



How Far, By Which Route, and Why? A Spatial Analysis of Pedestrian Preference



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MTI REPORT 06-06

**HOW FAR, BY WHICH ROUTE, AND WHY? A
SPATIAL ANALYSIS OF PEDESTRIAN PREFERENCE**

June 2007

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a publication of the
Mineta Transportation Institute
College of Business
San José State University
San José, CA 95192-0219
Created by Congress in 1991

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. FHWA/CA/OR-2006/24	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle How Far, By Which Route, and Why? A Spatial Analysis of Pedestrian Preference		5. Report Date June 2007	
		6. Performing Organization Code	
7. Authors Marc Schlossberg, Asha Weinstein Agrawal, Katja Irvin, and Vanessa Louise Bekkouche		8. Performing Organization Report No. MTI 06-06	
9. Performing Organization Name and Address Mineta Transportation Institute College of Business San José State University San José, CA 95192-0219		10. Work Unit No.	
		11. Contract or Grant No. 65W136	
12. Sponsoring Agency Name and Address California Department of Transportation Sacramento, CA 95815 U.S. Department of Transportation Research and Innovative Technology Administration 400 7th Street, SW Washington, DC 20590-0001		13. Type of Report and Period Covered Final Report	
		14. Sponsoring Agency Code	
15. Supplementary Notes			
<p>16. Abstract</p> <p>There is an increasing interest in community walkability, as reflected in the growing number of state and federal initiatives on Safe Routes to School, the new concern over a national obesity epidemic, and the rising interest in smart growth and related policy approaches to urban development. In each of these cases, walking is recognized as a key mode of travel, and increasing walking is viewed as a key goal.</p> <p>Despite the seeming simplicity of the goal of building communities that are good places to walk, we actually know very little about how our local infrastructure affects people's willingness or capacity to walk to access their desired destinations. The central research questions for this study are thus:</p> <ul style="list-style-type: none"> • How far do pedestrians walk to rail transit stations? • What environmental factors influence their route choice? <p>This research project surveyed people who walked to five rail transit stops to find out what route they walked and their preferences in choosing a walking route. In addition, we conducted an environmental audit of the streets and intersections around those stations.</p> <p>Combining the results from both activities, our analysis generated five key findings about pedestrian behaviors and preferences, including the finding that the average survey respondent walked a half mile, far farther than the quarter to a third of a mile assumed by many to be the maximum distance that Americans will walk. In addition, pedestrians in the study believed that their primary consideration in choosing a route is minimizing time and distance. Secondary factors influencing their route choice were safety from traffic and, to a lesser extent, attractiveness of the route, sidewalk quality, and the absence of long waits at traffic lights.</p> <p>Through the data collection and analysis process, we developed several recommendations related to the methodology for doing such detailed, block-by-block analysis. Three of these focus on how to reduce the time burden of collecting the data, allowing a research team to hone in on collecting only the most useful data. The final two findings address the practicalities of collecting the data—whether to use Pocket PCs or pen and paper, and the importance of ground testing maps if one uses a GIS-based system running on Pocket PCs.</p>			
17. Keywords Landscaping; Land use planning; Pedestrian walkways; Transit-oriented development; Walking	18. Distribution Statement No restriction. This document is available to the public through the National Technical Information Service, Springfield, VA 22161		
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 86	22. Price \$15.00

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Library of Congress Catalog Card Number: 2007924737

To order this publication, please contact the following:

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ACKNOWLEDGMENTS

We would like to thank the leadership and staff at the Mineta Transportation Institute for their support of all phases of this work, including Trixie Johnson, Sonya Cardenas-Carter, and Brendan McCarthy. We would also like to thank Laurie Miskimins and Janel Sterbentz, Portland State University graduate students who helped with survey distribution and other aspects of the Portland research sites.

Thanks are also offered to MTI staff, including Communications Director Leslee Hamilton and Graphic Artist Shun Nelson. Editing and publication services were provided by Catherine Frazier and Tricia Lawrence.

TABLE OF CONTENTS

EXECUTIVE SUMMARY	1
INTRODUCTION	7
LITERATURE REVIEW: PEDESTRIAN ROUTE CHOICE AND DISTANCES WALKED	9
DATA COLLECTION METHODS	13
ANALYSIS OF SURVEY FINDINGS	23
ANALYSIS OF WALKABILITY AUDIT DATA	33
CONCLUSIONS	45
APPENDIX A: SURVEY QUESTIONNAIRE	55
APPENDIX B: AUDIT INSTRUMENT	65
ENDNOTES	73
ABBREVIATIONS AND ACRONYMS	77
BIBLIOGRAPHY	79
ABOUT THE AUTHORS	83
PEER REVIEW	85

LIST OF FIGURES

1. Looking East to Japantown Station	14
2. Looking East to El Cerrito Plaza Station	15
3. The Hollywood Station, Located Between Heavy Rail and the Freeway	15
4. Looking at Both Sides of the Gresham Station	16
5. The Westbound Train at the Rockwood Station	17
6. Audit Tool	20
7. Examples of the Walkability Audit Data Entry Forms	21
8. Survey Respondent Origins, El Cerrito BART Station	24
9. Actual Walking Routes—Japantown Station	34
10. Pedestrian Volume With Safe From Crime Audit Data	35
11. General Appearance Index, Japantown	37
12. Overall Greenery Index, Japantown	38
13. Overall Appearance Index, Japantown	40
14. Japantown Attractiveness and Crime Subjective Assessments	41
15. Julian Street Drill-Down Using Objective Criteria Indexes	42
16. Julian Street	43
17. An Example of an Audit Tool Customized by Street Type	51

LIST OF TABLES

1. Survey Response Rates by Station	18
2. Variables Included in Walkability Audit	20
3. Demographics of Survey Respondents	25
4. Trip Purposes by Station	25
5. How Many People Stopped, For What Reason, and How Long	26
6. Self-Reported Distance Walked in Miles, Blocks, and Minutes	26
7. Actual Distances Walked	27
8. Accuracy of Self-Reported Trip Distances	27
9. Consistency of Route Choice	28
10. Percent of People Volunteering a Factor as Influencing Their Route Choice	29
11. Respondent Ratings: Importance of Factors That Might Influence Their Route Choice	30
12. Attitudes Toward Walking	31
13. General Appearance Index	36
14. Greenery Index	38
15. Overall Appearance Index	39

EXECUTIVE SUMMARY

STUDY OBJECTIVES AND METHODOLOGY

There is an increasing interest in community walkability, as reflected in the growing number of state and federal initiatives on Safe Routes to School, the new concern over a national obesity epidemic, and the rising interest in smart growth and related policy approaches to urban development. In each of these cases, walking is recognized as a key mode of travel, and increased walking is viewed as a key goal.

Despite the seeming simplicity of the goal of building communities that are good places to walk, planners and policymakers actually know very little about how the local built environment affects people's willingness or capacity to walk to access their desired destinations. The central research questions for this study are thus:

- How far do pedestrians walk to rail transit stations?
- What environmental factors influence their route choice?

This research project collected two types of data to assess how far people walk to rail stations and the environmental factors that influence their route choices:

1. Pedestrian survey: People who walked to five rail stations in Portland and the San Francisco Bay Area were given surveys and asked questions on walking behavior, preferences, and route choice. In addition, respondents were given a map and asked to trace their walking route, as well as to mark intersections and streets they avoided on their walk. A total of 328 surveys were returned, for a 45 percent response rate.
2. Walkability audit: A geographic information systems (GIS) and Pocket PC tool was developed to evaluate specific elements of the walking environment at a streetscape scale that previous researchers have identified as likely to affect a neighborhood's walkability. The audit tool assessed block segments and intersections separately, since pedestrians experience the two in different ways. For each block segment, the auditor gathered holistic, subjective assessments about the block as well as collected detailed data on the block's maintenance and cleanliness, amenities, sidewalk characteristics, buffer zone characteristics, front zone characteristics, and roadway characteristics. For each intersection, the audit collected data on factors affecting the ease of crossing the street, such as the presence of traffic control devices, crosswalks, and curb cuts. Audit data was collected for all streets in a half-mile radius around two stations.

STUDY FINDINGS

After this data was collected, the survey results were analyzed to assess respondents' own perceptions of how far they walked and why they chose their route. In addition, the walkability audit data was used to analyze the built environment characteristics of the routes people chose to walk and the places they avoided.

Findings on Walkability: Implications for Planning Practice

Three findings about walkability from the survey stood out as particularly relevant for future planning efforts. First, the survey showed that pedestrians walk considerably farther than commonly is acknowledged. In addition, the survey responses indicated that the respondents' primary goal in choosing a route was to minimize distance and time, but that safety and aesthetic considerations were also important to them.

Finding 1: Pedestrians walk considerably farther to access rail stations than commonly assumed.

Conventional wisdom among planners has been that pedestrians in the United States will only walk a quarter to a third of a mile for any reason, including to access transit. The results of our study suggest quite differently, at least for walk trips to access rail transit. The median trip distance was 0.47 miles, showing that fully half the people surveyed walked at least a half-mile to access the train station. The study results therefore show that the conventional wisdom underestimates actual pedestrian behavior, at least for the conditions we studied.

The study finding that pedestrians walk unexpectedly long distances suggests that transportation and land-use planners designing transit-oriented developments should plan to provide pedestrian infrastructure and pedestrian-scaled design within a larger radius than previously assumed.

Finding 2: Pedestrians believe that their primary consideration in choosing a route is minimizing time and distance.

The survey explored the reasons that pedestrians choose particular routes in two ways, first asking about route choice factors as an open-ended question and then asking respondents to rate the importance of a list of factors that might have influenced them. In both cases, respondents overwhelming indicated that their first priority was to choose the most direct and/or quickest route. Because almost all of our respondents were making a morning commute trip, it is not surprising that time would be a strong consideration for them.

These results suggest that land-use planners who want to increase walk trips should ensure that pedestrians have available direct routes to their destinations. Grid street patterns are a good choice because they provide direct routes (as well as route choice). If the grid has very long blocks, planners might want to consider adding mid-block footpaths through the center of the block. In neighborhoods that have been designed on a cul-de-sac pattern, planners could create pedestrian cut-through passages that allow walkers direct access to many different destinations.

Finding 3: Secondary factors influencing route choice are safety and, to a lesser extent, attractiveness of the route, sidewalk quality, and the absence of long waits at traffic lights.

In both the open-ended and closed-ended questions about route choice, the most highly rated factors after distance had to do with safety. In the open-ended question, safety factors were the only other issue listed by over a quarter of respondents. In the closed-ended questions, about

half of respondents rated it as “very important” to have traffic devices present and traffic driving at safe speeds. The next most-cited “very important” factor was having sidewalks in good condition (43 percent). Aesthetic factors, in the sense of attractive landscaping or buildings, were rated as very important by 35 percent of respondents, but raised by only 8 percent of the respondents in the open-ended question. The only other issues rated as “very important” by at least a quarter of respondents were having other people present (which may be a safety-related concern), and the absence of traffic lights with a long wait.

These results suggest that transportation planners and traffic engineers wanting to encourage walking should pay particular attention to ensuring that pedestrians feel safe crossing streets by keeping traffic to safe speeds and having traffic control devices present to help pedestrians cross intersections. Other transportation infrastructure issues to address are sidewalk availability and the length of time pedestrians must wait at traffic lights.

The fact that respondents significantly prioritized time saving over aesthetic qualities of the built environment raises the question of whether pedestrian planners need not initially worry too much about the urban design details that pedestrians experience. Our results suggest that if people have a quality destination that they can walk to, they will walk unless there is some significant barrier that prevents them from doing so. Perhaps the key to increasing the number of walk trips is not to design pedestrian environments full of amenities such as benches, tree cover, awnings, and wide sidewalks—although there is no doubt those assets can greatly enhance the pedestrian experience—but rather to prioritize giving people places to walk in an environment without any major barriers to walking.

Findings on the Survey Methodology: Implications for Research

The survey generated two key lessons for designing and interpreting research that collects information on how far people walk and the routes they take. First, the study demonstrated that asking participants to draw their route on a map works well. In addition, the study demonstrated that data derived from questions asking pedestrians to estimate the distance they walked must be interpreted cautiously.

Finding 4: Asking survey respondents to trace their walking route on a local map is an effective research technique.

Asking respondents to draw their route on a map has been a relatively undocumented survey technique, but the study results show that the technique is highly effective. Of the 328 surveys received, the map was filled out correctly 93 percent of the time, generating 261 routes that could be analyzed for actual distance and other route characteristics. The route tracings were legible and precise enough that the research team had no trouble transferring the exact routes into a GIS database where the distance could be automatically calculated and walking routes recorded. In addition, the relatively high response rate for the survey overall (45 percent) shows that the presence of the map did not discourage people from completing the survey.

The results of the map question on the survey suggest that asking respondents to draw a route on a map is an effective research technique that can gather high response rates. In addition to generating data on walking routes, it is a useful way to assess walk trip distances.

Finding 5: Pedestrians vary considerably in how accurately they estimate the distance of a regular walk trip.

Many travel surveys ask respondents to self-report the distances they travel. To date, there has been little published research into how accurate those self-reported estimates might be. This study found that the average difference between actual and perceived distance is modest, although a significant minority of respondents were also fairly far off. At least half of all respondents guessed within 0.13 miles of their actual route length. However, 25 percent of respondents' guesses were off by more than 50 percent or a quarter of a mile, suggesting that a substantial minority do not have a precise idea of how far they walked. A few of the individual guesses were also substantially off in terms of distance, as well as percent: guesses ranged from up to 1.07 miles over to 0.88 miles under the correct distance.

The findings on reported walking distances suggest that researchers cannot assume that pedestrians will provide a highly accurate estimate of the distances they walk, even for short and routine trips. This finding is useful for assessing the value of survey data that ask for self-reported walking distances. However, these study findings should be interpreted carefully when applying them to other surveys. Our survey asked people to estimate the distance of a route they walk routinely, so they may well have a more accurate sense of distance than they would on a less familiar trip. Other surveys asking people to report the distances of routine trips might have similar (in)accuracies, but the study results should not be assumed to hold true for other types of trips that surveyors ask about.

Findings on the Walkability Audit Methodology: Implications for Research

Through the data collection and analysis process, we developed several recommendations for how best to conduct detailed, block-by-block walkability analyses. Findings six through eight focus on ways to reduce the time burden of collecting walkability audit data, allowing a research team to hone in on collecting only the most useful data. The final two findings address the practicalities of collecting the data—whether to use Pocket PCs or pen and paper, and the importance of ground testing maps if one uses a GIS-based system running on Pocket PCs.

Finding 6: Spatially target the areas in which to collect walkability audit data.

Collecting data about the quality of street segments and intersections that pedestrians travel through generated very interesting findings that correlated with respondents' route choices, but we quickly realized that applying such a tool (or any walkability evaluation instrument) to every location was an inefficient use of time. For many neighborhoods, one useful way to limit the data collection burden is to focus on arterials and collector streets. It was also apparent from our study sites that, in some study neighborhoods, it was almost unnecessary to audit

residential streets because they were similar to each other and provided an adequate walking environment.

Focusing the audit on arterials, collectors, and their associated intersections may be a better use of data collection time for future projects. In essence, the more focused question could be “what makes a major automobile road more or less pedestrian friendly?” An alternative research approach to streamline the walkability audit data collection process may be to audit only those locations in a study area that have been identified as problematic.

Finding 7: Customize data collection by street type.

Based on the study experience, we concluded that walkability audit instruments should differentiate among street types, so that surveyors only have to collect the data most relevant to each type of street or path. It became clear during the walkability audit that arterial and collector streets presented a different set of attributes that needed documentation compared to neighborhood streets. Customizing data entry variables for different types of streets would streamline the data collection process and allow a greater range of streets to be surveyed in a shorter period of time. This strategy would also produce a more streamlined and relevant set of data for analysis, reducing the time needed for the data analysis.

Finding 8: Consider using holistic, subjective measures of walkability instead of more detailed quantitative measures.

