Crossroads had a larger commercial center than Proctor.

With pedestrian trip volume figures adjusted to the population living in the sites, Queen Anne (U), Ballard (U), Madison Park (U), and Wallingford (U) continued to lead, with the largest numbers of pedestrian trips per hour per 1,000 residents and the largest numbers of pedestrian trips adjusted to a full 500-acre site. Proctor (U), because of its low density, performed better than West Seattle (U) when the numbers of pedestrians were adjusted per 1,000 residents. On the other side of the spectrum, the sites with the lowest numbers of pedestrians, Juanita (S) and Kingsgate (S), performed similarly when adjusted to their respective population or to a full 500-acre site. Crossroads (S) and Mariner (S) had similar pedestrian volumes adjusted for both population and a full site, as did Oakbrook (S) and Kent East Hill (S).

Figures 37, 38, and 39 list the order of sites by pedestrian volume for actual and adjusted figures. They show substantial differences in the pedestrian volumes between the 12 study areas, with variations from 8 to 52 pedestrians per hour per 1,000 residents, or from 50 to 379 pedestrians per hour per 500-acre site. A marked difference in pedestrian volumes was noted between urban and suburban sites. All the urban sites had more pedestrians than the suburban sites.

Pedestrian Trip Volumes and Size of Centers—Matched Groups

As expected, in each group of sites matched on the basis of the size of the commercial center, urban sites always had higher numbers of pedestrians trips than their suburban counterparts. However, the size of the commercial center did not correlate with the volumes of pedestrians. Ballard (U) and Wallingford (U), as large urban commercial centers, had fewer pedestrians than Queen Anne (U), with a medium-sized center, and Madison Park (U), with a small center, respectively. Adjusted volumes for Kent (S), on the other hand, were lower than those of Crossroads (S), Mariner (S), and Oakbrook (S), even though Kent (S) was the largest commercial center site. Crossroads (S), though smaller than Kent (S), has a large commercial center and comparatively large numbers of pedestrians. Finally, Juanita (S) and Kingsgate (S) had the lowest volumes of pedestrians and the smallest commercial centers.

These results indicate that the size of a neighborhood center is not related to pedestrian volumes into the center. The results for urban sites showed no pattern in this relationship. Only for suburban sites was it possible to infer that neither very large centers such as Kent, nor small centers, such as Juanita and Kingsgate, generate high pedestrian volumes. In this study, medium-sized suburban center sites generated the largest numbers of pedestrians.

Pedestrian Trip Volumes and Density

The relationship between population density and pedestrian trip volumes also showed a difference between the urban and the suburban sites. The urban sites appeared to be more sensitive to density than the suburban ones, with Proctor (U) and West Seattle (U) having the least numbers of pedestrians of all the urban sites, as well as the lowest densities. No such relationship existed in the suburban sites. This may be explained in part by the fact that variations in density were largest for the urban sites selected (from 15.7 persons per acre in Wallingford to 9.6 in Proctor), whereas these variations were minimal in suburban sites (12.9 people per acre in Juanita to 11.5 in Kingsgate).

Pedestrian Trip Volumes and Site and Pedestrian Facilities Design Characteristics

Figure 40 plots measurements of total length of streets, mean block size, and total length of sidewalks in relation to the volume of pedestrians for each site in descending order. This analysis shows once again that the sites fell into either the urban or the suburban category. While the curve of pedestrian volumes slopes down, the values of site and pedestrian facilities design measures jump sharply up (for block size) and down (for total street and sidewalk lengths). The fact that the sharp difference in site and pedestrian facilities design measures is not matched with a sharp difference in pedestrian volumes indicates that pedestrian volumes are affected by other variables (including small variations in the control variables of density, land use, and income, as well as other variables such as the actual quality of the retail provided, census population age, and household composition).

The relationship between pedestrian volumes and the pedestrian route directness measures was similarly split between urban and suburban sites. Suburban sites had longer pedestrian routes and smaller pedestrian volumes than urban sites. Reflecting the influence of other variables, however, this relationship was not linear. Both Mariner (S) and Crossroads (S) had longer average route lengths than other suburban sites (except Kent), but they had higher pedestrian volumes. Still, route based measures add another explanatory variable to the differences between urban and suburban sites. The exceptionally long routes in Kent, due to the large commercial center, help explain the low pedestrian volumes.

Given these analyses relating pedestrian volumes to size of commercial center and density, the research results confirmed our initial hypothesis: pedestrian volumes are associated with the site's design characteristics and pedestrian facilities. Sites with urban characteristics consistently performed better than sites with suburban characteristics. All analyses indicated that the distinctions between urban and suburban sites and pedestrian facilities design characteristics were the primary explanation for the differences found in pedestrian volumes. Clearly, then, site and pedestrian facilities design characteristics must be taken into account beyond such traditionally used variables as density, income, and land use to explain pedestrian travel.

Pedestrian Volumes: Urban Versus Suburban Sites

On average, urban sites have three times as many pedestrians as suburban sites; there were 38 pedestrians per hour per 1,000 residents in urban sites versus 12 in suburban sites. However, variations in pedestrian volumes within the categories of urban or suburban sites were substantial. Sites with the highest numbers of pedestrians in either urban or suburban category had two to three times as many pedestrians as sites with the lowest numbers of pedestrians: Queen Anne (U) and Ballard (U) each had more than twice as many pedestrians as Proctor (U) or West Seattle (U); Crossroads (S) and Mariner (S) each had twice as many pedestrians as Juanita (S) or Kingsgate (S). These significant variations within each category indicate that, though clear and convincing, the explanatory power of the distinction between urban and suburban must rely on multiple measures of site and pedestrian facilities design characteristics.

Furthermore, within both urban and suburban sites, the values of any of the different site design and pedestrian facilities measures did not relate directly to pedestrian volumes. Madison Park (U), for instance, had fewer sidewalks than Wallingford (U), yet more pedestrians per hour per 1,000 residents. Oakbrook had almost no sidewalks and yet had the third highest suburban rate of pedestrians per 1,000 residents and per 500-acre site. Additional work is needed to explore the significance of any one or any combination of the measures of site and pedestrian facilities design characteristics in relation to pedestrian volumes. At this point, we can state that, given appropriate controls for density, income, and land use, pedestrian volumes are affected by a combination of site and pedestrian facilities design characteristics.

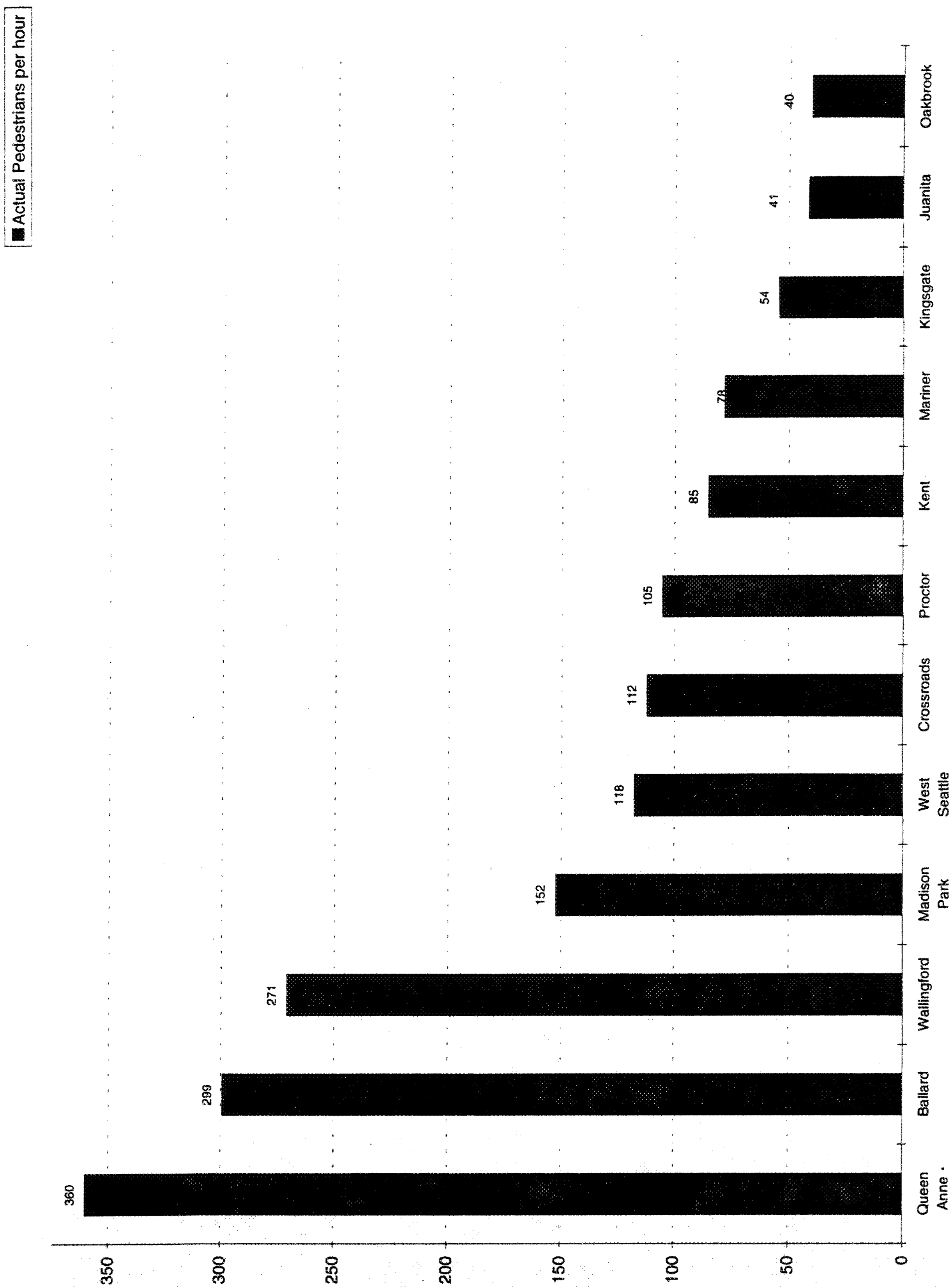

Figure 37. Pedestrian Trip Volumes, Actual per Hour

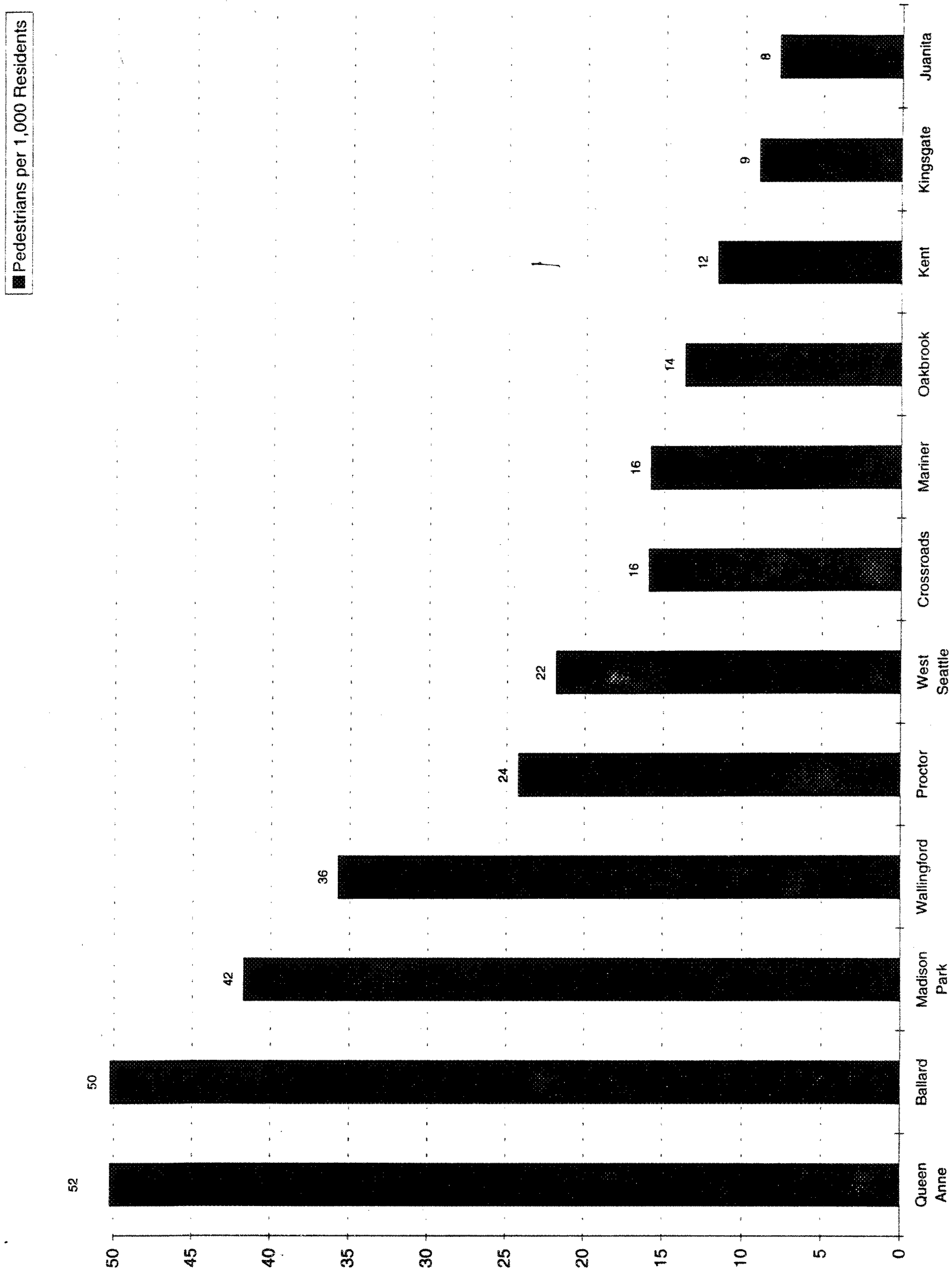

Figure 38. Pedestrian Trip Volumes Adjusted per Population (1000 Residents)

