# The Hidden Health Costs of Community Design

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Health and Community Design Lab www.act-trans.ubc.ca

# An Old English Quatrain

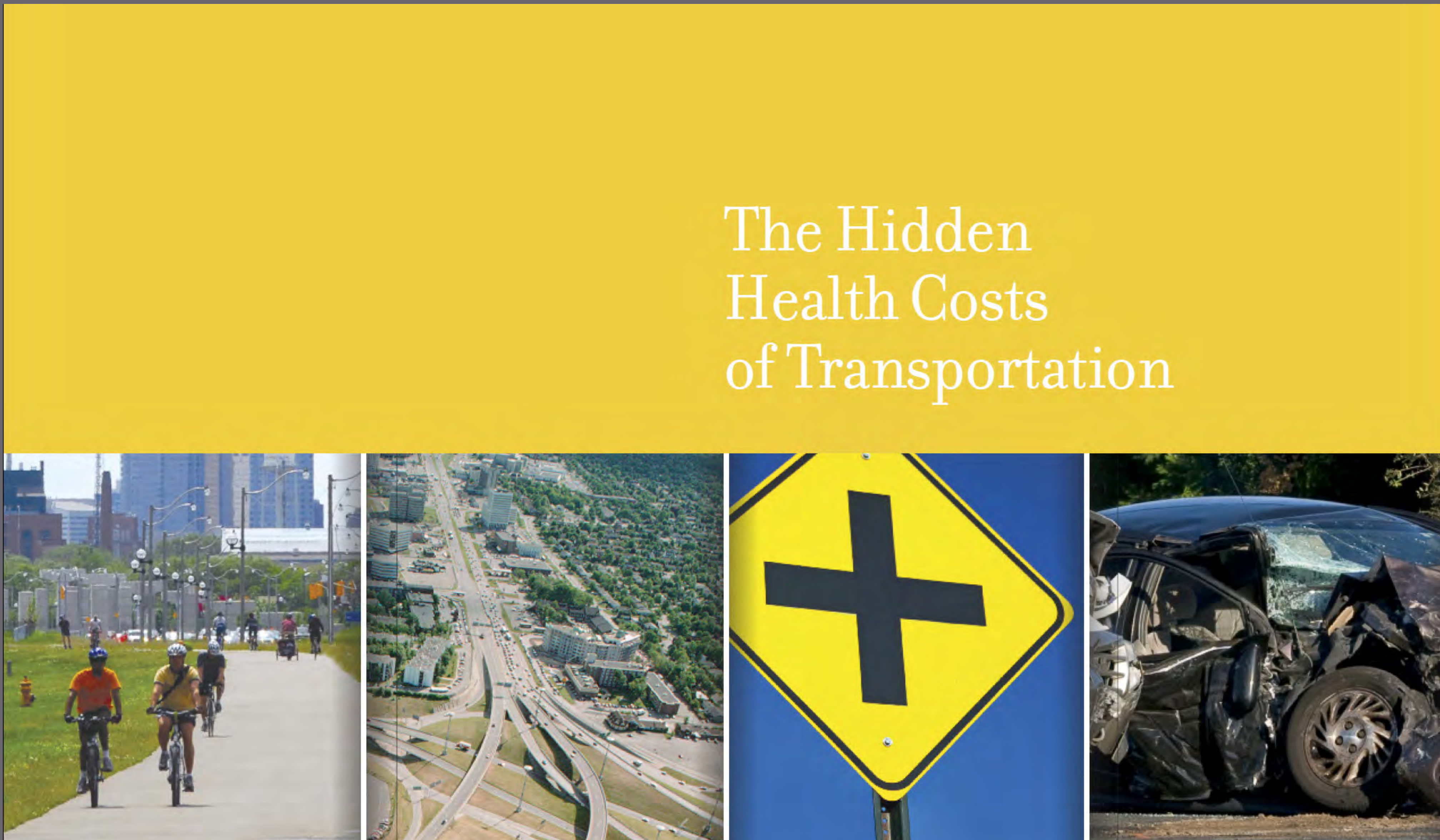
"The Law Locks Up Both Man and Woman that Steels the Goose from Off the Common …

But Lets the Greater Felon Loose,

*That Steals the Common from the Goose"*

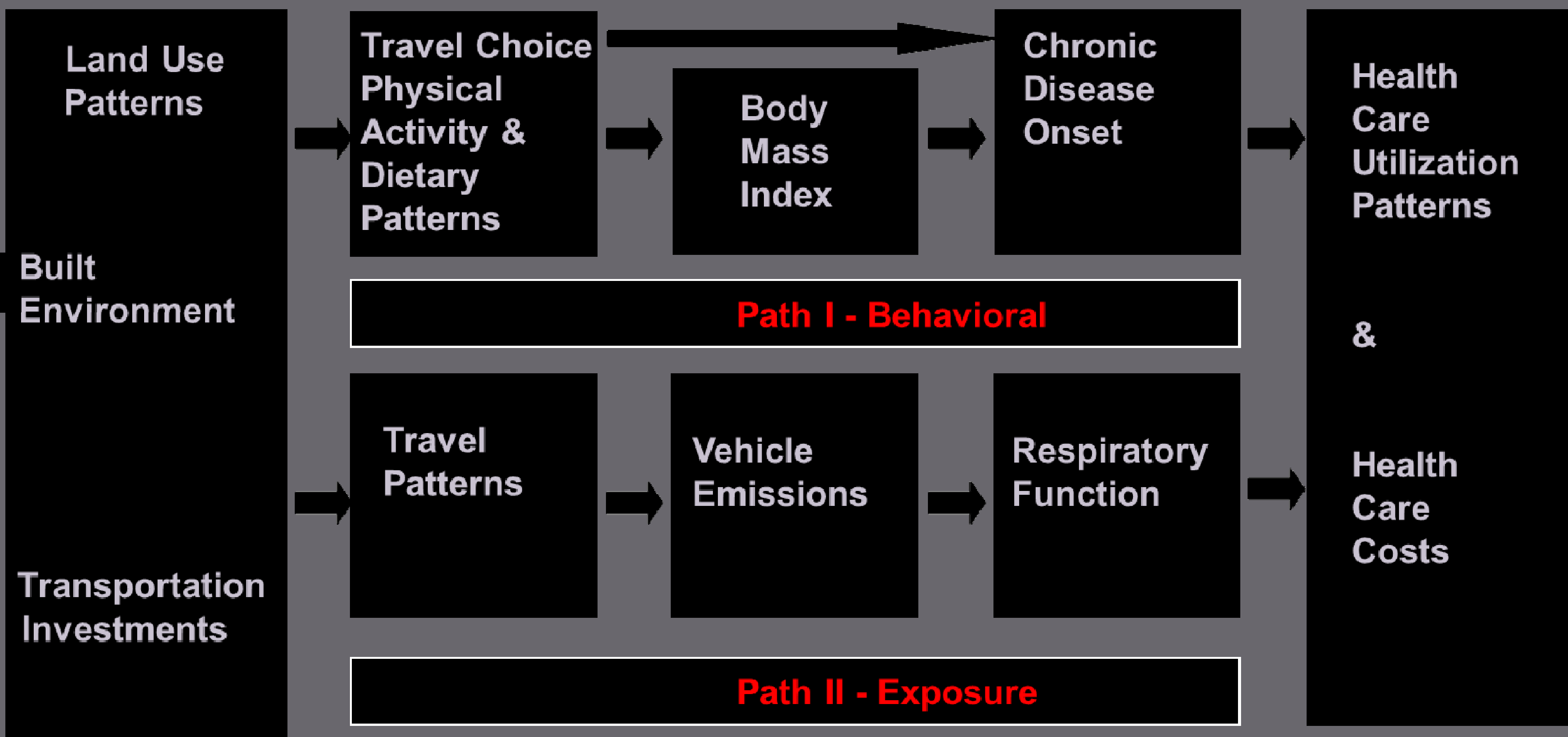
----------------------------------------------------------

a.k.a. The tragedy of the commons




Kavage, Frank, and Kolian 2010
American Public Health Association

# CONCEPTUAL MODEL




**Note:** Diet and nutrition, age, gender, income, genetics, and other factors also impact weight and chronic disease and to the extent possible are controlled in analyses. Vehicle age and climate impacts emissions and air quality, and respiratory function is also impacted by a variety of factors


Quality
of Life
Environmental Quality
Air Quality and Greenspace
Human Behavior
Travel Patterns and Physical Activity
Built Environment
Transportation Investments and Land Use

# BASIS FOR STUDY

1) Evidence is clear that built environments play a major role in shaping health outcomes and disparities

   a) behaviors and b) exposures

2) Recent evidence further clarifies that environments shape health outcomes independent of preferences and further suggests the relationship is causal