We found that, in many cases, the subjective assessment of how safe or attractive a block was seemed to better capture the pedestrian environment than did the many quantitative measures included in the walkability audit. These subjective measures are also obviously much quicker to collect, so future researchers may wish to concentrate on a few subjective measures only, to save data collection time.

One limitation of relying solely on broad subjective evaluations of walkability is that these do not provide decision makers with any guidance on how to design or retrofit areas targeted for pedestrian improvements. However, for studies of pedestrian route preference, such subjective measures may be enough to determine whether urban design features impact route choices or not, or whether shortest routes are the predominant factor in influencing trip making. More detailed audits of the design features in a neighborhood could be reserved for planning studies where planners and decision makers wish to identify specific environmental features that need to be upgraded.

Finding 9: Weigh carefully the benefits of collecting audit data on paper vs. on a Pocket PC.

Lastly we reflect on the utility of an electronic and GIS-enabled approach to audit data gathering versus a more traditional approach of paper, pen, and clipboard. The obvious benefit of the handheld GIS computer approach is that by collecting data both in an electronic and a GIS format, there is no need for subsequent data entry once the audit is complete. The GIS data collection approach also eliminates the danger that data collected on paper will be

incorrectly entered into the computer database when later converting the data to a GIS environment. Also, the GIS technology greatly reduces the total time involved, because the data does not have to later be converted to GIS from a paper form or electronic database. Disadvantages of the GIS technology were that recording field notes can be more difficult or even impossible; audit questions must be answered in the order they are written, not as they are observed; the battery life of Pocket PCs can be too short for all-day auditing unless extended batteries are purchased; some people just find the Pocket PC too cumbersome to use; carrying expensive computers while analyzing neighborhood streets and sidewalks can be unsafe in certain neighborhoods (or make auditors feel unsafe), and cost and technological accessibility could be a problem for projects with limited budgets.

Finding 10: Ground truth base maps.

Although we found that collecting GIS-enabled data at a streetscape level was generally straightforward, we did learn (the hard way) that it is critical to ground truth the street base map that will form the core of the data set before using the tool in the field. It is possible to add or delete street segments or adjust street ranges in the field by using the ArcPad program running on the Pocket PC, but it is critically important that some basic ground truthing of the base GIS data be conducted prior to auditing the environment. It is also important to check the address ranges of the streets within the TIGER data after uploading data to ArcPad to ensure they are consistent with actual address ranges of the streets. We found address ranges that were one block off, meaning we had to correct these errors in the map by hand before it was possible to accurately geocode our survey data.

INTRODUCTION

Understanding how the built environment impacts walking decisions is critically important as our society begins to recognize that the unwalkable development patterns of the last sixty years are unsustainable in terms of energy use, public health, and social cohesion. The increasing interest in community walkability is reflected in the growing number of state and federal initiatives on Safe Routes to School, the new concern over a national obesity epidemic (especially in children), and the rising interest in smart growth and related policy approaches to urban development. In each of these cases, walking is recognized as a key mode of travel, and increased walking is viewed as a key goal.

Despite the seeming simplicity of the goal of building communities that are good places to walk, we actually know very little about how our local infrastructure affects people's willingness or capacity to walk to access their desired destinations. A formidable challenge, then, is to characterize the local environment from a pedestrian point of view, understanding both the distance people are willing to walk to access a location and the characteristics of their preferred routes.

The central research questions for this study are thus:

1. How far do pedestrians walk to rail transit stations?
2. What environmental factors influence their route choice?

The first question, about the distances people walk, provides data the transportation planning community needs in order to plan communities that facilitate walking for residents. For decades, community planners have tended to assume that pedestrians will only walk a quarter or a third of a mile and planned neighborhoods accordingly. However, there is little evidence to back up this rule of thumb. Indeed, there is very little evidence about how far people walk for any type of trip. This paper helps to fill these gaps in knowledge about walking distances by providing data on the distances people walk for one type of trip: commute trips to access rail transit.

The second question recognizes that people base their decisions about walking on more than simply whether or not it is possible to get to a destination within a reasonable distance; the characteristics of each section of path that a pedestrian potentially uses could encourage or dissuade a person from walking. Too often advocates for increased walking assume that low rates of walking are a result of personality flaws such as laziness and thereby minimize the larger impact of urban form on people's capacity or desire to walk. This research report focuses on how pedestrians experience the most local, micro-scale aspects of the physical environment through which they walk, such as traffic control features or the presence or absence of greenery.

Although there is growing interest among researchers in how pedestrians react to the micro-level environment, few conclusive results have emerged from the body of work, as

discussed in the next section of the paper. This report adds to that developing body of literature. Conclusions from this research can then assist transportation and city planners to plan, develop, and retrofit urban spaces that will support walking.

This research project collected two types of data to assess how far people walk to rail stations and the environmental factors that influence their route choices:

1. Pedestrian survey: People who walked to train stations in Portland and the San Francisco Bay Area were given surveys and asked about their pedestrian preferences and their walking trip, including tracing their route on a map.
2. Walkability audit: A GIS and Pocket PC tool was developed to evaluate specific elements of the walking environment at a streetscape scale within the project study areas.

After this data was collected, the survey results were analyzed to assess respondents' own perceptions of how far they walked and why they chose their route. In addition, the walkability audit data was used to analyze the built environment characteristics of the routes people chose to walk and the places they chose to avoid.

The remaining sections of the report discuss the body of literature to which our study contributes, the study methodology, the results of the survey, and the analysis of the walkability audit data. The study concludes with a series of ten findings and associated recommendations for planning practice and future research methods.

Three findings from the survey about walkability stood out as particularly relevant for future planning efforts. First, the survey showed that pedestrians walk considerably farther than commonly is acknowledged. In addition, the survey responses indicated that the respondents' primary goal in choosing a route was to minimize distance and time, but that safety and aesthetic considerations were also important to them.

The survey generated two key lessons for designing and interpreting research that collects information on how far people walk and the routes they take. First, the study demonstrated that asking participants to draw their route on a map works well. In addition, the study demonstrated that data derived from questions asking pedestrians to estimate the distance they walked must be interpreted cautiously.

Through the data collection and analysis process, we developed several recommendations related to the methodology for doing such detailed, block-by-block analysis. Three of these focus on how to reduce the time burden of collecting the data, allowing a research team to hone in on collecting only the most useful data. The final two recommendations address the practicalities of collecting the data—whether to use Pocket PCs or pen and paper, and the importance of ground-testing maps if one uses GIS running on Pocket PCs.

LITERATURE REVIEW: PEDESTRIAN ROUTE CHOICE AND DISTANCES WALKED

As explained in the introduction, the study addressed two primary questions:

1. How far do pedestrians walk to rail stations?
2. What environmental factors influence their route choice?

For neither question is there a well-established literature providing firm answers. Rules of thumb and educated guesses about walking behavior abound; however, relatively little research exists regarding these topics in particular. Until the mid-1990s, pedestrian behavior was largely ignored in the transportation and planning literatures. In the last decade—and especially the last five years—the topic has suddenly become popular and many studies about pedestrians have been published or are underway. Much of the new literature has come from the public health community, complementing work done by planning and transportation researchers. Despite this outburst of activity, however, little of it has documented walk trip distances and there is also little consensus about which environmental factors influence pedestrians most.

WALK TRIP DISTANCES

Very little published literature looks specifically at how far pedestrians walk to any destination, including rail stations. The main sources of information on walk trip distances are the U.S. Census, National Household Travel Survey (NHTS), and regional household travel surveys. These surveys often report the number of walk trips made, but do not necessarily include trip distances, and even when they do, the data is often suspect. In the 2001 NHTS, for example, surveyors recoded many walk trip distances to the nearest *mile*.¹ Given that most walk trips are quite short, this recording method makes the data almost useless for understanding walk trip distances with any precision.

In terms of how far pedestrians walk to access rail transit specifically, most of the existing data is collected when transit agencies conduct internal surveys of their passengers. Researchers usually do not have easy access to this data, since transit agencies rarely publish their findings. In addition, such surveys usually ask respondents to estimate the distance they walked, so the data accuracy has been questionable because there is little research testing the reliability of these estimates. One published study from the mid-1990s, however, gathered a few such surveys from the United States and Canada and conducted an additional survey of light rail riders in Calgary, Canada. The authors found that the median walking distance to a rail station in Calgary was about a fifth of a mile, though at suburban stations it was twice that distance.²

THE INTERACTION BETWEEN WALKING AND THE BUILT ENVIRONMENT

Researchers have studied the second question, the environmental factors that influence route choice, in somewhat more detail than walk trip distances, but the field is still very much in development. The earliest and largest body of research on pedestrian behavior, which comes from the transportation planning community, assesses the environmental factors that influence people to choose one mode of travel instead of another. In general, the authors of these studies want to understand how to shift Americans away from solo driving trips and toward transit, biking, or walking. Because the research was usually designed solely to discover why people choose to walk instead of drive, most studies did not examine the distances or routes walkers traveled. The majority of these studies claim to look at what is often called the “three Ds,” density, diversity, and design, but in reality the studies tend to focus on the first of the two Ds, density and diversity of land uses. Many researchers have concluded that residents are more likely to walk in dense neighborhoods that include a diverse mix of nonresidential uses within a short distance,³ although a subset of the research community remains unconvinced that the association is very strong, except for comparisons between extremely high and extremely low densities.⁴

Despite the rhetoric about the three Ds, these planning and transportation studies assessing mode choice usually ignored micro-scale urban design and environmental factors, likely because no pre-existing datasets captured design factors such as the presence of greenery, attractive buildings, sidewalk quality, traffic control devices that aid pedestrians crossing the street, or the presence of heavy traffic.

Nevertheless, in North America and Europe scattered studies starting in the 1970s investigated such design factors, many focusing on how heavy traffic volumes discourage walkers.⁵ Since 2000, a burst of new research is taking on the design question more rigorously, with a number of studies on the topic appearing in the last decade.⁶ However, researchers have quickly discovered that pedestrian behavior is highly complex and difficult to study, and the existing body of research points to few consistent findings. One exhaustive review of the evidence linking physical activity with the built environment concluded that there is limited evidence showing a connection between neighborhood design and walking, but that further research is needed to determine if there is truly no link or if existing research has not been designed properly to reveal real relationships.⁷

A new body of research recently trying to better understand how design impacts pedestrians focuses on developing audit tools to collect data on and measure the variety of streetscape elements that might promote or hinder walking behavior. These audit tools try to define the context of the relationship between walking and urban form at a much finer geographic scale and much more comprehensively than has been done before.

Moudon and Lee developed an audit tool and conceptual framework for measuring walkability, both to set current work into a theoretical context and to help direct future research efforts. To develop their framework, they performed an exhaustive review of over thirty published methodologies and inventorying tools that have been developed to assess

walkability. They outlined a theoretical framework called the Behavioral Model of Environments that seeks to account for personal, physical, and internal response factors that may explain the connection between individual pedestrians and their walking environment. In essence, Moudon and Lee attempt to lay the theoretical groundwork describing the characteristics of place and urban form that influence pedestrian behavior. Because Moudon and Lee do not test their variables in research with real pedestrians, their work provides no evidence linking the urban design elements to actual walking behavior at the streetscape scale.⁸

Ewing et al. approached urban design professionals to gather professional opinions about design and walkability to: (1) develop operational definitions of the built environment relevant to pedestrians; and (2) translate those definitions into a field survey instrument.⁹ The basic goal of this research was to identify those more subtle urban design qualities that may intervene between the nature of the built form and walking behavior. The study identified five areas—imageability, enclosure, human scale, transparency, and complexity—that could be reasonably measured to test the link between design and behavior.

One of the outputs of the research by Ewing et al. is a scoring sheet to measure specific design elements within the five urban design categories of imageability, enclosure, human scale, transparency, and complexity. Examples of the measurements include the number of courtyards, plazas, and parks (imageability), number of long sight lines (enclosure and human scale), proportion of windows at the street level (transparency), and number of basic building colors (complexity). This work provides an important contribution in linking the pedestrian experience in a specific space to the larger design elements of both the block and the city. It is not clear, however, if these more subtle urban design elements impact pedestrian behavior or preference for one route over another. It also seems that this work is geared more to casual urban strolling rather than walking as an efficient mode of travel to access particular destinations such as a transit stop. Finally, although this study presents characteristics of urban design that may influence pedestrian perceptions, the study offers no evidence that the measures do in fact influence pedestrian or route choice behavior because actual pedestrian behavior was not incorporated into the study.¹⁰

One pedestrian and urban design assessment tool that is looked upon as a standard in this emerging field is an environmental audit instrument called SPACES. It is a comprehensive tool that inventories the characteristics of the built environment along a roadway segment.¹¹ The authors categorize different factors of a walking environment into five classifications:

1. functional (physical attributes of the street)
2. safety (characteristics of a safe environment)
3. aesthetic (elements such as trees or gardens)
4. destination (relationship of neighborhood services to residences)
5. subjective (attractiveness and difficulty)

Examples of the measures include intersection design, path continuity, path design, path maintenance, path surface, traffic speed, cleanliness, trees, and lighting.

Building on SPACES, Clifton and Livi developed the Pedestrian Environment Data Scan (PEDS) audit tool, which includes 78 measures of streetscape characteristics that other research has shown to influence walkability. Clifton and Livi studied the inter-rater reliability of the instrument in order to understand the potential of such tools to be used in broad geographic areas with a diversity of audit administrators. They found relatively high reliability scores for many of the questions contained within the audit instrument, despite a wide range of street segment uses, conditions, and aesthetics.¹²

Finally, despite the development of these new conceptual and operational frameworks for assessing local walkability, researchers have been limited by the amount of time required to conduct block-by-block assessments of every street segment and intersection within a study area. As researchers identify more aspects of the built environment that may be important in creating walkable environments, the burden of applying those measures to each street segment grows. Thus, actual application of walkability audit tools has lagged despite a growing number of them being available to planners.

DATA COLLECTION METHODS

This study used two primary data collection methods: 1) a pedestrian survey; and 2) a block-by-block audit of the walking environment in two neighborhoods. Surveys were distributed at five transit stations. Two were in California's San Francisco Bay Area: one in San José (Japantown) and one in El Cerrito (El Cerrito Plaza). The other three were in Portland, Oregon (Hollywood, Gresham, and Rockwood). The Walkability Audit focused on the El Cerrito Plaza and Japantown station areas. Details of the methods and the study sites are presented below.

STATION AREA SELECTION

The primary criteria for selecting the station areas was to find neighborhoods where pedestrians would have a reasonably high number of different route options. Because we assumed that people would not be willing to walk more than a little bit out of their way to find a nicer route, we selected only neighborhoods with streets laid out in a grid pattern. With a grid street pattern, respondents had multiple routes to choose from that were all approximately the same distance. We also chose neighborhoods where walkers would have a mix of local and collector or arterial streets, as well as both residential and mixed-use or commercial streets. The stations finally selected were chosen after a combination of site visits, visual overview from aerial photographs, and review of basic census and transit agency ridership information in order to choose stations that had a potentially sufficient number of people who accessed transit by foot.

Japantown

The Japantown station, in San José, California, is part of the Santa Clara Valley Transportation Authority's light rail system (see [Figure 1](#)). The light rail system has 62 stations and 77 miles of tracks, and it serves northern Santa Clara County. Overall ridership is relatively small, with about 21,000 weekday boardings in 2005.¹³

The station is located in historic Japantown, an area of traditional neighborhoods just outside of downtown San José. Built environment conditions in the area are slowly improving, but maintenance and other conditions still vary substantially from block to block. Several medium- and high-density residential projects have been completed since 2000, to the east near Japantown and to the south near First and Julian Streets. In contrast to this walkable environment, the area west of Highway 87 is largely designated for open space to protect the airport flight path, which further strengthens the pedestrian boundary created by the freeway.