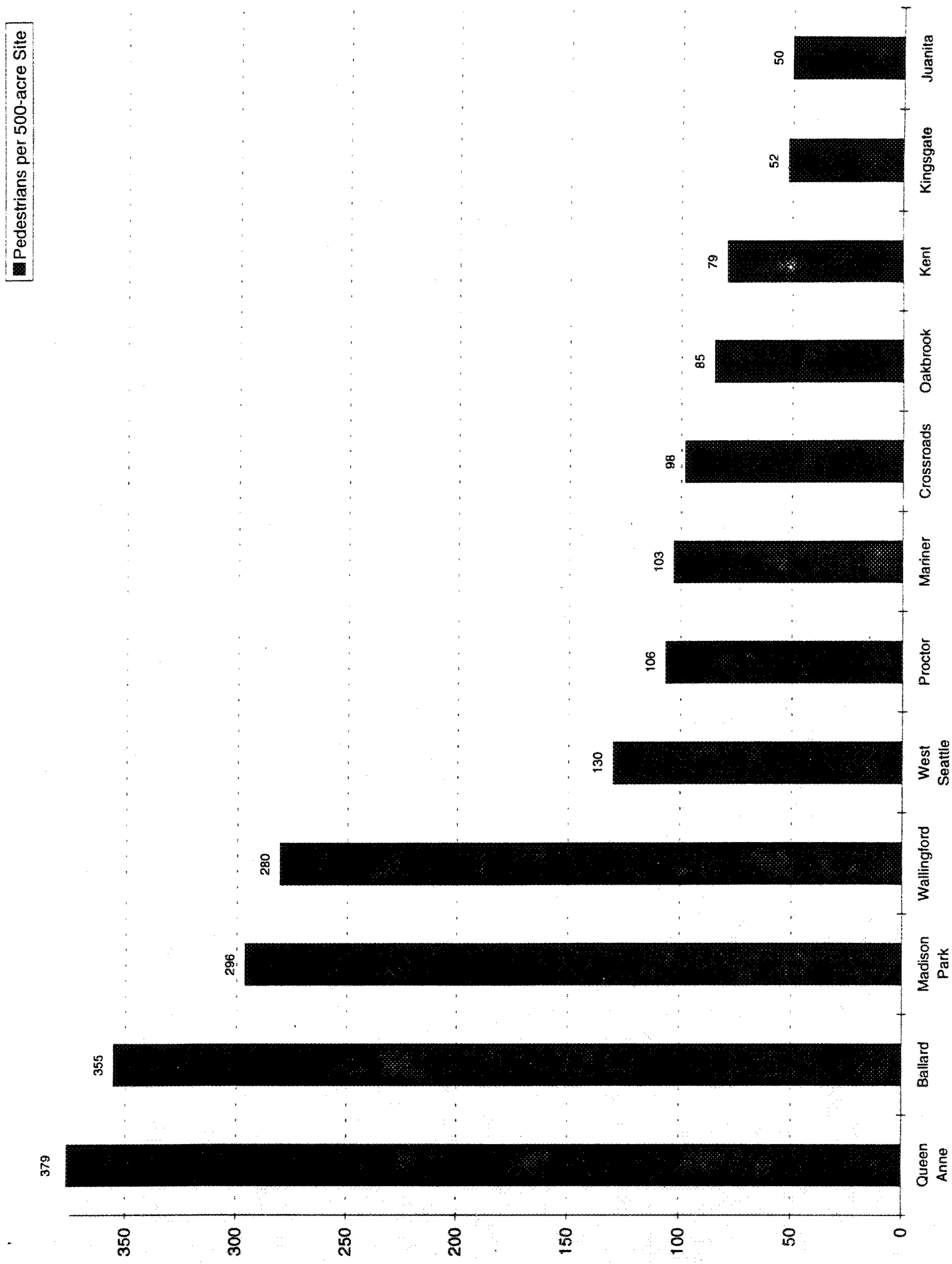

Figure 39. Pedestrian Trip Volumes, Adjusted per 500-Acre Site

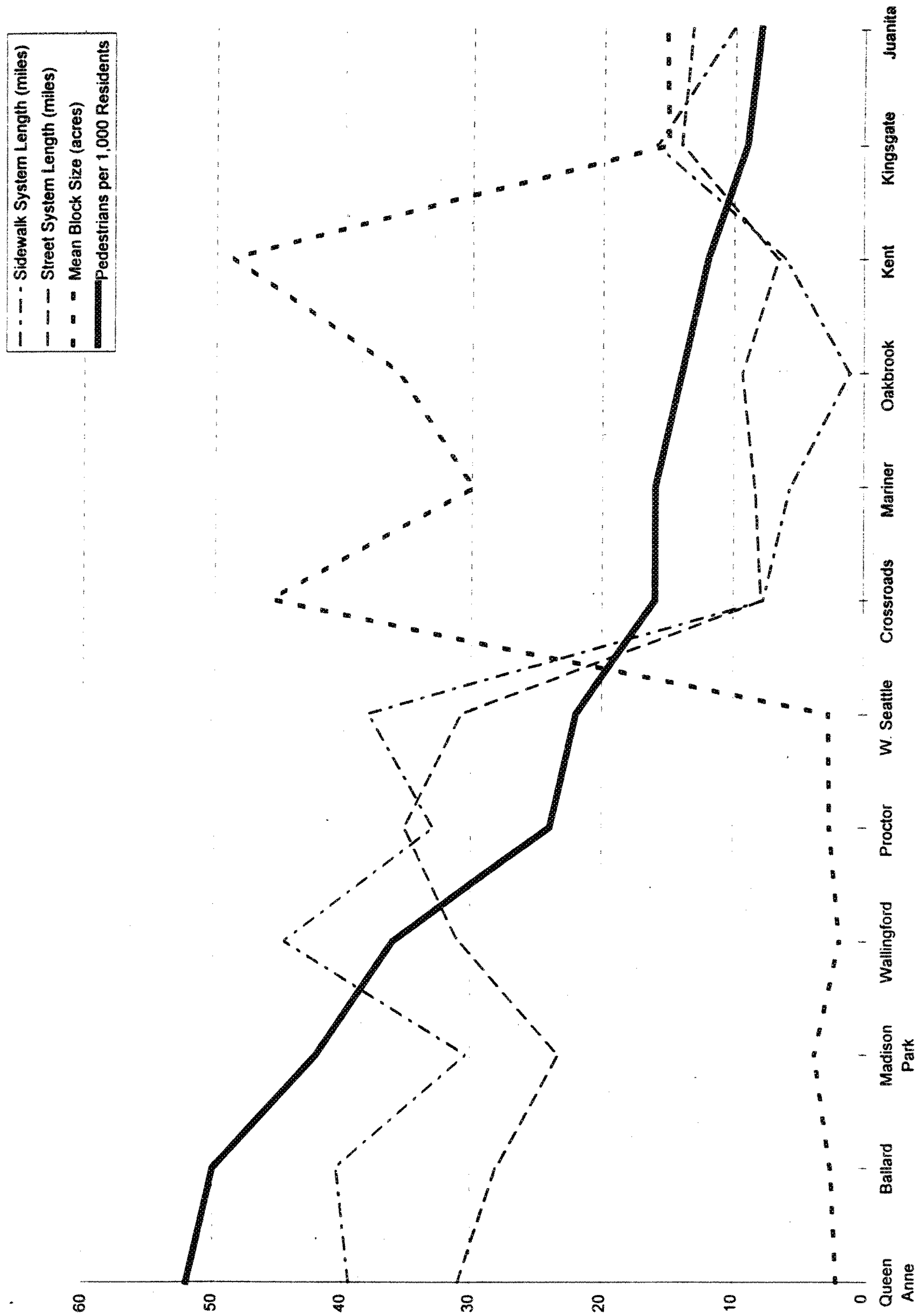

Figure 40. Pedestrian Trip Volumes by Site Design Measures

Table 15. Total Pedestrian Trip Volumes per Hour, per 1000 Population and per a Full, 500-Acre Site, in Matched Group

Site	Actual Pedestrians per hour	Pedestrians per hour per 1,000 residents	Pedestrians per hour per 500 acre site
Large Centers Ballard	299	50	355
Kent	85	12	79
Large Centers Wallingford	271	36	280
Crossroads	112	16	98
Medium Centers Proctor	105	24	105
Queen Anne	360	52	379
West Seattle	118	22	130
Mariner	78	16	103
Oakbrook	40	14	85
Small Centers Madison Park	152	42	296
Juanita	41	8	50
Kingsgate	54	9	52

2. SOCIO-DEMOGRAPHIC PROFILES OF PEDESTRIANS

Age

The approximate age of pedestrians was recorded in three broad categories: under 18, between 18 and 65, and over 65. Comparisons were made between the age of the pedestrian population with the age of each site's population. Figure 41 shows the pedestrian volumes by age category.

Except for Kent (S), Mariner (S), and Kingsgate (S), the majority of pedestrians at the other sites were between 18 and 65. At the other three suburban sites, more young people were walking than people in the two older age categories. Mariner (S) had similar numbers of young and medium-aged pedestrians. In the urban areas, the numbers of young and older pedestrians were low, except for Proctor, which had more young pedestrians, and Ballard, which had more elderly pedestrians. In the suburban areas, the number of older pedestrians was far lower than the number of either young or medium-aged pedestrians, except for Juanita.

In the urban sites, on average, 114 percent more young people were walking than were in the population census, but the comparative numbers were similar for medium-aged and older pedestrians. In the suburban sites, there were 182 percent more young pedestrians, 121 percent more older pedestrians, and 28 percent less medium-aged pedestrians than people of those age groups in the census population. Figure 42 plots the difference between the age of the census population of each site and the age of its pedestrian population. Young pedestrians are clearly over-represented in suburban sites, a reflection of the lack of transportation options available to the young. Proctor (U, 146 percent), Crossroads (S, 184 percent), Kent (S, 248 percent), Kingsgate (S, 184 percent), Mariner (S, 209 percent), and Oakbrook (S, 161 percent) had substantially higher percentages of young pedestrians than young people found in the census population.

These figures raise serious questions regarding the safety of young pedestrians in suburban sites with few, if any, pedestrian facilities.

Expectedly, the driving-age population (between 18 and 65) was underrepresented in suburban sites—Crossroads (74 percent), Juanita (84 percent), Kent (52 percent), Kingsgate (64 percent), and Mariner (66 percent). It was also underrepresented in Ballard (87 percent) and Proctor (84 percent).

As for older pedestrians, Ballard (U, 145 percent), Crossroads (S, 136 percent) and Juanita (S, 341 percent) had a higher percentage of these pedestrians than senior citizens found in the census population. Kent (60 percent), Kingsgate (64 percent), and Oakbrook (37 percent) had lower percentages of older pedestrians than seniors found in the census population.

Race

Pedestrians were initially categorized by ethnicity as White, African-American, Asian, and "Other." People of Latin heritage were recorded as being in "Other." Because of difficulties in recording this information accurately on site and the small sample size, these categories were combined into two groups of "Caucasian-looking" and "People of Color-looking" pedestrians. As with the age data, the pedestrian volumes of each category were compared to the census population data for each site.

On average, almost 90 percent of pedestrians counted in the urban sites were Caucasian-looking. In the suburban sites, this average dropped to 71 percent, ranging from 63 percent in Mariner and Crossroads to figures comparable with urban sites in Juanita.

Figure 43 shows the percentages of Caucasian-looking people and People of Color of all pedestrians counted. Figure 44 illustrates the ratio of the percentage of pedestrians of Color relative to their census population. With the exception of Queen Anne (U), Wallingford (U), Ballard (U), and Juanita (S), all sites had a disproportionately high number of pedestrians of Color relative to their population. At 919 percent, Crossroads (S) had the highest percentage of pedestrians of Color in comparison to the census. Among the urban sites, Proctor (300 percent), West Seattle (339 percent), and Madison Park (210 percent) had substantially higher percentages of pedestrians of Color than People of Color in the census population.

Note that this study's suburban sites were more ethnically diverse than the urban sites and the Puget Sound's population in general. The over-representation of pedestrians of Color walking into this study's commercial center raises equity questions. More so than for the high proportion of young people walking, the reasons that People of Color are walking are complex. They may have restricted access to automobiles, they may be culturally inclined to walk, or their shopping habits may be different from those of Caucasians. In any case, it is important to provide these pedestrians with adequate and safe facilities.

Gender

The distribution of female and male pedestrians was close to 50 percent at most sites, except for Madison Park (U), Proctor (U), and Oakbrook (S), where more than 55 percent of the pedestrians were females. West Seattle (U) and Mariner (S) were the only sites where fewer female pedestrians were counted than males, at 43 percent of the total pedestrians counted. Figure 45 shows the percentage of female pedestrians and the relationship between the number of female pedestrians counted and the study areas' census populations. Ballard (U), West Seattle (U), Kingsgate (S), and Juanita (S) had ratios of fewer female pedestrians than found in the census population. Oakbrook (S) and Proctor (U) had a higher representation of female pedestrians than women in the census population, at 116 percent and 109 percent, respectively.

Overall, there seemed to be no marked imbalance between male and female pedestrians in any of the sites, especially in comparison to the differences found with respect to age and race.

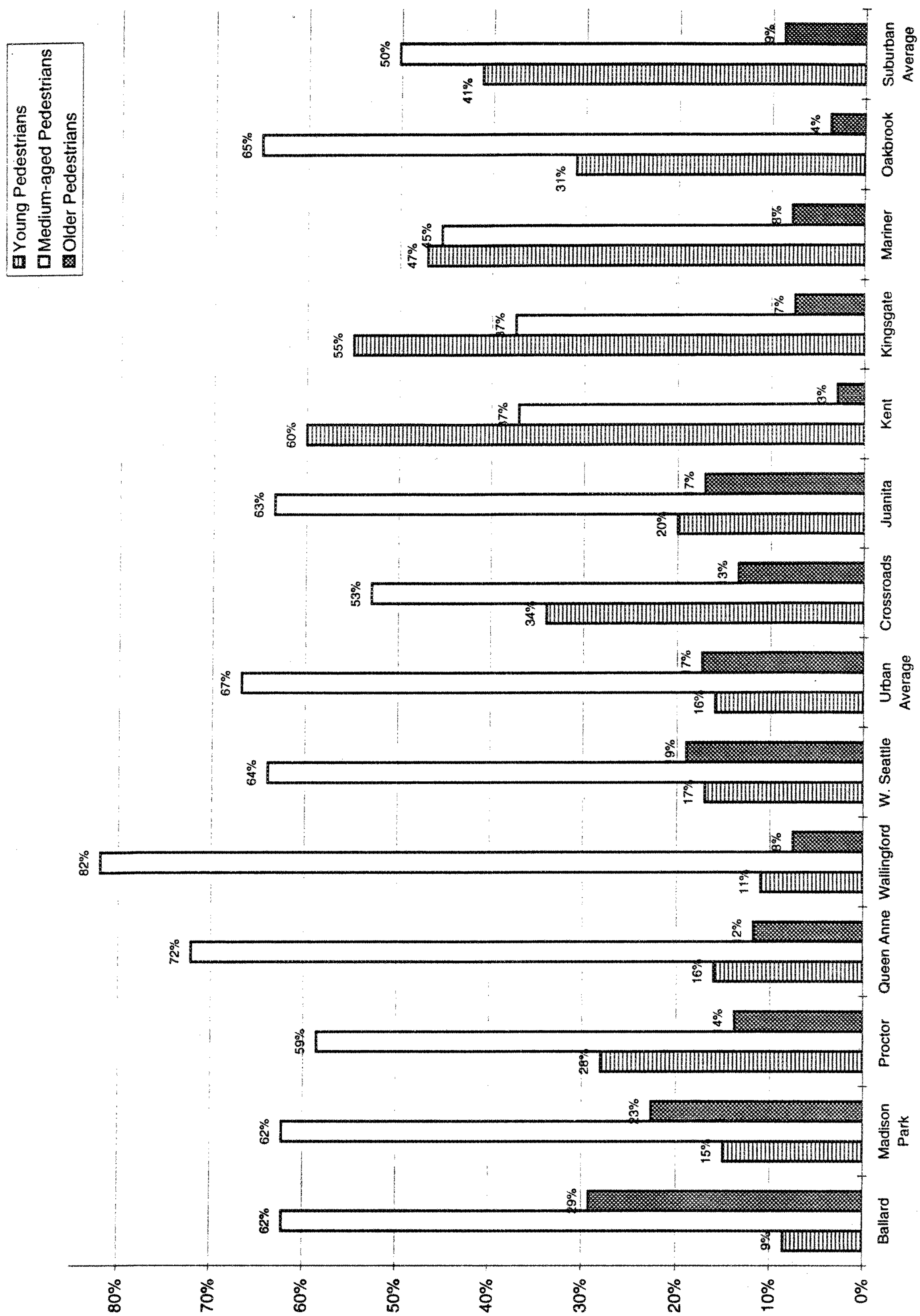

Figure 41. Pedestrian Trip Volumes by Age: Young (under 18), Medium-aged, Older (over 65)