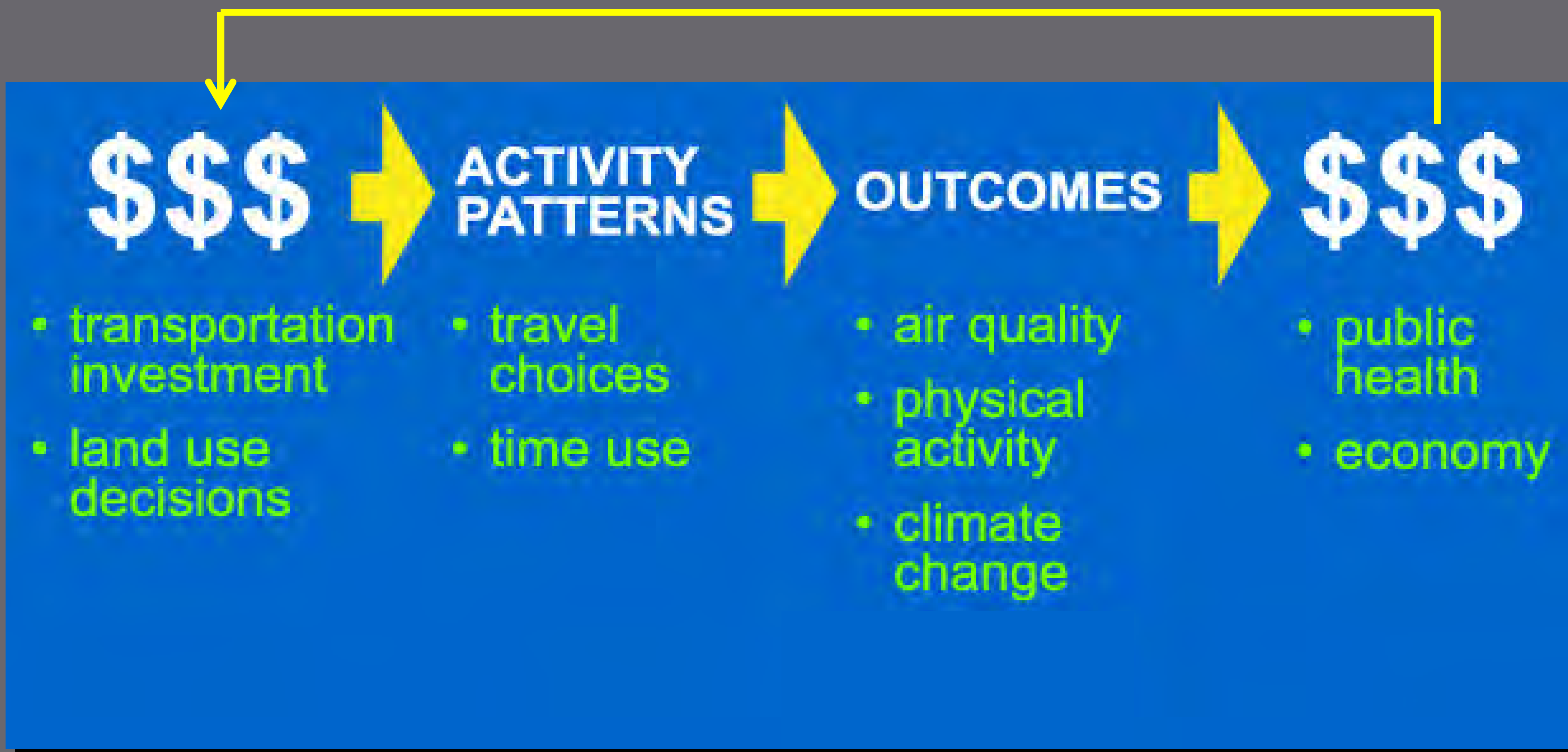
3) Increased odds of meeting physical activity guidelines and reduce risk of obesity are associated with transit use and more walkable environments

   a) reduces odds of chronic disease onset for several morbidities

   b) logically reduces demands on health care system and associated costs

4) **It is both *possible* and *timely* to monetize these costs**

# The Externalities

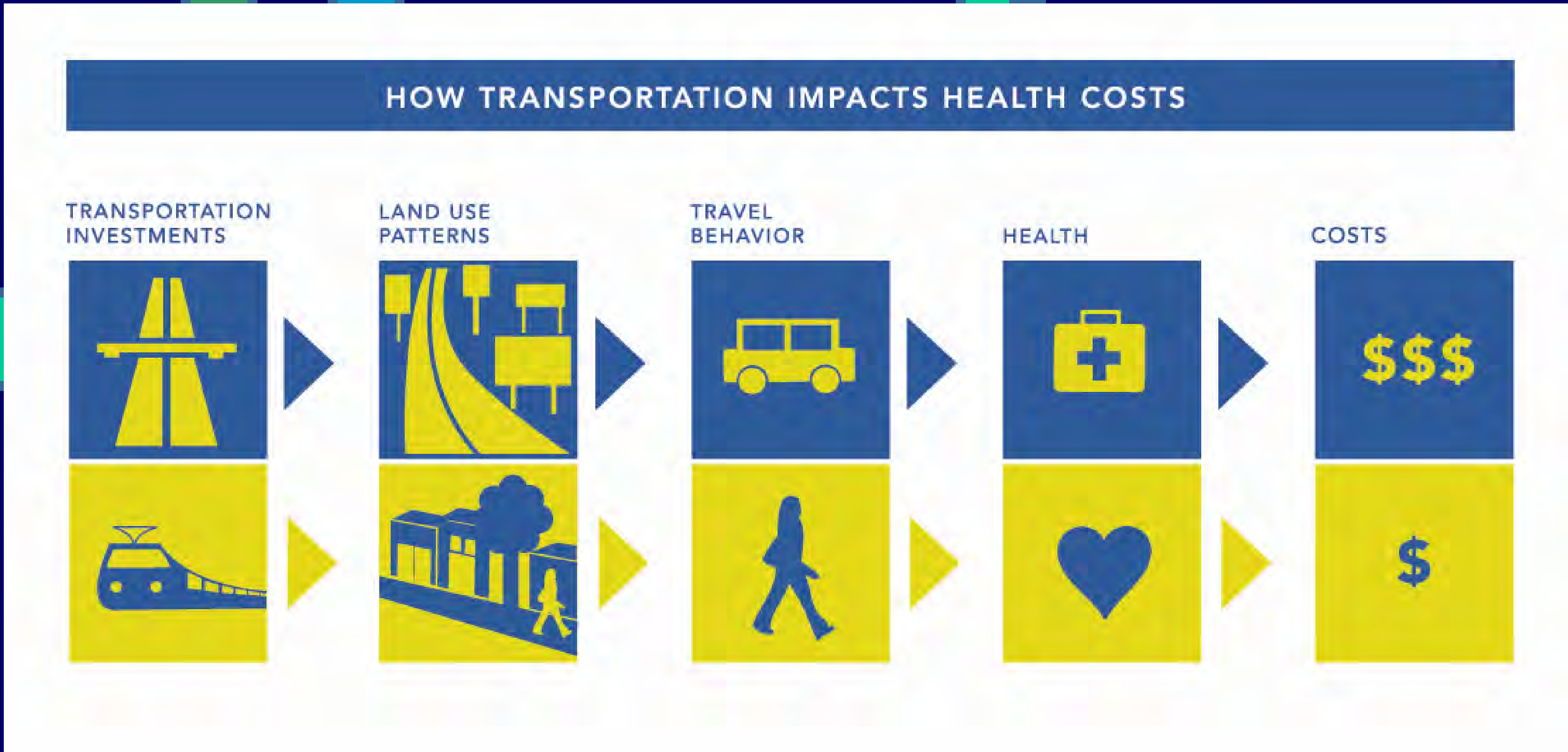


# 2008 Estimated Costs of Transportation Related health Outcomes (USA)

| The National Health Costs of… | $$ (Billions) | Estimate Includes | Source |
|---|---|---|---|
| Obesity and Overweight | $ 142 | • Healthcare costs<br>• lost wages due to illness & disability<br>• future earnings lost by premature death | National Institutes of Health, National Institute of Diabetes, Digestive and Kidney Diseases. Statistics Related to Overweight and Obesity: The Economic Costs.<br><br>Available at: http://win.niddk.nih.gov/statistics/index.htm. |
| Air Pollution from traffic | $ 50-80 | • Healthcare costs<br>• Premature death | Federal Highway Administration. 2000. Addendum to the 1997 Federal Highway Cost Allocation Study Final Report, May 2000.<br><br>Available at: www.fhwa.dot.gov/policy/hcas/addendum.htm |
| Traffic Crashes | $ 180 | • Healthcare costs<br>• Lost wages<br>• Property damage<br>• Travel delay<br>• Legal / administrative costs<br>• Pain & suffering<br>• Lost quality of life | AAA. Crashes versus Congestion Report. What's the Cost to Society? Cambridge, MD: Cambridge Systematics, Inc.; 2008.<br><br>www.aaanewsroom.net/assets/files/20083591910. crashesVscongestionfullreport2.28.08.pdf. |

