Systems Thinking in Communities:

Understanding the Causes of Inactivity, Poor Diet/Nutrition, and Childhood Obesity in Columbia, Missouri

UNITE 4 HEALTHY NEIGHBORHOODS

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Introduction

Unite 4 Healthy Neighborhoods is one of 49 community partnerships participating in the national *Healthy Kids, Healthy Communities* program of the Robert Wood Johnson Foundation (www.healthykidshealthycommunities.org). The purpose of this *Unite 4 Healthy Neighborhoods* project was to introduce systems thinking at the community level by identifying the essential parts of the Columbia, Missouri system and how the system influences policy and environmental changes to promote healthy eating and active living as well as to prevent childhood obesity. To accomplish this goal, community partners and residents participated in a group model building session and discussions. The group model building exercises were designed by staff from Transtria LLC and the Social System Design Lab at Washington University in St. Louis, Missouri as part of the *Evaluation of Healthy Kids, Healthy Communities* funded by the Robert Wood Johnson Foundation. These exercises actively involved a wide range of participants in modeling complex systems and provided a way for different representatives (e.g., residents, government agencies, community-based organizations, universities) to better understand the systems (i.e., dynamics and structures) in the community (see the *Healthy Kids, Healthy Communities Group Model Building Facilitation Handbook*, www.transtria.com/hkhc). Overall, the evaluation was designed to assess policy, system, and environmental changes as a result of the community partnerships' efforts to increase healthy eating and active living in order to reduce childhood obesity.

Columbia, Missouri: Background and Local Participation

Columbia is a college town located in the center of Missouri, with five neighborhoods of interest to the *Unite 4 Healthy Neighborhoods* efforts, including: First Ward, Bear Creek, Indian Hills, White Gate, and Chris Drive. The neighborhoods are predominately located in the First and Sixth Wards, and these wards have the largest population of lower-income individuals in Columbia as well as greater racial and ethnic diversity (57% of these residents are African American).

Columbia's Healthy Community Partnership was formed in 2000 through the collaborative efforts of PedNet and the Boone County Health Department in order to bridge a gap between governmental and non-profit, community-based agencies working on public health goals. Today, more than 100 Columbia and Boone County agencies are affiliated with this partnership, including: city and county government agencies, University of Missouri departments, public and private schools, non-profit organizations, and local businesses, each working individually and collectively to develop and implement policy and programmatic initiatives to promote and support healthy living.

The *Unite 4 Healthy Neighborhoods* partnership was established when a marketing and communications firm specializing in work with lower-income and African American communities was hired to develop a two-day community-wide gathering and kick-off event. The event was called *Unite 4 Healthy Neighborhoods* and ultimately became the recognized brand for the partnership moving forward.

Unite 4 Healthy Neighborhood's Priorities and Strategies

Community partners and residents identified priority steps needed to increase healthy eating and active living in the community, such as increasing the availability of affordable, nutritious foods and making area streets and parks more conducive to walking, bicycling, and safe play for children and families. During the first year of the grant, six action teams were formed around healthy eating and active living environment and policy priorities, including:

- **Neighborhood Association Revitalization Team** (Leaders: PedNet Coalition and City of Columbia Office of Neighborhood Services)
- **Youth Voice 4 Advocacy Team** (Leaders: Urban Empowerment Ministries and University of Missouri at Columbia College of Education)
- **Public Transportation Expansion Team** (Leaders: Engineering Surveys and Services and Russell Chapel Baptist Church)
- **Accessible and Affordable Local Produce Team** (Leaders: Sustainable Farms and Communities and University of Missouri at Columbia Master's in Public Health Graduate Program)

- **Food Production at Home and in the Community Team** (Leaders: Columbia and Boone County Department of Public Health and Human Services and Columbia Urban Center for Agriculture)
- **Food System Mapping Team** (Leaders: Boone County Smart Growth Coalition and Columbia Public Schools)

Each team had leadership from institutional and community partners paired together (noted above) and the action teams met monthly while the entire Healthy Community Partnership met quarterly. In addition, partners offered mini grants to community-based organizations to target policy and environment change.