Figure 1 Looking East to Japantown Station

El Cerrito

The El Cerrito Station (see [Figure 2](#)) is part of the Bay Area Rapid Transit system (BART), which serves four counties in the Bay Area region. The system has 101 miles of tracks and 66 stations.¹⁴ In 2005, BART reported almost 93 million passenger trips.¹⁵

The neighborhood around the El Cerrito Plaza BART station is laid out in a grid street network. The area is primarily residential, with several commercial streets, plus a large shopping center to the south of the BART station. Underneath the BART tracks runs a popular bicycle and pedestrian path, the Ohlone Greenway.

The catchment area for potential walkers to the BART station is quite large. There are no competing BART stations within walking distance, although there is frequent bus service along San Pablo Avenue, as well as lines that run along Fairmount, Central, and Pierce, all of which stop at the BART station. There are no major barriers created by freeways or other features of the built environment. To the east of the station, the neighborhoods rise up a moderately steep hill. To the west, the land is relatively flat except for a large hill about 1/3 mile to the southwest.



Figure 2 Looking East to El Cerrito Plaza Station

Hollywood (Portland)

The three Portland area stations are all on the TriMet Max Light Rail system, east of downtown Portland. There are 44 miles of track and 66 stations on the system's three lines. Average weekday boarding across the light rail system is about 100,000 per day.¹⁶

The Hollywood station (see [Figure 3](#)) lies between a freeway and a heavy rail line, and is accessed from either side by a pedestrian foot bridge. One side of the station consists mainly of residential housing, with mostly residential streets closest to the station. The other side of the station is bordered by a bus drop-off zone, commercial and office space, and a combination of multi-family and single-family residential sections. This side also has two fairly heavily used arterials bisecting the space.



Figure 3 The Hollywood Station, Located Between Heavy Rail and the Freeway

Gresham (Portland)

The Gresham station is adjacent to a centralized bus hub, and the two transit facilities combined are considered one of TriMet's transit centers. The Gresham area was developed prior to World War II and to the south and east of the station there is a street grid pattern typical of that era. There are no arterials or other major roads between this residential area and the station. Outside this gridded area, there are a number of major roads, some within the quarter-mile area. There are also large commercial areas and offices nearby, and a mixture of both single-family and multi-family residential areas (see [Figure 4](#)).



Figure 4 Looking at Both Sides of the Gresham Station

Rockwood (Portland)

The Rockwood Transit Station (see [Figure 5](#)) is located on 188th and East Burnside in Gresham. The east and westbound platforms are separated by the signal at 188th. The station sits on a busy commercial corridor with multi-family and single-family residences adjacent to it in all directions.

The station is accessible via one bus line and there are sidewalks throughout the neighborhood area around the transit stop. There are signalized crossings at Burnside and 188th, but the distance to cross is quite long because the streets are major arterials. Directly across from the westbound platform sits a large commercial lot that is currently unoccupied, although it has become an informal park-and-ride lot.



Figure 5 The Westbound Train at the Rockwood Station

PEDESTRIAN SURVEY

In the survey conducted for this research, respondents were asked a series of questions about how far and how long they walked to the station, what factors influenced their choice of route, their attitudes toward walking, and some basic demographic questions. The survey questionnaire is included in [Appendix A](#).

Surveys were distributed at transit stations to people who walked to the transit stop. Between one and three surveyors distributed surveys, depending on the day and station, and they worked between 6 A.M. and 10 A.M. on mostly weekday mornings from February to May 2006. The surveyors followed a script for consistency. At four of the stations, surveyors approached all people waiting at the station and ask how they arrived at the station. At the El Cerrito BART station, which has higher ridership, the surveyors selected a random sample of the riders waiting on the platform.¹⁷

Those people who responded that they walked to the station were asked follow-up questions to determine their eligibility for the study: (1) if they were over 18 years of age, and (2) if they

would be willing to participate in the study anonymously. Willing survey respondents received a six-page written survey, a pen, and a pre-addressed and stamped return envelope. They were asked to either return the completed survey to the surveyor at the station or mail it back in the pre-stamped envelope. Very few respondents returned surveys at the station because the trains arrived quite frequently.

The survey included three sections:

1. Questions on walking behavior, preferences, and route choice.
2. A map inserted in the survey on which respondents were asked to trace their walking route. Respondents were also asked to mark intersections and streets they avoided on their walk.
3. Basic demographic questions.

A total of 328 surveys were returned. [Table 1](#) shows the number returned per station, as well as the response rate per station. Almost two-thirds of the surveys (64 percent) came from the two Bay Area stations; over a third of the surveys came from El Cerrito Plaza station and just over another quarter came from the Japantown. Of the remaining surveys, almost a quarter came from Portland's Hollywood station (24 percent), and the Gresham and Rockwood stations in Portland generated the remaining few.

Table 1 Survey Response Rates by Station

Station	Number of Completed Surveys	Response Rate% ^a
El Cerrito Plaza	120	71
Japantown	90	49
Hollywood	78	45
Gresham	15	15
Rockwood	25	23
Total	328	45

a. Response rate is defined as the number of surveys returned as a proportion of the number of surveys distributed. Some riders contacted were not given a survey because they had not walked or refused to participate.

The response rate for the survey was quite high. For the total population, the response rate was 45 percent. El Cerrito Plaza had the highest response rate at 71 percent, whereas response rates from the other stations ranged from 15 percent to 49 percent. We calculated the response rate as the number of surveys returned as a proportion of the number of surveys distributed. Some transit riders approached by our surveyors were not given a survey to complete because they did not wish to participate, had not walked to the station, or were under age 18, or because the train approached too quickly after they arrived on the station platform.

Although some surveys had missing responses for a few individual questions, all of the surveys were complete enough to be included in the final data set. The number of completed responses varied slightly for each question, however. Of the 328 surveys received, the map was filled out correctly 93 percent of the time, generating 261 routes that could be analyzed for actual distance and other route characteristics.

WALKABILITY AUDIT

A comprehensive audit of the physical environment within 1/2 to 3/4 mile of the Japantown light rail station and the El Cerrito BART station was conducted to assess various aspects of the built environment that previous researchers have identified as likely to affect a neighborhood's walkability. The audit instrument developed for this study is included in [Appendix B](#).

The audit tool assessed block segments and intersections separately, because pedestrians experience the two in different ways. For each block segment, the auditor assessed the characteristics listed in [Table 2](#). The first three questions asked the auditor to enter holistic, subjective assessments: how attractive the block segment was, how safe from traffic the auditor felt walking there, and how safe from crime the auditor felt. These holistic and rather subjective assessments were followed by questions about a detailed set of specific factors addressing maintenance and cleanliness, amenities, sidewalk characteristics, buffer zone characteristics, front zone characteristics, and roadway characteristics. These questions were designed to collect more quantitative data. For each intersection, the audit collected data on factors affecting the ease of crossing the street, such as the presence of traffic control devices, crosswalks, and curb cuts (for more details, see [Table 2](#) and [Appendix](#)). The intersection audit collected data on just six variables, including traffic control devices and crossing infrastructure (see [Figure 6](#) for a photo of the audit tool; [Figure 7](#) for sample screenshots of the tool in use).

Table 2 Variables Included in Walkability Audit

Street Characteristics	Intersection Characteristics
Attractive for walking	Traffic signals
Safe from crime	Safe crossing
Safe from traffic	Pedestrian crossing signs
Landscape maintenance	Number of curb cuts
Building maintenance	Crosswalks
Broken, boarded, or bars on windows	
Litter	
Graffiti	
Benches	
Buffer width	
Grass/hedges/cement in buffer	
Number of street trees	
Slope	
Sidewalk width	
Sidewalk condition	
Walk through parking lots to buildings	
Number of off-street parking spaces	
Percent of block used for off-street parking	
Number of medium/high volume driveways	
One-way or two-way street	
Number of traffic lanes	
On-street parking (0, 1, 2 sides)	

**Figure 6 Audit Tool**



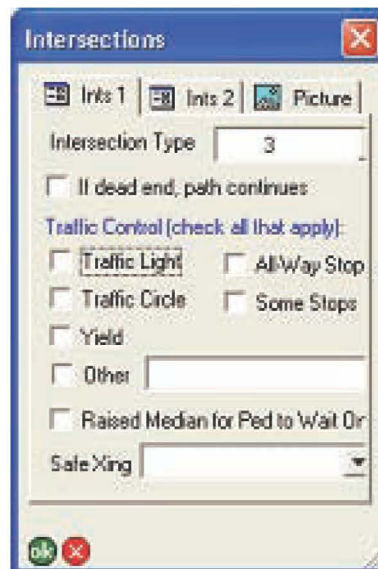
The screenshot shows the 'Info' tab of the 'Ped Corridor Audit Tool'. It includes a 'Load Default Record' button, a 'Name' dropdown, 'Today's Date' set to 7/27/2006, 'Street' set to N Pacific St, 'From' 3453 and 'To' 3498, and dropdown menus for 'Safe from Crime', 'Safe from Traffic', and 'Attractive Walking'. There are 'ok' and 'x' buttons at the bottom.



The screenshot shows the 'Buffer' tab of the 'Ped Corridor Audit Tool'. It features a 'Buffers' radio button set to 'Y', checkboxes for 'Hedges', 'Grass/Flowers', 'Fence', and 'Gravel/Cement', a '# Trees' dropdown, an 'Other' text field, 'Buffer Width' and 'Slope' dropdowns, and a 'Click to enter SW data' button. There are 'ok' and 'x' buttons at the bottom.



The screenshot shows the 'Road' tab of the 'Ped Corridor Audit Tool'. It includes a 'One Way Street' checkbox, dropdowns for '# Midblock Lanes', 'On Street Parking', 'Off Street Parking', 'Speed Limit', and 'Driveways'. A red 'You're Done!' message and a 'Make this record the default' button are visible. There are 'ok' and 'x' buttons at the bottom.



The screenshot shows the 'Intersections' dialog box. It has tabs for 'Ints 1', 'Ints 2', and 'Picture'. The 'Intersection Type' is set to 3. There is a checkbox for 'If dead end, path continues'. Under 'Traffic Control (check all that apply):', there are checkboxes for 'Traffic Light', 'All-Way Stop', 'Traffic Circle', 'Some Stops', 'Yield', and 'Other'. There is also a checkbox for 'Raised Median for Ped to Wait Or' and a 'Safe Xing' dropdown. There are 'ok' and 'x' buttons at the bottom.

Figure 7 Examples of the Walkability Audit Data Entry Forms

ANALYSIS OF SURVEY FINDINGS

This section first describes the basic sociodemographic characteristics of the survey respondents, and then discusses the results of the survey. The results discussed include respondents' trip purposes, how many people stopped along their walk and what for, how far respondents said they walked, our own calculations of the distances they traveled, the factors that influenced their route choices, and their attitudes toward walking.

WHO WERE THE SURVEY RESPONDENTS?

Table 3 summarizes some sociodemographic statistics about the survey respondents. They were roughly half male and half female, about three-quarters self identified as white, and three-quarters were adults between the ages of 30 and 59. The median household income was \$60,000, and slightly over half the respondents were renters rather than homeowners. Almost one-third of the group rarely or never had access to a car, indicating that a fairly high proportion of the respondents were transit dependent.

The groups of respondents from each station were roughly similar to the total population of respondents, with just a few notable differences. The Bay Area respondents were a racially diverse group, whereas the Portland respondents were nearly all white. Also, the small sample of respondents from the Portland stations of Gresham and Rockwood had considerably lower household incomes and, correspondingly, were more likely to rent than own their homes. The Rockwood population was also highly transit dependent, with 67 percent saying that they never or only occasionally had access to a car.

TRIP PURPOSES AND ORIGINS

Most respondents made home-based trips to work (see Table 4). Among the full population, 81 percent made commute trips, another 5 percent made trips to school, and 8 percent made personal shopping trips. This pattern held roughly consistent across all the stations, except that Japantown had fewer commute trips and considerably more shopping trips (21 percent), whereas Gresham riders made fewer commute trips and more trips to school (33 percent).

Respondents walked to the stations from a wide variety of origins. Figure 8, for example, shows a map of El Cerrito respondents' origin points.

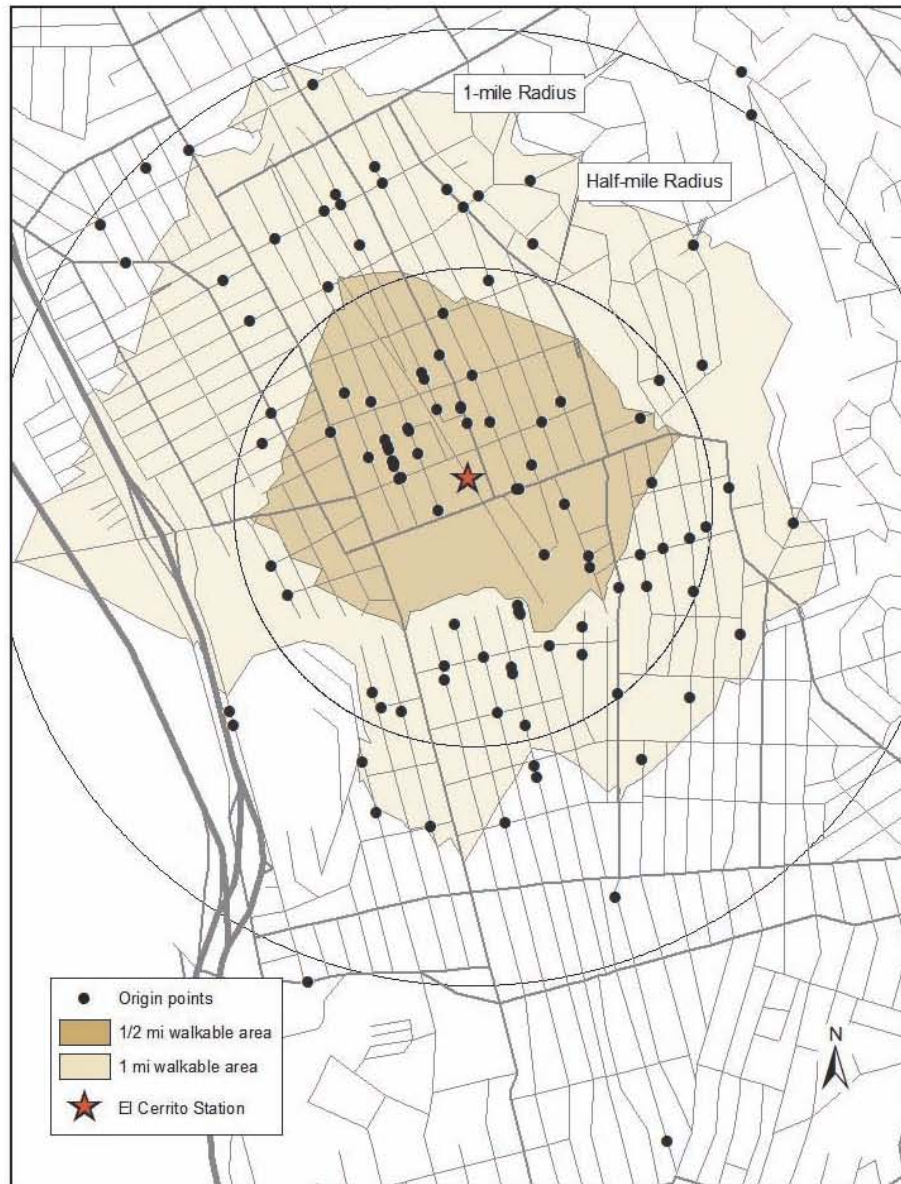


Figure 8 Survey Respondent Origins, El Cerrito BART Station

STOPS DURING THE TRIPS

After reporting how far and for how long they walked, respondents were asked if they had stopped along the way. If they had, follow-up questions probed the reason for the stop and how long they stopped for. The vast majority, 87 percent, did not stop (see [Table 5](#)). Of the 13 percent of respondents who did stop, about half stopped to buy food or a drink; the others stopped either to buy a newspaper, to talk to somebody, or for “other” reasons. The median time for these stops was just three minutes, consistent with stops made by people popping into a small business to make a quick purchase. The average stop times were longer, however,

reflecting the fact that some people did stop for much longer time periods (up to 45 minutes for the longest stop).