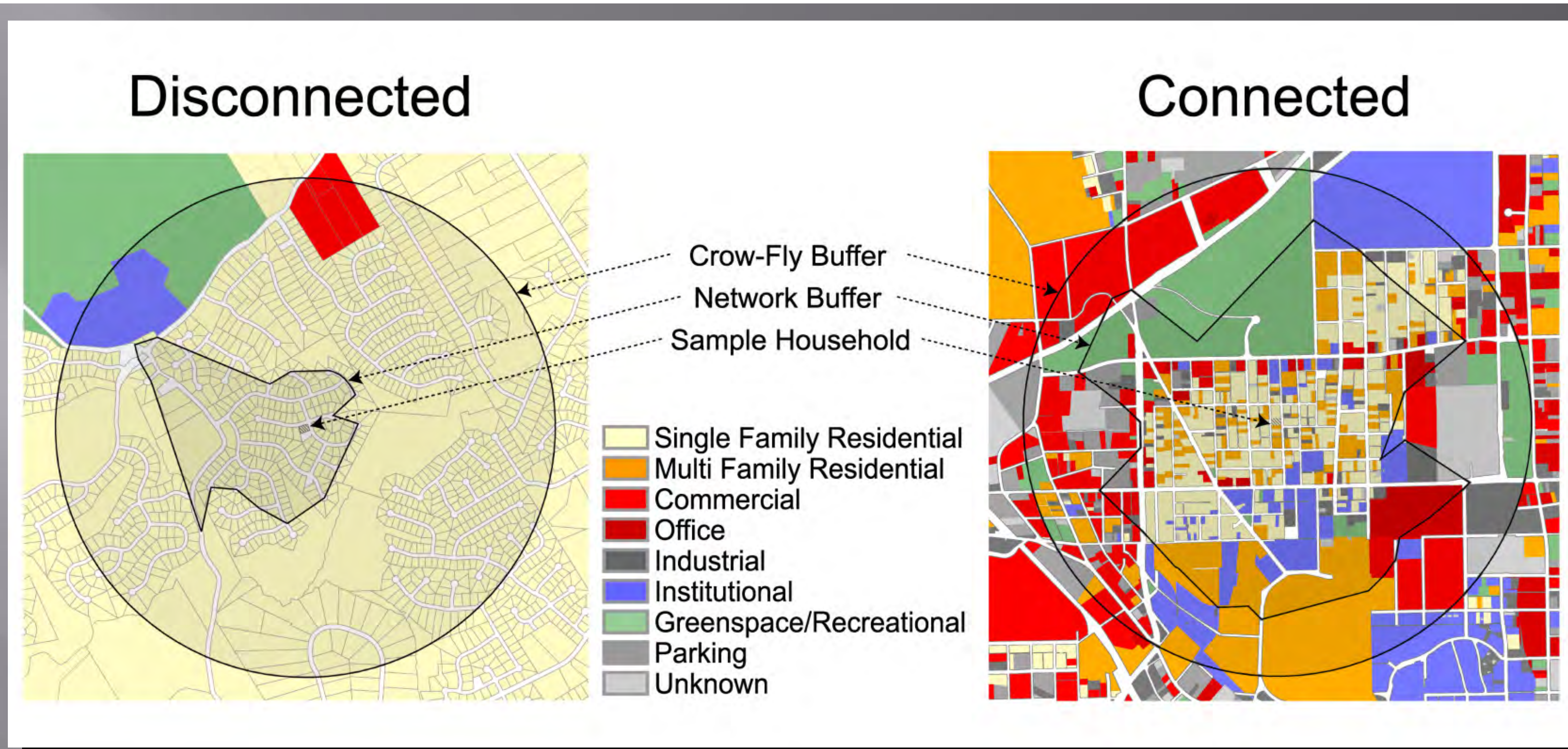
# Proposed Approach

- Summarize the evidence
  - evidence on each link of the behavioral and exposure based causal pathway
- Document methods used to prioritize transportation and land use decisions
  - Cost benefit tools and their lack of accounting for health costs (see:
    - http://www.apha.org/NR/rdonlyres/F84640FD-13CF-47EA-8267-E767A1099239/0/HiddenHealthCostsofTransportationShortFinal.pdf
- Propose to spatially link built environment data with Canadian Community Health Survey and with Health Care Utilizitation Records
  - Vancouver, Toronto, Waterloo

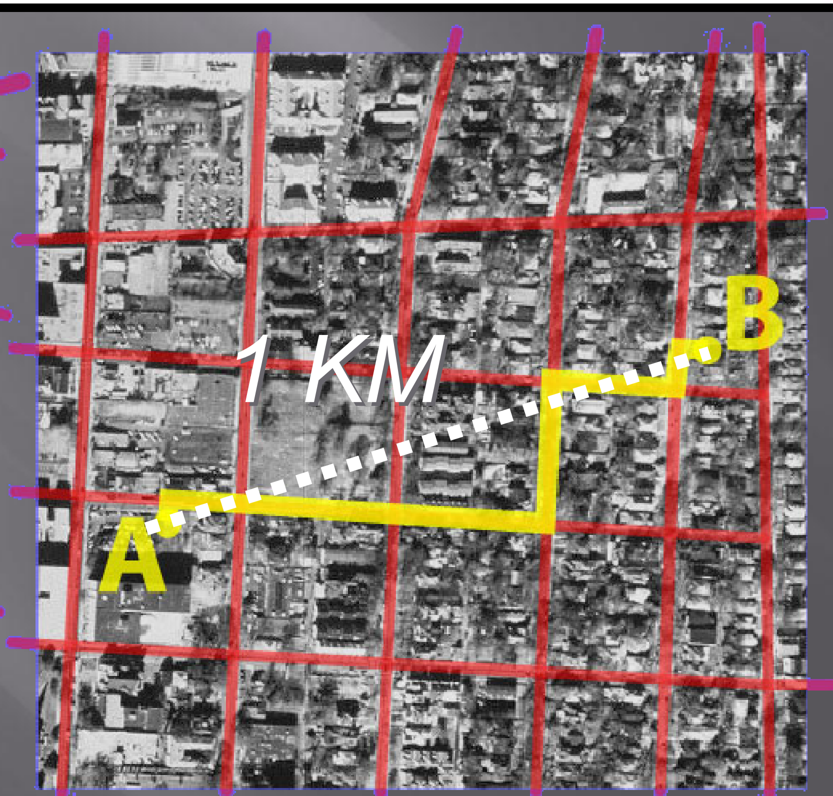



"The Hidden Health Costs of Transportation" - Frank et al 2010
American Public Health Association

