

1 **Perceptions of Green Streets and their Influence on Walking**

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1 ABSTRACT

2 An increasing number of cities in the U.S. are implementing green streets as a more sustainable and cost-
3 effective option to traditional stormwater infrastructure. Green streets are streets that incorporate natural,
4 landscape-based features (such as bioswales) that manage stormwater runoff at the source, through
5 infiltration, reuse, or evapotranspiration. This paper examined opinions about green streets and their
6 relationship to walking through the use of surveys conducted in two areas with green streets and two
7 nearby comparison or “control” areas in Portland, OR (n=748). The findings indicate that green streets
8 may encourage more walking. Bivariate analysis and a regression model found that residents in one of the
9 green street neighborhoods walk more frequently in their neighborhood, compared to the other
10 neighborhoods. Residents in the other green street neighborhood were about twice as likely (compared to
11 its control neighborhood) to say they were walking more in their neighborhood compared to before the
12 green streets were built. But their frequency of walking was not significantly higher than the control
13 neighborhoods. These findings point to the challenge of measuring behavior change using a single, cross-
14 sectional survey, in addition to the limitations of self-reported behavior data. Residents noticed the
15 increase in vegetation and street and pedestrian features associated with the green streets and their
16 opinions of the green streets were generally positive. When asked specifically about the green streets, a
17 large majority felt they made their neighborhood a better place to live. Much smaller shares felt that the
18 green streets caused problems, such as more litter, or making parking or driving difficult. There were
19 some demographic differences with respect to opinions. In general, older adults (65+) had more negative
20 opinions about green streets than younger adults.

21

22

1 INTRODUCTION

2 An increasing number of cities in the U.S. are implementing green streets as a more sustainable and cost-
3 effective option to traditional stormwater infrastructure. Green streets are streets that incorporate natural,
4 landscape-based features (such as bioswales) that manage stormwater runoff at the source, through
5 infiltration, reuse, or evapotranspiration. This form of green infrastructure can reduce the need to build
6 and expand “gray” infrastructure, e.g. stormwater pipes and sewers. Through landscaping, shading and
7 breaking up continuous paved surfaces, features of a green street may also mitigate the urban heat island
8 effect, reduce pollution, and provide wildlife habitat (1; 2). Green streets may also accommodate multiple
9 travel modes, particularly walking and bicycling.

10 While there is a wide body of literature about the multiple co-benefits of greenery and
11 landscaping in urban areas, the research on green streets and similar green infrastructure is limited. One
12 study found that home sales prices increased as distance from a green street facility increased, though the
13 effect was small. However, prices increased when the tree canopy in the nearest green street facility
14 increased and there may be positive effects when there is an abundance of green street facilities in a
15 census tract (3). Other studies of low-impact development stormwater systems have found both negative
16 (4) and positive (5) effects on home prices.

17 Despite the growing use of green infrastructure, several barriers to implementation have been
18 identified, including uncertainties about their effectiveness, financing mechanisms, ownership and
19 maintenance issues, and agency coordination (6). The novelty and visibility of green streets may also
20 require greater public acceptance before widespread adoption (7). This points to the need for research on
21 public perceptions of green streets. Two studies in Portland using interviews with residents found
22 generally positive attitudes of people living nearby (7; 8). A separate, longitudinal study in Portland, OR
23 found that residents’ perceptions of their neighborhood improved in areas where green street features
24 were installed and that public engagement efforts could improve acceptance of the facilities (9).

25 Certain aspects of green street facilities may influence resident perceptions. A survey in the
26 Netherlands examining perceptions of green infrastructure related to climate change found that residents
27 preferred diverse and aesthetically attractive infrastructure; streets with shrubs and trees were preferred to
28 those with grass strips. Respondents who received information about the positive climate effects of green
29 infrastructure were particularly positive towards street trees (10). A survey in Germany found that
30 residents preferred traditional and tended green areas in their neighborhood, rather than the more natural
31 landscaping in an unmanaged green urban brownfield. However, opinions shifted when the benefits of the
32 natural landscape for the ecosystem was explained (11). Some of the Portland residents in one study
33 raised concerns about litter and the messy appearance of the plants in the bioswales, though just as
34 frequently as they mentioned aesthetic benefits (7). Maintenance was also a concern, while problems with
35 parking did not come up often.