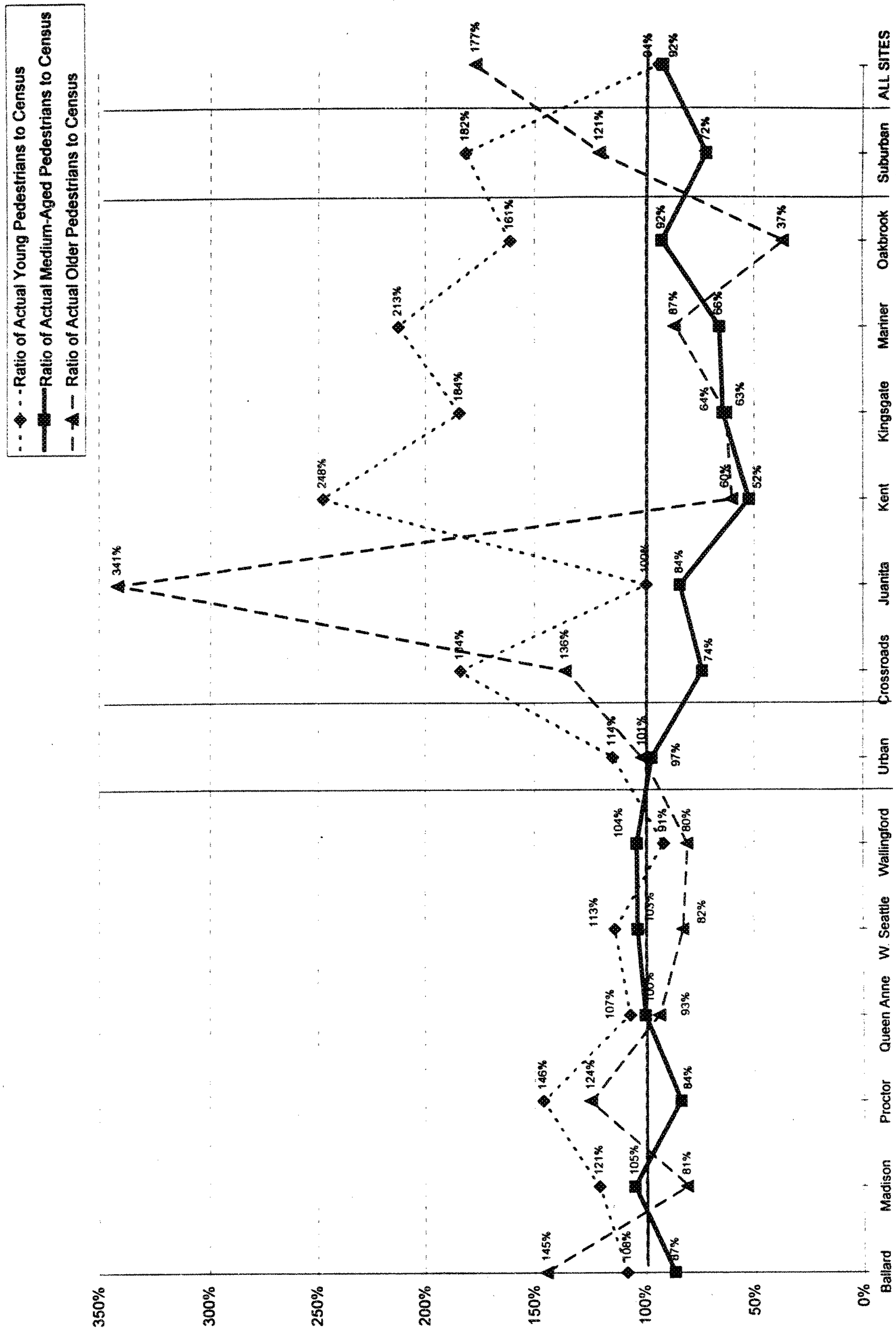

Figure 42. Pedestrian Trip Volumes by Age, Comparison to Census Population

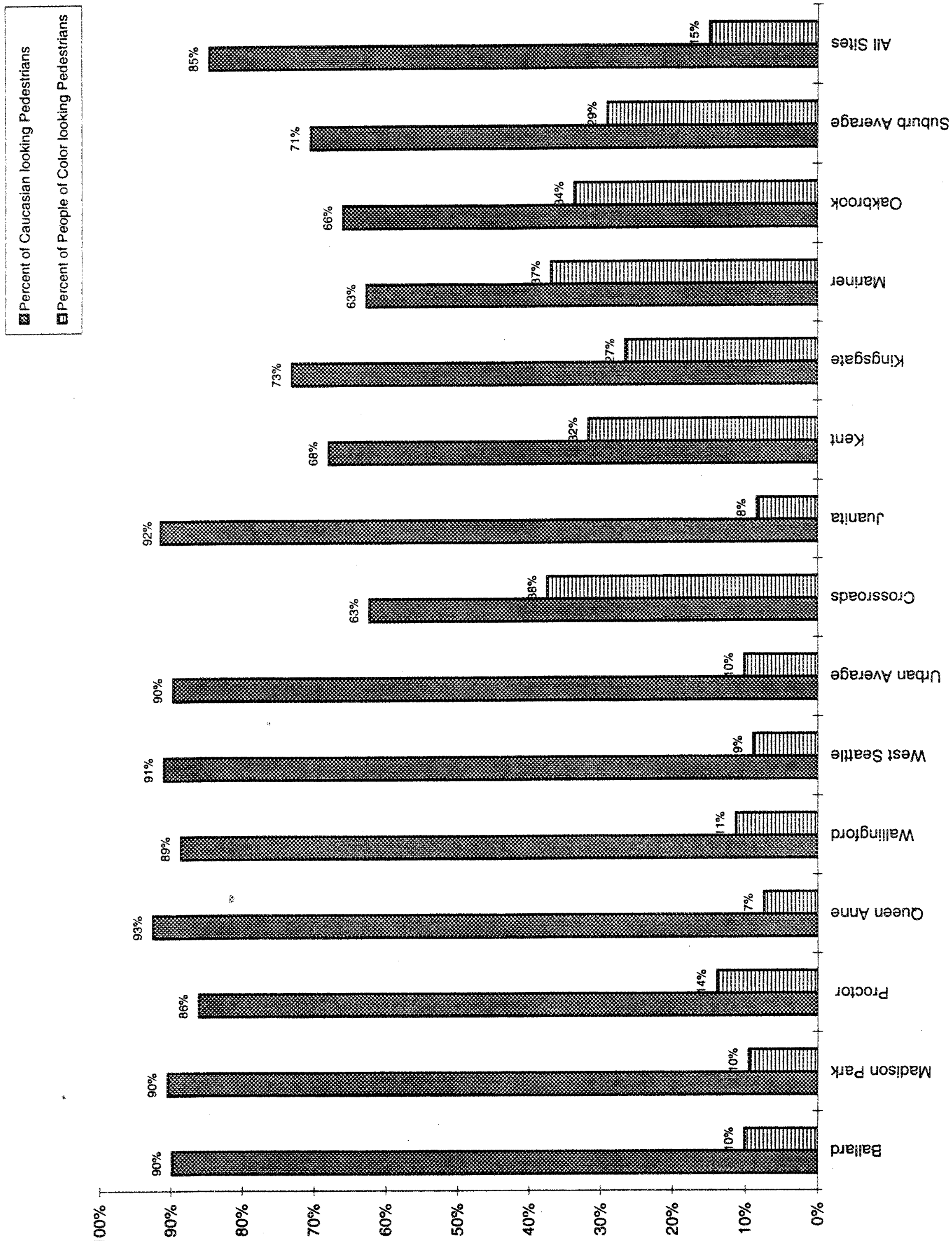

Figure 43. Pedestrian Trip Volumes by Race: Caucasian, People of Color

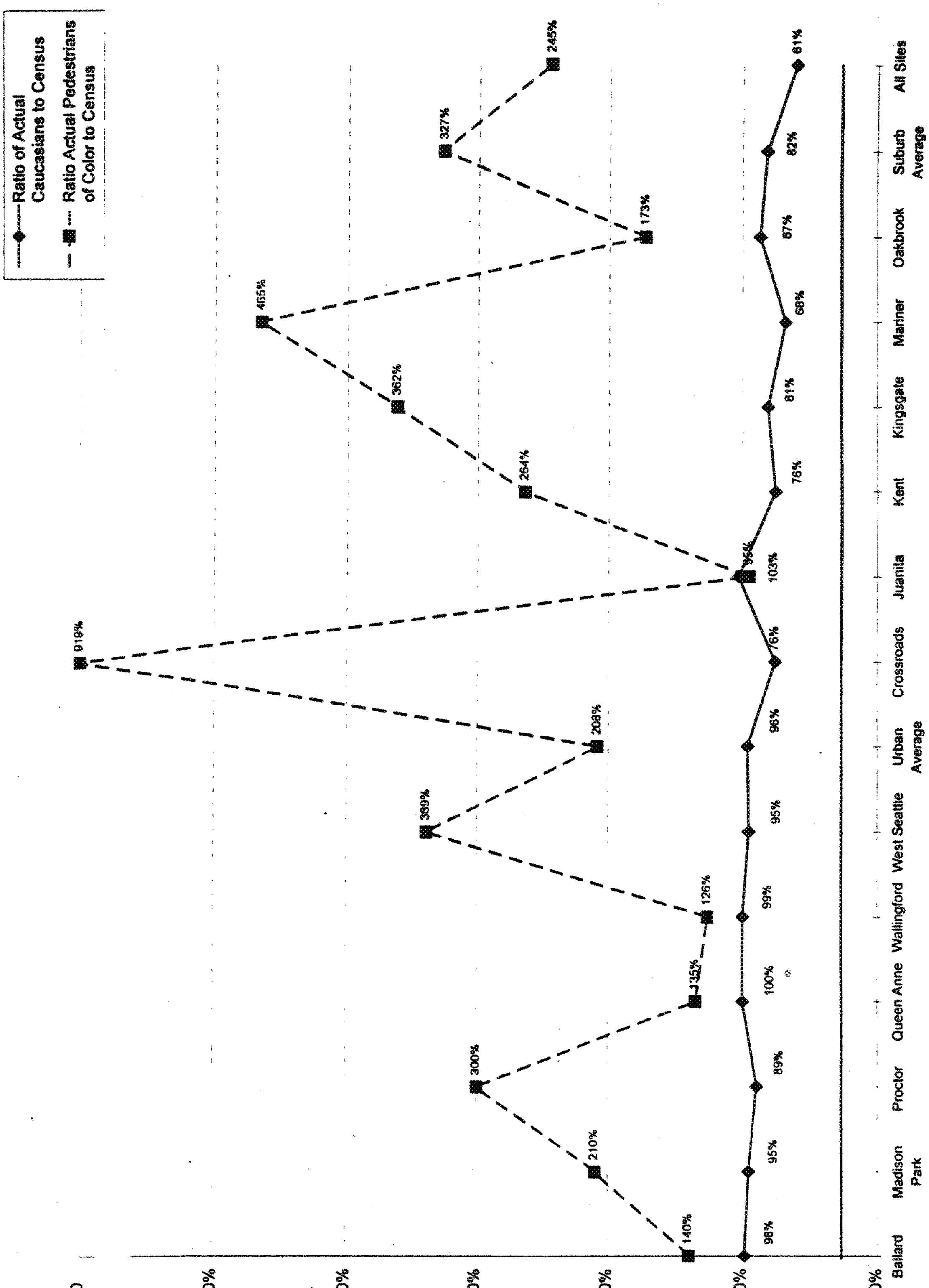

Figure 44. Pedestrian Trip Volumes by Race, Comparison to Census Population

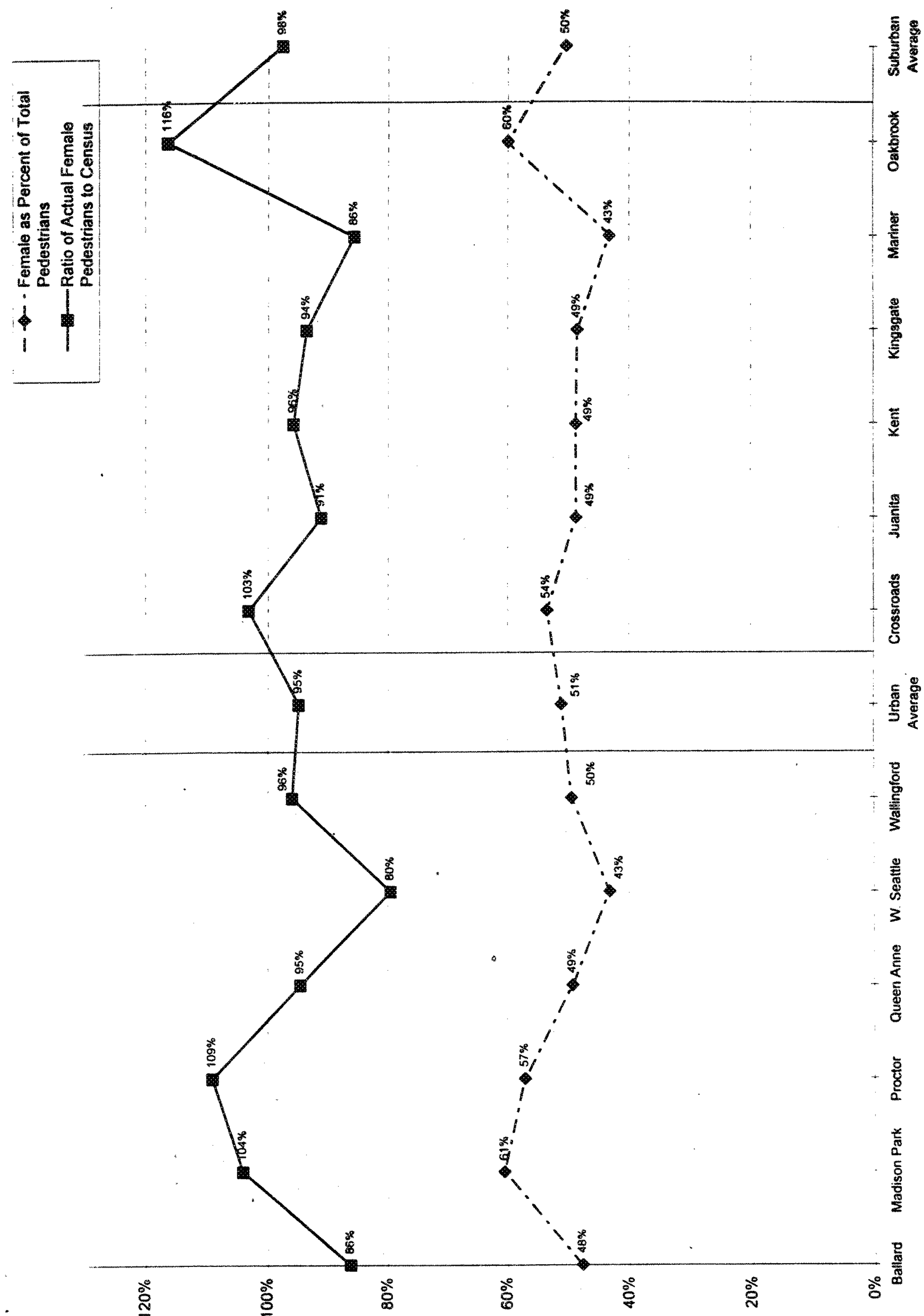

Figure 45. Pedestrian Trip Volumes by Gender, Comparison to Census Population

3. VARIABILITY IN PEDESTRIAN COUNTS

Variability within Specific Sites

The actual and adjusted volumes of pedestrians walking into the commercial centers provided interesting insights about the characteristics of the individual sites, as well as about this project's definition of the study area. The following are comments regarding some of the sites that require specific attention.

The high pedestrian volumes at Queen Anne (U) were likely influenced by the fact that the study area was adjacent to the South Slope of Queen Anne, one of the highest density residential districts in Seattle. That fact may have been mitigated by the sharp topographical differences between the study area and the South Slope, restricting pedestrian access to the commercial center. However, within the Queen Anne's study area, significant changes in the slope of the terrain should also have acted as a deterrent to pedestrian travel.

The Wallingford (U) low adjusted pedestrian volumes relative to Ballard (U), Queen Anne (U), and Madison Park (U), could be considered a surprise in view of the popularity of the area. It could be explained by the difference in topography in the area south of Wallingford's main commercial street, 45th Street NE. Note that the actual numbers of pedestrians in Wallingford were almost as high as in Ballard. The latter's adjusted figures benefit from the fact that Ballard was a "partial" site, with a significant part lying in the water.