**Proximity**

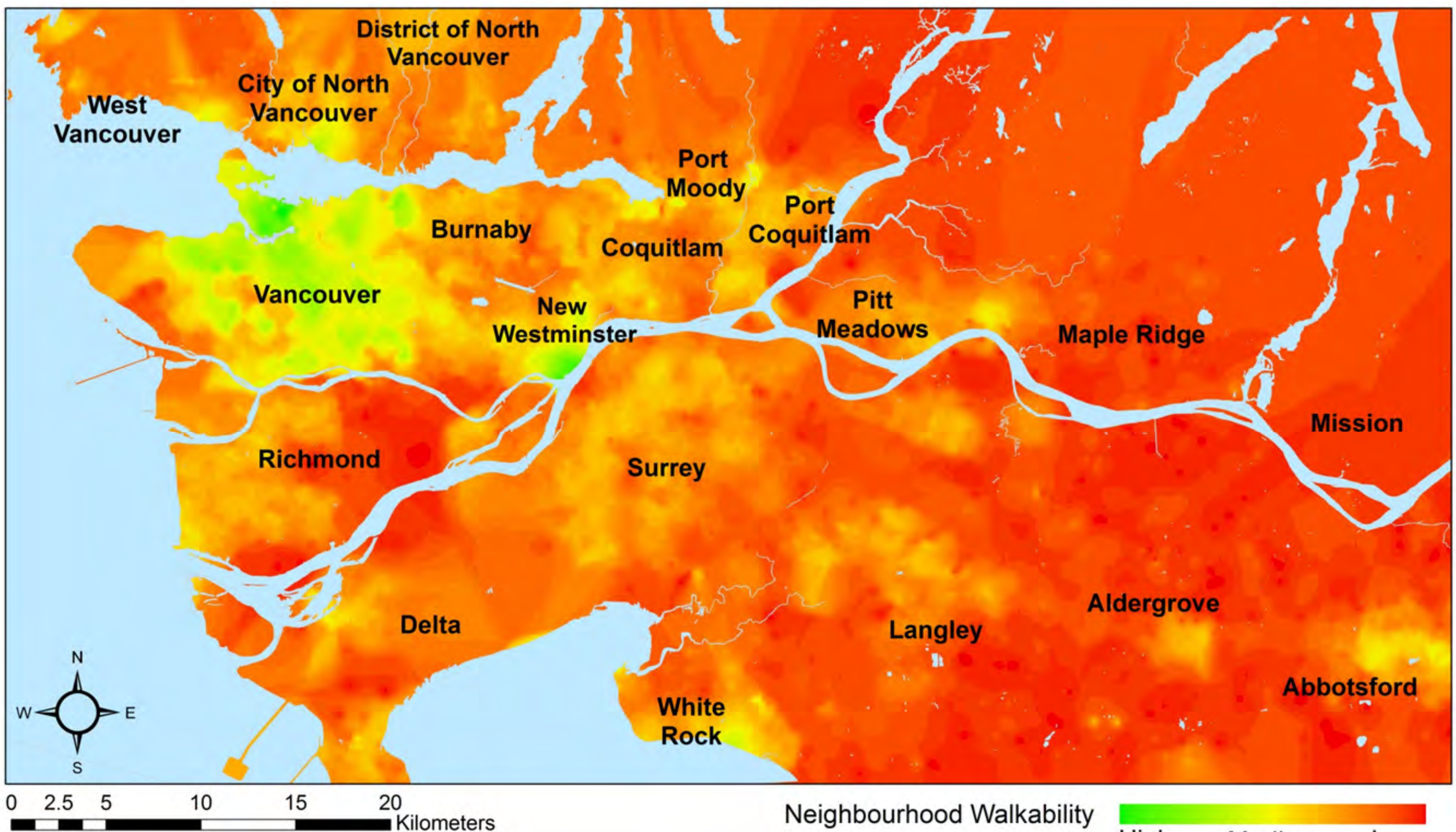




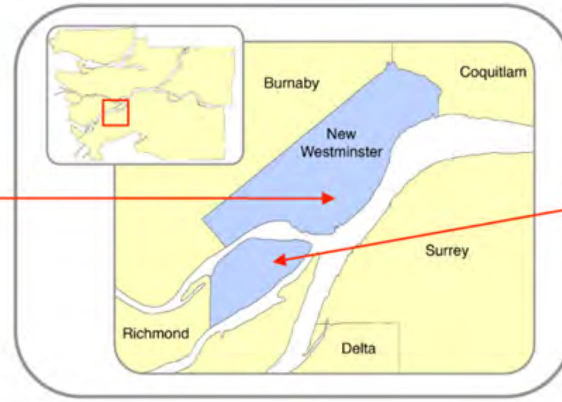



**Connect-ivity**

# Lower Mainland Walkability Map



# Comparing Two Communities




|  | Uptown Moody Park | Queensborough |
|---|---|---|
| Net Residential Density (dwelling units/acre) | 40.29 | 7.73 |
| Mixed Use Index (range 0 – 1) | 0.58 | 0.09 |
| Intersection Density (per square km) | 70.12 | 27.91 |
| Retail Floor Area Ratio | 0.64 | 0.30 |
| Overall Walkability | 4.26 | -3.74 |

# Adult Findings – Walking

Built environment characteristics explaining walking in adults

| | Any walk trip | Work/school walk trip | Non-work/school walk trip |
|---|---|---|---|
| Higher residential density | +++ | +++ | +++ |
| Higher street connectivity | +++ | +++ | +++ |
| Higher commercial density | +++ | +++ | +++ |
| Higher mix of land uses | ++ | + | ++ |
| More nearby parks and open spaces | +++ | + | +++ |
| Higher overall neighbourhood walkability | +++ | ++ | +++ |

NS = not significant, '+' = 95% significant; '++' = 99% significant, '+++' = 99.9% significant

Devlin and Frank, 2009

# Adult Findings – Transit Use

Built environment characteristics explaining transit use in adults

| | Any transit trip | Work/school transit trip | Non-work/school transit trip |
|---|---|---|---|
| Higher residential density | ++ | + | + |
| Higher street connectivity | ++ | + | ++ |
| Higher commercial density | +++ | NS | + |
| Higher mix of land uses | ++ | ++ | NS |
| More nearby parks and open spaces | NS | NS | NS |
| Higher overall neighbourhood walkability | ++ | ++ | ++ |

NS = not significant, '+' = 95% significant; '++' = 99% significant, '+++' = 99.9% significant

Devlin and Frank, 2009

# Objective physical Activity and Objective Built Environment

- 2005 study found that residents of the most walkable areas in Atlanta were 2.4 times more likely to get the recommended amounts of physical activity
- 18 percent in the lowest Versus 37 Percent in the highest levels of walkability got recommended levels of physical activity

- Frank LD, Schmid TL, Sallis JF, Chapman JE, Saelens BE. 2005. "Linking Objective Physical Activity Data with Objective Measures of Urban Form." American Journal of Preventive Medicine. Volume 28, No. *2 (Suppl2): pp.* 117-125.

# Predictors of Obesity

| | Coefficient | t-Ratio | P-Value |
|---|---|---|---|
| ↑ Age | 0.012 | 6.00 | 0.000 |
| ↓ Education | -0.080 | -4.71 | 0.000 |
| ↓ Income | -0.057 | -4.75 | 0.000 |
| ↓ Walk Distance | -0.049 | -2.04 | 0.034 |
| ↑ Car Time | 0.001 | 2.875 | 0.003 |
| ↓ Land Use Mix | -2.035 | - 5.65 | 0.000 |
| ↑ Black Male | 0.311 | 3.930 | 0.000 |
| ↑ Black Female | 0.372 | 5.09 | 0.000 |
| ↓ White Female | -0.871 | -11.3 | 0.000 |
| Constant | -0.497 | -2.22 | 0.026 |

Frank, L., Andresen, M., and Schmid, T., Obesity Relationships With Community Design, Physical Activity, and Time Spent in Cars. American Journal of Preventive Medicine. June 2004.

# Results

Every additional hour driving per day translates into a 6% increase in the likelihood of obesity

- –Time spent driving increases as walkability decreases

Every additional Kilometer walked translates into a 4.8% reduction in the likelihood of being obese

- –Distances walked increases with walkability

# Transit Use and Physical Activity

- Transit use was significantly associated with greater odds of meeting physical activity recommendations (OR=3.42; CI=2.40-4.87)
  - by walking for transportation
- The odds of meeting 30 minute Physical Activity Recommendation is negative for additional trips as a car driver when compared to moderate walking (OR =.87; CI=0.76-0.99)

Source: LaChapelle and Frank, *In press*

# LOGISTIC REGRESSION ANALYSES PREDICTING THE ODDS OF WALKING AT LEAST ONCE OVER 2-DAYS

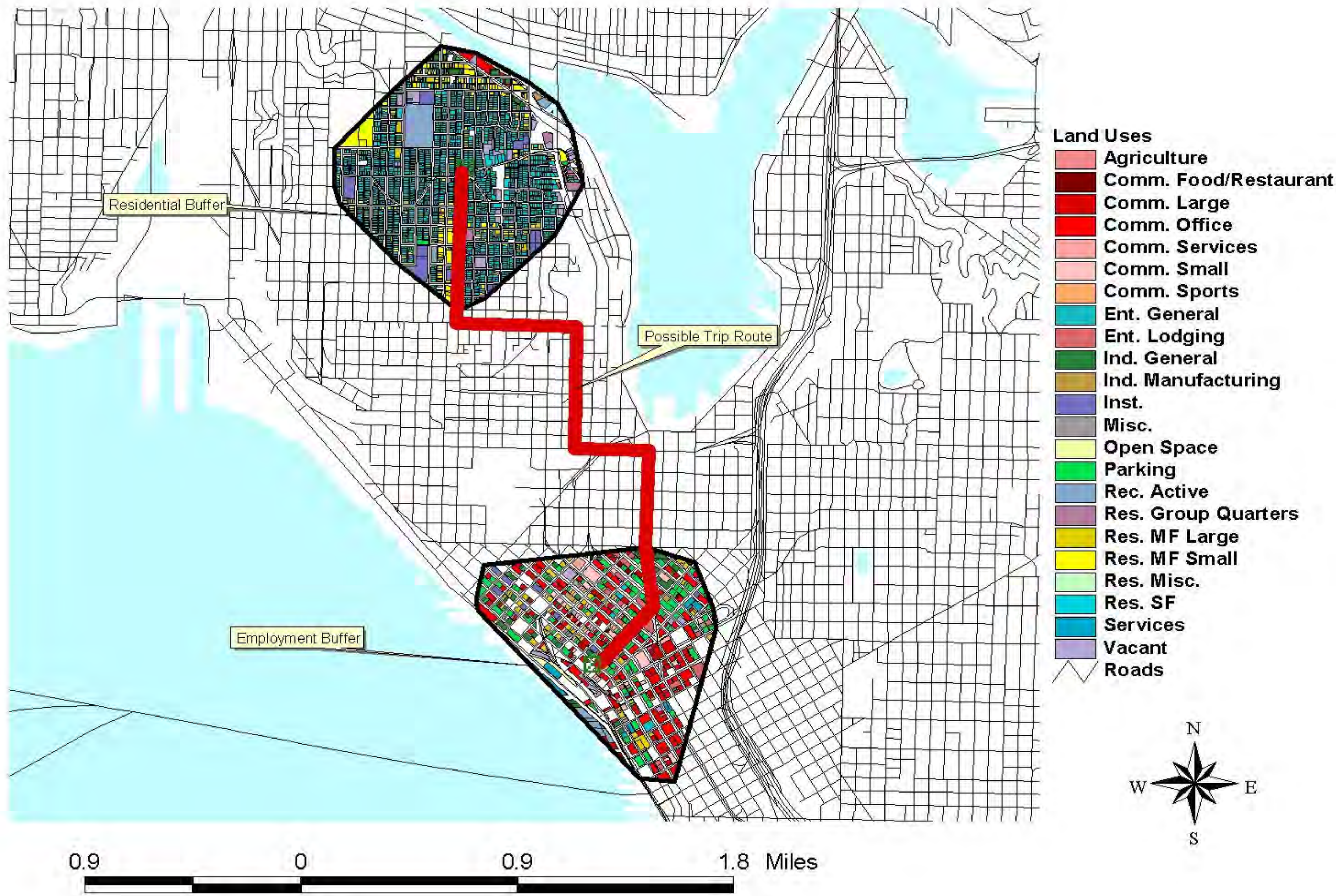
| YOUTH Age Range | 5-8 years OR (95% CI) | 9-11 years OR (95% CI) | 12-15 years OR (95% CI) | 16-20 years OR (95% CI) |
|---|---|---|---|---|
| | N=847 | N=632 | N=867 | N=815 |
| Intersection highest tertile (vs lowest) | 1.7 (1.0-2.9) | 1.3 (0.8-2.3) | 1.7 (1.1-2.8)* | 2.0 (1.1-3.6)* |
| Density highest tertile (vs lowest) | 1.8 (1.0-3.1) | 2.3 (1.2-4.3)** | 3.7 (2.2-6.4)*** | 2.0 (1.0-4.1) |
| Mixed land use (vs no mix) | 1.5 (0.9-2.4) | 1.5 (0.9-2.5) | 2.5 (1.6-3.8)*** | 1.9 (1.0-3.2)* |
| At least 1 commercial land use (vs 0) | 1.5 (0.9-2.4) | 1.6 (1.0-2.5) | 2.6 (1.7-4.0)*** | 1.7 (1.0-3.1) |
| At least 1 recreation/open space land use (vs 0) | **2.1** (1.3-3.4)*** | 1.8 (1.1-2.9)* | 2.5 (1.7-3.6)*** | 1.8 (1.1-2.9)** |