36 One of the potential secondary benefits of green streets could include increased physical activity
37 through walking and bicycling in the neighborhood. We could not identify any published research
38 literature directly linking green streets to travel behavior. Several studies linking travel behavior to the
39 built environment have included street trees and landscaping as variables. Lund (12) found that
40 amenities (e.g., parks and retail shops) that were combined with pedestrian-friendly streetscapes (e.g.,
41 planting strips, sidewalks) were associated with more pedestrian travel and interaction within a
42 community. The density of street trees in London was linked to more walking (13). A Tokyo study found
43 that older adults had a higher probability of living longer if they lived in a walkable neighborhood with
44 parks and tree-lined streets (14). However, some studies have not found links between street trees and
45 walking (15; 16).

46 This paper uses data from neighborhoods in Portland, OR to assess resident perceptions of green
47 streets and relationships to walking in the neighborhood. The primary questions are: (1) Do residents
48 living near green streets walk more in their neighborhood? (2) What are residents’ opinions of green
49 streets? and (3) Are there variations by age or other demographic factors in individuals’ responses to
50 green streets? The study collected survey data from two neighborhoods with green streets and two
51 control neighborhoods.

METHODOLOGY

Neighborhood Selection

Using a GIS database provided by the City of Portland, the research team examined all completed green street installations as of 2009 to help select the study areas. The criteria for selecting the study areas included the following:

- (1) A concentration of several green street elements, including a minimum of ten individual green street treatments over a minimum of a five-block area.
- (2) Primarily residential land uses. Studying green streets implemented in areas with a balanced mix of residential and commercial land uses would present the additional difficulty of controlling for the effects of the wide range of commercial land uses.
- (3) Installation of the green street treatments in an existing neighborhood. This would allow residents to recall the neighborhood prior to installation. Given timing and funding constraints, a before-after study was not possible. Therefore, we needed to rely on retrospective recall.

The research team then visited the handful of areas that met these criteria. The two treatment study areas were selected because the team felt that the green street features were in significant contrast from the other landscaping in the neighborhood, particularly in the yards of homes. Once the two treatment areas were selected, we looked for potential comparison, or “control,” neighborhoods nearby. Limiting the search to areas nearby helped control for the potential effects of regional accessibility and other factors. The two selected areas were chosen because they had similar demographic characteristics and comparable architectural styles of homes.

The two treatment neighborhoods are referred to as “92nd Avenue” and “104th Avenue” and are located approximately seven miles southeast of downtown Portland. These study areas were defined to include all street segments (aka blocks) within a one-quarter mile walking distance from the green street features (Figure 1). This definition means that many households in the study area do not live *on* a block with green street features, but they all live within a reasonable walking distance from the features. The two areas differ in the nature and types of green street treatments installed. The 92nd Avenue green street features are along a linear corridor (SE 92nd Avenue, shown in green in Figure 1). The 104th Avenue green street facilities are in a cluster of several streets. The neighborhoods are shown in Figure 2. Characteristics of the neighborhoods are shown in Table 1.