Madison Park's (U) high pedestrian volumes were greatly helped by the definition of the study area because low-density residential development to the west of the commercial center (Broadmoor) was excluded from consideration. In actual numbers, Madison Park had almost half of the pedestrians that Wallingford (U) had.

Juanita (S) had more actual numbers of pedestrians walking into its center than Kingsgate (S). However, Juanita's relatively high density within the half-mile area made it a poor performer in comparative terms.

Variability by Observation Times

Pedestrian counts were carefully distributed through specific periods of the weekday and the weekend to capture as much of the pedestrian traffic as possible—lunch time, the after-school period, and pre-dinner time during the weekday, and late morning to mid-afternoon for Saturday counts. Results showed variety in pedestrian volumes during these different counting periods, both within the urban/suburban site categories and between them. The time allocated to counting during these periods was too short to draw any meaningful conclusions from these variations. Figure 46 shows the weekday and weekend totals, adjusted per hour per 1,000 residents. As expected, there were more pedestrians on Saturdays than on weekdays at all sites, except Kent (S) and Kingsgate (S). West Seattle (U) had the same number of pedestrians; Oakbrook (S) had only slightly more pedestrians on weekdays than on weekends. These variations must be considered in light of the limited time during which counts were performed.

Variability by Weather Conditions

Because weather is known to affect pedestrian travel volumes, temperature and sky conditions were recorded for all counting times. Counting was typically done only on sunny and warm days to capture pedestrian volumes under the best conditions. As noted, however, unusually wet spring and hot summer conditions may have affected some of the pedestrian volumes. Nevertheless, it is unlikely that the atypical weather conditions affected the basic findings of this study. The following comments concern the daily recorded weather as it related to hourly pedestrian volumes for weekdays, weekends, or the combined total.

Four urban sites—Queen Anne, Ballard, Wallingford, and Madison Park—consistently had the four highest actual pedestrian volumes (pedestrians per hour). The

Ballard and Madison Park counts were not conducted on any days with atypical weather patterns. The Queen Anne Saturday counts, which were especially high, took place on a sunny September day that followed many days of cold rain. People clearly came out to enjoy the break in the weather, and it is likely that counts would have been lower under a different weather pattern. However, weekday counts in Queen Anne, which were made under normal weather conditions, were high enough in comparison to other urban sites to consider the overall pedestrian volumes for this site reliable.

The Wallingford (U) and Proctor (U) Saturday counts took place on extremely hot days for the Seattle region, which may explain the comparatively lower counts for these sites. In this case, again, however, overall counts for both Wallingford and Proctor remain reliable when compared to the weekday counts of the other urban sites.

Two suburban sites, Juanita (S) and Kingsgate (S), consistently had the lowest hourly pedestrian volumes, although the order changed for weekdays, weekends, and the combined total. Only the Kingsgate weekend counts occurred on a day with atypical (hot) weather. Because Kingsgate's weekday counts were also the lowest counts of all weekday counts, it is likely that better weather conditions for the Saturday counts in this site would not have modified the overall performance of the site.

In Crossroads (S), weekend counts occurred on the same hot day as at Kingsgate, and counts were lower than the Crossroads' weekday counts. Crossroads could have performed better under more favorable weather conditions. However, given a comparison of weekday counts among Crossroads, Proctor (U), and West Seattle (U), it is unlikely that the Crossroads' weekend counts would have reached the levels of Proctor or West Seattle.

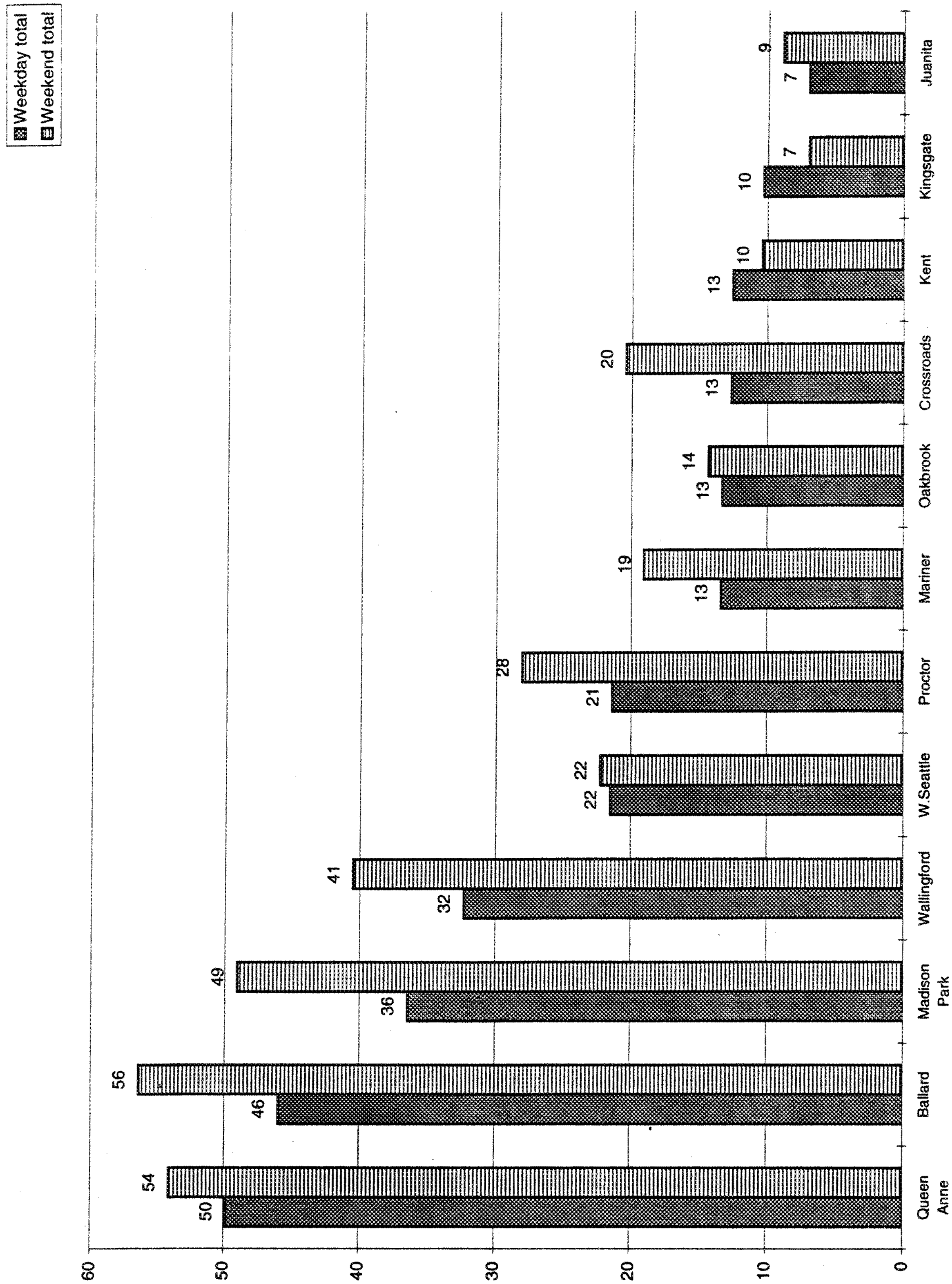

Figure 46. Pedestrian Trip Volumes by Weekday and Weekend per 1000 Residents

4. VARIABILITY IN PEDESTRIAN BEHAVIOR

Travel Speed

The speeds at which pedestrians walked as they crossed the cordon line included slow, medium, fast, and running (Figure 47). The majority of pedestrians were traveling at medium speed, with a very small percentage recorded as speed-walking (fast) or running. Between 15 and 35 percent of the pedestrians were recorded as walking slowly. Figure 48 demonstrates the lack of relationship between the number of older pedestrians recorded and a slow walking speed for any of the sites.

Impaired Pedestrians

Figure 49 shows the number of "special-needs" pedestrians recorded as either in wheelchairs or impaired in some way—blind, mentally challenged, and other. These two categories were combined for this study's analysis because of the low numbers in both groups. Ballard (U), Crossroads (S), West Seattle (U), and Madison Park (U) were the three sites with the highest numbers of impaired pedestrians. Juanita (S), Kingsgate (S), and Oakbrook (S) attracted no people in wheelchairs or impairments. People with disabilities are not as likely to live in areas that are difficult to access by public transit or that are difficult and unsafe to move around in. As a result, it is significant to find impaired pedestrians in sites such as Kent (S) and Crossroads (S), where pedestrian and transit facilities are limited.

Walking in Groups

Observers recorded whether pedestrians walked into the cordon in groups of two people or more, including adults with children. Figure 50 shows the volume of pedestrians walking in groups adjusted for a 500-acre site. Proctor (U), Kingsgate (S), Crossroads (S), and Kent (S) had the most pedestrian groups. There was no real break-point between urban and suburban sites. Ballard (U), Madison Park (U), and Oakbrook

(S) had the lowest number of pedestrians in groups. There was no clear relationship between the ages of pedestrians (especially the young) and the occurrence of groups.

Walking with Dogs

Observers also recorded pedestrians walking a dog. The presence of dogs may relate to the socio-economic level of residents and to the type of residential development in the area; the urban sites with the single-family residential areas were likely to be more conducive to dog ownership. Queen Anne (U), Madison Park (U), and Wallingford (U) had the highest rates of pedestrians walking dogs, although the number recorded was quite low, at three pedestrians per hour per 500-acre site with dogs. Proctor (U), West Seattle (U), Ballard (U), Kingsgate (S), Juanita (S), and Oakbrook (S) had under one pedestrian per hour per 500-acre site and Crossroads (S), Kent (S), and Mariner (S) had no recorded pedestrians walking with dogs.

Walking with Very Young Children

Pedestrians carrying or pushing a young child in a stroller were recorded. Older children accompanying adults were recorded individually and as pedestrians walking in groups. Queen Anne (U), Ballard (U), and Wallingford (U) had the highest counts, but again the pedestrian rate was under three per hour per 500-acre site. Crossroads (S), Juanita (S), Mariner (S), Kingsgate (S), Kent (S), and Proctor (U) had very low numbers, and Madison Park (U), West Seattle (U), and Oakbrook (S) had no children recorded. Not surprisingly, few people walked with strollers in the suburbs, where conditions for pedestrians are difficult.

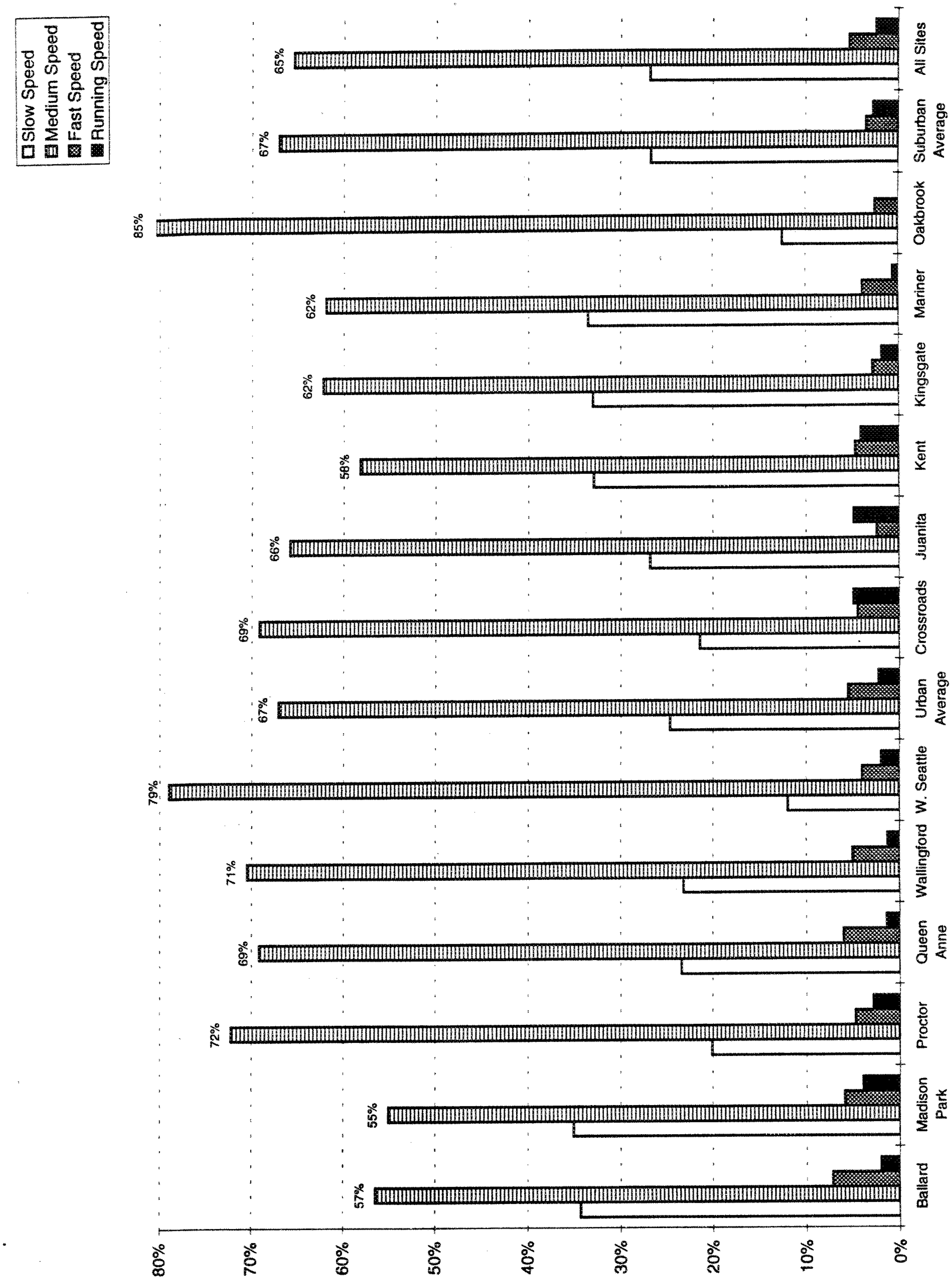

Figure 47. Pedestrian Trip Volumes by Speed: Slow, Medium, Fast, Running

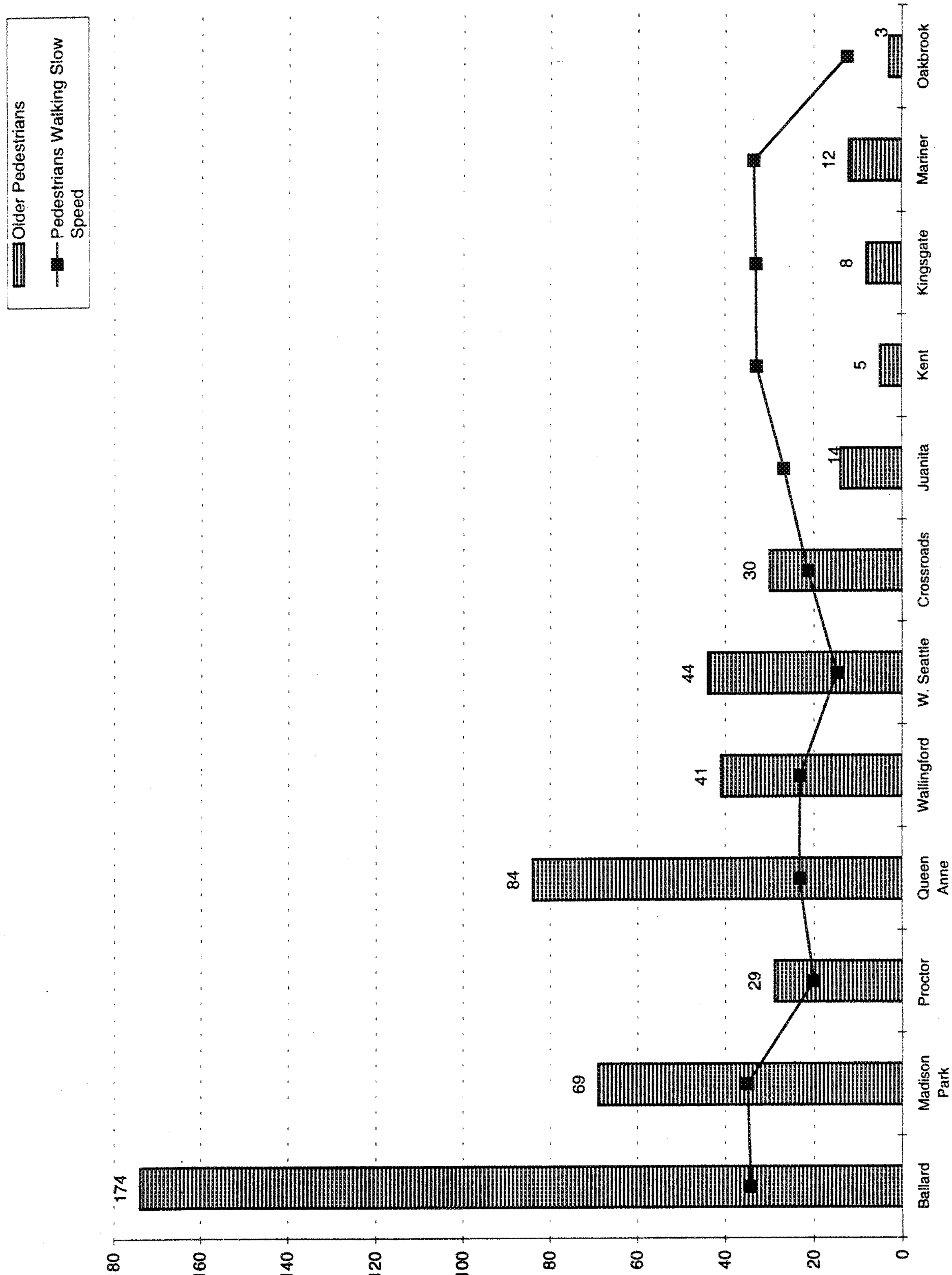

Figure 48. Comparison of Number of Older Pedestrians to Percentage of Pedestrians Walking Slowly