Table 3 Demographics of Survey Respondents

	Bay Area			Portland		
	All Stations	El Cerrito	Japantown	Gresham	Hollywood	Rockwood
Gender						
Male	53%	49%	66%	40%	47%	52%
Female	47%	51%	34%	60%	53%	48%
Race						
White	74%	68%	59%	93%	96%	86%
Black	2%	0%	2%	0%	1%	9%
Asian/Pacific Islander	15%	23%	20%	0%	1%	5%
Other	5%	4%	11%	0%	0%	0%
Mixed race	5%	5%	9%	7%	1%	0%
Age						
18–29	19%	15%	25%	23%	15%	29%
30–39	30%	34%	26%	15%	32%	29%
40–49	23%	20%	26%	39%	25%	13%
50–59	20%	25%	12%	8%	23%	25%
60+	8%	7%	10%	15%	6%	4%
Household income						
Median	\$60,000	\$80,000	\$60,000	\$35,000	\$70,000	\$20,000
Own/rent home						
Own	44%	45%	38%	29%	60%	21%
Rent	56%	55%	62%	71%	40%	79%
Driver's license?						
Yes	84%	91%	76%	80%	86%	75%
No	16%	9%	24%	20%	14%	25%
Access to a car?						
Never/occasionally	30%	16%	36%	33%	32%	67%
Most of the time/always	70%	84%	64%	67%	60%	33%

Table 4 Trip Purposes by Station

Trip Purpose	Bay Area			Portland		
	All Stations	El Cerrito	Japantown	Gresham	Hollywood	Rockwood
Work	81%	87%	68%	86%	84%	67%
School	5%	4%	2%	4%	4%	33%
Personal shopping	8%	3%	21%	6%	4%	0%
Other origin	6%	6%	8%	4%	8%	0%
Home	96%	99%	92%	95%	100%	100%
Work	1%	1%	1%	1%	0%	0%
Other	3%	0%	7%	4%	0%	0%

Table 5 How Many People Stopped, For What Reason, and How Long

	Bay Area			Portland		
	Combined	El Cerrito	Japantown	Hollywood	Rockwood	Gresham
% stopping for any reason	13%	10%	12%	14%	32%	0%
% stopping for:						
Food	7%	10%	4%	9%	28%	0%
Newspaper	2%	4%	2%	0%	4%	0%
To talk	2%	8%	6%	0%	0%	0%
Other	4%	2%	3%	8%	0%	0%
Time stopped						
Mean	6 min.	6 min.	5 min.	7 min.	7 min.	n/a
Median	3 min.	3 min.	2 min.	3 min.	6 min.	n/a

TRIP DISTANCES

Self-reported distances

Respondents were asked how far they had walked, in both miles and blocks. Almost all respondents entered the number of blocks (91 percent), but only 64 percent entered the distance in miles.¹⁸ For the full group of respondents, the mean reported distance was 0.58 miles (see Table 6). Looking at how the data broke out in quartiles shows that a quarter of people reported walking just a quarter of a mile or less, the second quartile of people reported walking between a quarter-mile and a half-mile, the third quartile reported walking between half a mile and almost a full mile (0.95 miles), and the final quarter said they walked more than 0.95 miles. The responses clustered around a quarter mile, half mile, and one mile, indicating the tendency of people to round off distances.

Table 6 Self-Reported Distance Walked in Miles, Blocks, and Minutes

	Distance in miles (percentiles)				Distance in blocks (percentiles)				Time in minutes (percentiles)			
	mean	25th	50th	75th	mean	25th	50th	75th	mean	25th	50th	75th
All stations	0.58	0.25	0.5	0.95	6	3	5	8	10	5	10	12
Bay Area												
El Cerrito	0.65	0.25	0.5	1	6	3	5	8	11	6	10	15
Japantown	0.45	0.13	0.28	0.69	4	2	4	6	8	5	6	10
Portland												
Gresham	0.43	0.11	0.3	0.8	4	2	2	4	7	3	6	10
Hollywood	0.62	0.39	0.5	1	8	4	6	10	11	5	10	13
Rockwood	0.49	0.25	0.5	0.75	5	2	3	6	10	5	10	13

Actual distances

We asked respondents to trace on a map the route they walked. For the El Cerrito, Japantown, and Hollywood stations, these routes were entered into a GIS database and the information used to calculate the exact length of each trip. The mean trip distance was just over a half mile (see [Table 7](#)), with the shortest trip 0.02 miles and the longest 1.88 miles. Looking at the distance data broken into quartiles shows that a quarter of respondents walked a quarter mile or less, the next quartile walked between a quarter and half mile, the third quartile walked between a half and two-thirds of a mile, and the final quarter walked over two-thirds of a mile.

Table 7 Actual Distances Walked

	Distance (miles)
Mean	0.52
Medium	0.02
Maximum	1.88
25th percentile	0.27
50th percentile	0.47
75th percentile	0.68

The accuracy of self-reported distances

We were interested to learn how accurately respondents estimated the distances they had walked. Many travel surveys ask respondents to estimate the distances they walk, but little is known about how accurate these estimates are. Close to half of the responses analyzed (43 percent) were quite accurate guesses, within a tenth of a mile (see [Table 8](#)).¹⁹ However, other guesses were highly inaccurate, ranging from up to 1.07 miles over to 0.88 miles under the correct distance. The average guess was off by about 0.2 miles. Percentage-wise, guesses were off by 45 percent of the actual distance on average, with 25 percent of respondents guessing within 11 percent and half guessing within 30 percent of the correct distance in miles. On the other hand, 25 percent of respondents' guesses were off by more than 50 percent, a surprisingly large error, and 10 percent were off by more than 90 percent. It should be noted that, because the distances walked were short, the actual error in miles was trivial for most respondents, although 26 percent of respondents made guesses that were off by a quarter of a mile or more.

Table 8 Accuracy of Self-Reported Trip Distances

Accuracy of Distance Estimate	Percent	Cumulative Percent
Within .1 mile	43	43
Off by .1 to .25 mile	31	74

Table 8 Accuracy of Self-Reported Trip Distances

Accuracy of Distance Estimate	Percent	Cumulative Percent
Off by .25 to .5 mile	20	94
Off by > .5 mile	6	100

CONSISTENCY OF ROUTE CHOICES

The survey asked respondents two questions designed to identify how much they varied their route from day to day. After respondents drew on the map the route they had walked that day, the survey asked, “The last time you walked here from the same place, did you take the exact same route?” (See [Appendix A](#), Question 5). Virtually all (92 percent) said that they had. A follow-up question asked respondents how many different routes they took during the last five times they walked to the station when leaving from the same destination ([Appendix A](#), Question 6). This question revealed only slightly more variation. Seventy-four percent said that they took the same route for all five trips, and another 19 percent reported taking only two different routes over the five trips (see [Table 9](#)). To look at the data another way, only six percent varied their route frequently, taking three or more routes over the course of five trips.

Table 9 Consistency of Route Choice

# of Different Routes Last 5 Times Walking	Percent
1	74 ^a
2	19
3	5
4	1
5	1

a. Includes people who responded “zero,” which we assume was an error and intended to be “1.”

FACTORS INFLUENCING ROUTE CHOICES

After respondents traced their walking route on the map, the survey asked them to identify the factors that led them to choose a particular route. The survey addressed this issue in three steps. First, respondents were asked the open-ended question, “What are the main reasons why you chose your route today?” and given space to write three answers in their own words. On the next page, respondents were asked to rank the importance of 11 potential factors that might have influenced their route choice. The instructions read, “Below is a list of factors that other researchers have found to influence the routes people walk along. For each one, please

mark how important it is to you.” Finally, a last open-ended question asked, “Are there any other factors, positive or negative, that influenced your choice of route today?” Relatively few people answered this final question, so only the results of the first two questions are discussed below.

The first, open-ended question showed that by far the most important factor was choosing the shortest or fastest route. As shown in [Table 10](#), 52 percent of respondents wrote this as the first item in their list, and almost two-thirds mentioned this factor somewhere among their three responses. An additional 9 percent of respondents mentioned “convenience” as an important factor, and it may well be that convenience was their way of expressing the same concept—choosing the quickest route.

The second most common set of responses had to do with safety, mentioned by 28 percent of respondents. Most of these responses related in some way to safety from traffic, such as low traffic volumes or an intersection where it was easy to cross a large street. Only a small number of people described safety issues in terms of crime. Although safety was a fairly common response somewhere in the list of three answers, only 8 percent of people put it as their first item on the list. Safety was somewhat more common as the second item, appearing here 14 percent of the time.

Finally, very small numbers of respondents mentioned choosing their routes based either on the attractiveness of the route (e.g., nice landscaping or attractive buildings) or because they wanted to stop at a particular business.

Table 10 Percent of People Volunteering a Factor as Influencing Their Route Choice

Factor Type	Anywhere in List	First	Second	Third
Shortest/fastest	64	52	10	3
Safety	28	8	14	6
Convenience	9	6	2	1
Attractive	8	2	3	2
Habit	6	3	1	2
Stopped at a business	3	2	2	0
Other	27	13	9	5
Meaning of response unclear	16	9	5	3
Left blank	n/a	3	50	77

These priorities were partially validated in the next question, which asked respondents to rate the importance of 11 different factors. As shown in [Table 11](#), 99 percent of respondents rated choosing the shortest route as either very important or somewhat important, with the bulk of those saying it was very important (82 percent of respondents). This finding confirms the results of the open-ended question, where responses related to distance predominated. On the other hand, safety considerations showed up as considerably more important in the second

question than they did in the previous, open-ended question. About half of respondents rated as “very important” having traffic devices present and having traffic drive at safe speeds, and those numbers jumped considerably, to 85 percent and 87 percent, when one combines the responses of people who responded that these factors were either very or somewhat important. Other factors rated as “very” or “somewhat” important by at least 50 percent of respondents were: having sidewalks in good condition; the presence of attractive buildings, trees, and landscaping; having no traffic lights where it took a long time to cross; the presence of other people out walking; and having shops or businesses to stop in. Only the first two of these (sidewalks and attractive buildings) were rated as “very important” by at least a third of respondents, however. Finally, three factors rated as important by relatively few people were having shops or businesses with windows to look at, having benches or other places to sit, and having a friend or neighbor along the route.

Table 11 Respondent Ratings: Importance of Factors That Might Influence Their Route Choice

Question: Below is a list of factors that other researchers have found to influence the routes people walk along. For each one, please mark how important it is to you.			
Statement	Strongly Agree (%)	Agree (%)	Disagree or Strongly Disagree (%)
Shortest route	82	17	1
Traffic devices are present	55	30	15
Traffic drives at safe speeds	46	41	13
Sidewalks in good condition	43	44	13
Presence of attractive buildings, trees, and landscaping	35	44	21
No traffic lights where it takes a long time to cross	29	39	32
Other people out walking	23	37	40
Shops/businesses to stop in	14	32	54
Shops/businesses with window to look in	11	25	65
Benches/places to sit	11	15	75
Friend/neighbor along the route	7	18	75

Note: Factors were ordered differently in the survey itself.

ATTITUDES TOWARD WALKING

Toward the end of the survey, respondents were asked how strongly they agreed with a series of statements describing different reasons that they might choose to walk. Overall, respondents had very positive attitudes toward walking, which may explain their high level of willingness to complete and return the survey. The first two questions asked if people liked

walking and if they found walking relaxing, and in both cases 97 percent either strongly agreed or agreed with the statement (see Table 12). Another question asked if respondents walked in order to get exercise or health benefits, and again virtually all agreed or strongly agreed (94 percent). Slightly lower percentages of people agreed that they sometimes walk because it is the most convenient mode of travel (89 percent) or because it is the cheapest way to travel (80 percent).

Table 12 Attitudes Toward Walking

Question: For each statement below, please mark how strongly you agree or disagree with it.			
Statement	Strongly Agree (%)	Agree (%)	Disagree or Strongly Disagree (%)
I like walking	78	19	3
Walking is relaxing	70	27	3
I walk to get exercise or other health benefits	71	23	6
I sometimes walk because it is the fastest and/or most convenient way to get somewhere	55	34	12
I sometimes walk because it is the cheapest way to get around	46	34	19

In sum, the survey results show that pedestrians walking to a rail station for their morning commute are willing to walk considerably longer than previously thought, desire to minimize their walk distance and time, pay attention to safety and their walking environment, and do not often vary their route.

The following section takes a closer look at how safety and the walking environment were evaluated using a walkability audit tool designed to rate specific characteristics of the walking environments in the station areas.

ANALYSIS OF WALKABILITY AUDIT DATA

The next step of the research was to evaluate and measure the features of the built environment around the El Cerrito BART and Japantown light rail stations. Once the built environment features were identified, measured, and mapped, we could evaluate the built environment characteristics of the actual routes people chose to walk in order to identify any patterns.

The study area locations are served by fairly gridded street patterns which offer alternative routes with similar overall distances. The question, then, is: when a pedestrian chooses one shortest path over another, what factors in the built environment (if any) influence that choice? One could imagine that a pedestrian either chooses a certain path because of its “pedestrian friendliness” or alternatively chooses a path that avoids areas that are “unfriendly”; that is, a good path may be one that has an absence of repulsion. This section presents findings from the comparison between the walkability audit and the actual routes that people walked using data collected at the Japantown light rail station.

The walkability audit tool was described in more detail earlier in this report. As an overview, however, the audit tool contained about 60 different built environment variables that ranged from subjective questions such as “How attractive is this street segment?” to specifying objective characteristics such as whether a buffer exists between the sidewalk and street and whether this buffer is made of grass, trees, concrete, other landscaping, or some combination of these attributes.

Each built environment factor was a numeric score depending on how it was rated (e.g., a sidewalk in good condition may receive a score of 3 and a sidewalk in fair condition may receive a score of 1). In some cases, factors were looked at individually and in others they were combined to create indices of built environment characteristics. Maps of the audited characteristics were then produced and used to highlight street segments that were either very good or very poor quality walking environments in terms of the urban design and environmental characteristics measured by the audit.

INTEGRATING THE SURVEY AND AUDIT DATA

The survey asked respondents to trace their actual walking route on a map of the station area. Each of these traced routes was then converted into a digital form for analysis within the GIS mapping environment (see [Figure 9](#)). The discussion below summarizes the results from the micro-scaled analysis of streetscape and individual route choice of our study sample.