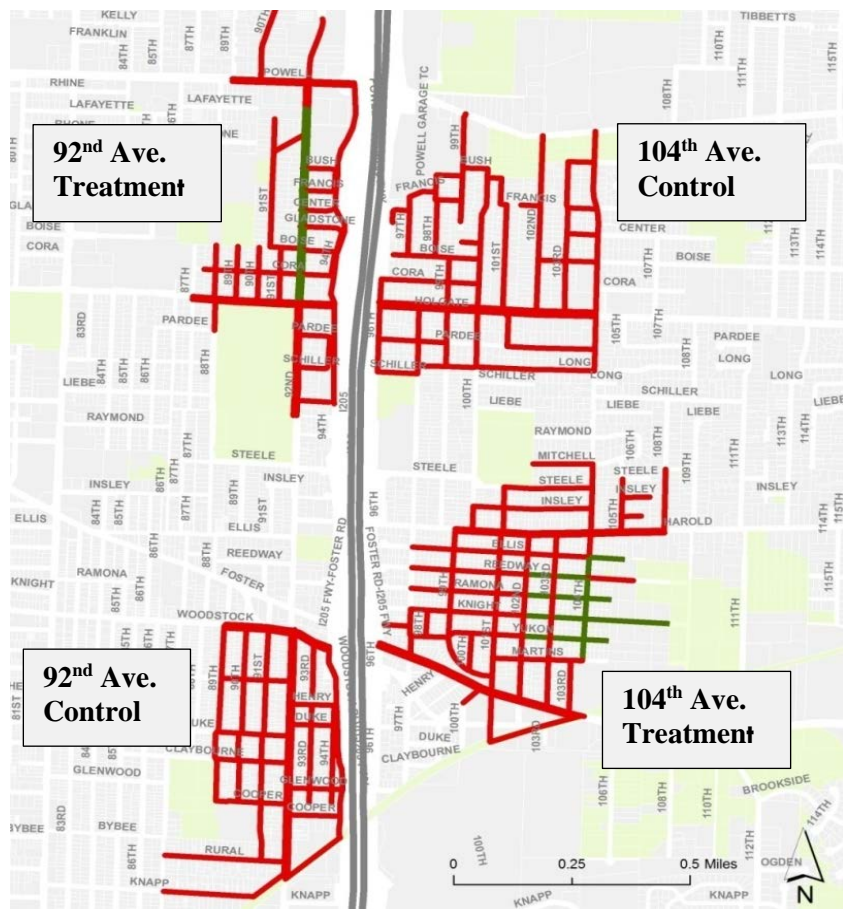


Figure 1: Treatment and Control Study Areas

92nd Green Street Area



92nd Control Area



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104th Green Street



104th Control Area



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6
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Note: The top row in the green street area includes green street features; the bottom row is a view of a nearby street in the green street study area without green streets.

Figure 2: Treatment and Control Areas

1 **Table 1: Characteristics of Treatment and Control Areas**

	92 nd Avenue Treatment Area	92 nd Avenue Control Area	104 th Avenue Treatment Area	104 th Avenue Control Area
Number of Households	415	388	676	683
Median Household Income	\$19,326	\$34,430	\$37,761	\$42,658
Median Family Income	\$37,761	\$37,120	\$47,290	\$42,658
Over 55 years	35%	14%	12%	20%
No Vehicles	36%	14%	4%	8%
White	74%	74%	74%	77%
% of households with English as a primary language	75%	63%	75%	73%
Median Year Home Built	1976	1957	1953	1956
Owner occupied	33%	51%	63%	65%
Walkscore™	72	52	51	52
Street Connectivity	0.81	0.81	0.91	0.85

2 Sources: 2000 Census, www.walkscore.com, Metro Regional Land Information System (RLIS).

3 Notes: Street connectivity is measured as the Connected Node Ratio, a ratio of connected nodes to total nodes. A
4 node represents each end of every street segment. A connected node includes three-or-more-way intersections.
5 Unconnected nodes are, for example, the ends of cul de sacs. The maximum value is 1.0, where there are no dead
6 end streets. Walkscore is a measure that represents the number of destinations that people may want to walk to (e.g.,
7 coffee shops, grocery stores, etc.) within a reasonable walking distance.

8

9 **Neighborhood Survey: Instrument**

10 There were four unique versions of the survey, one for each study area. The two treatment area
11 surveys differed from the two comparison area surveys due to the inclusion of questions specifically
12 about green streets. The surveys for the 92nd Avenue treatment and control areas differed from those for
13 the 104th Avenue study areas simply because of different dates of installation of their respective green
14 streets. All four surveys asked residents questions about their neighborhood before the date the relevant
15 green street features were installed. Except for these minor differences, the four versions were identical

16 Walking was measured using a scale of how often *At this time of year* (0 = Never, 1 = Less than 1
17 time per month, ... 4 = 2 to 4 times per week, 5 = 5 or more times per week) respondents walked (or ran
18 or jogged) from their home to 13 categories of destinations: 1) Work or school, 2) A church or civic
19 building, 3) A service provider, 4) A restaurant, bar or coffee place, 5) A store or place to shop, 6) A
20 place to exercise, 7) The home of a friend or family member, 8) An entertainment spot, 9) Taking
21 someone else to school or daycare, 10) To a bus stop, 11) To a MAX (light rail) stop, 12) No particular
22 destination, but walking a dog, and 13) No particular destination, just out of the house.