The partnership and capacity building strategies of *Unite 4 Healthy Neighborhoods* included:

- **Neighborhood Associations**: In 2010, partners assisted with the formation of the City of Columbia's Office of Neighborhood Services with a mission to strengthen neighborhoods and neighborhood associations in underserved areas. In 2011-2012, partners helped to establish or re-establish three neighborhood associations: Worley Street Park Neighborhood Association, West Ash Neighborhood Association, and Douglass Park Neighborhood Association. Partners also contributed to a Neighborhood Congress, convening 70 neighborhood association leaders, elected officials, and underserved residents.
- **Food Policy Council**: Through partners' influence, Columbia's Board of Health instituted a Food Policy Task Force, a temporary entity designed to use food system data and other information to build a case for why Columbia needs a Food Policy Council to facilitate community participation and support.

The healthy eating and active living strategies of *Unite 4 Healthy Neighborhoods* included:

- **Farmers' Markets**: Partners assisted in the installation of Electronic Benefit Transfer (EBT) equipment and the implementation of the Access to Healthy Foods program (i.e., double bucks) at the Columbia Farmers' Market. Partners supported creation of a market at the Columbia Housing Authority location as well as smaller satellite markets at different locations in Columbia.
- **Community Gardens**: The partnership established 11 gardens and 5 edible landscapes between 2008 and 2012, and partners supported an ordinance for urban hens.
- **Public Transportation**: In 2010, the Public Works department received three new buses, allowing them to increase the coverage area by 10-20% and total service (number of routes, times, hours, of operation) by 11%. A new transfer route and new stops were added and existing routes were re-routed, restored, or rescheduled to extend the service area (e.g., companies and jobs, farmer's markets, campus) or to decrease congestion and prevent delays. In 2011, partners launched the *Columbians for Modern, Efficient Transit* (CoMET) campaign to support a modern, efficient transit system that provides reliable, convenient transportation services promoting health opportunity and sustainability.
- **Traffic Calming**: In 2009, helped to pass two pedestrian safety ordinances, one against the harassment of a bicyclist, pedestrian, or person in a wheelchair and the other limiting speed on city residential streets. Partners also supported the installation of solar-powered speed-feedback signs in 2011 and the allocation of federal transportation funds ($200,000) to construct a pedestrian-actuated crosswalk system on a high-speed, high-traffic state highway running through public housing neighborhoods.
- **Safe Routes to School/Walking School Bus**: Partners rallied for new school policies on student safety, resulting in a single-lane drop-off and pick-up at school. Partners supported crosswalk signs and striping to increase safety along an established Safe Routes to School route and installation of approximately 50 traffic control devices throughout Columbia.
- **Parks and Recreation**: In 2010, partners stimulated enhancements to recreational facilities to encourage physical activity, including: pool improvements, demolition and installation of spray grounds at Douglass Park, sidewalk repair for connectivity improvements at Douglass Park, and baseball field renovation (i.e., graded/replaced topsoil, replaced older outfield fence, and sidewalk improvements) near the park.

For more information on the partnership, please refer to the Columbia case report (www.transtria.com/hkhc).

Systems Thinking in Communities: Columbia, Missouri

"Systems thinking" represents a range of methods, tools, and approaches for observing the behaviors of a system (e.g., family, community, organization) and how these behaviors change over time; changes may occur in the past, present, or future. Figure 1 illustrates a system of policies, environments, local collaborations, and social determinants in Columbia, Missouri that influence healthy eating, active living, and, ultimately, childhood obesity. This system and the dynamics within the system are complicated with many different elements interacting.

Models, such as Figure 1, provide a way to visualize all the elements of the system and their interactions, with a focus on causal relationships as opposed to associations. Through the model, specific types of causal relationships, or feedback loops, underlying the behaviors of the dynamic system, can be identified to provide insights into what is working or not working in the system to support the intended outcomes (in this case, increases in healthy eating and active living, and decreases in childhood overweight and obesity). In system dynamics, the goal is to identify and understand the system feedback loops, or the cause-effect relationships that form a circuit where the effects "feed back" to influence the causes.