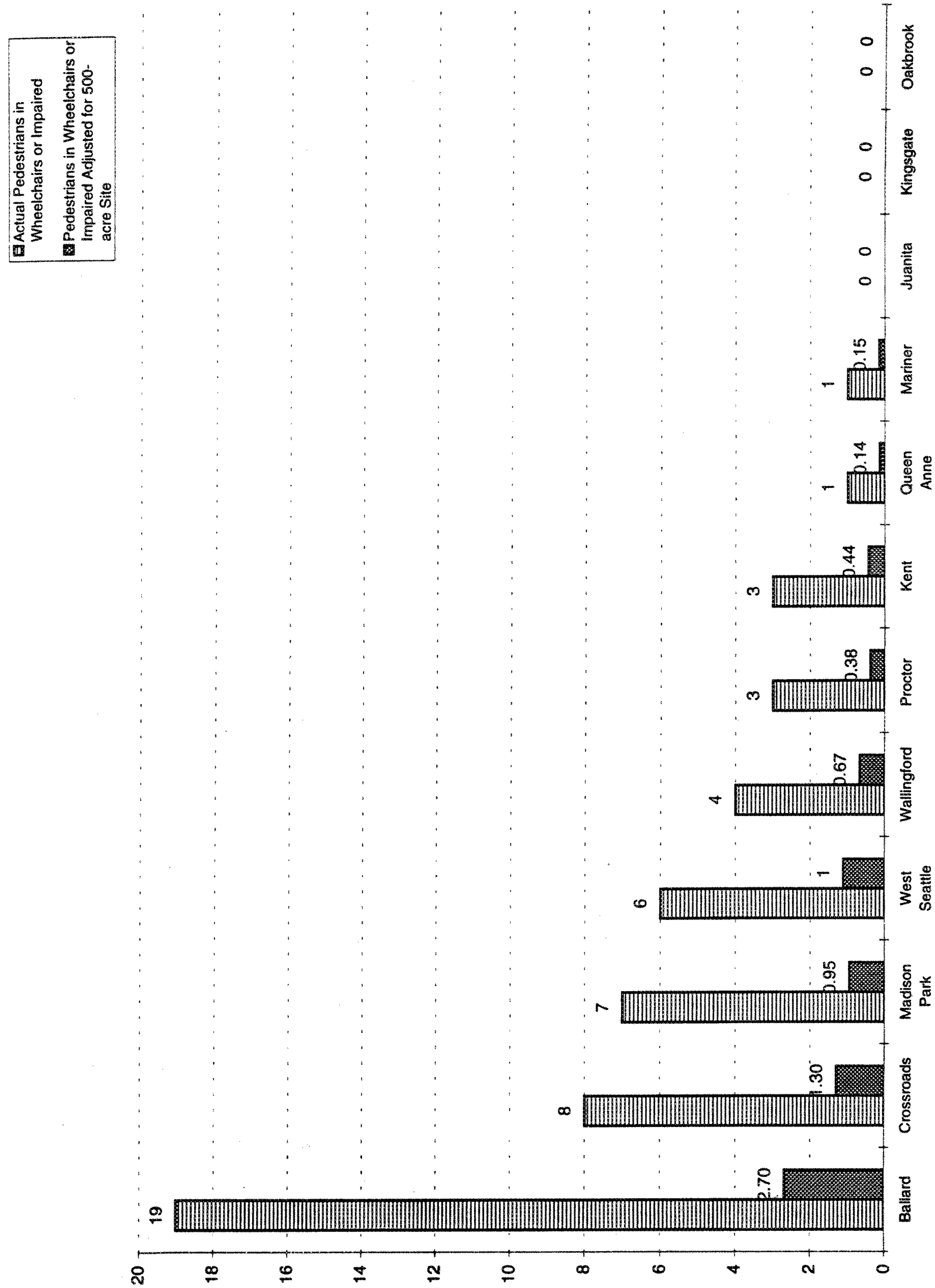

Figure 49. Pedestrian Trip Volumes by Pedestrians in Wheelchairs or Impaired

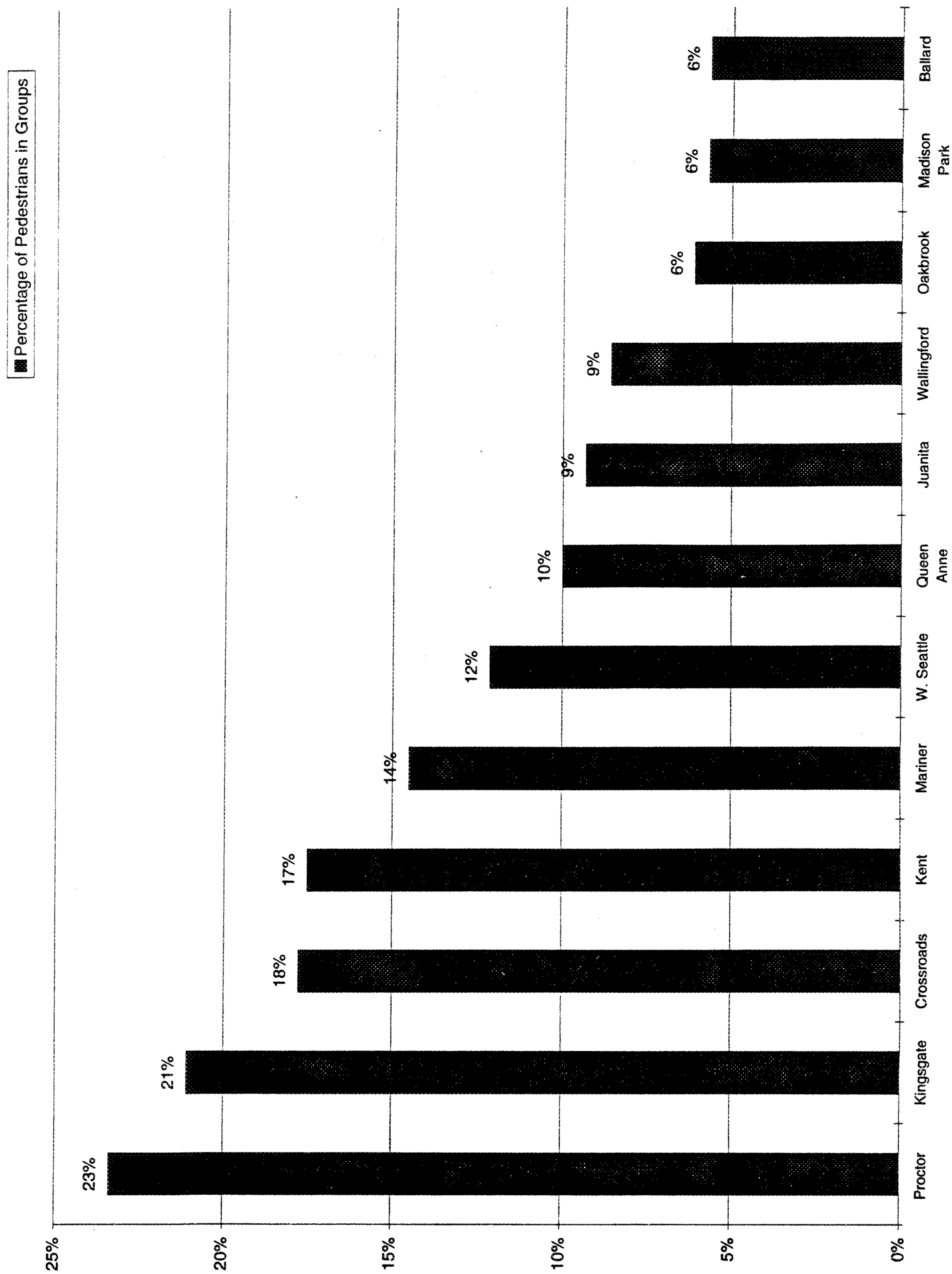

Figure 50. Pedestrian Trip Volumes Recorded in Groups of Two or More Pedestrians

5. PEDESTRIAN VOLUMES AND CORDON CONDITIONS

Variability by Entry Point

Figures 51 and 52 show that the distribution of pedestrians among the different observation points was (and expectedly so) uneven. In some sites, like West Seattle (U) and to some extent Wallingford (U), pedestrians entered the cordon at either end of the commercial street and at every other cross-street. In Madison Park (U), Queen Anne (U), and Proctor (U), on the other hand, pedestrians used many of the cross-streets, and only a few streets showed very high or very low volumes of pedestrians. In two of the suburban sites, Crossroads and Mariner, pedestrian volumes were also spread out evenly around the cordon. However, pedestrian volumes related to entry points for the other suburban sites were more varied.

Variability of Street Types Used by Pedestrians

The question of whether pedestrians used specific types of streets and cordon points can be asked by classifying all streets into the cordon for all sites. Street width, the presence of sidewalks, and the presence of bus routes were used to categorize cordon points.

In urban sites, the cordon points were located at street intersections one block off the main commercial street and these streets were all lined with sidewalks. There were three roadway widths: 48 feet or more, 30 to 48 feet, and 25 feet or less. In suburban sites, entry points into the cordon consisted of streets, parking lot entrances, and gates in the fences that separated the multi-family apartments from the nearby commercial area. For suburban sites, roadway widths included 60 or more feet, 36 to 60 feet, and 25 feet or less. Only some suburban streets contained sidewalks, although all of the streets that were 60 feet or wider had sidewalks.

Analysis of the distribution of pedestrians around the cordon indicated that in both suburban and urban sites, most pedestrians walked along the wider, generally commercial streets, as well as along streets with bus routes (Table 16).

In urban areas, 41 percent of the pedestrians crossed the cordon along a street that was 48 feet wide or wider, even though this type of street represented only 26 percent of the possible cordon points at urban sites. Thirty-two percent of the pedestrians used streets that were between 30 and 48 feet wide, a type of street representing 32 percent of the cordon points at urban sites. The remaining 26 percent of pedestrians used streets that were 25 feet wide or less. Less than 2 percent of pedestrians were counted crossing urban parking lots or alleys. The urban sites ranged from Wallingford, where 52 percent of pedestrians crossed into the cordon on streets 30 feet or wider, to West Seattle, with 98 percent of pedestrians crossing on streets 30 feet or wider. These findings show that in urban sites, wide streets serve pedestrians as well as motorized traffic.

In suburban areas, 60 percent of the pedestrians used streets with sidewalks, even though this type of street represented only 43 percent of the possible cordon points. Furthermore, wide streets (60 feet and wider) with sidewalks were used by 47 percent of the pedestrians, though these streets represented only 31 percent of the possible cordon entry points. Pedestrians were also more likely to be on streets with buses. These findings show that the majority of suburban pedestrians use not only streets with sidewalks, but important streets that are traditionally considered automobile channels.

In the suburban sites, parking lots acted as cordon entry points for an average of 14 percent of pedestrians. For three of the suburban sites, however, parking lot entries counted for more than 25 percent of the pedestrians. The use of gates through fences varied greatly from one suburban site to the other, with the highest uses recorded when the gate linked dense apartment buildings with grocery stores. In Oakbrook (S), where there were very few sidewalks and few streets, the majority of pedestrians were found crossing at gates, parking lots, and private streets; 44 percent of pedestrians crossed at a wide street with no sidewalk. In Mariner (S) and Kingsgate (S), 30 and 38 percent of the pedestrians, respectively, crossed at gates and parking lots.

The reasons for the pedestrian's travel choice of wider, commercial, and bus route streets are likely to differ between the urban and suburban sites. In the urban areas, people may value the safety and comfort of streets that have more activity. Also, whatever negative influence the commercial businesses may have on the quality of the walk along the street may be diluted because of the presence of mixed uses (residential, commercial, and other uses) along each street in these neighborhoods. Finally, some of the pedestrians are likely to be transit users.

In suburban areas, the prevalence of pedestrians walking along wide, commercial roads indicates preference for such streets over minor through-streets, parking lots, and the many gates in fences separating multi-family and commercial developments.

In both urban and suburban sites, the distribution of pedestrians entering a cordon showed a positive relationship between pedestrian volumes and location of the grocery store, as evidenced in Ballard (U), Proctor (U), Wallingford (U), West Seattle (U), Crossroads (S), Kent (S), Kingsgate (S), and Oakbrook (S). Pedestrians were seen entering the cordon near the grocery store and leaving the cordon later with grocery bags.

Proximity to Schools

In three of the suburban and five of the urban sites, schools were located near the commercial center; the sites were Kent (S), Mariner (S), Oakbrook (S), Ballard (U), Madison Park (U), Proctor (U), Queen Anne (U), and West Seattle (U). This study purposely placed schools outside the cordon to include children walking from a school to the commercial area for lunch or after school on weekdays. The school's presence near the cordon did appear to affect pedestrian volumes, especially for Kent (S), Mariner (S), Oakbrook (S), Queen Anne (U), and West Seattle (U).

In Kent (S), all 54 pedestrians counted at the cordon point nearest the school were young people (100 percent of pedestrians versus 60 percent for the entire site). This cordon point lay along a 60-foot-wide street with sidewalks along both sides. The street's principal intersection had a traffic light, crosswalks, and a pedestrian light. Incidentally, a McDonalds was next door to the school. At 248 percent, Kent had the second highest proportion of young people as pedestrians in comparison to young people in the census population.

In Mariner (S), two-thirds of the pedestrians at the two cordon points near a school were young people, versus 47 percent for the entire site. One of these cordon points was a parking lot entrance to a motel as well as a bike path. The other cordon point was along a 60-foot-wide road with sidewalks, crosswalks, and pedestrian signals at the traffic lights. Overall, Mariner recorded 209 percent more children walking than children in the census population.