23 This was supplemented by six items assessing attitude toward walking and satisfaction with the
24 neighborhood for walking and biking. The attitude toward walking items used the following four-point
25 scale 1 = Strongly disagree, to 4 = Strongly agree and were: 1) Walking can sometimes be easier for me
26 than driving, 2) Traveling by car is safer overall than walking, 3) I prefer to walk rather than drive
27 whenever possible, and 4) I like walking. These four items were also averaged to create a measure of
28 each respondent's overall attitude toward walking. The last two items asked respondents to indicate on a
29 five-point scale (1 = Very dissatisfied, to 5 = Very satisfied) the extent to which they were satisfied with
30 their neighborhood as a place for walking and biking.

31 Items from the Neighborhood Environment Walkability Scale—Abbreviated (17) were used to
32 measure the following five constructs associated with neighborhood walkability: land-use accessibility,
33 neighborhood aesthetics, neighborhood crime, traffic hazards, and infrastructure and safety for walking.
34 Subscales were averaged to compute independent measures of walkability.

35 Additional measures were created to assess changes to the neighborhood prior to green street
36 installation within the relevant treatment area. These items required respondents to indicate whether or

1 not the following items had changed (1 = Increased, 2 = Stayed the same, 3 = Decreased): trees, bushes or
2 other plants, sidewalks, street lights, paved streets, pavement markings (such as crosswalks), car and/or
3 truck traffic, people walking, people on bicycles, children playing outside, and noise level. Respondents
4 were then asked to indicate whether the change was positive or negative (1 = Positive, 2 = Neither
5 positive nor negative, 3 = Negative). A separate set of questions were designed to assess perceptions of
6 general changes in the neighborhood such as overall aesthetics and whether individual and neighborhood
7 resident activity behaviors had changed. For the treatment areas, a series of questions assessed awareness
8 of green streets and their function.
9

10 **Neighborhood Survey: Survey Administration**

11 The survey process was conducted in four stages over about five weeks, starting in early May
12 2010: (1) a pre-letter co-signed by the president of the neighborhood association, telling residents that the
13 survey would be coming the following week; (2) an initial survey packet with a cover letter, two copies of
14 the survey (**one** for each adult), a postage-paid return envelope, and an entry form for a drawing; (3) a
15 reminder postcard; and (4) a follow-up survey packet to all non-respondents identical to the initial packet
16 except for some wording in the cover letter. In all cases, the cover letter was in English on the front and
17 Spanish on the back. Spanish-speaking respondents could call a phone number and request copies of the
18 survey in Spanish.

19 The mailing list for the surveys (aka “sampling frame”) was developed using two sources: (1) a
20 mailing list purchased from a vendor; and (2) Metro’s Regional Land Information System (RLIS). RLIS
21 data includes single-family homeowner names, but does not include complete data on multi-family units.
22 The purchased mailing list included names for more than half of the addresses, including some renters. To
23 improve response rate, respondents could enter a random drawing for 80 \$10 gift cards to a local grocery
24 store.

25 The pre-letter was mailed to a total of 2,462 households in our four study areas. After all four
26 mailings were complete, 299 households were excluded from the sample because at least one mailing was
27 returned as undeliverable. Of the remaining 2,163 valid households in the sample, we received responses
28 from 572, for a 26.4% response rate. Given the length of the survey (8 pages (comparison neighborhoods)
29 or 12 pages (treatment neighborhoods) and the demographics of the neighborhoods (lower- to moderate-
30 income, multilingual), this result is satisfactory. Those 572 responding households completed 748
31 surveys, since several households have more than one adult who completed a survey.
32

33 **FINDINGS**

34 **Survey Respondents**

35 Basic demographic characteristics of the survey respondents appear in Table 2, along with
36 comparable 2000 Census data for the neighborhoods. Just over half of the respondents were women and
37 over 70% were white. A sizeable share (16% to 27%, depending upon the area) were 65 years old or over.
38 On some measures for most of the study areas, the respondents are similar to the population, as estimated
39 using the 2000 Census data for the overlapping block groups. However, homeowners may be
40 overrepresented. For two of the study areas (92nd Green Street and 104th Control), lower income residents
41 may be significantly underrepresented. For three of the areas, older adults may be overrepresented.