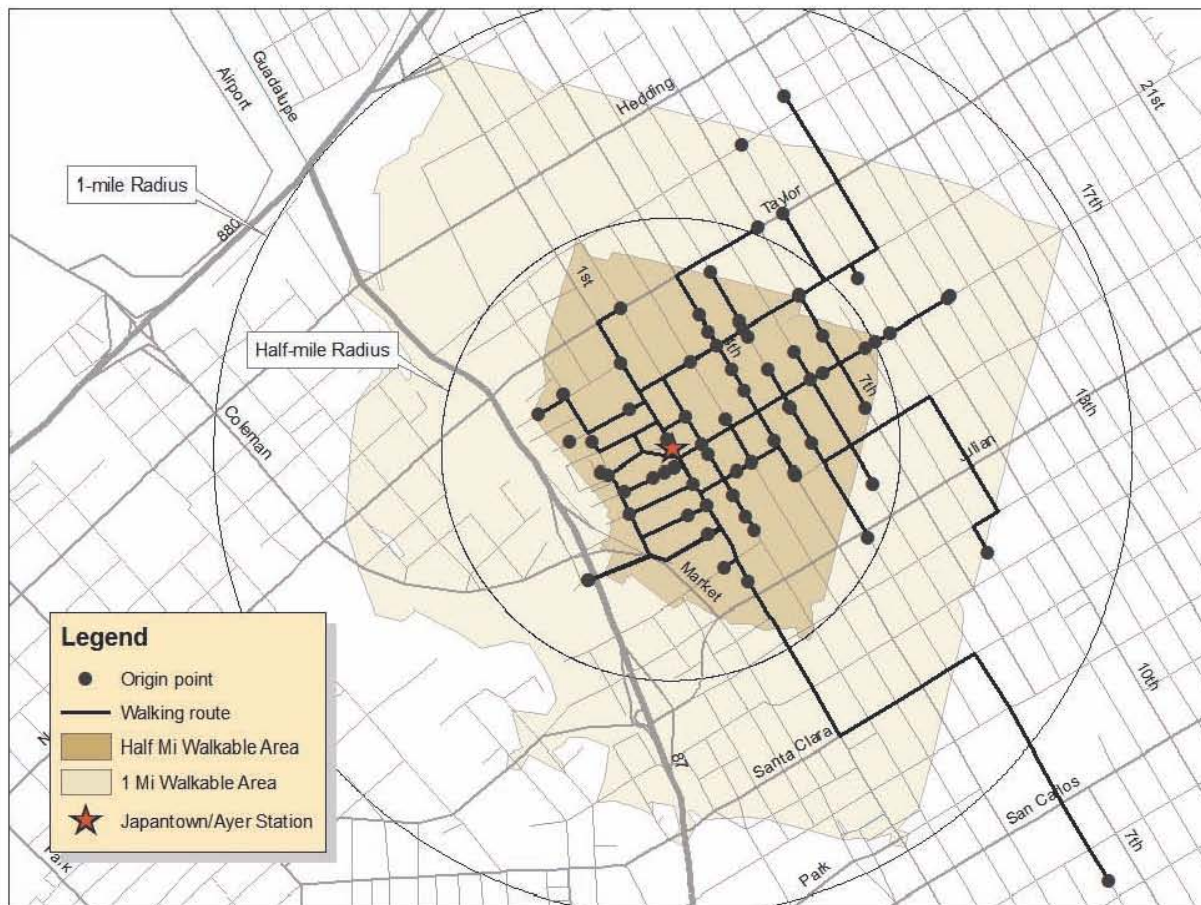


Figure 9 Actual Walking Routes—Japantown Station

AUDIT DATA ANALYSIS—A SPATIAL OVERVIEW

Combining the survey and audit data into the same maps allowed us to compare our assessments of the physical walking environment with the routes that the survey respondents took while walking to their transit stop. The types of data used in the analysis were the audit data, the pedestrian origin points, the actual walking routes, and the streets and intersections that survey respondents said they avoided. Basic analysis of the audit data involved mapping each audit characteristic and examining the results for nodes or corridors where the streets varied substantially from those in the area as a whole.

For some of the audit measures, there was little variability in the study areas, so analysis to see if people avoided or sought out routes exhibiting those traits was impossible. In particular, sidewalk conditions, which were found to be important in previous studies, were quite good throughout both areas and therefore did not appear to influence route choices. In addition, the study areas were safe from traffic overall, so analysis of this factor was also impossible. Few traffic calming devices were found in the station areas, so it was not possible to analyze the

influence of features such as traffic circles and curb extensions. However, the subjective measures, and measures related to green buffers, street trees, home and landscape maintenance, and litter displayed more variability.

Integrating Survey Data

We were interested to see if our survey respondents chose or avoided segments shown by the walkability audit to have especially agreeable or disagreeable characteristics. If such correlations were found, perhaps a pattern of characteristics that most influence pedestrian choices would also be revealed.

Pedestrian volumes along each street segment were calculated so that we could add this to our analysis of the layer. The map in [Figure 10](#) shows an example of pedestrian volumes overlaid on the “safe from crime” audit variable for the Japantown area. There is some indication that respondents avoided streets rated as very or somewhat unsafe.

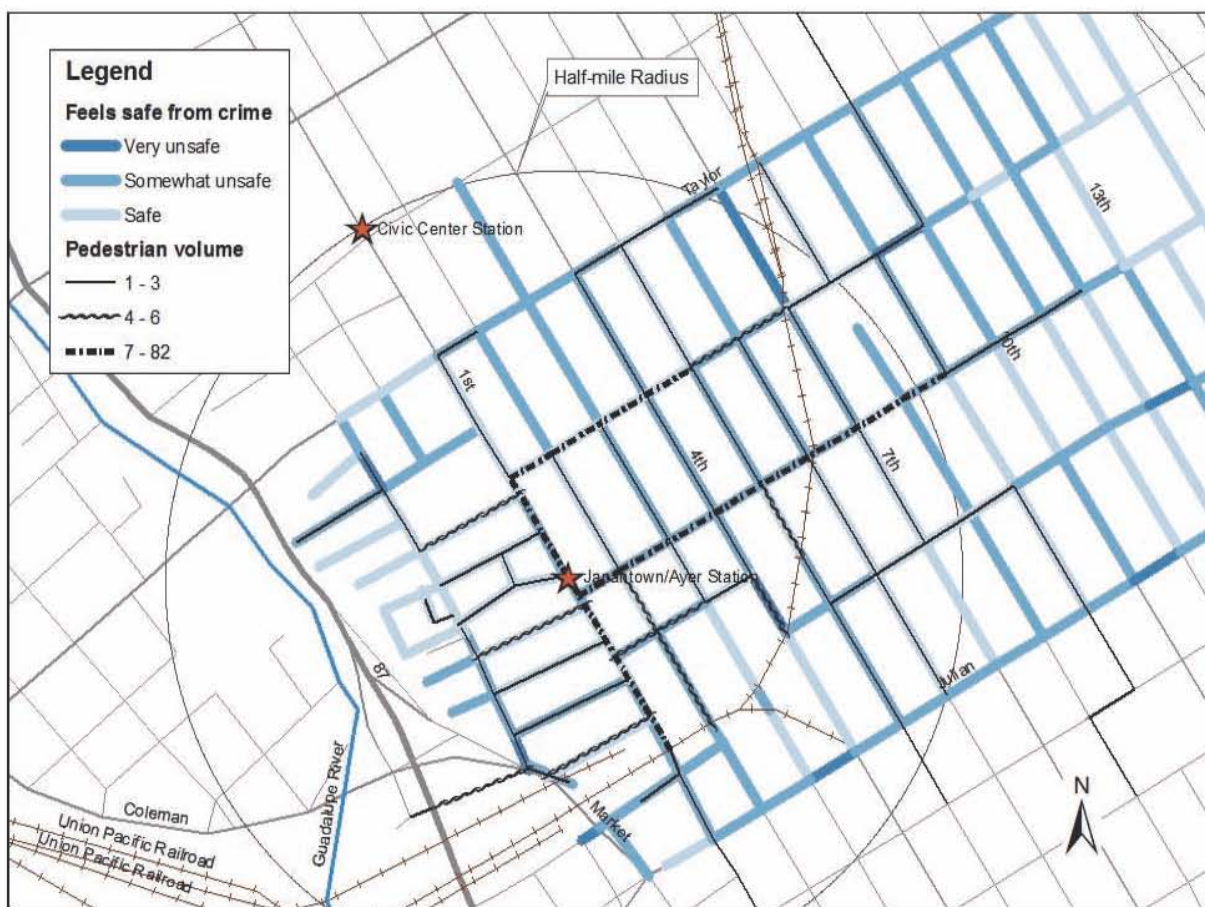


Figure 10 Pedestrian Volume With Safe From Crime Audit Data

AUDIT-BASED INDICES

As our analysis evolved, we realized that although it was easy to understand the relevance of the more general, subjective measures (attractiveness for walking, safety from crime, safety from traffic, and safe crossing at intersections), it was difficult to make use of the more specific audit characteristics such as the presence of litter and the number of street trees per 1000 feet. It seemed unlikely that any single one of these characteristics would, on its own, influence walking routes. Therefore, many of these specific audit measures were combined to form three composite measures: a General Appearance Index, a Greenery Index, and an Overall Index. These indices are discussed below using data from the Japantown station area.²⁰

General Appearance Index

A high score for the general appearance index represents an attractive block, which we defined as a litter-free street segment with well-kept buildings and gardens. Table 13 lists the individual variables that make up the General Appearance Index and the associated weighting of each potential variable response.

Figure 11 shows this index applied to a map of the Japantown area. Most of the blocks around each study area were of average to good appearance. Very few street segments had a poor overall appearance.

Table 13 General Appearance Index

Measure	Response Values	Index Values ^a	Weight
Landscape Maintenance	< 50% = 1	0	Unweighted
	50% to 75% = 2	0.5	
	> 75% = 3	1	
Building Maintenance	< 50% = 1	0	Unweighted
	50% to 75% = 2	0.5	
	> 75% = 3	1	
Litter	None or almost none = 0	1	Unweighted
	Some = 1	0.5	
	Lots = 2	0	
Graffiti	None or almost none = 0	1	Unweighted
	Some = 1	0.5	
	Lots = 2	0	
Bars/Boarded/Broken Windows?	Yes = T	0	Unweighted
	No = F	1	

a. Index range is 0 to 5; Low = 0 to 2, Medium = 2.5 to 3.5, High = 4 to 5

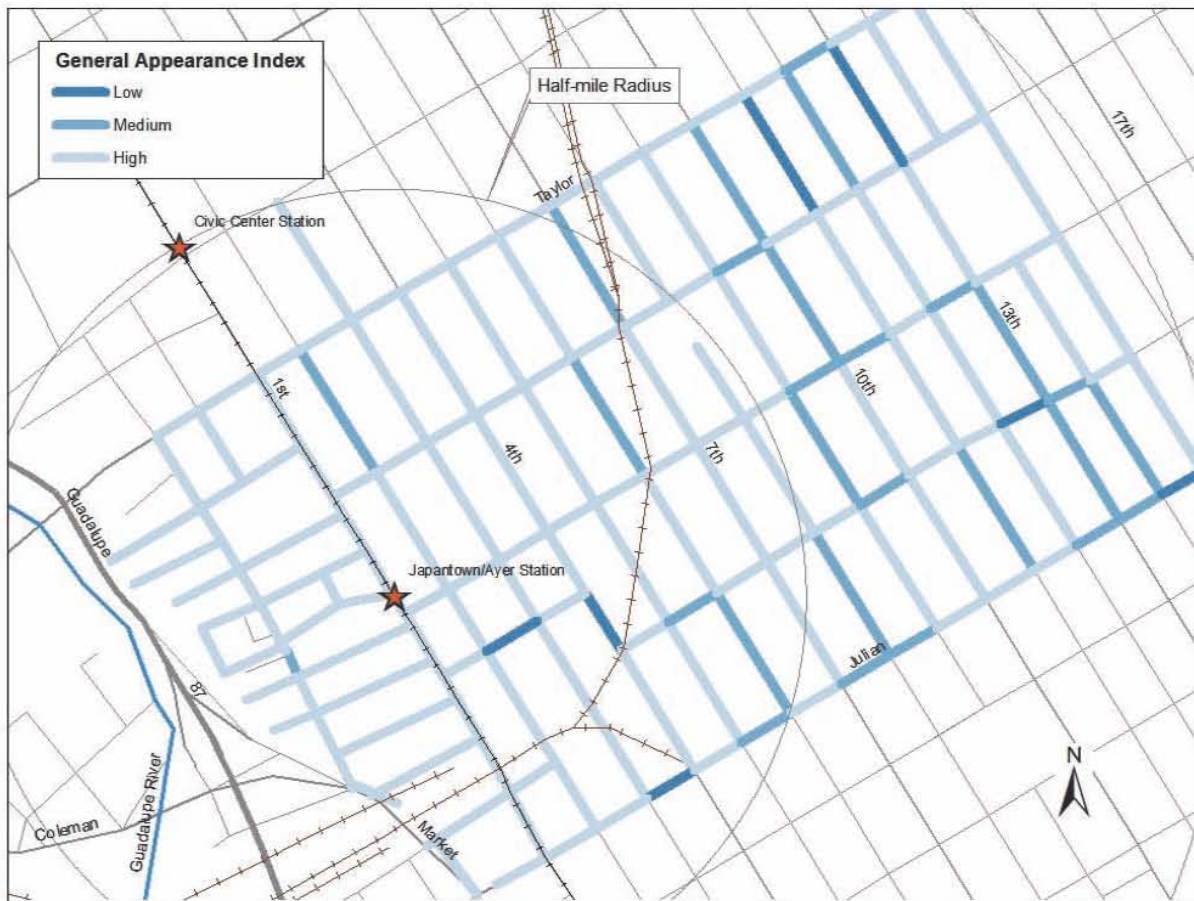


Figure 11 General Appearance Index, Japantown

Greenery Index

A high score for the greenery index represents a street segment with an extensive green canopy or environment. [Table 14](#) lists the individual variables that make up the Greenery Index and the associated weighting of each potential variable response. [Figure 12](#) shows this index spatially presented for the Japantown area. Most of the area surrounding the transit stops had average or good scores on the greenery index, accurately reflecting the common presence of trees and grass sidewalk buffers.

Table 14 Greenery Index

Measure	Response Values	Index Values ^a	Weight
Buffer Greenery	Only cement	0	Unweighted
	Cement/grass/hedges	0.5	
	Only grass/hedges	1	
Trees per 1,000 Feet	0 to 15	0	2
	15.01 to 25	0.5	
	> 25	1	
Buffer Width	No buffer = 0	0	Unweighted
	< 1 foot = 1	0	
	1 foot to 4 feet = 2	0.5	
	> 4 feet = 3	1	

a. Index range is 0 to 5, with Low = 0 to 2; Medium = 2.5 to 3.5; High = 4 to 5



Figure 12 Overall Greenery Index, Japantown

Overall Appearance Index

The overall appearance combines the general appearance index with two measures from the greenery index and two parking measures (see [Table 15](#)). A high score for the overall appearance index represents a clean street segment with well-kept buildings and gardens, a relatively high number of street trees, greenery in the buffer, and few or no large parking lots visible from the sidewalk. [Table 15](#) lists the individual variables that make up the Greenery Index and the associated weighting of each potential variable response. [Figure 13](#) shows this index spatially presented for the Japantown area. As with the other two indices, the map shows that the general appearance was decent or good in most of the surrounding street segments.