controlling for socio-demographics and stratified by age group
(Averaged over a two day period)

*p<.05, **p<.01, ***p<.001

# (Youth) Walking and Vehicle Ownership

- Compared with youth from households with 3 or more cars (99.9% confidence level):
  - Youth from households with 2 cars were 1.4 times more likely to walk at least once over a two day period
  - Youth from households with 1 car were 2.6 times more likely to walk at least once over a two period and 2.2 times more likely to walk more than a ½ mile per day
  - Youth from households with no cars were 7.7 times more likely to walk at least once a two day period and 6.8 times more likely to walk more than a ½ mile per day.


Residential Buffer
Possible Trip Route
Employment Buffer
Land Uses
Agriculture
Comm. Food/Restaurant
Comm. Large
Comm. Office
Comm. Services
Comm. Small
Comm. Sports
Ent. General
Ent. Lodging
Ind. General
Ind. Manufacturing
Inst.
Misc.
Open Space
Parking
Rec. Active
Res. Group Quarters
Res. MF Large
Res. MF Small
Res. Misc.
Res. SF
Services
Vacant
Roads
N
W
E
S
0.9
0
0.9
1.8 Miles

# Methodology to Estimate Household Emissions

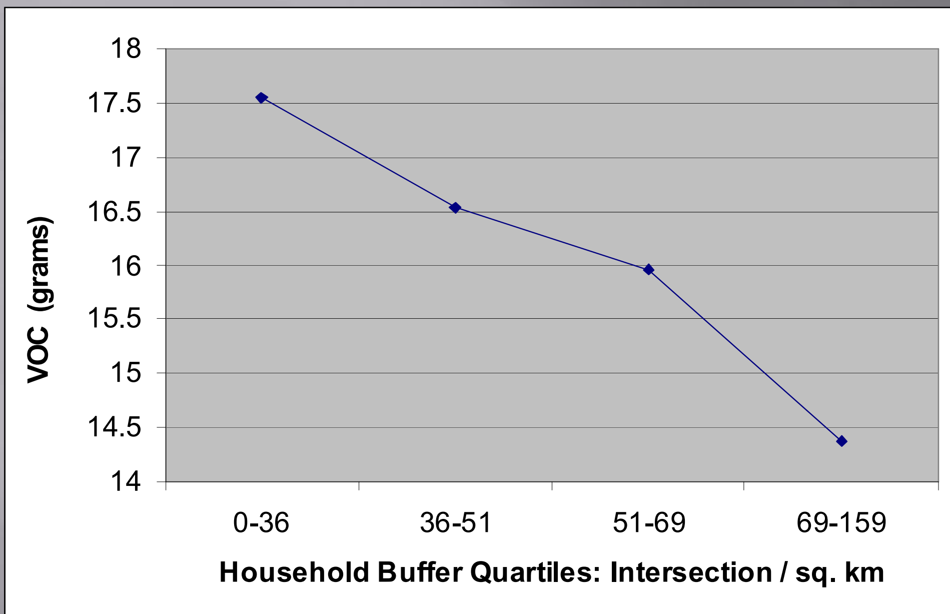

| Facility Type | Distance | AM Peak Speed | Emission Estimates |
|---|---|---|---|
| | *(miles)* | *(mph)* | |
| Local Road | 0.8 | 20 | *Using EPA sanctioned models, gram per mile emissions of HC, CO, NOx, and PM will be calculated.* |
| Minor Arterial | 0.5 | 25 | |
| Major Arterial | 4 | 35 | |
| Freeway | 7.5 | 55 | |
| **Total** | **12.8** | | |

***The model speed will be used based on the facility type instead of assuming an average trip speed.***

GeoStats and LFC, Inc.