1 **Table 2: Characteristics of Survey Respondents Compared to 2000 Census**

	92nd Green St.	92nd Control	104th Green St.	104th Control
65 or older	21% (27%)	16% (8%)	17% (7%)	27% (15%)
Own home	66% (34%)	70% (59%)	72% (69%)	75% (63%)
Female	54% (53%)	57% (49%)	58% (47%)	59% (51%)
Hispanic	9% (6%)	9% (11%)	8% (13%)	4% (12%)
White	77% (75%)	72% (74%)	85% (75%)	84% (78%)
Income <\$25,000	38% (56%)	43% (31%)	36% (31%)	33% (63%)
Can't make ends meet	19%	26%	18%	20%
n	125	158	216	238

2 Note: 2000 Census data appear in parentheses below the survey data.

3 Of the 128 respondents in the 92nd Avenue Green Street area, 17 (13%) live on a green street; 30
 4 (14%) of the 219 respondents in the 104th Avenue Green Street area live on a green street. Depending
 5 upon the analysis desired, these numbers may not always be large enough to separate out these
 6 respondents from others living in the green street areas.

8 **Do residents living near green streets walk more in their neighborhood?**

9 There were differences in reported walking activity between the four neighborhoods (Table 3). Residents
 10 in the 92nd Ave. green street area were more likely to walk five or more times a week, and they walked an
 11 average of 27 times per month. This was significantly higher than the other areas.

13 **Table 3: How often Survey Respondents Walked to Places in their Neighborhood**

	92nd Green Street	92nd Control	104th Green Street	104th Control
Less than once a week	19%	28%	30%	29%
1 to <5 times a week	26%	30%	28%	34%
5 or more times per week	55%	42%	41%	37%
	100%	100%	100%	100%
Avg. # times per month	27	20	19	18
n	127	159	218	239

14 Notes: Reflects walking to all destinations, combined

15 The average # of times walked per month was created using the answers to questions regarding the frequency of
 16 walking to various destinations. Categories were converted to numbers, e.g. 1-3 times per month was converted to 2
 17 times per month and summed across the destinations. The variable was capped at 60 times per month.

18 For categorical data, Chi-Square=12.73, p<0.05.

19 Data for average number of times per month capped at 60. One-way ANOVA, p<0.01.

21 The presence of green streets is likely only one factor that may explain the differences in walking
 22 frequency in the neighborhoods. Other factors include having destinations within a reasonable walking
 23 distance, demographics (e.g. age) and attitudes. To help account for the influence of these factors, we
 24 estimated a linear regression model, with the total number of times per month the respondent walked from
 25 home as the dependent variable. The results are shown in Table 4. The analysis indicates that
 26 demographic characteristics are important. People who are renters (perhaps a proxy for income) walk

1 more often, while people with a driver's license or physical limitations walk less. Walking frequency also
 2 decreases with age. Respondents' attitudes towards walking were significant; a more positive attitude
 3 towards walking was associated with more walking. This was measured by having respondents indicate
 4 their agreement with statements such as "walking can sometimes be easier for me than driving" and "I
 5 like walking." Respondents' level of agreement with the statement "There are many places to go within
 6 easy walking distance of my home" was not significant. This variable was included to help account for
 7 the fact that having destinations nearby is necessary for many walking trips, and it is surprising that it is
 8 not significant in the model. We also tested variables representing the actual number of stores and
 9 restaurants within one-quarter mile and found no significant relationships. These findings warrant further
 10 analysis. Finally, dummy variables were included representing the two areas with green streets.
 11 Respondents living in the 92nd Avenue Green Street area did walk significantly more, while those in the
 12 104th Green Street area were not. With the other variables in the model, this may indicate that the green
 13 street features along 92nd Avenue may be having a positive effect on walking behavior in that area.
 14

15 **Table 4: Regression Analysis of Walking Frequency**

Variable	Coefficient (unstandardized beta)	Sig.
Constant	2.76	0.51
Respondent is renter	6.53	<0.01
Valid driver's license	-9.45	<0.01
Age	-0.11	0.01
Physical limitations walking several blocks	-4.82	<0.01
Attitude towards walking*	11.34	<0.01
There are many places to go within easy walking distance of my home	0.49	0.46
92 nd Green Street	4.49	0.02
104 th Green Street	-1.70	0.25
Adjusted R ²	0.33	
<i>n</i>	659	

16 * Scale variable created from four questions assessing respondents' attitudes towards (question 5, see Appendix C).
 17 Higher values indicate more positive attitudes towards walking.