Table 15 Overall Appearance Index

Measure	Response Values	Index Values ^a	Weight
Landscape Maintenance	< 50% = 1	0	Unweighted
	50% to 75% = 2	0.5	
	> 75% = 3	1	
Building Maintenance	< 50% = 1	0	Unweighted
	50% to 75% = 2	0.5	
	> 75% = 3	1	
Litter	None or almost none = 0	1	Unweighted
	Some = 1	0.5	
	Lots = 2	0	
Graffiti	None or almost none = 0	1	Unweighted
	Some = 1	0.5	
	Lots = 2	0	
Bars/Boarded/Broken Windows?	Yes = T	0	Unweighted
	No = F	1	
Buffer Greenery	Only cement	0	Unweighted
	Cement/grass/hedges	0.5	
	Only grass/hedges	1	
Trees per 1,000 Feet	0 to 15	0	2
	15.1 to 25	0.5	
	> 25	1	
Walk Through Parking Lots?	No = F	1	0.5
	Yes = T	0	
Percent of Block Used by Parking Lots	None = 0	1	0.5
	< 30% = 1	1	
	31% to 60% = 2	0	
	> 60% = 3	0	

a. Index range is 0 to 9; Low = 0 to 4, Medium = 4.5 to 6.5, High = 7 to 9

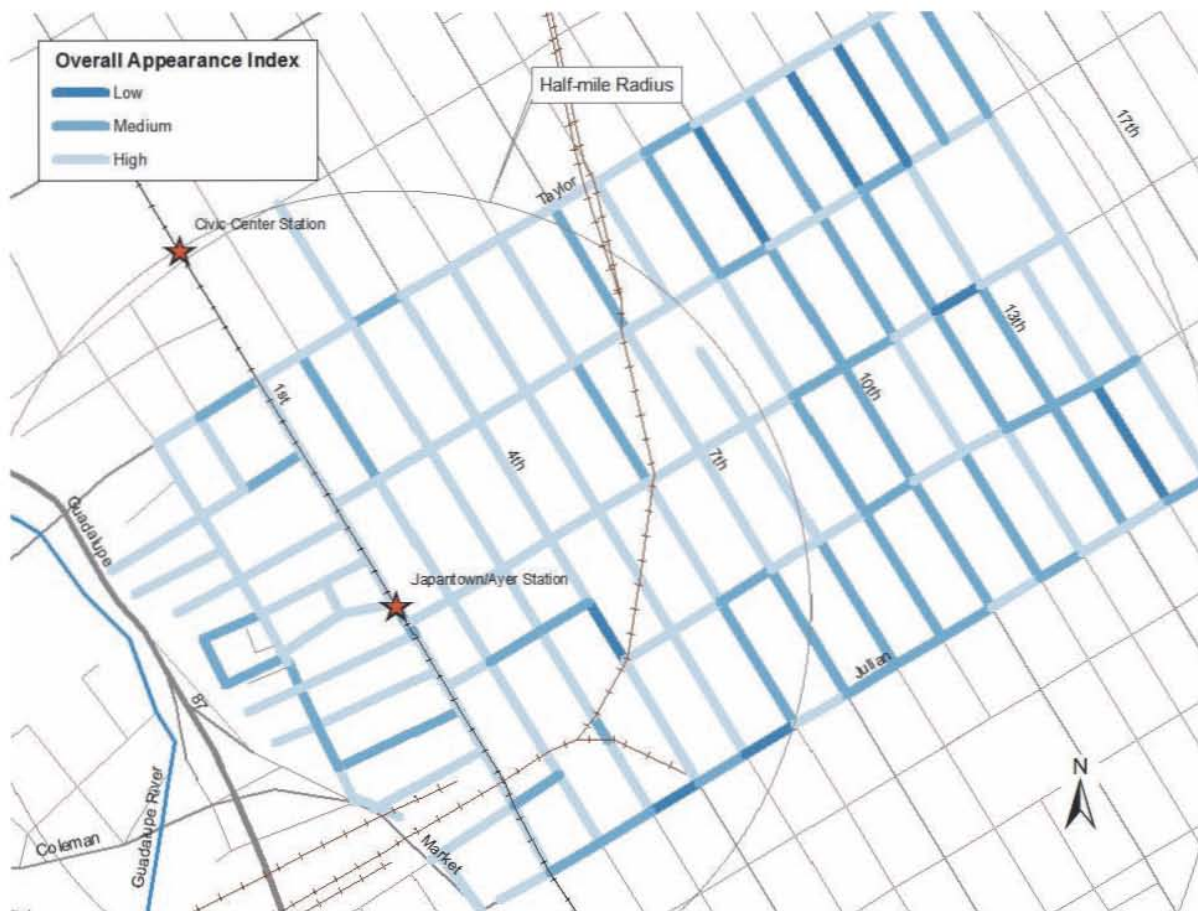


Figure 13 Overall Appearance Index, Japantown

Reflection and Use of Audit Data

It is fairly clear after viewing the maps above that there is little variability across most streets in the study areas. In addition, the actual routes that our respondents took, as well as their reasonable alternative route choices, for the most part were all reasonably accommodating pedestrian environments. Thus, understanding why one path was chosen over another is hard to determine. Further, because respondents so clearly put a priority on finding the shortest and quickest route on their morning commute walk (the time when the survey was administered), slight variations in pedestrian environments likely would have little significant influence.

That said, the areas that showed the most variability and were rated more poorly as walking environments almost all occurred on arterials or collectors, rather than residential streets. Focusing on these potential pedestrian impediments may provide some insight into route choice and pedestrian decision making. The audit data allows for a more focused investigation of those poorly rated areas at the streetscape scale, allowing researchers or planners to understand what makes the walking environment more or less hospitable to pedestrians. An example of how this audit data may be used to understand very specific environments is

presented below, using Julian Street in the Japantown transit station area. Julian Street was one that some survey respondents identified as a street they avoid or carefully consider where to cross when accessing the transit stop. With such feedback from pedestrians, these maps give the researcher or planner an idea of the different elements of that particular area that may be causing pedestrians to try to avoid it.

Figure 14 shows the individual subjective audit variables of attractiveness and safety of each individual street segment. Looking at the entire study area in this manner allows problem areas to be pinpointed. The map shows a mixture of ratings within the Japantown area and on Julian Street in particular.



Figure 14 Japantown Attractiveness and Crime Subjective Assessments

Figure 15 gives a little more detail about the streetscape along Julian Street. Looking at the different indices presented, it appears that one of the negative attributes that may be influencing pedestrian decision making may have to do with the low presence of greenery. The General Appearance Index and the Overall Index do not show much more variability in condition compared to the transit area as a whole, but the Greenery Index is quite different for Julian Street than other locations. It may be that the lack of greenery negatively impacts pedestrians' perception of Julian Street and causes them to avoid that location if possible. It may also be that potential pedestrians may be dissuaded from walking to the transit stop because of the barrier presented by Julian Street.



Figure 15 Julian Street Drill-Down Using Objective Criteria Indexes



Figure 16 Julian Street

This analysis of Julian Street demonstrates the types of analyses and micro-scaled investigations that could be possible when investigating areas with more variability and lower ratings than the larger study area. If walking decisions are influenced in part by the condition of the surrounding environment, then utilizing tools that adequately capture those local conditions can be very important for both research and applied applications. There is, of course, a trade off between collecting extensive data at the micro scale and the time investment needed to collect such data over a significant geographic area. Trade-offs and ideas for more focused application of walkability audit tools are presented in the following section.

CONCLUSIONS

This study surveyed pedestrians walking to five different rail stations to determine how far they walked and the environmental factors that they believed influenced their choice of route. An additional audit of walkability conditions conducted by the authors was used to compare with the respondents' own evaluations of the environmental factors that influenced them. This section summarizes the primary conclusions from the study and assesses their implications for planning practice and future research. The first part discusses three key findings about pedestrian behavior, followed by findings about the survey methodology and then the walkability audit methodology.

FINDINGS ON WALKABILITY: IMPLICATIONS FOR PLANNING PRACTICE

Three findings about walkability from the survey stood out as particularly relevant for future planning efforts. First, the survey showed that pedestrians walk considerably farther than commonly is acknowledged. In addition, the survey responses indicated that the respondents' primary goal in choosing a route was to minimize distance and time, but that safety and aesthetic considerations were also important to them.

Finding 1: Pedestrians walk considerably farther to access rail stations than commonly assumed.

Conventional wisdom among planners has often been that pedestrians in the United States will only walk a quarter to a third of a mile for any reason, including to access transit. A paper from the mid-1990s looking at how far transit agencies and transportation modelers assume that pedestrians will walk to a light rail station found very short distances, most well under a half mile.²¹ The results of our study suggest quite differently, at least for walk trips to access rail transit. The median trip distance was 0.47 miles, showing that fully half the people surveyed walked at least a half mile to access the train station. The study results therefore contradict the common wisdom, supported in part by past research, that says people are only willing to walk a quarter to a third of a mile to a destination, transit or otherwise. Those rules of thumb are shown to underestimate actual pedestrian behavior, at least for the conditions we studied.

The study finding about the relatively long distances that pedestrians walk suggests that transportation and land-use planners designing transit-oriented developments should assume many train riders will walk considerably farther than they may have previously thought, at least for commute trips to a rail station. For planning practice, this suggests that the pedestrian zones around key destinations (transit, schools, markets, parks) are larger than previously acknowledged. Planners should plan for good pedestrian infrastructure and

pedestrian-scaled design within a large radius around major destinations such as schools, transit centers, or shopping areas.

Of course, the study may be capturing the high end of the pedestrian spectrum, because we surveyed current walkers to transit, and it would be reasonable to expect that other walkers may be more inclined to walk shorter distances. However, just as maximum periods of usage are considered when building parking lots and road systems, planners should consider these maximum likely walking distances when making land use and transportation decisions.

Finding 2: Pedestrians believe that their primary consideration in choosing a route is minimizing time and distance.

The survey explored the reasons that pedestrians choose particular routes in two ways, first asking about route choice factors as an open-ended question and then asking respondents to rate the importance of a list of factors that might have influenced them. In both cases, respondents overwhelmingly indicated that their first priority was to choose the most direct and/or quickest route. Because almost all of our respondents were making a morning commute trip, it is not surprising that time would be a strong consideration for them.

These results suggest that land use planners who want to increase walk trips should ensure that pedestrians have available fairly direct routes to their destinations. Grid street patterns generally provide direct routes (as well as route choice), so planners are advised to adopt grid street patterns for pedestrian infrastructure when laying out new communities. If the grid has very long blocks, planners might want to consider adding mid-block footpaths through the center of the block. Neighborhoods that do not follow a grid pattern tend to require that travelers cover much longer distances to reach their destinations. In such cases, planners should try to create pedestrian cut-through passages that allow walkers direct access to many different destinations.

Finding 3: Secondary factors influencing route choice are safety and, to a lesser extent, attractiveness of the route, sidewalk quality, and the absence of long waits at traffic lights.

In both the open-ended and closed-ended questions about route choice, the most highly rated factors after distance had to do with safety. In the open-ended question, safety factors were the only other issue listed by over a quarter of respondents. In the closed-ended questions, about half of respondents rated it as “very important” to have traffic devices present and traffic driving at safe speeds. The next most-cited “very important” factor was having sidewalks in good condition (43 percent). Aesthetic factors, in the sense of attractive landscaping or buildings, were rated as very important by 35 percent of respondents, but raised by only 8 percent of the respondents in the open-ended question. The only other issues rated as “very important” by at least a quarter of respondents were having other people present (which may be a safety-related concern), and the absence of traffic lights with a long wait.

When interpreting these results, it is important to keep in mind the context in which the respondents answered. First, all were thinking about a commute trip in the morning; for other

trip purposes, their responses might vary. In addition, the audits conducted around two of the stations in this study showed that the pedestrian environment was relatively safe from crime and traffic, and most of the residential streets were of at least average attractiveness in terms of the built environment. Had the survey been conducted in extremely run-down neighborhoods, respondents might have placed higher priority on the visual quality and maintenance of the built environment.

These results suggest that transportation planners and traffic engineers wanting to encourage walking should pay particular attention to ensuring that pedestrians feel safe crossing streets, including keeping traffic to safe speeds and having traffic control devices present to help pedestrians cross intersections. Other transportation infrastructure issues to address are sidewalk quality and the length of time pedestrians must wait at traffic lights. Finally, planners who work with communities to improve the aesthetics of the built environment might see somewhat increased walking as a result, in addition to the other numerous benefits associated with attractive neighborhoods.

FINDINGS ON THE SURVEY METHODOLOGY: IMPLICATIONS FOR RESEARCH

The survey generated two key lessons for designing and interpreting research that collects information on how far people walk and the routes they take. First, the study demonstrated that asking participants to draw their route on a map works well. In addition, the study demonstrated that data derived from questions asking pedestrians to estimate the distance they walked must be interpreted cautiously.

Finding 4: Asking survey respondents to trace their walking route on a local map is an effective research technique.

Asking respondents to draw their route on a map is a relatively undocumented survey technique. We were unsure whether respondents would be willing to provide this information, or if they would fill out the map correctly so that the data would be useful. The study results show that the survey technique is highly effective. Of the 328 surveys received, the map was filled out correctly 93 percent of the time, generating 261 routes that could be analyzed for actual distance and other route characteristics. The route tracings were legible and precise enough that the research team had no trouble transferring the exact routes into a GIS database where the distance could be automatically calculated and walking routes recorded. In addition, the relatively high response rate for the survey overall (45 percent) shows that the presence of the map did not discourage people from completing the survey.

The results of the map question on the survey suggest that asking respondents to draw a route on a map is an effective research technique that can gather high response rates. In addition to generating data on walking routes, it is a useful way to assess walk trip distances. If researchers wish to collect accurate data about how far people walk, this method proved reliable and is

cheaper and less burdensome to respondents than the currently popular alternatives of asking respondents to wear a GPS device to track their movements or to wear a pedometer that counts overall steps.

Finding 5: Pedestrians vary considerably in how accurately they estimate the distance of a regular walk trip.

Many travel surveys ask respondents to self report the distances they travel. To date, there has been little published research into how accurate those self-reported estimates might be. This study found that the average difference between actual and perceived distance is modest, though a significant minority of respondents were also fairly far off. At least half of all respondents guessed within 0.13 miles of their actual route length. However, 25 percent of respondents' guesses were off by more than 50 percent or a quarter of a mile, suggesting that a substantial minority do not have a precise idea of how far they walked. A few of the individual guesses were also substantially off in terms of distance, as well as percent: guesses ranged from up to 1.07 miles over to 0.88 miles under the correct distance.

The findings on these reported walking distances suggest that researchers cannot assume that pedestrians will provide a highly accurate estimate of the distances they walk, even for short and routine trips. This finding is useful for assessing the value of other surveys that ask for self-reported walk distances, though it should be interpreted carefully when applying it to other surveys. Our survey asked people to estimate the distance of a route they walk routinely, so they may well have a more accurate sense of distance than they would on a less familiar trip. It seems likely that other surveys asking people to report the distances about routine trips might have similar (in)accuracies, but the study results should not be assumed to hold true for other types of trips that surveyors ask about. In addition, it may be that people making significantly longer trips would estimate distances less accurately than did our respondents, who were walking relatively short distances.

To counter this problem of inaccurate distance estimates, we recommend that future travel surveys ask residents to provide the address (or nearest intersection) of the trip origin and destination. This will allow surveyors to use automated GIS processes to estimate the distance along the shortest route on the street network.

FINDINGS ON THE WALKABILITY AUDIT METHODOLOGY: IMPLICATIONS FOR RESEARCH

Through the data collection and analysis process, we developed several recommendations for how best to conduct detailed, block-by-block walkability analyses. Findings six through eight focus on ways to reduce the time burden of collecting walkability audit data, allowing a research team to hone in on collecting only the most useful data. The final two findings address the practicalities of collecting the data—whether to use Pocket PCs or pen and paper,

and the importance of ground testing maps if one uses a GIS-based system running on Pocket PCs.

Finding 6: Spatially target the areas in which to collect walkability audit data.

Collecting data about the quality of street segments and intersections that pedestrians travel through generated very interesting findings that correlated with respondents' route choices, but we quickly realized that applying such a tool (or any walkability evaluation instrument) to every location was an inefficient use of time. Auditing all the streets is a lot of work for results that may not vary greatly over space (e.g., if residential streets throughout a study area do not vary much).

For many neighborhoods, one useful way to limit the data collection burden is to focus on arterials and collector streets. It was also apparent from our study sites that, in some study neighborhoods, it was almost unnecessary to audit residential streets and that focusing the audit on arterials, collectors, and their associated intersections may have been a better use of data collection time. In some neighborhoods, all residential streets had sidewalks and were pleasant and safe enough to walk along. In such cases, the key to evaluating the potential pedestrian friendliness of one's journey from home to transit (or other destination) was to examine the attributes of the major roads and the intersections between neighborhood roads and major roads.

In essence, the more focused question could be: "What makes a major automobile road more or less pedestrian friendly?" In this approach, all neighborhood streets could be assumed to be generally walkable and the focus would concentrate on locations where pedestrians had to travel on or across streets with high volumes of automobiles and/or high-speed automobiles. It is in these locations that interventions on behalf of walking might be best targeted. Comparing route choices and route avoidance by pedestrians along these major streets would allow planners and policymakers to focus resources and interventions where they are most needed, and the audit data could point these decision makers into appropriate directions for their interventions. Of course, in study areas where sidewalks are not universally present, or where street widths in particular vary quite a bit and could be deemed important barriers for walking, then including neighborhood roads in the audit may be important.