In Oakbrook (S), two-thirds of the pedestrians counted at the cordon points near the school were young people, versus 31 percent for the entire site. The two cordon points near the school consisted of a gate to the main street and the school's parking lot entrance. The gate led to the main road, which did not contain a sidewalk. Overall, Oakbrook recorded 161 percent more young pedestrians than young people in the census population.

In Ballard (U), 14 percent of the pedestrians recorded near a school were young people, versus 9 percent for the entire site. This comparatively low number may have been due to the location of the school three blocks northwest of the commercial area. Overall, Ballard had 108 percent more young people as pedestrians than young people in the census population.

In Madison Park (U), almost one-fourth of the pedestrians were young people at the cordon point closest the school, versus 15 percent for the entire site. As in Ballard, the school was three blocks away from the cordon area, and children were seen being dropped off by school buses from schools outside of the neighborhood. Overall, Madison Park had 121 percent more young people than young people in the census population.

The presence of the Madison Park Beach and Pool at the edge of the cordon may have accounted for these additional young people.

In Proctor (U), almost one-third of the pedestrians were young people at cordon points closest to the school, versus 28 percent for the entire site. Unlike Ballard (U) and Madison Park (U), the school lay along the cordon area across the street from the commercial zone. These streets contained sidewalks on both sides but no crosswalks or traffic lights adjacent to the school. Overall, Proctor had 146 percent more young people than youths in the census population.

In Queen Anne (U), 30 percent of the pedestrians counted were young people at cordon points closest to the high school and middle school in Queen Anne, versus 16 percent for the entire site. One of these points had the most children of all the cordon points. These streets contained sidewalks, crosswalks, and are primarily residential. Overall, Queen Anne had 107 percent more young people walking than young people in the census population.

In West Seattle (U), 47 percent of the pedestrians were young people at the two cordon points closest to the schools, versus 17 percent for the entire site. One of these points had the most young people of all the cordon points of the site. That point had a traffic light, crosswalks, and a pedestrian signal. The other cordon point was primarily a residential street. Overall, West Seattle recorded 123 percent more young people than youths in the census population.

The effect of a school's presence on pedestrian volumes, especially in suburban sites, combined with the high proportion of young pedestrians in general, points to the need to provide pedestrian facilities that ensure the safety of this portion of the population, for whom few alternative transportation modes are available.

Cordon Crossing Surfaces Used

The specific types of surfaces pedestrians used as they crossed the cordon were recorded. Most cordon crossing occurred at street intersections. However, pedestrians could also cross the cordon while walking along a sidewalk (turning around the street corner leading to the commercial center), and they could cross at a non-street intersection. When crossing at a street, the pedestrian had the choice to use a marked crosswalk, to cross legally at an unmarked intersection, or to jaywalk. Jaywalkers were defined as pedestrians who crossed a street at mid-block, against a traffic light, or diagonally at the intersection. This study's definition of jaywalking did not conform to the Washington State legal definition of jaywalking, which allows mid-block crossing under certain circumstances.

Figures 53 and 54 show all the crossing surfaces used, namely a crosswalk, an unmarked intersection, jaywalking across a street, walking along a sidewalk, and other non-street crossings (using gates, parking lots). A substantial number of pedestrians crossed the cordon walking along a sidewalk: 42 and 24 percent in the urban and the suburban sites, respectively. Furthermore, 38 percent of the cordon crossing in suburban areas took place at non-streets (gates, parking lots, other), versus 1 percent in the urban sites. This means that only 38 percent of the pedestrians in suburban sites crossed a street as they entered the cordon, whereas 57 percent crossed a street in urban sites.

Of those pedestrians who crossed the cordon at a street, 63 percent used an unmarked intersection in urban areas, versus 6 percent in the suburban sites. Of this same group, 17 percent used a marked crosswalk in urban areas, versus 62 percent in suburban sites. These figures reflect the fact that urban street intersections are typically much more narrow than their suburban counterparts. Almost all suburban street intersections are signalized and have marked crosswalks. Finally, 20 percent jaywalked in urban areas, versus 32 percent in suburban sites. Although jaywalking is relatively safe in urban sites, where most streets are narrow and automobile traffic is slow, it represents substantial risk-taking on the part of the suburban pedestrian crossing wide, heavily trafficked streets. The high incidence of jaywalking in suburban sites is cause for concern; it indicates that pedestrians have such limited options to cross major streets than they are willing to take high risks and put safety aside.

Walking Along the Cordon Edge

Figure 55 shows pedestrian trip volumes per hour of total observation for each site for pedestrians walking along the cordon edge. High numbers of pedestrians were expectedly found in Ballard (U) and Crossroads (S), where part of the cordon edge corresponds to a major street with sidewalks. Few pedestrians walked along the cordon in the other urban sites (approximately one-fifth of the pedestrians entering the cordon), perhaps indicating a preference for walking along the commercial shopping street inside the cordon. The number of pedestrians along the cordon in suburban areas was also quite low because of the absence of streets or defined pedestrian pathways connecting entry points along the cordon.