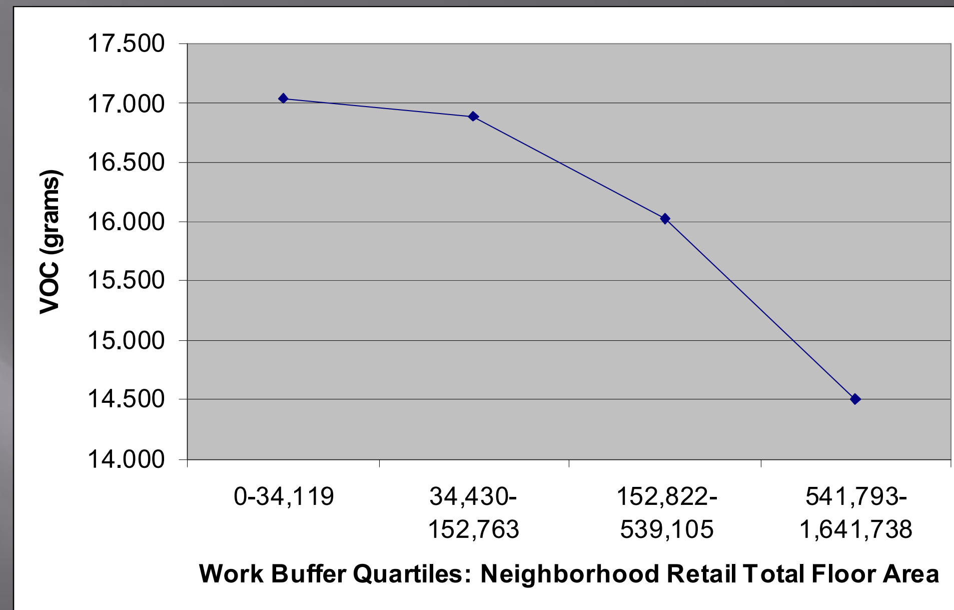
# OZONE - AIR POLLUTION

## LIVE




**Volatile Organic Compounds & Intersection Density Where People Live * (n=2467)**

## WORK




**Volatile Organic Compounds and Retail Use Where People Work * (n=2467)**

* Controlled for gender, income, age, total number of vehicles in the house

* VOC differences across quartiles significant ($p<0.001$

# Stepping Towards Causation

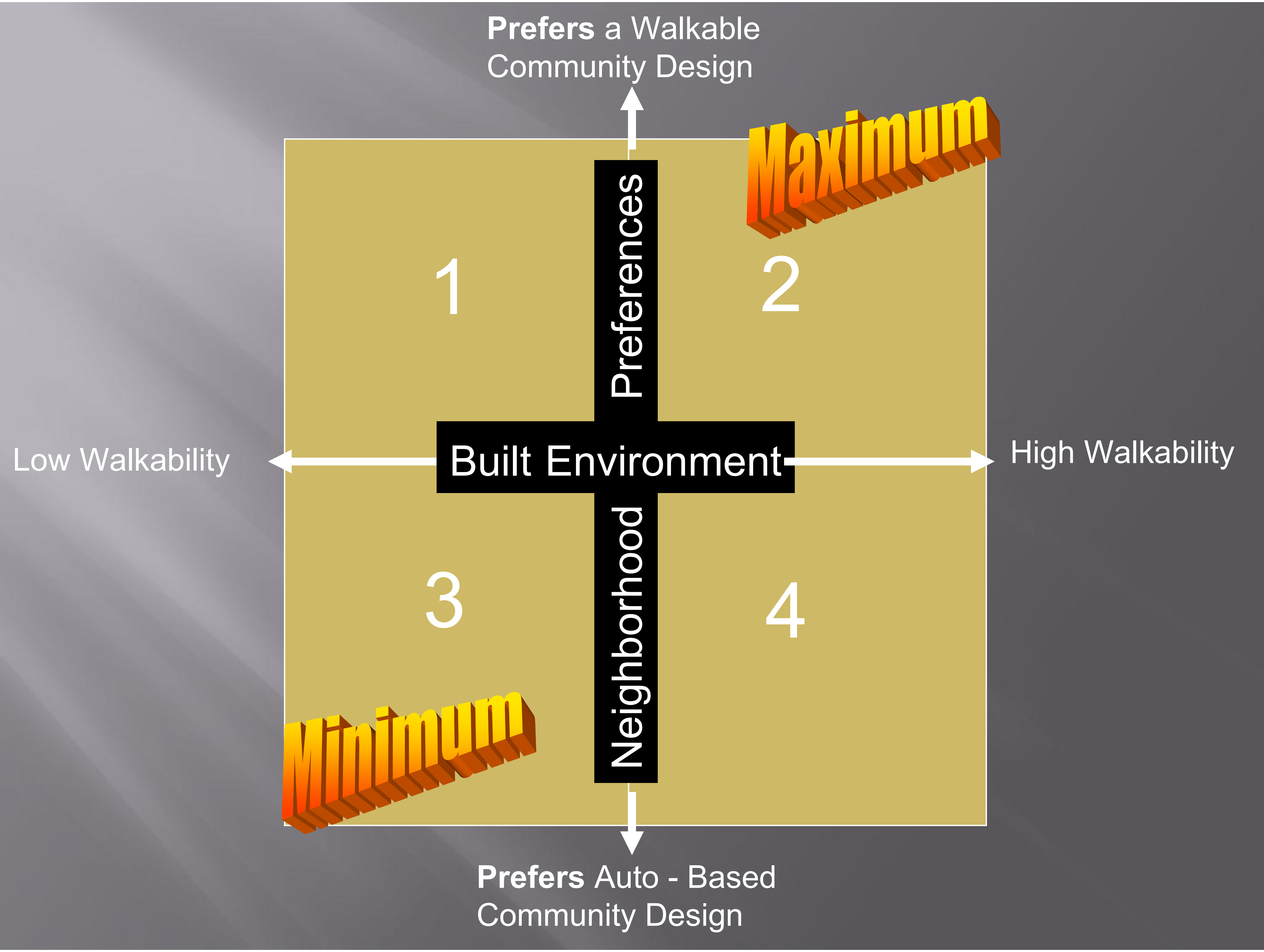
# Residential Density and Mix of Housing Type

A.

B.

*If I were to move, I'd like to find a neighborhood . . .*

| | | |
|---|---|---|
| **A.** that is a lively and active place, even if this means it has a mixture of single family houses, townhouses, and small apartment buildings that are close together on various sized lots. | *or* | **B.** with single family houses farther apart on lots 1/2 acre or more, even if this means that it is not an especially lively or active place. |


**Prefers** a Walkable
Community Design
Maximum
1
2
Preferences
Low Walkability
Built Environment
High Walkability
3
4
Neighborhood
Minimum
**Prefers** Auto - Based
Community Design

# PREFERENCE VS NEIGHBORHOOD DESIGN

| | **Walkability & Preference Groups** | | **Percent Taking a Walk Trip (n)** | **Average Daily Vehicle Miles Traveled (n)** |
|---|---|---|---|---|
| | Preference for Neighborhood Type | Walkability of Current Neighborhood | | |
| **I** | **High** | **Low** | 16.0% (188) | 36.6 (188) |
| **II** | **High** | **High** | 33.9% (446) | 25.8 (446) |
| **III** | **Low** | **Low** | 3.3% (246) | 43.0 (246) |
| **IV** | **Low** | **High** | 7.0% (43) | 25.7 (43) |

# Physical Activity Case Study: Estimated Costs Savings from Walkable Urban Design

| Land Use/Urban Design Characteristics | Change in Amount of Walking (Miles, over a two-day period) | | Number of Persons Who Will Move from First to Second Tertile of Physical Activity | | Annual Lives Saved | | Present Discounted Value (in Dollars) | |
|---|---|---|---|---|---|---|---|---|
| | Low (median–75th percentile) | High (median-95th percentile) | Low | High | Low | High | Low | High |
| Street connectivity (intersection density) | 0.3816 | 1.1844 | 22.79 | 78.59 | 0.0456 | 0.1572 | $2,255,107 | $23,205,007 |
| Retail employment density (retail 0.0652 jobs/square mile | 0.0652 | 0.9734 | 4.72 | 62.09 | 0.0094 | 0.1242 | $466,574 | $18,331,955 |
| Total employment density (jobs/ 1.0648 square mile) | 0.0019 | 1.0648 | 1.57 | 66.02 | 0.0031 | 0.1320 | $155,525 | $19,492,206 |
| Population density (persons/ square mile) | 0.2581 | 0.549 | 15.72 | 28.29 | 0.0314 | 0.0566 | $1,555,247 | $8,353,802 |
| Distance to central business district (miles) | –0.8108 | –2.5054 | 45.58 | 209.05 | 0.0912 | 0.4181 | $4,510,215 | $61,725,318 |

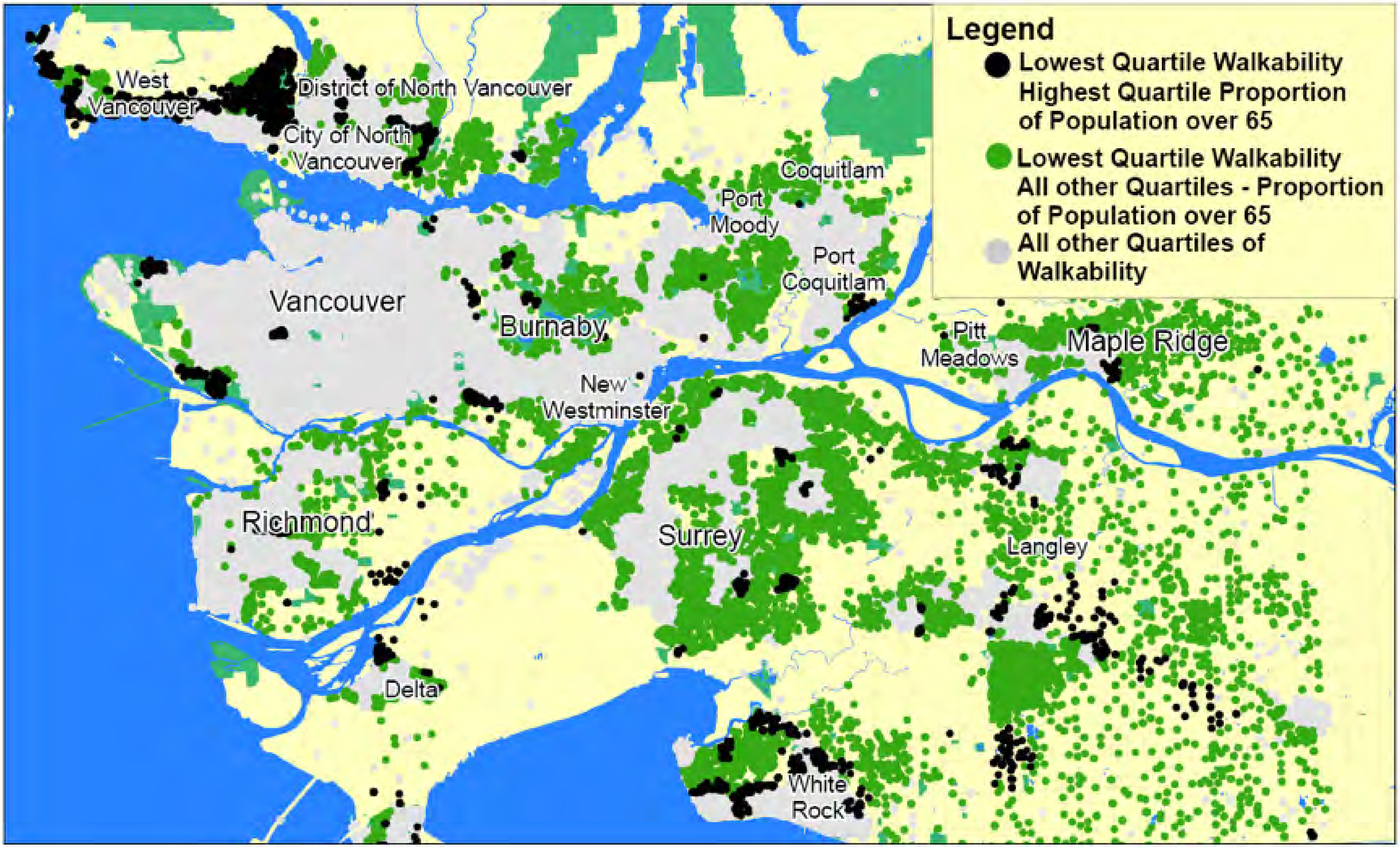
# Changing Demographics

- Aging population in Canada
  - Smaller communities are attractive for retiring baby boomers
  - Requires recreational amenities and high quality walkable environments to reduce vehicle dependence
- Where will the 65-plus population live?
  - Access to services
  - Less reliance on driving for safety reasons
  - Maintaining Independence
- For elderly, considering cost of service delivery with Aging in Place
  - Suburban Vs Urban setting

# Healthy Aging Paper – Summary of Findings

- Increased walkability was related with more walking (OR 2.02), less time spent traveling in a car (OR .53), and lower odds of being overweight (OR .68).
- Those with 1 or no cars were more likely to walk (OR 2.9) and spend less time in cars (OR .53); but also less likely to get recommended levels of PA (OR .55).
- Visiting a fast food outlet was associated with increased odds of obesity (OR 1.81).