An alternative research approach may be to audit only those locations in a study area that have been identified as problematic. Researchers could first survey pedestrians to ask what blocks or intersections they avoid. Once these barriers have been identified, then planners could audit those areas to assess and document conditions precisely. In this approach, the assumption is that pedestrians choose to avoid hostile areas more than they seek friendly ones. By surveying pedestrians (or potential pedestrians) about their walking barriers, use of the audit tool can be better targeted to areas where the greatest concern exists. Research time can therefore be focused on areas that citizens have specifically identified as barriers instead of gathering extensive lists of built environment characteristics that may not be necessary or useful.

Finding 7: Customize data collection by street type.

Based on the study experience, we concluded that walkability audit instruments should differentiate among street types, so that surveyors only have to collect data relevant to each type of street or path. It became clear during the walkability audit that arterial and collector streets presented a different set of attributes that needed documentation compared to neighborhood streets. For example, street width, sidewalk buffers, on-street parking, and the number of high-volume driveways to cross were all much more important on arterials and collectors, where the volume and speed of vehicles presents much more of a safety threat and level of discomfort, compared to neighborhood streets. On neighborhood streets, at least in our study areas, the features in the built environment seemed unlikely to influence walking behavior. For these streets, perhaps the one exception to that rule would be to document whether or not the streets have sidewalks.

Customizing data entry variables for different types of streets would streamline the data collection process and allow a greater range of streets to be surveyed in a shorter period of time. This strategy would also produce a more streamlined and relevant set of data for analysis, reducing the time needed for the data analysis.

Figure 17 shows an example of a potential data filtering system by street type. These are two screenshots from a new tool, the School Environment Assessment Tool (SEAT), being developed to audit walkability for Safe Routes to School. The image on the left is the initial data entry page that appears and it provides an initial filter as to the street type being audited. Subsequent pages are customized based on which street type is selected. The image on the right is the data entry screen that appears for a street segment that ends with a cul-de-sac. Most streets that end in a cul-de-sac are neighborhood roads with low volumes of cars and are most likely not severely impacted by different measures of walkability. Documenting whether a pedestrian can cut through the end of the cul-de-sac, however, is important, but because it only pertains to segments ending in cul-de-sacs, this question only appears for streets selected as cul-de-sacs on the first data entry page.

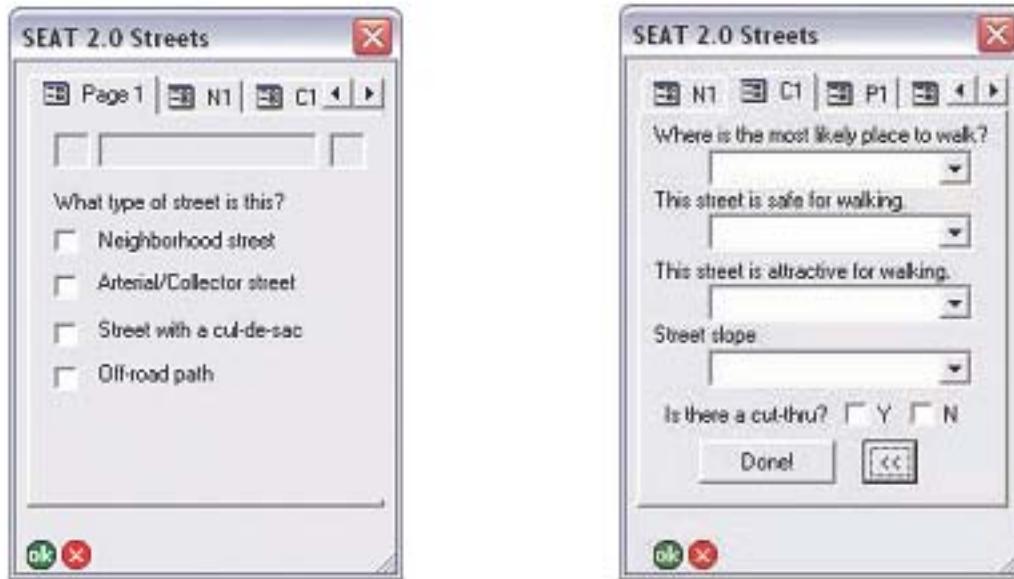


Figure 17 An Example of an Audit Tool Customized by Street Type

Finding 8: Consider using holistic, subjective measures of walkability instead of more detailed quantitative measures.

We found that in many cases the subjective assessment of how safe or attractive a block was seemed to better capture the pedestrian environment than did the many quantitative measures included in the walkability audit. These subjective measures are also obviously much quicker to collect, so future researchers may wish to concentrate on a few subjective measures only, to save data collection time.

There were street segments in our audit evaluation that felt like poor environments to walk along due to aesthetics, proximity to heavy traffic, and just a general feeling of being uncomfortable places. It would be easy to imagine that pedestrians would simply choose parallel paths to walk along. However, analyzing the objective variables contained in the audit tool did not always convey the general impression the surveyors received about the street segment. For example, one of these uncomfortable walking streets had a buffer between sidewalk and street, trees in this buffer, on-street parking, only two travel lanes in each direction, and properties that were decently maintained. In short, the segment had all the attributes that one would expect to make for a safe and attractive walking environment—even though the overall impression was otherwise. A similar conclusion about the value of subjective audit questions was reached in a study where the authors found that “walking behavior is better explained by perceptions than sociodemographics or objective assessment of the environment.”²²

One limitation of relying solely on broad subjective evaluations of walkability is that these do not provide decision makers with any guidance on how to design or retrofit areas targeted for pedestrian improvements. However, for studies of pedestrian route preference, such subjective measures may be enough to determine whether urban design has impact on route choices or not, or whether shortest routes are the predominant factor in influencing trip making. More detailed audits of the design features in a neighborhood could be reserved for planning studies where planners and decision makers wish to identify specific environmental features that need to be upgraded.

Finding 9: Weigh carefully the benefits of collecting audit data on paper vs. on a Pocket PC.

Lastly we reflect on the utility of an electronic and GIS-enabled approach to audit data gathering versus a more traditional approach of paper, pen, and clipboard. The obvious benefit of the handheld GIS computer approach is that by collecting data both in an electronic and a GIS format, there is no need for subsequent data entry once the audit is complete. The GIS data collection approach also eliminates the danger that data collected on paper will be incorrectly entered into the computer database when later converting the data to a GIS environment. With handheld GIS technology that risk is minimized, because data can be collected in closed-ended questions directly within a GIS environment. Also, the GIS technology greatly reduces the total time involved, because the data does not have to later be converted to GIS from a paper form or electronic database.

The handheld computer approach has the additional benefit of instant map making, which may be important for community-based approaches to walkability assessments. For example, planners or researchers may wish to have a group of community or elementary school volunteers use the audit tool to assess streets and intersections within a mile of a target school and then immediately show the results to the volunteers. With the handheld GIS approach to conducting walkability audits, it would be possible for this group of volunteers to easily collect data in a few hour period, gather together at the end of data collection, and synthesize the data from each handheld device used into a single data file that can be mapped on the spot. Incorporating portable printer technology would allow each volunteer to leave the day's auditing with initial walkability maps based on data collected that day. For community-based approaches to walking issues, the ability to transform volunteer energy into a tangible map can be vital in sustaining community interest and catalyzing decision makers into taking appropriate action in regards to the needs of pedestrians.

Of course, the use of this advanced technology in assessing the walking environment can also be limiting or carry risks. Perhaps the biggest limitation of handheld computer technology is that recording field notes can be more difficult or even impossible. When conducting a walkability audit, auditors sometimes wish to make specific notes about an audit variable, and unless the Pocket PCs are specifically programmed to allow this, handheld computers may offer limited note-taking capabilities. There are potential technological fixes to this problem,

such as using the built-in word processing, voice-recording, or picture-taking capabilities of Pocket PCs, but writing observations or comments directly onto a survey form is probably still easier to do with a pen-and-paper audit.

Another limitation of the digital approach is that audit questions are permanently pre-ordered and auditors are forced to answer audit questions as they are written, not as they are observed. Paper versions of audits allow the auditor to answer questions in the most logical order for what is being observed, but electronic approaches make this approach too cumbersome to be useful. Some auditors in projects similar to this study have complained to the study authors that they can record the data much faster on paper than using a Pocket PC.

Other technology issues are that battery life of Pocket PCs can be short for all-day auditing unless extended batteries are purchased. Also, some people just find the Pocket PC too cumbersome to use. Good training and preparation can overcome this hurdle, however. Finally, carrying expensive computers while analyzing neighborhood streets and sidewalks can be unsafe in certain neighborhoods (or make auditors feel unsafe), especially if auditing teams are perceived as outsiders to that neighborhood. Making good community connections, as should be done with any project where a potential problem of outsider vs. insider may exist, should be a prerequisite to doing the auditing work.

Finally, cost and technological accessibility could be a problem with the electronic approach. The cost of a PDA plus an extended battery, available from a variety of vendors such as Dell or HP, is about \$500 per unit. High-end units with integrated GPS can cost as much as \$2,500. The software needed to program the PDA with a GIS-based audit tool is called ArcPad and ArcPad Application Builder. It is available from ESRI, the maker of the popular ArcGIS suite of tools, for around \$1,500.

Finding 10: Ground truth base maps.

Although we found that collecting GIS-enabled data at a streetscape level was generally straightforward, we did learn (the hard way) that it is critical to ground truth the street base map that will form the core of the data set before using the tool in the field. We used the Topologically Integrated Geographic Encoding and Referencing (TIGER) street file as our base map because we wanted to use a freely accessible source of data that would be available to any community in the United States. As is often the case with TIGER data, the map did not always accurately reflect existing streets. In some cases, the TIGER data included streets that did not exist, and in others, streets existed that were not included in the TIGER data. It is possible to add or delete street segments or adjust street ranges in the field by using the ArcPad program running on the Pocket PC, but it is critically important that some basic ground truthing of the base GIS data be conducted prior to auditing the environment.

It is also important to check the address ranges of the streets within the TIGER data after uploading data to ArcPad to ensure they are consistent with actual address ranges of the streets. We found address ranges that were one block off, meaning we had to correct these errors in the map by hand before it was possible to accurately geocode our survey data.

RECOMMENDATIONS FOR FUTURE RESEARCH

This study has shown the feasibility of the map-based survey method combined with walkability audits as a method to explore pedestrian route choices and distances walked. The results should be extended by applying the methods developed to study different kinds of walk trips, walkers, and neighborhoods.

One useful variation on this study would be to survey people taking trips for purposes other than a morning commute. For the commuters surveyed in this study, the key factor in their route choice was minimizing distance and time. Although it is unsurprising that people on their way to work in the morning want to minimize their travel time, walkers on other types of trips may be less sensitive to time and more sensitive to their surroundings. Future studies could target pedestrians walking to destinations, such as shopping, local services, or schools, to see how far they actually travel and what route choices they make.

Second, the methods could be applied to different populations to see if the study results are unique in any way to commuters. The elderly, children, and adults who do not work during the daytime are examples of groups who might have very different walking habits and preferences for both route choice and distance.

A third useful application of the study methodologies would be to research a neighborhood with more overtly unpleasant walking conditions. The study areas investigated were relatively safe, and although not all corridors were exactly beautiful, there were not many obvious deterrents to walking, such as huge vacant lots, abandoned buildings, or highly dangerous intersections.

APPENDIX A

SURVEY QUESTIONNAIRE

Instructions for Surveyor

Ask verbally. DO NOT read the list of options, but check off the right option based on the response.)

Hello, I'm with the University of Oregon and I'm surveying people about how they got to the BART station today. Would you mind answering a few questions while you're waiting for the train?

Could you tell me how you got to this station today?

Keep a tally (hatch marks) of modes of travel to the station for the following categories as you pass out the surveys.

If subject DID NOT walk, make sure to record their mode of transportation below and say:

For this study, we're focusing on the various routes people used to walk here, instead of <biked/ drove/took the bus>. But thank you for taking the time to speak with me. Have a good day!

If subject DID walk, say:

We're interested in finding out more information from people who walk to the station. Do you have five minutes to complete a survey for me? Your participation is voluntary, and all information you provide will be kept completely anonymous. (if they don't want to participate, record in the table.)

Before we start, I have to confirm that you're at least 18 years old. Are you? (If they are obviously over 18, do not bother to ask.)

If under 18, record above and thank them. Okay. Unfortunately, because of research restrictions, we can only survey people over 18 years of age. Thank you for taking the time to speak with me. Have a good day!

Here's the survey. As part of the survey we ask you to draw the route you walked on this map [show map]. If you finish before the train comes, you can give it back to me. Otherwise, you can mail it to us in this postage-paid envelope [show envelope]. Also, here's a pen that is a small thank you gift from us, in appreciation of your time.



Mineta Transportation Institute Survey: Walking to the Transit Station

For this survey, we are interested in the walking route you used to get to the station today, and why you chose it.

After you complete the survey, please hand it back to one of the surveyors. If you do not finish the survey before your train arrives, please complete the survey on the train and mail it back in the stamped envelope provided.

If you have any questions about the survey, the last page provides you with information about how to contact the researchers, who are based at the Mineta Transportation Institute at San José State University and the University of Oregon.

1. How far do you estimate that you walked to get here? Please respond in both miles and blocks, and be as precise as possible.

___ Miles ___ Blocks

2. How long did it take you to walk to the station?

___ Minutes

3. Did you stop along the way to buy something, talk to somebody, or for any other purpose?

___ Yes ___ No

If yes, continue to questions 3a – 3c

If no, continue to question 4

3a. What did you stop to do?

___ Buy food/drink

___ Buy newspaper or other retail good

___ Talk to somebody

___ Other (please indicate): _____

3b. How long did you stop for?

___ Minutes

3c. If you had not stopped, what would your actual walking time have been? Please estimate to the nearest minute.

___ Minutes

4. For the attached map, please do the following:

- Trace the route that you took today on the attached map, being as specific as possible about your starting point.

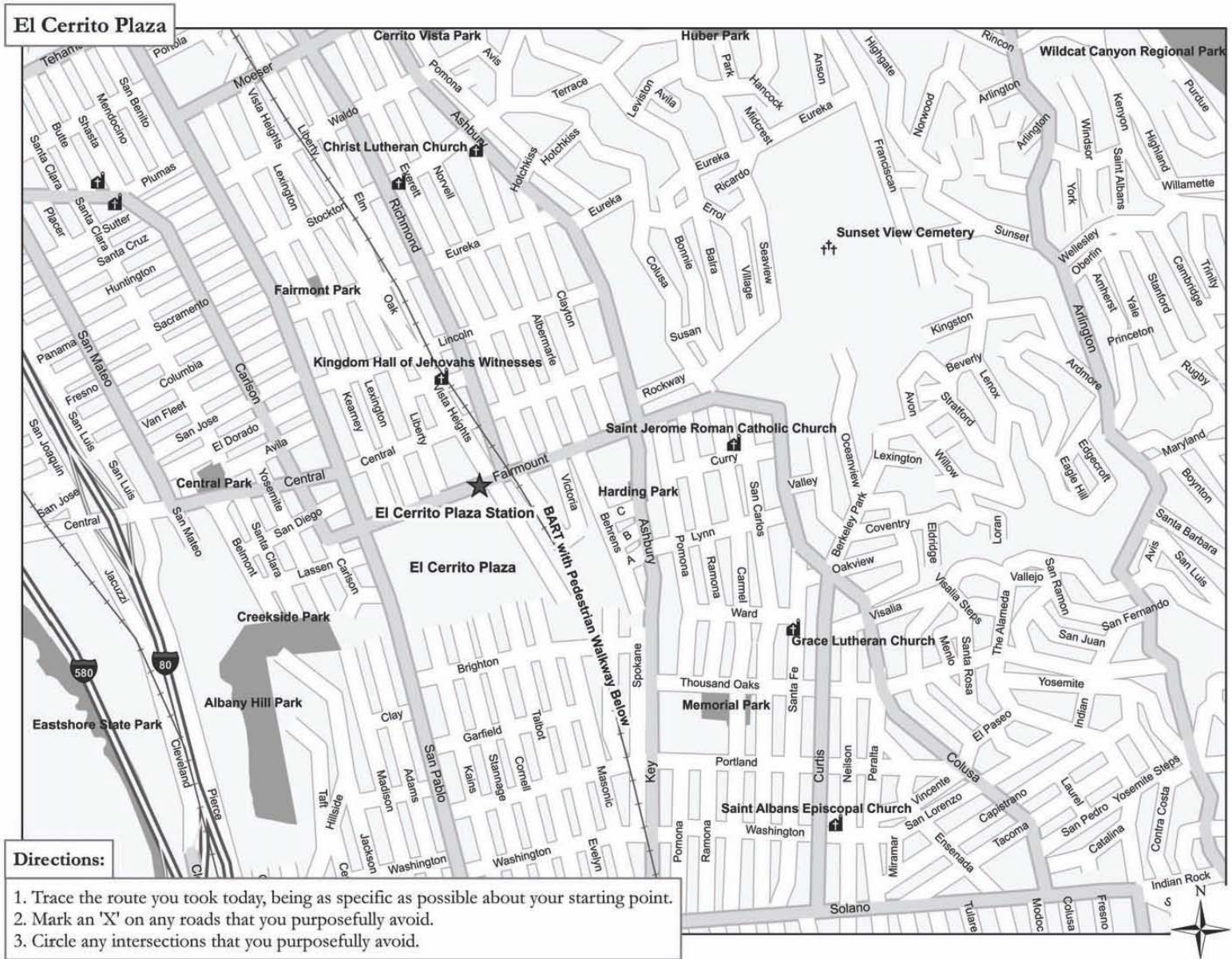
- Mark an X on any roads that you purposefully avoid.