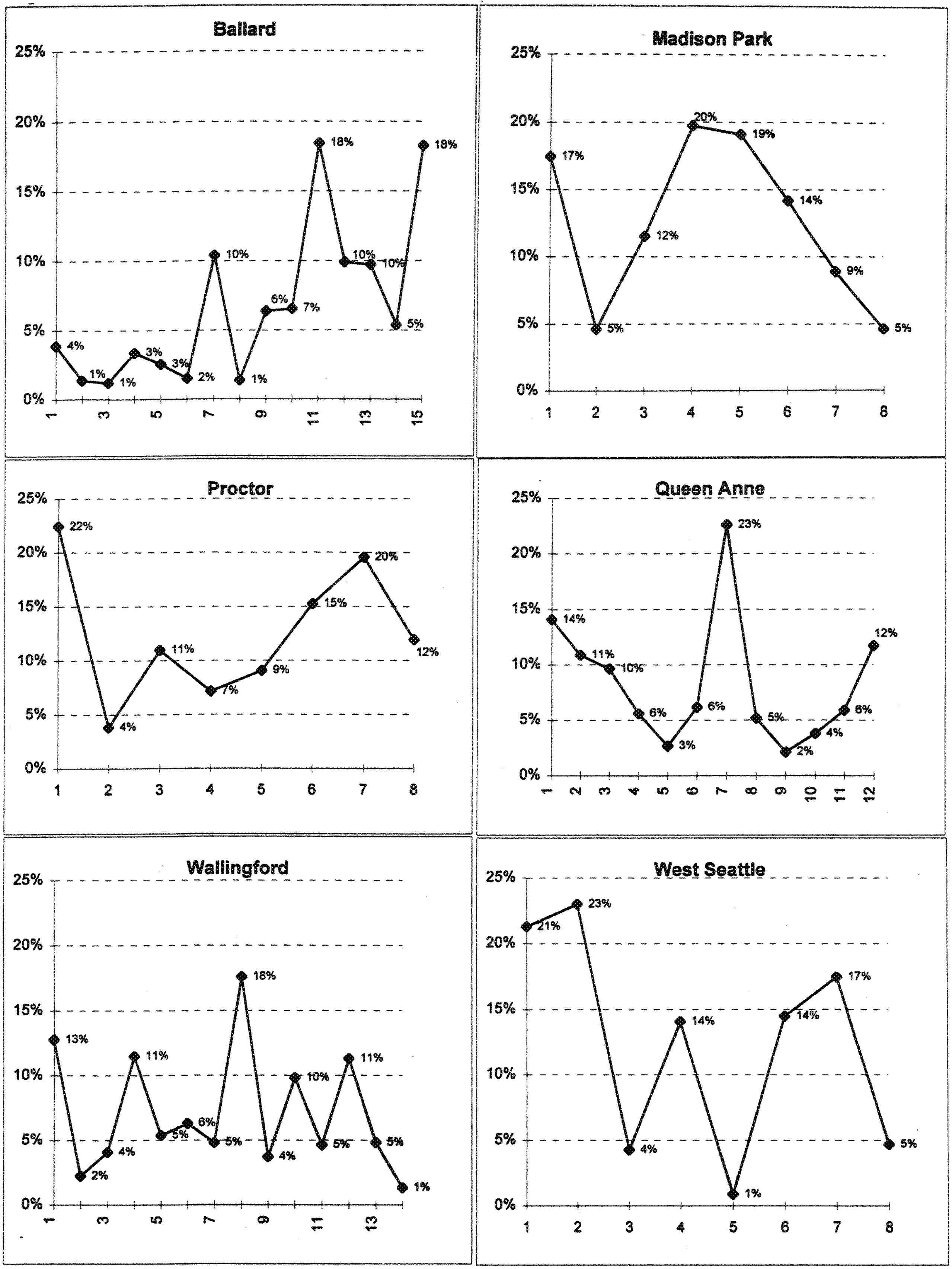

Figure 51. Distribution of Pedestrians around Cordon, Urban Sites

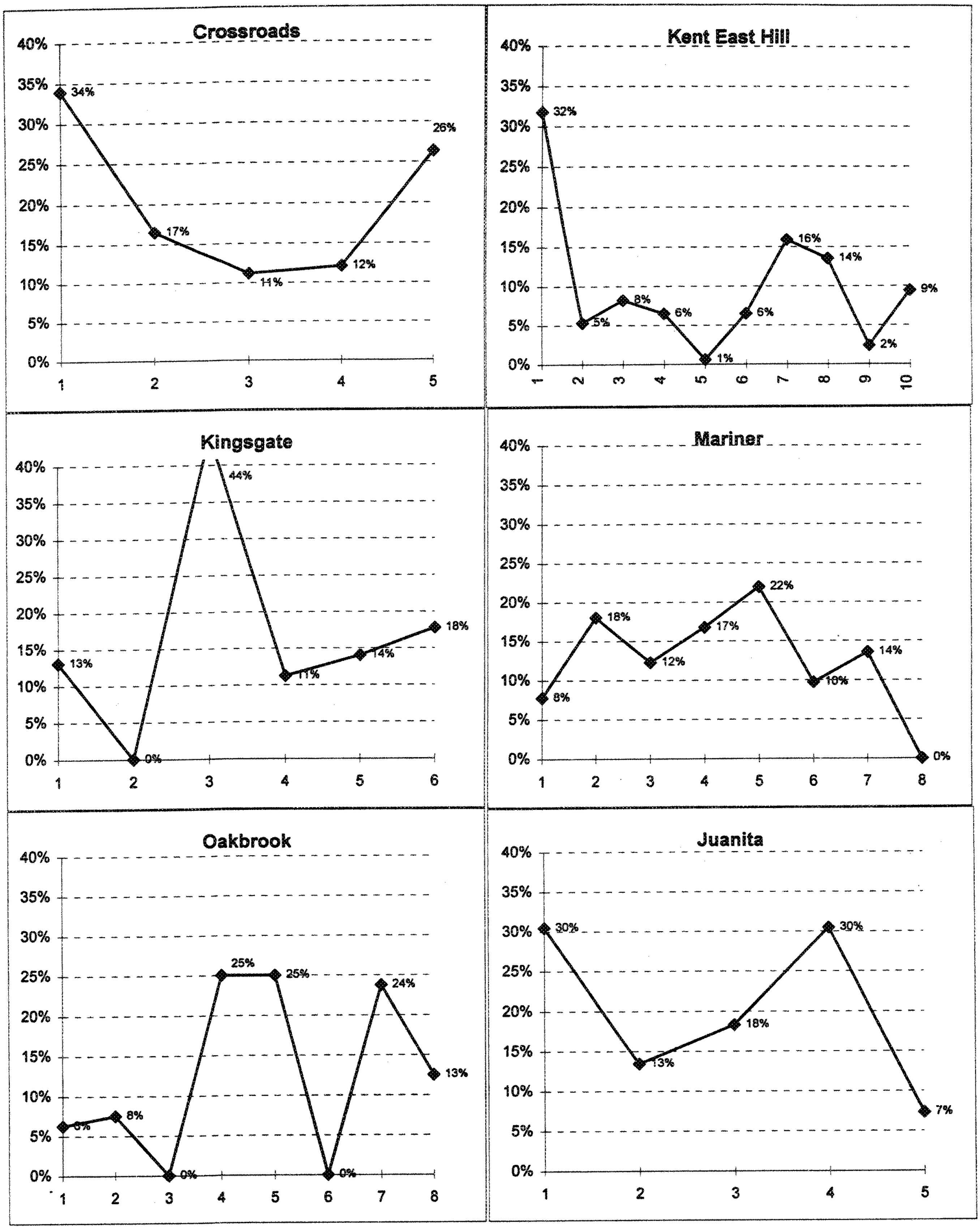

Figure 52. Distribution of Pedestrians around Cordon, Suburban Sites

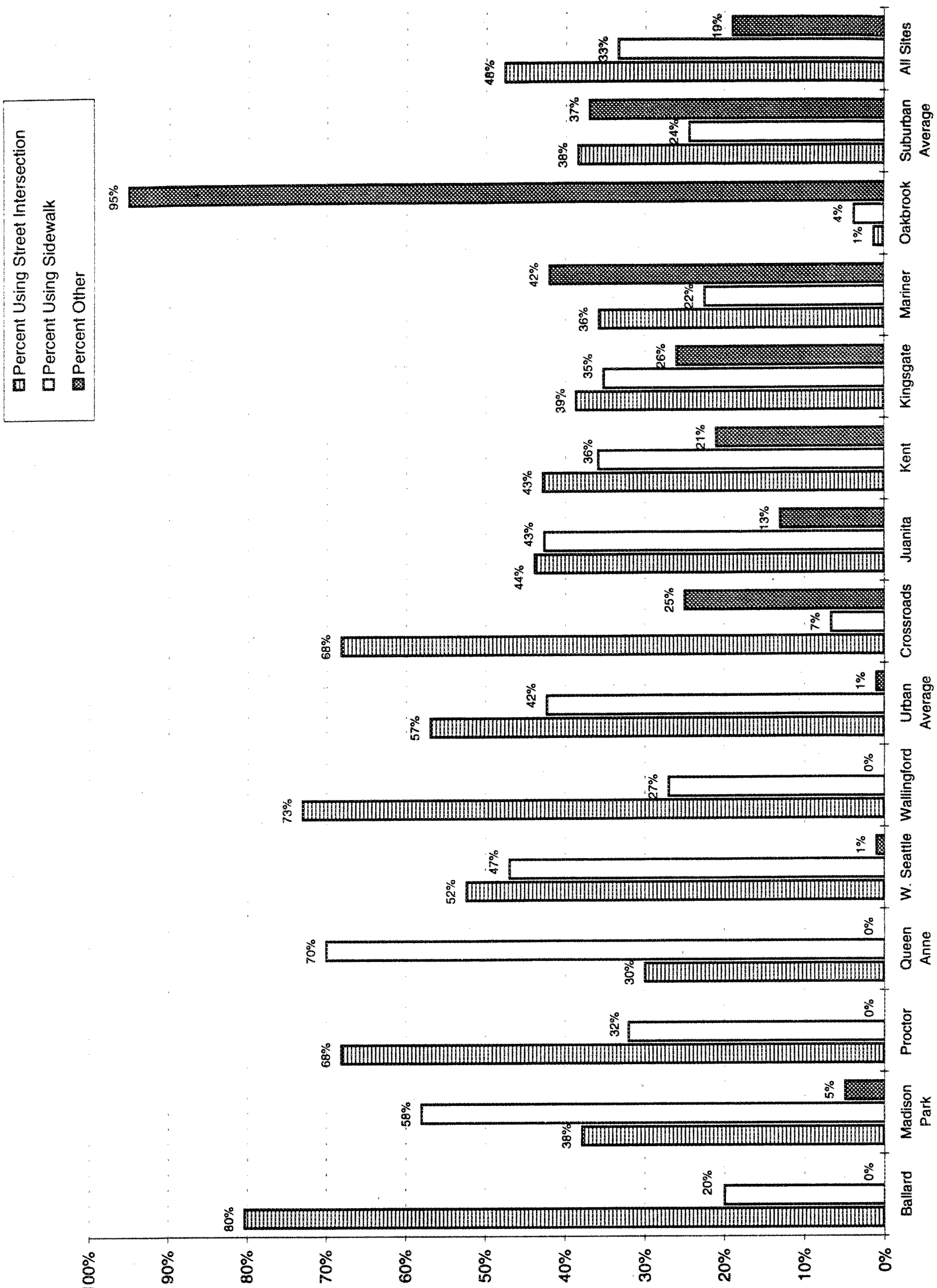

Figure 53. Crossing Conditions for All Pedestrians at Cordon Points

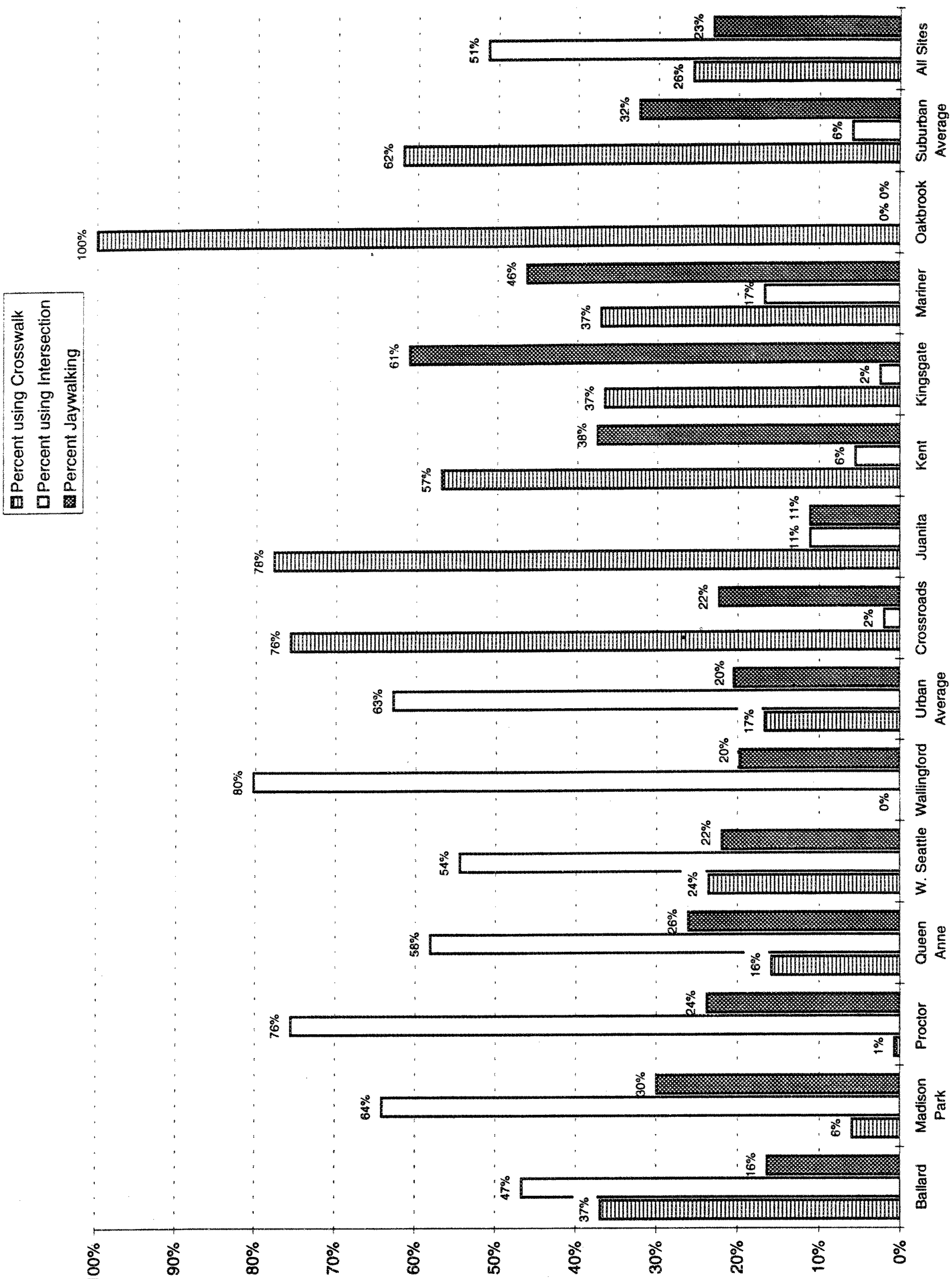

Figure 54. Crossing Conditions for Pedestrians Who Cross a Street into the Cordon

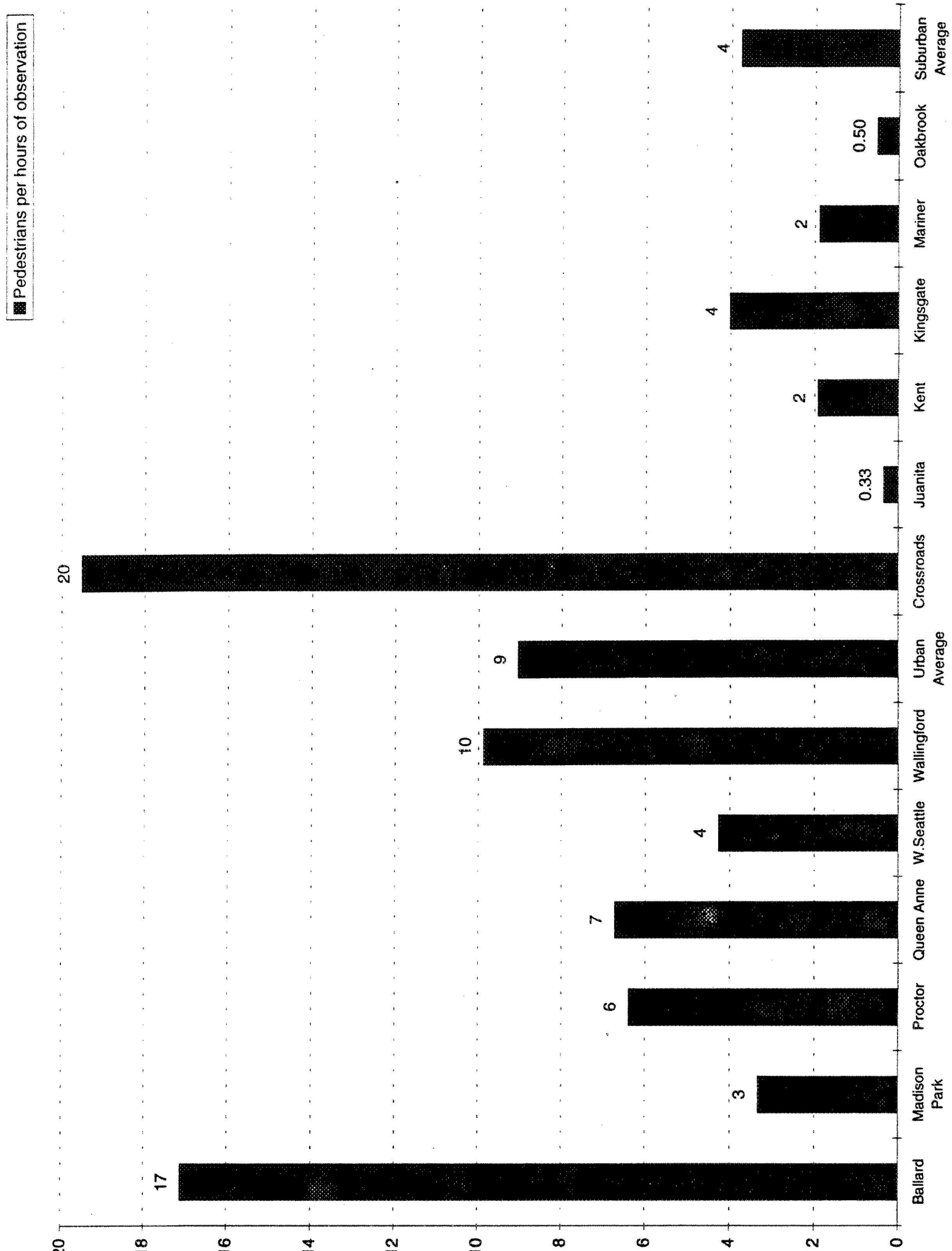

Figure 55. Pedestrian Trip Volumes along Cordon Edge, per Hour of Observation

Table 16. Percentage of Pedestrians Crossing the Cordon by Type of Entry Point

	60 + feet SW	48 + feet SW	36 - 60 feet SW	36 - 60 feet NO SW	30 - 48 feet SW	25 feet or less SW	25 + feet NO SW	Gate /Path	Parking lot entrance	Alley	Private street
Ballard	-	43%	-	-	38%	18%	-	-	-	-	-
Madison Park	-	36%	-	-	37%	23%	-	-	-	5%	-
Proctor	-	42%	-	-	58%	0%	-	-	-	-	-
Queen Anne	-	37%	-	-	30%	35%	-	-	-	-	-
Wallingford	-	31%	-	-	21%	47%	-	-	-	-	-
West Seattle	-	75%	-	-	23%	-	-	-	1%	-	-
Urban Average*		41%			32%	26%			0.08%	1%	
Crossroads	74%	-	-	-	-	-	-	-	26%	-	-
Juanita	60%	-	18%	-	-	-	13%	-	-	-	7%
Kent	57%	-	14%	14%	-	-	6%	3%	5%	-	-
Kingsgate	-	-	44%	18%	-	-	-	11%	27%	-	-
Mariner	49%	-	22%	-	-	-	-	30%	-	-	-
Oakbrook	-	-	-	44%	-	-	0%	24%	25%	-	8%
Suburban Average*	47%		13%	11%			3%	10%	14%		1%
Average Percent of Pedestrians of Total Pedestrians for All Siites	11%	31%	3%	3%	25%	20%	1%	2%	3%	0%	0%
Number of Cordon Points in each category for All Sites	13	18	5	5	23	22	3	9	6	1	2
Number of Cordon Points in each category for Urban Sites		18			23	22			1	1	
Number of Cordon Points in each category for Suburban Sites	13		5	5			3	9	5		2
Percent of Cordon Points	12%	17%	5%	5%	43%	41%	3%	8%	7%	2%	2%

Note: "-" indicates no cordon point of this category for that site; SW indicates presence of sidewalk. All urban streets in the cordon areas have sidewalks.

* Based on actual pesdestrian counts. Because of rounding, the average of the column above does not equal the urban or suburban average.

6. BICYCLISTS

Like pedestrians, bicyclists can be found in both urban and the suburban sites. However, counts of bicyclists showed almost 9 times fewer bicyclists than pedestrians crossing the cordon and entering the commercial area—a mean count for all sites of 3 bicyclists per hour per 1,000 residents versus 25 pedestrians per hour per 1,000 residents. Volumes of bicyclists varied as much as volumes of pedestrians, with a low of 1 bicyclist per hour per 1,000 residents to a high of 7, or a low of 6 bicyclists per hour per complete site to a high of 49.

Figures 56, 57, and 58 show bicycle volumes, adjusted per 1,000 residents, and per 500-acre site. The urban sites of Wallingford, Ballard, Queen Anne, and Proctor had relatively high volumes. West Seattle (U), Kent (S), Mariner (S), Juanita (S), and Oakbrook (S), were in a second tier. Kingsgate (S), Madison Park (U), and Crossroads (S) were in a third, lowest tier.

Bicycle volumes also divided the sites into urban and suburban categories, although less distinctly than the pedestrian volumes. Madison Park (U) was an exception as one of the three sites with the lowest overall bicycle volume, even though it had high pedestrian volumes. Proctor (U), on the other hand, had a relatively high volume of bicyclists. Madison Park's low volume can be explained by the relative isolation of the site and by its compactness, which may render bicycling less practical than walking. Proctor's relatively high volume of bicyclists can be related to the site's low density.

It is important to recognize that the design of this study did not lend itself to good measures of bicycle travel. Bicyclists use a travel shed that is larger than the one-half mile used for pedestrians—hence topographical conditions would need to be taken into account for larger areas than the study areas used. Because their travel speed can be substantially higher than pedestrians, bicyclists are less sensitive to density, mixed uses, and block size. Bicyclists also use paths with characteristics that are necessarily different from those of pedestrians paths. Motor vehicle travel speed, presence of a bike lane or shoulder, bike parking, and other factors are all important elements of the bicyclist's environment that were not controlled for in this study's site selection process. Finally, it is not clear that bicycling is a travel mode often selected for reaching a neighborhood center for shopping trips.

Age, Gender, and Race of Bicyclists

In Ballard (U), Madison Park (U), Proctor (U), Wallingford (U), Juanita (S), and Mariner (S), most of the bicyclists were between the ages of 19 and 65. However, if the bicyclists wore a helmet or were biking quickly, it was difficult to distinguish between medium-aged and over 65. In Crossroads (S), Kingsgate (S), and Oakbrook (S) there were more young people biking than people the other age categories.

For all sites, more males were biking than females, consistent with national bicycling rates by gender. In addition, there were more Caucasian-looking bicyclists than People of Color. However, as in the age determination, people's race was difficult to categorize.

Location of Bicyclists Crossing the Cordon

Figure 59 shows the location of bicyclists as they entered the cordon, i.e., along the street, sidewalk, or within a parking lot. In urban areas, most bicyclists rode along the street as they crossed into the cordon, with the exceptions of Queen Anne and West Seattle where sidewalks were often used. In the suburban areas, bicyclists in Kent, Kingsgate, and Mariner were more likely to ride on sidewalks. Bicyclists in Oakbrook (S) either rode into the cordon at entry points within parking lots or along a street. Note that Oakbrook had very few miles of sidewalk. Most bicyclists in Juanita (S) and Crossroads (S) biked on the street.

The choice of where people bike may include factors such as the bicyclists age and proficiency in biking in traffic, as well as the nearby traffic and geometric conditions of the route. Also, bicyclists are educated not to bike on sidewalks. In Queen Anne (U), West Seattle (U), and Kent (S), the percentages of young bicyclists and those between 18 and 65 were similar. The presence of young bicyclists may explain why sidewalks were chosen. These children may have felt safer on the sidewalk or may have been instructed to bike only on the sidewalk.