18 Notes: Bold indicates significant variable, $p < 0.05$. Dependent variable is the number of times per month the
 19 respondent typically walks to destinations in their neighborhood, capped at a maximum of 60.
 20

21 The survey also asked if people were walking more in their neighborhood compared to 2006 or
 22 2007 (before the green streets were built). Over one-quarter (26%) of the residents in the 104th green
 23 street area said that they were (Table 5). This was about twice as high as the share in the 104th Control
 24 Area. About 31% of the respondents in the 92nd Ave. green street area said they were walking more,
 25 compared to 22% in the 92nd Ave. Control area; this difference was not significant. Residents of the 92nd
 26 green street area were significantly more likely to agree that walking in the neighborhood was now more
 27 pleasant (44%). There were no significant differences in visiting neighbors outside or riding a bike in the
 28 neighborhood, nor opinions about changes in safety for walking in the neighborhood.

1 **Table 5: Walking and Other Activity Now Compared to Prior to Green Street Installation**
 2 **Year**

% of Respondents who...	92nd Green Street	92nd Control	104th Green Street	104th Control	Significant Difference?
Walk more in their neighborhood	31%	22%	26%	13%	yes
Walking in the neighborhood is now more pleasant	44%	22%	36%	20%	yes
Walking in the neighborhood is safer now	24%	19%	22%	17%	no
I visit more with neighbors outdoors now	13%	23%	20%	18%	no
I ride my bike more in my neighborhood	17%	16%	16%	12%	no
n	78-82	122-123	153-157	161-174	

3 Notes: Cells represent % of respondents who agreed (somewhat or strongly) with the statement. Significance tested
 4 using Chi-square, $p < 0.05$. Cells with standardized residuals < -2.0 or $> +2.0$ bolded. These represent the proportions
 5 that differ the most from the other areas.
 6

7 Another question asked respondents if they thought there was an increase in people walking in
 8 their neighborhood now compared to 2006 or 2007 (green street installation years). There were no
 9 significant differences between the green street and control areas, with 42% and 39%, respectively,
 10 indicating noticing an increase. However, 58% of the respondents *living on* a green street indicated an
 11 increase in people walking in the neighborhood. This is significantly more than the 35% of other
 12 respondents in the two green street areas.
 13

14 **What are residents' opinions of green streets?**

15 Residents of the green streets areas were more likely than those in the control areas to say that there were
 16 more trees, bushes and other plants, along with sidewalks, streetlights, and paved streets now (Table 6).
 17 They were also more likely to observe children playing outside more. Moreover, 37% and 40% of the
 18 residents in the green streets areas said that their neighborhood was now a better place to live, which was
 19 significantly more than in the control areas. They were also more likely to say that walking in their
 20 neighborhood was now more pleasant. Respondents in the green street areas were significantly less likely
 21 to say that driving is now more difficult in their neighborhood. This may reflect the fact that some streets
 22 were paved or repaved when the green streets were installed.

1 **Table 6: Respondents' Observations Now Compared to before Green Street Installation Year**

Indicated increases in...	92 nd Green St.	92 nd Control	104 th Green Street	104 th Control
Trees	42%	20%	34%	21%
Bushes & other plants	43%	27%	32%	19%
Sidewalks	50%	14%	52%	11%
Street lights	13%	10%	16%	5%
Paved streets	20%	10%	49%	9%
Pavement markings (such as crosswalks)	44%	40%	18%	39%
Car or truck traffic	55%	55%	64%	70%
People walking	33%	41%	42%	43%
People on bicycles	40%	56%	46%	39%
Children playing outside	38%	28%	36%	25%
Noise level	49%	47%	52%	44%
My neighborhood is now a better place to live	37%	22%	40%	21%
Walking in the neighborhood is now more pleasant	44%	22%	36%	20%
Walking in the neighborhood is safer now	24%	19%	22%	17%
Trees & other greenery have increased	51%	35%	44%	23%
I visit more with neighbors outdoors now	13%	23%	20%	18%
Children play outside more now	28%	27%	34%	28%
Parking on the street is now more difficult	29%	42%	24%	22%
Driving is now more difficult	34%	41%	28%	45%
Getting in and out of the car is now more difficult	19%	23%	17%	21%
There is more litter in my neighborhood now	55%	37%	42%	51%

2 Bold indicates that that proportion is significantly different than the corresponding control area, $p < 0.05$.

3

4

The surveys for the two green street study areas included a section with questions specifically about the green streets. This first included pictures of a green street with questions to establish whether the respondent had noticed the features and knew their purpose. Most (77%) of the survey respondents from the green street areas had noticed the green street features, and most (64%) were aware of their purpose prior to the survey.