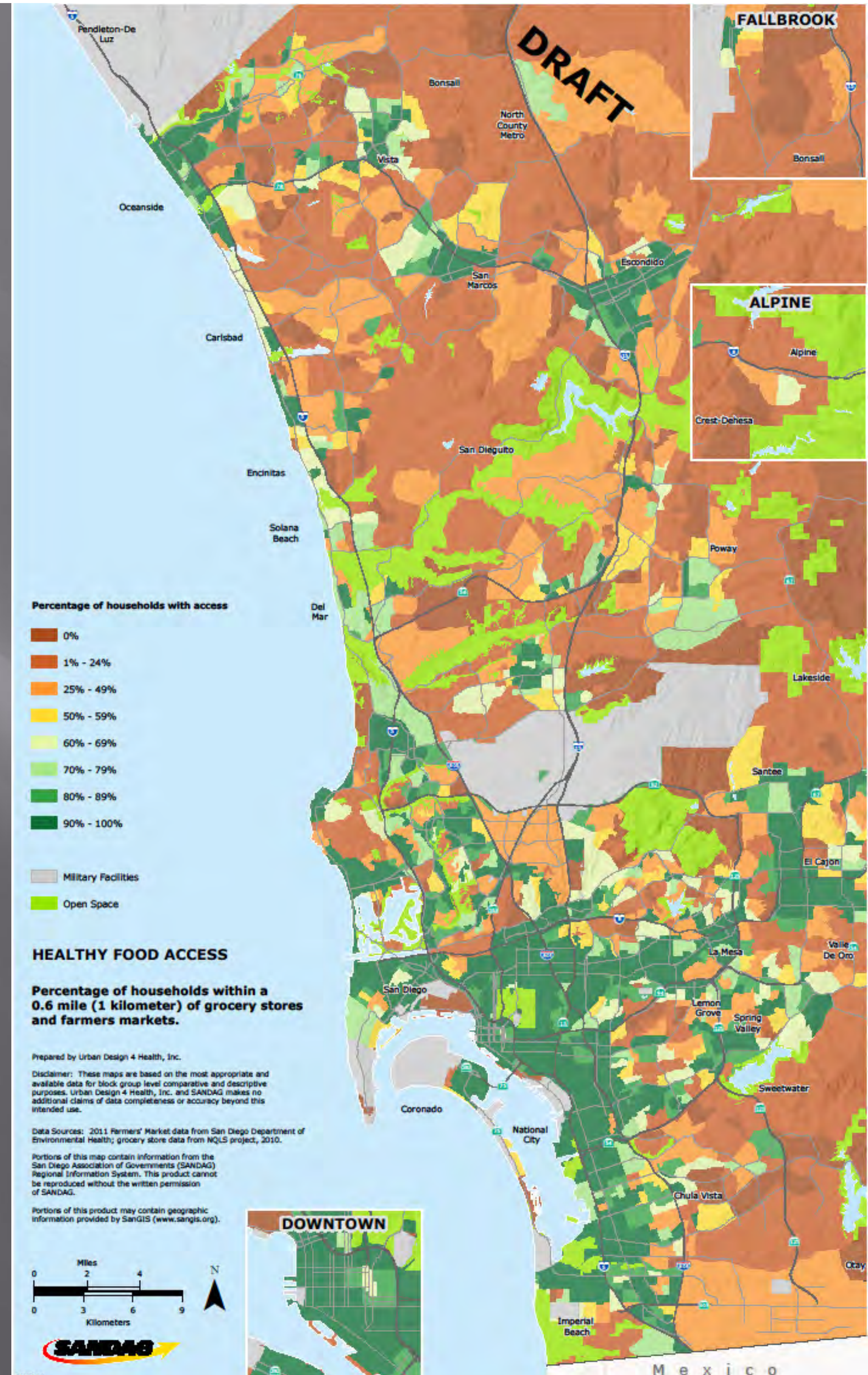
# Walkability and Elderly

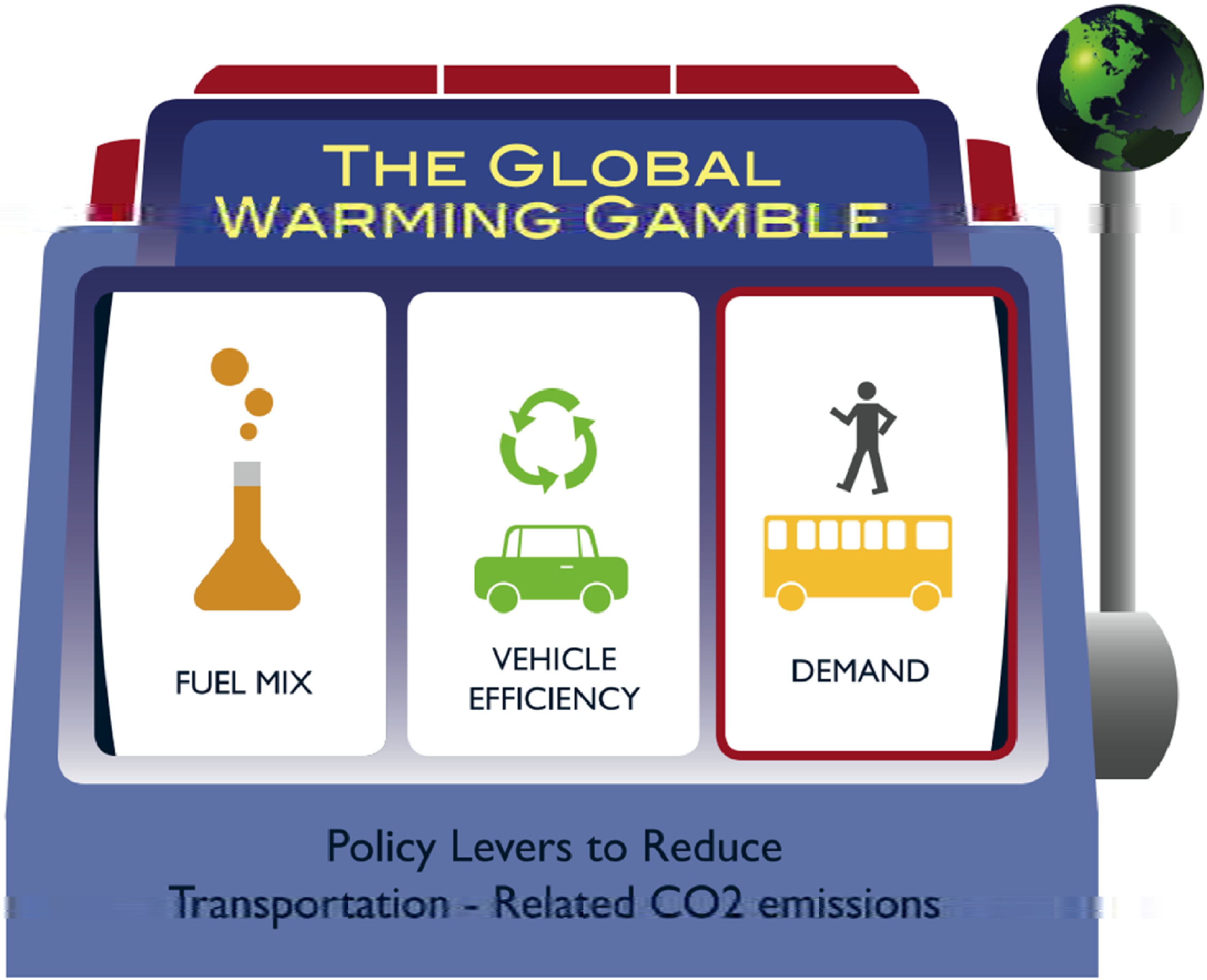


# Food Environments Impact Obesity as Well

# Healthy Foods Access

- Percentage of households within 0.6 miles (1 km) of a grocery store, produce market, specialty market or farmers' market
- Uses Neighborhood Quality of Life Study (NQLS) food outlet data - subject to detailed field verification in 2010.
- Over **80 percent of multi-family households** - and nearly **60 percent of all households** - have access to a grocery store or farmers' market within walking distance.