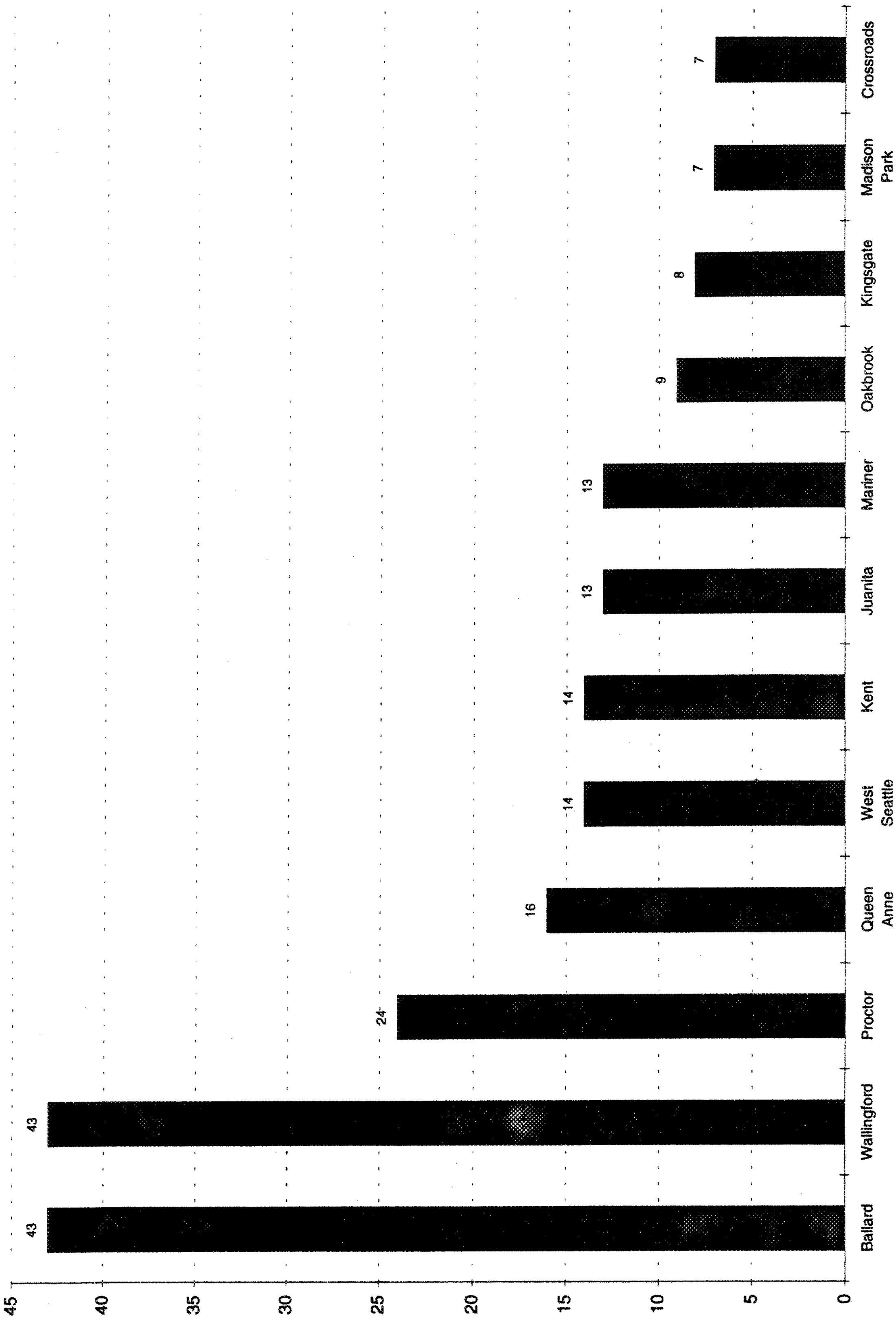

Figure 56. Actual Bicycle Trip Volumes

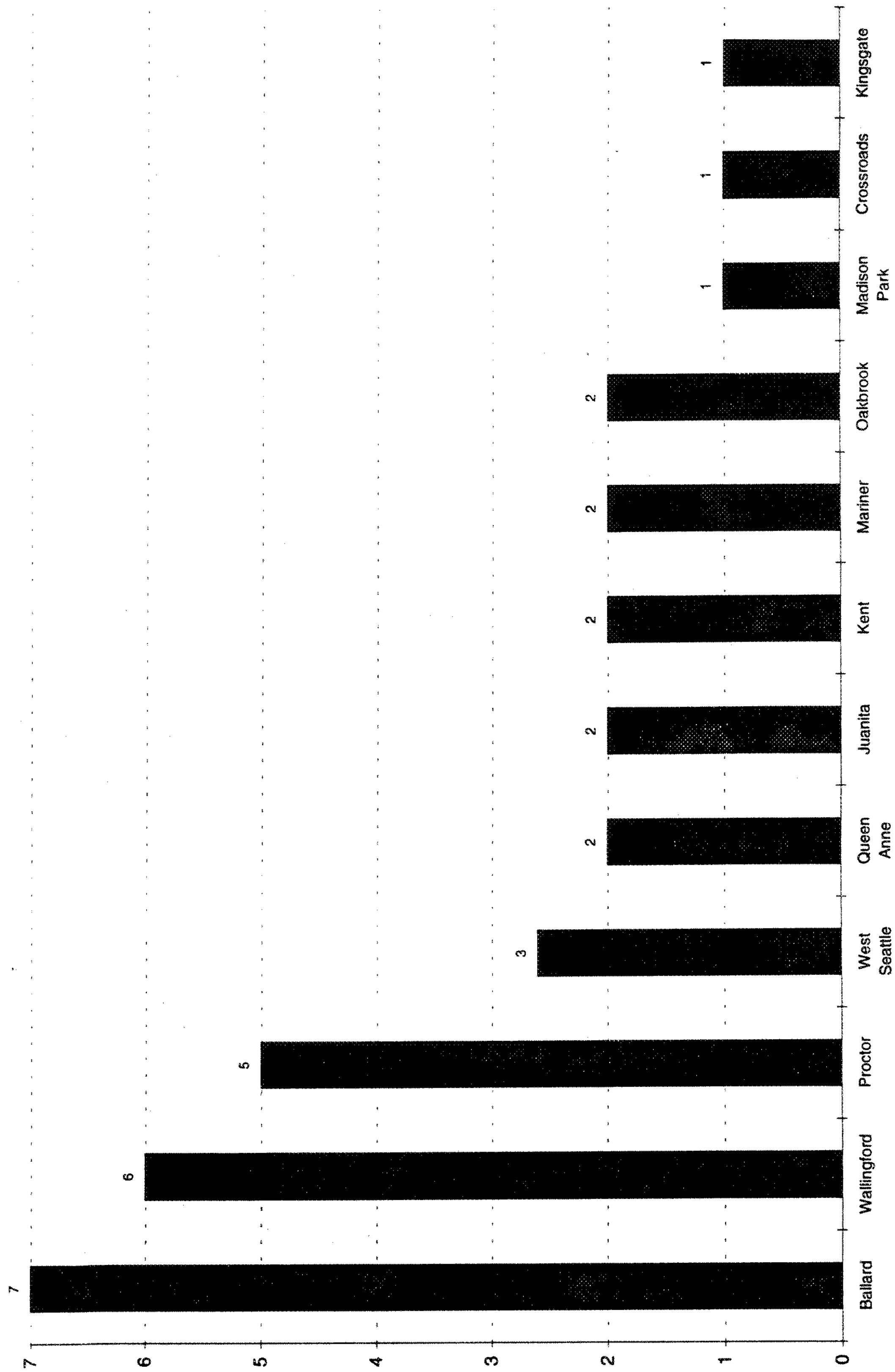

Figure 57. Bicycle Trip Volumes Adjusted per 1000 Residents

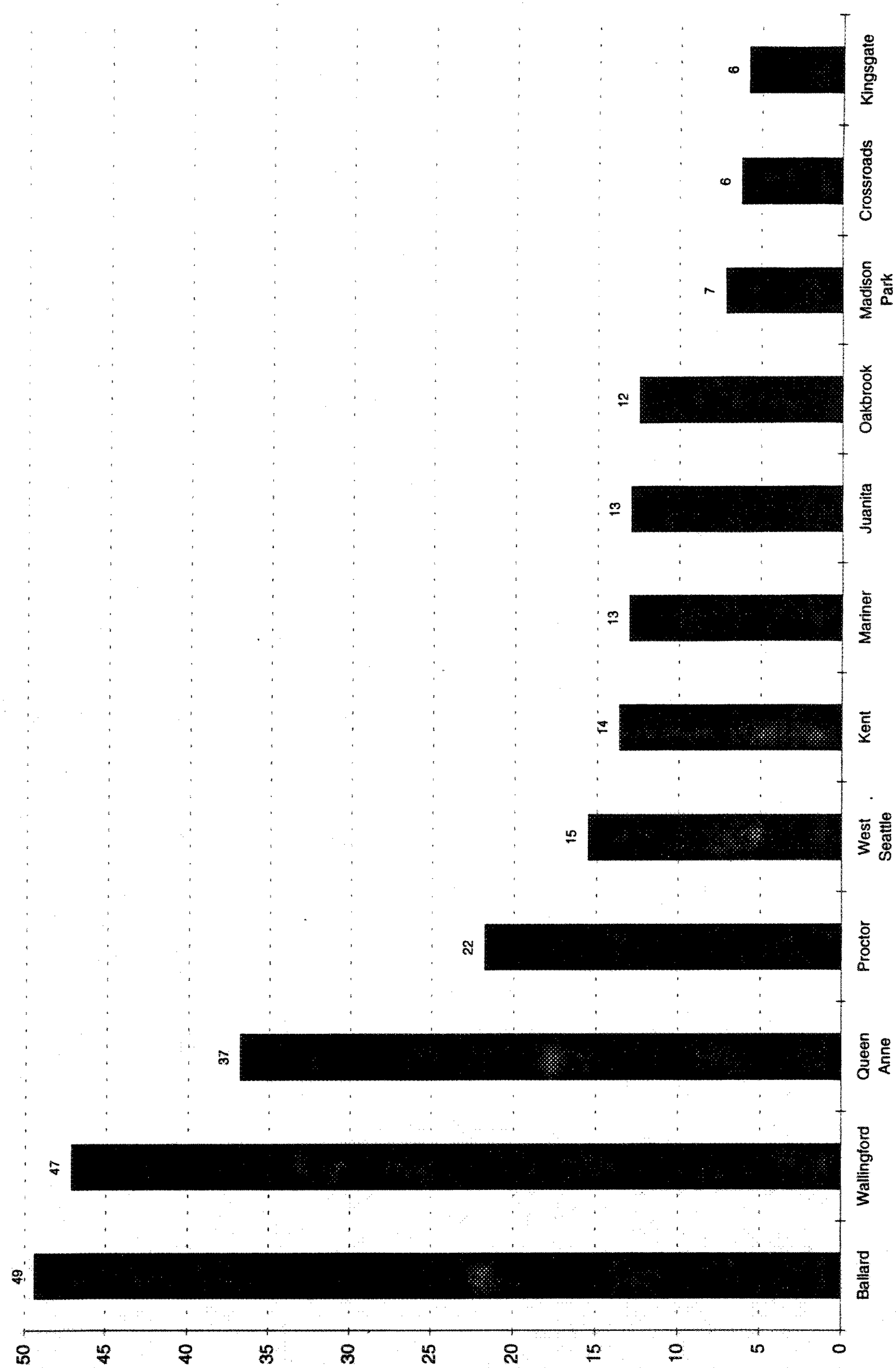

Figure 58. Bicycle Trip Volumes Adjusted per 500-Acre Area

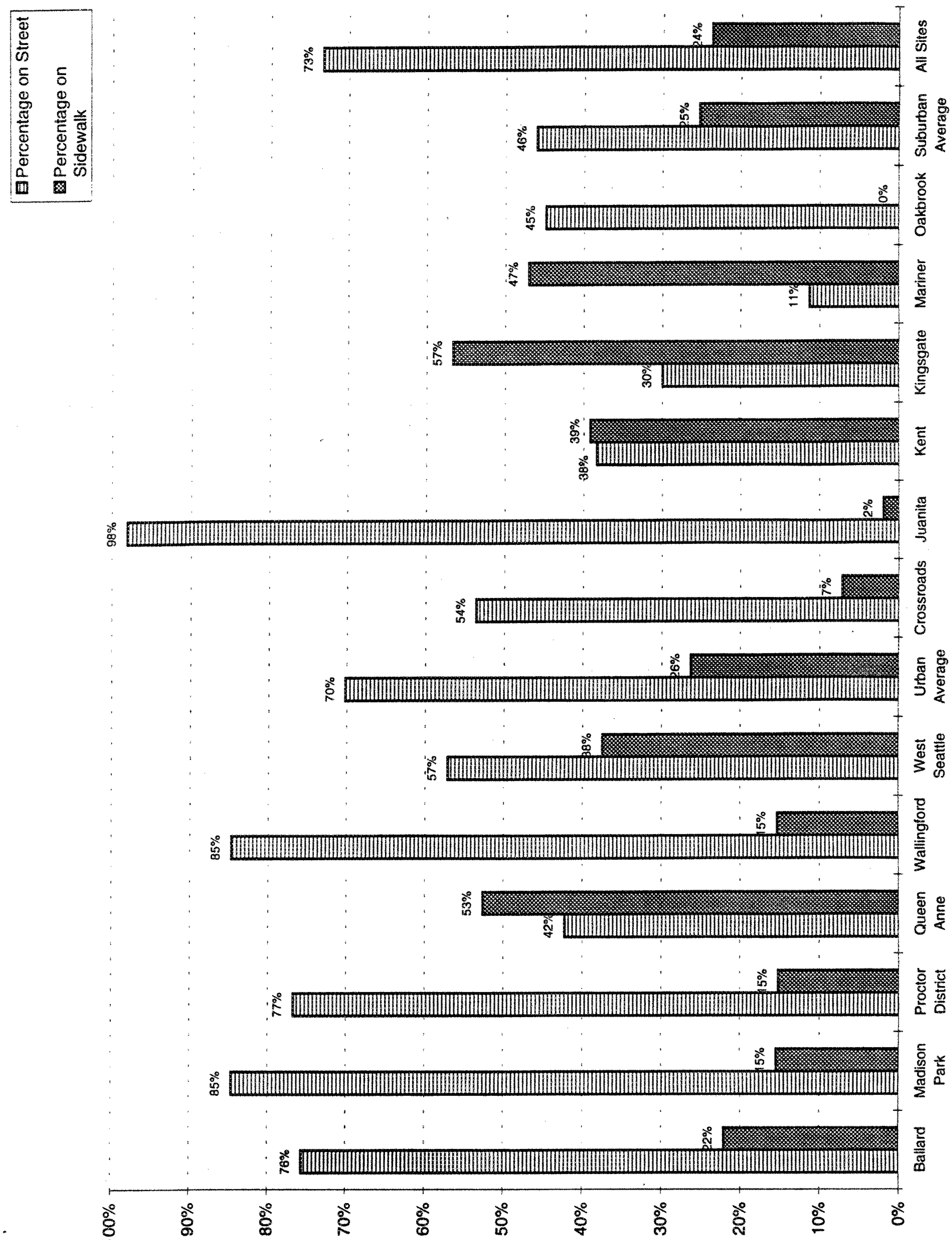

Figure 59. Percentage Location of Bicyclists Crossing the Cordon

IV. CONCLUDING REMARKS

This study shows that pedestrian volumes are related to site design. As such, the study points to the need for providing at least the basic pedestrian facilities in all areas, both urban and suburban, where there is a concentration of population living within compact, mixed-use development. In concluding this report, it is important to stress that the techniques in which site design characteristics were measured in this study only reflect the most salient site design differences between urban and suburban areas. Block size, length of sidewalk system, sidewalk completeness, and travel route directness measures only begin to define how dissimilar pedestrian environments are in urban and suburban sites. Additional measures to further depict the difficult conditions that pedestrians encounter in suburban areas would include computations of actual time distance of pedestrian travel (for example, the width of arterial streets in suburban sites increase substantially the time distance of pedestrian travel), as well as the quality of walking in parking lots, along narrow sidewalks, or on unpaved surfaces. Such trips require the pedestrian to be on constant alert and thus delays the trip (not to mention making it uncomfortable).

Furthermore, the psychological basis for selecting walking as a mode of transportation was not addressed in this study, although it is known to have a significant impact on mode choice. Estimating the length of a walking trip and assessing the pedestrian's level of safety are important mental processes that people make, consciously or unconsciously, before they confront the outdoors. These mental processes include emotional and perceptual interpretations that include consideration of more than the characteristics of the pedestrian facilities provided. The presence of other people on the street and the level of complexity of the physical environment surrounding the pedestrians are two variables that are known to affect walking.

These comments are not meant to diminish the value of this study. Given the complexity of the decision-making processes related to mode choice, it is all the more significant that this study's simple measures of site design and pedestrian facilities characteristics have been found to be related to pedestrian volumes. Rather, the comments are meant to caution future study about the complexity of the task ahead: building sidewalks and providing safe street crossing are first steps toward helping people walk. Further steps involve helping make the pedestrian trip comfortable and fun. At that point, the latent demand for pedestrian travel in suburban areas that this study has uncovered will become a reality.

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