9

A majority of the respondents agreed that the green streets made their neighborhood a better place to live – 65% in the 92nd Avenue area and 59% in the 104th Avenue area (Table 7). Nearly three-quarters (73%) felt that the green streets made walking in the neighborhood more pleasant and 70% agreed that they improved the amount of trees and other plants. The survey also tried to assess potential negative effects of the green streets, though most residents did not agree that the green streets led to these potential effects. For example, 23% agreed that the green streets made parking on the street more difficult and 19% felt that they resulted in more litter. Some of the green streets include planter areas that are several inches below the sidewalk level. Litter can blow into and remain in these areas. Only 9% felt that they made getting in and out of the car more difficult.

18

1 **Table 7: Survey Respondents' Opinions on Green Streets (Treatment Areas only)**

% agreeing that These green streets...	92 nd Green Street	104 th Green Street	Total
Make my neighborhood a better place to live	65%	59%	61%
Make walking in the neighborhood more pleasant	78%	70%	73%
Make walking in the neighborhood safer	43%	39%	41%
Improve the amount of trees & other plants	70%	70%	70%
Result in my walking more	30%	28%	28%
Result in my riding a bicycle more	17%	15%	16%
Result in my driving less	12%	11%	12%
Result in my visiting more with neighbors outdoors	10%	17%	15%
Result in children playing outside more	19%	28%	25%
Make parking on the street more difficult	24%	22%	23%
Make driving more difficult	15%	15%	15%
Make getting in and out of the car more difficult	9%	9%	9%
Result in more litter in my neighborhood	23%	16%	19%

2 Bold indicates that the proportions are significantly different from one another, $p < 0.05$.

3
4 **Are there variations by age or other demographics in individuals' responses to green streets?**

5 The most notable demographic differences with respect to opinions of the green street were between older
6 and younger adults. In general, older adults (65+) had more negative opinions about green streets than
7 younger adults (Table 8). In particular, older adults were less likely to say that the green streets make
8 walking in their neighborhood more pleasant (50% compared to 78% of adults under 65 years). Older
9 adults were also more likely to say that the green streets make parking on the street more difficult (34%
10 versus 21%) and driving more difficult (25% versus 13%).

11
12 **Table 8: Survey Respondents' Opinions on Green Streets, Difference by Age**
13 **(Green Street Areas only)**

% agreeing that These green streets...	Under 65	65 or older
Make my neighborhood a better place to live	64%	54%
Make walking in the neighborhood more pleasant	78%	50%
Make walking in the neighborhood safer	42%	38%
Improve the amount of trees & other plants	76%	46%
Result in my walking more	28%	30%
Result in my riding a bicycle more	16%	15%
Result in my driving less	11%	13%
Result in my visiting more with neighbors outdoors	15%	11%
Result in children playing outside more	28%	11%
Make parking on the street more difficult	21%	34%
Make driving more difficult	13%	25%
Make getting in and out of the car more difficult	8%	15%
Result in more litter in my neighborhood	19%	22%
<i>n</i>	265-269	52-56

14 Bold indicates that the proportions are significantly different from one another, $p < 0.05$.

15
16 Respondents with children under the age of 18 in the household also indicated some differences
17 in responses to the green streets compared to those without children in the household. They were more
18 likely to agree that the green streets had resulted in them walking more (33% vs. 20%, $p < 0.05$), in visiting

1 more with neighbors outdoors (18% vs. 4%, $p<0.01$), and in children playing outside more (32% vs. 13%,
2 $p<0.01$). On the other hand, respondents without children were more likely to indicate that the green
3 streets resulted in more litter in the neighborhood (28% vs. 13%, $p<0.01$). There were no differences with
4 respect to gender.