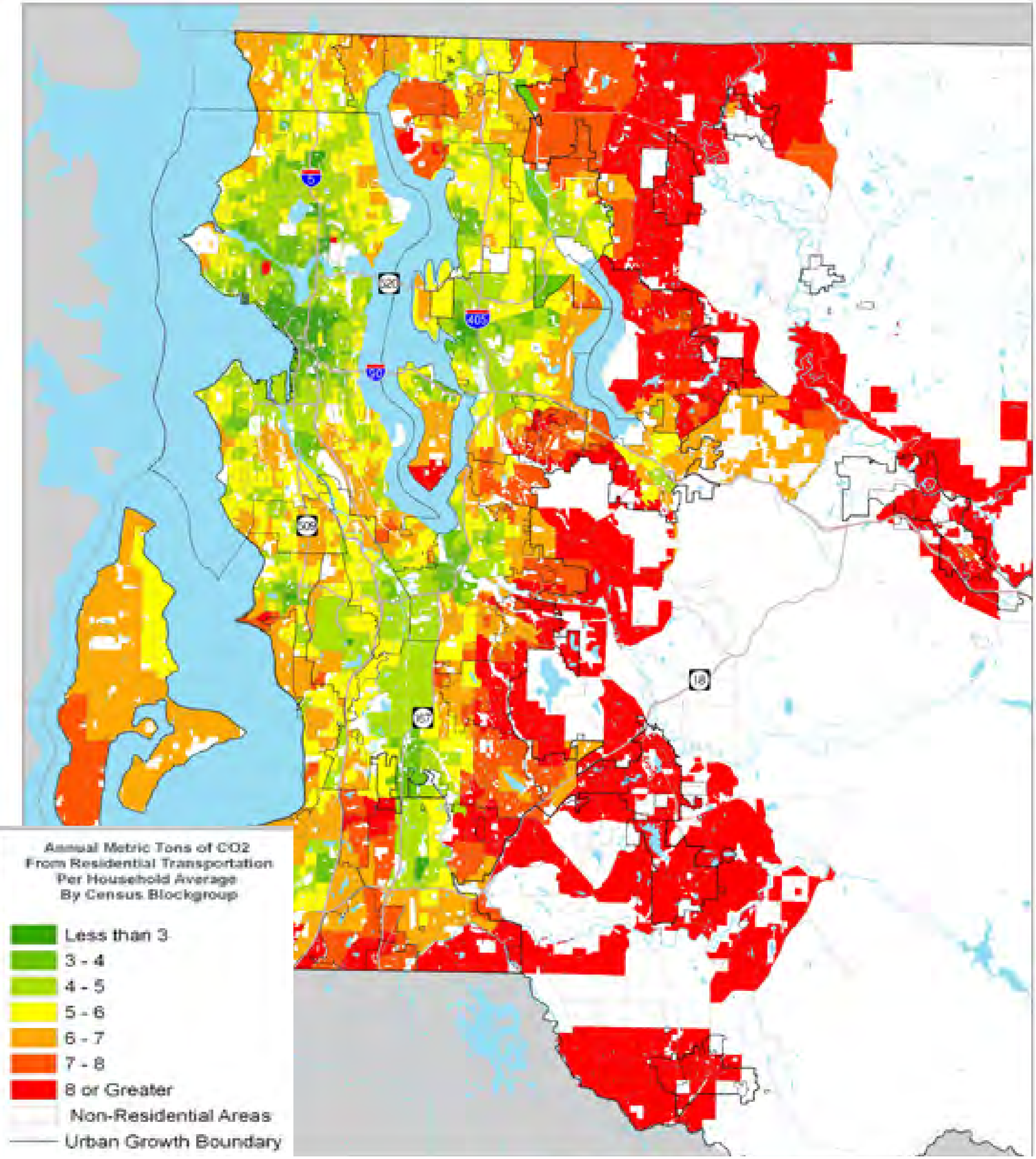

THE GLOBAL
WARMING GAMBLE
FUEL MIX
VEHICLE
EFFICIENCY
DEMAND
Policy Levers to Reduce
Transportation - Related CO2 emissions

Our Car Culture – me at 11

# Driving 1/3 As Much in 2050

| 2050 Payoff Scenarios | VEHICLE EFFICIENCY<br>MPG | FUEL MIX<br>GHGs/gal | DEMAND<br>daily VMT per capita |
|---|---|---|---|
| MAJOR PROGRESS | 47 | -35% | 8.4 |
| TECHNOLOGY BREAKTHROUGH | 61 | -65% | 20.9 |

Brookings Draft Report – King County




# Final Map of CO2 emissions from transportation

Includes:

Local urban form (land use mix, intersection density, retail FAR)

Regional location (auto travel time

Transit accessibility & travel time

Demographics

LFC, Inc.
May. 19, 2009

# Results – Urban Form + Major Progress – Seattle Study

- All else equal, households living in the most walkable King County neighborhoods were 54 percent more likely to meet the 8.4 daily mile threshold.
- Each ten-minute decrease in regional transit travel time increased the odds of meeting the vehicle miles traveled target by 11 percent.

# Summary

- Document (likely) health care COST$ (auto dominated) and BENEFIT$ of (transit & active) transportation investments
- Working across sectors
  - Research - Integration of health and urban planning research and data collection
  - Practice - Training planners to understand health and health practitioners to understand more about planning
- Zoning *for* Health
  - Health, safety, and welfare underpin development regulations and transportation investments
- Tying Transportation Funding to Measurable Performance

# Thank You!


www.act-trans.ubc.ca

# Traffic Safety Case Study

The San Francisco Department of Public Health (SFDPH) estimated how plans for growth in five San Francisco neighborhoods would impact pedestrian injuries from motor vehicle collisions.[16,17]

1. **DETERMINING AFFECTED POPULATION:** The population in 5 San Francisco neighborhoods which were being studied for increased residential development.

2. **DETERMINING HEALTH IMPACTS:** A citywide analysis was used to determine which factors were most highly correlated with pedestrian – vehicle injury crashes.[18] These factors included traffic volume, proportion of arterial streets without public transit service, land area, proportion of households without cars, proportion of residents commuting via walking or public transit, and the total number of residents. These results were applied to projected increases in population and traffic in each of the neighborhood plans in order to estimate the change in pedestrian injury collisions, resulting in a projected increase of 17 percent, or 32 additional collisions in those 5 neighborhoods each year.

   To estimate the health impacts of these pedestrian injury crashes, the distribution of pedestrian crashes by severity for the City of San Francisco over a five-year period was applied to the additional projected crashes (see first column in table).[19]

3. **DETERMINING HEALTH COSTS:** California Highway Patrol estimates of traffic injury costs were the basis of the health costs calculation, as shown in the table's second column. The cost factors include cost of property damage, lost earnings, medical and legal expenses, and costs of pain and lost quality of life, and were adjusted for inflation.[20] These estimates are also conservative, in that they assume only one pedestrian is injured per vehicle collision.

## TABLE 3 THE COST OF TRAFFIC CRASHES IN FIVE SAN FRANCISCO NEIGHBORHOODS

| | Citywide Crash Distribution (5 year average) | CHP value per accident | Estimated existing crashes | Estimated cost of existing crashes | Projected additional crashes with new development | Estimated cost of additional crashes with new development |
|---|---|---|---|---|---|---|
| Fatalities | 3% | $ 2,709,000 | 28.3 | $ 76,664,700 | 0.96 | $ 2,600,640 |
| Severe Injuries | 10% | $ 180,000 | 94.2 | $ 16,956,000 | 3.2 | $ 576,000 |
| Visible Injuries | 36% | $ 38,000 | 339.1 | $ 12,885,800 | 11.52 | $ 437,760 |
| Pain Complaints | 51% | $ 20,000 | 480.4 | $ 9,608,000 | 16.32 | $ 326,400 |
| Total | 100% | – | 942 | $ 116,114,500 | 32 | $ 3,422,400 |

# Air Pollution Case Study

Researchers from Cal State Fullerton calculated the health cost savings of meeting federal standards for fine particulates and ozone in California's South Coast and San Joaquin Valley regions.[21]

1 **DETERMINING AFFECTED POPULATION:** Researchers used a computer model to estimate the population that is currently exposed to unsafe levels of air pollution in both regions.

2 **DETERMINING HEALTH IMPACTS:** Research results from the scientific literature on air pollution were used to estimate the health impacts to the affected population. The researchers calculated impacts for the current conditions, and for a scenario in which air quality standards were met.

3 **DETERMINING HEALTH COSTS:** In the cost estimating step, other research findings and federal standards were used to calculate the cost of premature death, medical expenses due to illness and hospitalization, lost wages, and the value of avoided illness (where possible, these rates were adjusted for California income levels and current year (2007) dollars). These rates were applied to each of the health impacts that would be avoided by meeting the standards.