- Circle any intersections that you purposefully avoid, or write them in the space provided below:

Intersection of _____ and _____

Intersection of _____ and _____

Intersection of _____ and _____



5. The last time you walked here from the same place, did you take the exact same route?

Yes

No

6. The last five times you walked to this station, leaving from the same place, how many different routes did you take?

1

2

3

4

5

7. What are the main reasons why you chose your route today?

i.

ii.

iii.

8. Below is a list of factors that other researchers have found to influence the routes people walk along. For each one, please mark how important it is to you.

Factors in Route Choice	Very Important	Somewhat Important	Not Important
Traffic drives at safe speeds	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
There are traffic control devices like traffic lights, stop signs, and crosswalks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
There are no traffic lights where I have to wait a long time to cross	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
There are attractive trees, landscaping, or buildings along the street	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The sidewalks are in good condition, without litter, cracks, or obstacles	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Factors in Route Choice	Very Important	Somewhat Important	Not Important
There are shops or businesses that I like to stop in	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
There are shops or businesses with windows I like to look at	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
A friend or neighbor is along the route	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
There are benches and/or places to sit	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
There are other people out walking	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
It is the shortest route	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Are there any other factors, positive or negative, that influenced your choice of route today?			

10. For each statement below, please mark how strongly you agree or disagree with it.

Statement	Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree
a. I like walking	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. Walking is relaxing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c. I walk to get exercise or other health benefits	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d. I sometimes walk because it is the fastest and/or most convenient way to get somewhere	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
e. I sometimes walk because it is the cheapest way to get around	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

11. What is the primary purpose of your BART trip today?

- Work commute
- School commute
- Personal shopping or errands
- Other (please indicate): _____

12. What place did you start from today on your way to the BART station?

- Home
- Work
- School
- Other (please indicate): _____

13. What is your gender?

- Male
- Female

14. How old are you?

_____ Years

15. Do you own the home you live in, or do you rent?

- Rent
- Own

16. Do you have a driver's license?

- Yes
- No

17. How often do you have access to a car when you are going somewhere?

- Always
- Most of the time
- Occasionally
- Never

18. Please indicate your approximate household income to the closest \$10,000:

- \$10,000
- \$20,000
- \$30,000
- \$40,000
- \$50,000
- \$60,000
- \$70,000
- \$80,000
- \$90,000
- \$100,000
- +\$100,000

19. Are you of Hispanic or Latino background?

- Yes
- No

20. What racial group or groups do you identify with? You can mark more than one.

- Caucasian
- African American
- Asian
- Native American
- Pacific Islander
- Other (please indicate): _____

21. Please provide us with the exact address that you left from today so that we can calculate how far you walked. We will not use your address to contact you, and we will not give it to anyone.

Thank you very much for your time.

Please return this survey to a researcher or mail it in the stamped, addressed envelope provided.

If you have any questions about this survey, the last page of this packet has information about how you can contact the researchers.

(You may tear off and keep this last page for your records)

For further information about the survey, or to receive a final copy of the report, please contact:

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APPENDIX B

AUDIT INSTRUMENT

Question/Variable	ArcPad	Variable Name	Possible Answers	Details
Street Form				
Page 1—Info				
Load default record	Load Default Record		Yes/No	If you have saved a record that you would like to reuse (default), check this box to populate all the fields with the default answers
Assessor's name	Name	ass_name		
Today's date	Today's date	ass_date		
Street	Street	prefix name type		direction of street name of street type of street
From	From	l_f_add		from address of segment
To	To	r_t_add		to address of segment
Attractive for walking	Attractive Walking	att_walk	1 = Strongly Agree 2 = Agree 3 = Disagree 4 = Strongly Disagree	Response to "Would you want to walk/bike in this segment?" Included feeling safe, finding the area aesthetically pleasing, and destination
Feels safe from crime	Safe from Crime	safe_crime	1 = Safe 2 = Somewhat unsafe 3 = Very unsafe	How safe from crime would you feel walking down this segment at night?
Feels safe from traffic	Safe from Traffic	safe_traff	1 = Safe 2 = Somewhat unsafe 3 = Very Unsafe	How safe from traffic do you feel walking down this segment?
PAGE 2—Chars				
Percent of landscape maintained? (includes both private property landscaping and buffers)	Percent landscape maintained	ls_maint	1 = < 50% 2 = 50% to 75% 3 = > 75%	1 = < 50% well maintained (well maintained is defined as few weeds/dead or heavily overgrown plants) 2 = 50% to 75% well maintained 3 = > 75% well maintained

Question/Variable	ArcPad	Variable Name	Possible Answers	Details
Percent of buildings maintained?	Percent buildings maintained	bldg_maint	1 = < 50%	1 = < 50% well maintained (well maintained is defined as no peeling paint, broken windows, or other maintenance issues.)
			2 = 50% to 75%	2 = 50% to 75% well maintained
			3 = > 75%	3 = > 75% well maintained
Building windows (defensible space)	Do buildings have: (check all that apply)	wind_bars	check box Yes/No	Bars on windows
		wind_broken	check box Yes/No	Broken windows
		wind_board	check box Yes/No	Boarded up windows
Cleanliness (leaves, branches, and brush all count toward cleanliness based on the amount and if it is clearly visible and in the pedestrian path.)	Litter	st_litter	0 = None or Almost None	There is no obvious garbage, litter, or broken glass in segment
			1 = Some	There are a few wrappers, or other litter or garbage evident
			2 = Lots	There is noticeable garbage, and/or broken glass along the segment
Graffiti	Graffiti	st_graff	0 = None or Almost None	There is no obvious graffiti
			1 = Some	There is a little graffiti
			2 = Lots	There is noticeable graffiti
Slope	Slope	slope	0 = Flat	No hill present along segment
			1 = Slight hill	There is a slight hill in the segment, but not enough to make walking uphill difficult
			2 = Steep hill	This hill in the segment makes walking it difficult
PAGE 3—Roads				
One way?	One way street	st_dir	Yes/No	
Travel lanes at midblock	Number of lanes	st_num_lanes	1 = 1 lane	Number of lanes at midblock. All lanes but parking lanes (includes turn only lanes).
			2 = 2 lanes	
			3 = 3 lanes	
			4 = 4 lanes	
			5 = 5 (+) lanes	

Question/Variable	ArcPad	Variable Name	Possible Answers	Details
Posted speed limit	Speed Limit	speed_lim	1 = None posted 2 = 5 3 = 10 4 = 15 5 = 20 6 = 25 7 = 30 8 = 35 9 = 40 10 = 45 11 = 50 12 = 55+	Mark "none posted" unless there is a sign WITHIN the segment that displays the speed limit. Even if there is a sign outside the segment, within plain view, it does not count.
On-street parking	On-street parking	on_st_park	0 = none 1 = 1 side of the street 2 = Both sides of street	If pavement is unmarked, mark parking present only if cars are parked within segment
Off-street parking	Off-street parking	off_st_park	1 = 0 to 5 spaces 2 = 6 to 25 spaces 3 = 26 or more spaces	Count all off-street parking spaces in segment. Cars in single-family home driveways do not count. Only spaces in actual parking lots count. There must be access to the lot from the segment.
Driveways (only record high-medium volume driveways)	Driveways	num_dways	1 = < 2 2 = 2 to 4 3 = > 4	High-medium volume driveways are driveways that often have cars pulling in and out, like commercial driveways or driveways of apartment buildings (12 or more units). Single-family residential driveways are low volume and do not count.
Sidewalk	Is there a sidewalk?	Path_Exist	Click button if there is a sidewalk	(THIS IS A FILTER QUESTION TO DIRECT YOU TO THE SIDEWALK PAGE) If there is a sidewalk, the button SW Data will take you to the sidewalk input page. Once you complete the sidewalk input page, check a button to return to the main form.

PAGE 4—CP Zones

Question/Variable	ArcPad	Variable Name	Possible Answers	Details
Buffer type between road and path	Buffers (Check all that apply)	buff_no, buff_yes buff_fence buff_trees buff_hedge buff_grav buff_grass buff_other buff_txt_o	Yes/No: Is there a buffer? Fence Trees Hedges Gravel/cement Grass/flower bed/ wood chips Other Other text	If there is a buffer, then go on to the options below. If there is not a buffer, clicking the "N" radio button will disable the buffer options below and the buffer width control.
Buffer width	Buffer Width	buff_width	0 = No buffer 1 = < 1 foot 2 = 1 foot < 4 foot 3 = 4 feet +	U.S. Department of Transportation guideline. If buffer width varies, use the average or typical width.
Street amenities	Amenities (check all that apply)	am_yes, am_no am_garbcn am_benches am_benches am_bikepk am_stven	Are there amenities? Yes/No: garbage cans Yes/No: benches Yes/No: water fountain Yes/No: bike parking Yes/No: vendors	If there are street amenities, go on to options below. If no street amenities ("N" radio button), the amenity controls below will be disabled. Do not count private, residential garbage cans. Includes public pay phones, mailboxes and newspaper dispensers.
PAGE 5—Frontage				
Building setbacks (edge of sidewalk)	Edge of sidewalk	setb_edge	1 = None 2 = Up to 50% 3 = > 50%	Building setbacks from street
Building setbacks (< or = 20 feet)	< or =20 feet	setb_20f	1 = None 2 = Up to 50% 3 = > 50%	Building setback from street
Building setbacks (> 20 feet)	> 20 feet	setb_20m	1 = None 2 = Up to 50% 3 > 50%	Building setbacks from street
Walk through parking lot	Walk through parking lot	walk_parkl	Yes/No	From the sidewalk (or curb if there is no sidewalk) must you walk through a parking lot to get to most (> 50%) buildings?
Percent of block is parking lot?	Percent of block is parking lot?	parkl_pct	1 = < 30% 2 = 31% to 60% 3 = > 60%	If there is a parking lot, how much of the length of the segment does it occupy?

Question/Variable	ArcPad	Variable Name	Possible Answers	Details
Make record default	Make this the record default		Yes/No	When checked, all the values for the fields will be saved. They will then be available to populate the next form. Use if you are on a street with many similar segments. Can only save one default configuration at a time.

PAGE 6—Sidewalk

Sidewalk completeness	Is sidewalk missing along segment?	path_comp	Yes/No	SW is complete if it does not have any breaks within the segment. SW is incomplete if it ends or has gaps within the segment.
Path width	Sidewalk width	path_width	0 = < 3 feet 1 = 3 feet to 4 feet, 11 inches 2 = > 5 feet	If SW width varies, use the average or typical width.
Path condition	Path condition	path_cond	0 = Poor 1 = Fair 2 = Good 3 = Under repair	Many bumps/cracks/holes. A stroller cannot be pushed without many jarring motions and/or if it clearly needs to be replaced. (patches would not be sufficient) Some bumps/cracks/holes. A stroller can easily be pushed along the sidewalk with few jarring motions to the passenger and/or the sidewalk only needs patches or other minor repair. Very few bumps/cracks/holes. A stroller can easily be pushed along the sidewalk without jarring motions to the passenger and/or it needs no repair at this time. If there is evidence of work being done to improve the sidewalk. Orange cones are not enough. If construction work is being done adjacent to the sidewalk, blocking it off as a result, it is considered "under repair."

INTERSECTION FORM

PAGE 1—Ints I

Question/Variable	ArcPad	Variable Name	Possible Answers	Details
Type of intersection?	Intersection type	valence	1 = Dead end 3 = 3-way 4 = 4-way 5 = 5-way 6 = 6+ way	This is the number of streets that meet at an intersection (valence). Previously calculated from GIS analysis.
Traffic control devices	Traffic control (check all that apply)		Traffic light All way stop Some stops Traffic circle Other Other text	Count only the traffic control devices within the segment, not those that are visible but outside the segment. All segments have stop signs Only some segments have stop signs Count on all the segments that go into the circle. Triangular traffic control devices can also be counted under this category.
Median	Is there raised median?	median	Yes/No	Is there a raised median that a pedestrian can wait on?

PAGE 2—Ints 2

Crossing aids in segment	Crossing aids (check all that apply)	ped_paddle curb_ext overunder ped_xing_sign flsh_warn detect_warn ped_sig	Yield to pedestrian paddles Curb extension Overpass/underpass pedestrian crossing sign Flashing warning Detectable warning (ADA) Pedestrian signal	
How many marked crosswalks are there?	Number of marked pedestrian crossings	crosswalk	0 1 2 3 4 5+	Note all marked crosswalks in segment. "Marked" refers to lines on the pavement (not automobile stop lines) or signs, lights, or signals.
Corners with curb ramps	Number of corners w/ curb ramps	crb_ramp	0 1 2 3 4 5+	How many corners have curb ramps?

Question/Variable	ArcPad	Variable Name	Possible Answers	Details
Is there a pedestrian signal?	Pedestrian signal	ped_sig	Yes/No	Is there a pedestrian signal?
Feels safe to cross?	Safe crossing	safe_xing	1 = safe 2 = somewhat unsafe 3 = very unsafe	How safe from traffic do you feel walking across this intersection?

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17. The method at El Cerrito was as follows. First, surveys were only disseminated on the southbound side of the platform because that is where all the people are boarding in the morning. The surveyor started at the south end of the platform and approached each line of people waiting for trains until the north end of the platform was reached, and then returned and approach people sitting or standing at the back of the platform. When a train arrived and the platform became empty again, the surveyor restarted the above process at the most convenient place on the platform where people began to line up again.
18. The discrepancy may result from either the questionnaire design or respondents’ inherent comfort estimating distances by miles. First, the question was formatted on the page with a space to enter the distance in miles followed by a space to enter the number blocks on the same line. This particular layout on the page may have encouraged some people to think they could enter just one or the other (see Appendix A, survey question #1). However, it is also likely that people just feel more comfortable reporting in blocks because they know they don’t have a very accurate sense of distances measured in miles.

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20. Analysis of the El Cerrito data revealed similar patterns.
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ABBREVIATIONS AND ACRONYMS

BART	Bay Area Rapid Transit
GIS	Geographic information system
NHTS	National Household Travel Survey
PDA	Personal digital assistant
PEDS	Pedestrian Environment Data Scan
SEAT	School Environment Assessment Tool
SPACES	Systematic Pedestrian and Cycling Environmental Scan
TIGER	Topologically Integrated Geographic Encoding and Referencing

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