5 While a majority of all respondents agreed that the green streets made their neighborhood a better
6 place to live, those with more than a high school diploma (some college through four-year degrees or
7 more, including technical/vocational school), were more likely to agree (65% vs. 55%, $p<0.05$). They
8 were also less likely to agree that they made parking more difficult (19% vs. 29%, $p<0.01$). Consistent
9 with this, there was a weak, but statistically significant negative correlation between income and
10 agreement with the litter statement. There was also a weak, statistically negative correlation between
11 income and whether the respondent agreed that the green streets made parking more difficult and driving
12 more difficult. The reasons for these relationships to negative aspects of the green streets (litter, parking,
13 driving) is unclear. It could be related to knowledge about the function of the green streets. Other research
14 found that knowledge of the function of green streets made survey respondents more positive about them.
15 Knowledge could be correlated with education. It may also relate to where lower income households live
16 within the neighborhoods, e.g. near green street facilities that catch more litter.

17 Renters were significantly more likely to indicate that the green streets resulted in them visiting
18 more with neighbors outside (20% vs. 12% for owners, $p<0.05$) and resulted in children playing outside
19 more (35% vs. 21%, $p<0.01$). These differences were observed in both of the green street neighborhoods.
20 There were some weak, though statistically significant negative correlations between opinions about
21 green streets and the number of years the respondent had lived in their home. However, after controlling
22 for age, the only significant correlations were with “result in my walking more” ($r=-0.14$, $p<0.05$) and
23 “result in children playing outside more” ($r=-0.14$, $p<0.05$).

24 25 **CONCLUSIONS**

26 This paper examined opinions about green streets and their relationship to walking through the use of
27 surveys conducted in two areas with green streets and two nearby comparison or “control” areas. These
28 findings provide support for agencies that are considering installing green street infrastructure, in addition
29 to some areas for attention.

30 There are some indications that green streets may encourage more walking, though the findings
31 were not always consistent among the different ways we measured walking behavior. Bivariate analysis
32 and a regression model indicate that residents in one of the green street neighborhoods walk more
33 frequently in their neighborhood, compared to the other neighborhoods. Residents in this area were also
34 more likely to agree that walking in the area was more pleasant now. However, they did not claim to be
35 walking more now, compared to those in the nearby control neighborhood. On the other hand, residents in
36 the other green street neighborhood were about twice as likely (compared to its control neighborhood) to
37 say they were walking more in their neighborhood compared to before the green streets were built. But
38 their frequency of walking was not significantly higher. These findings point to the challenge of
39 measuring behavior change using a single, cross-sectional survey, in addition to the limitations of self-
40 reported behavior data. A majority of the respondents *living on* a green street indicated seeing more
41 people walking in the neighborhood, significantly more than the other respondents in the green street
42 areas. Nearly three-quarters (73%) of the residents indicated that the green streets made walking more
43 pleasant, and just over one-quarter (28%) of the residents indicated that they were walking more because
44 of the green streets.

45 Residents noticed the increase in vegetation and street and pedestrian features associated with the
46 green streets and their opinions of the green streets were generally positive. The residents in the green
47 street neighborhoods were more likely (compared to the control neighborhoods) to note changes in their
48 neighborhood over time that were consistent with the green street improvements, such as more trees,
49 bushes and other plants. They were more likely to agree that their neighborhood was now a better place to
50 live and that walking was now more pleasant, compared to residents in the control neighborhoods. When
51 asked specifically about the green streets, a large majority felt they made their neighborhood a better

1 place to live. Much smaller shares (less than one-quarter) felt that the green streets caused problems, such
2 as more litter, or making parking or driving difficult.

3 There were some demographic differences with respect to opinions. In general, older adults (65+)
4 had more negative opinions about green streets than younger adults. In particular, they were less likely to
5 say that the green streets made walking in their neighborhood more pleasant and more likely to say that
6 the green streets make parking on the street and driving more difficult. A smaller share agreed that the
7 green streets made their neighborhood a better place to live, though this difference was not statistically
8 significant. Groups that had more positive responses to some aspects of the green streets included
9 respondents with children under the age of 18 in the household, those with more than a high school
10 diploma, newer residents, and renters.

11 In addition to the limitations of the survey method noted above, it is important to note that this
12 paper only looked at certain aspects of green streets. We did not, as some other research has done,
13 evaluate the effect on property values or their environmental benefits. There may also be additional co-
14 benefits related to neighborhood cohesion and health that we did not examine here. These are all areas
15 worthy of future research.
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