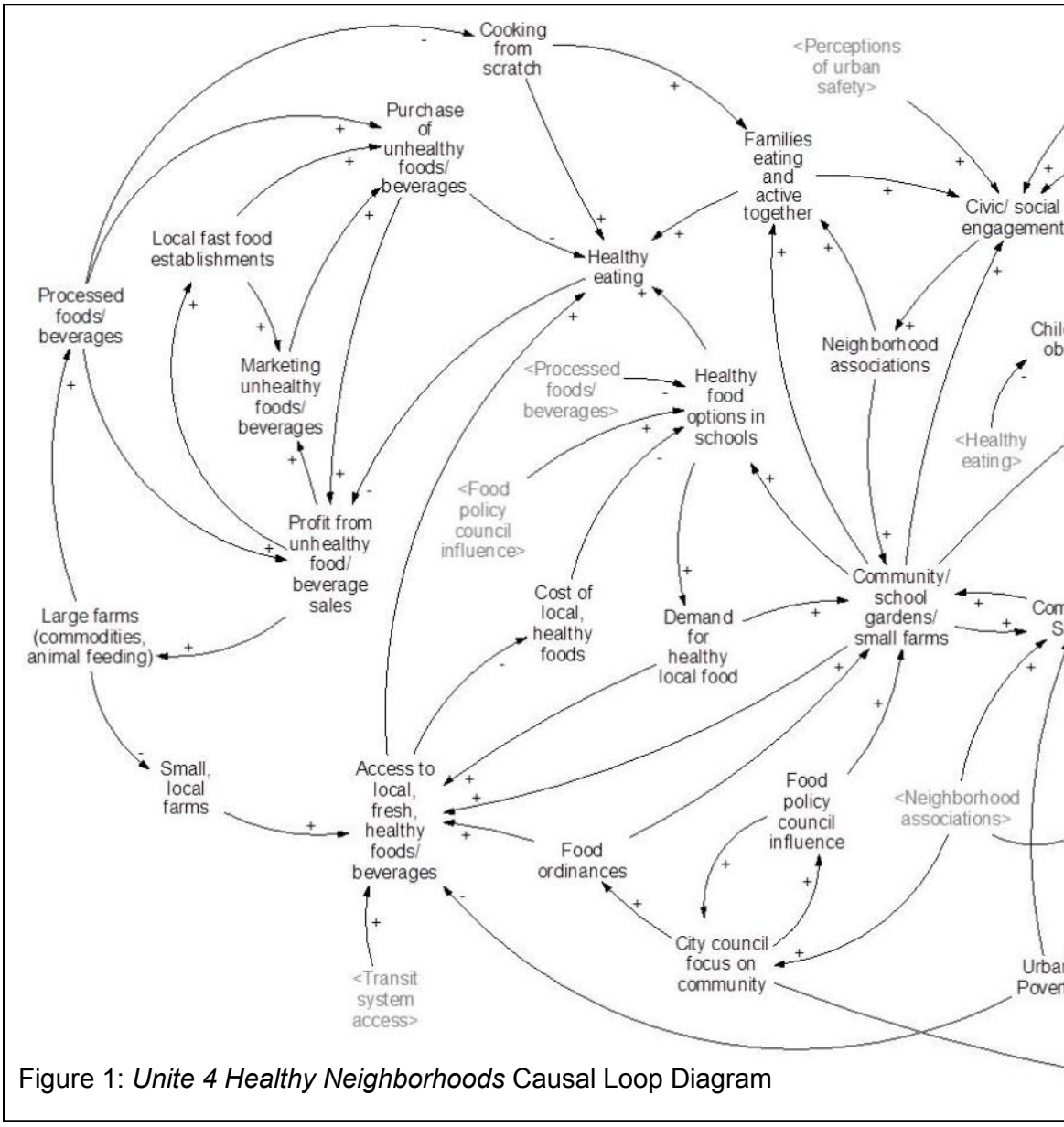
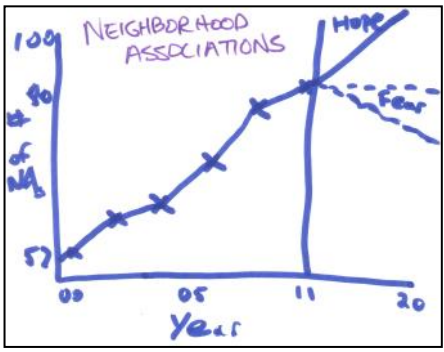


Figure 1: *Unite 4 Healthy Neighborhoods* Causal Loop Diagram

Group Model Building

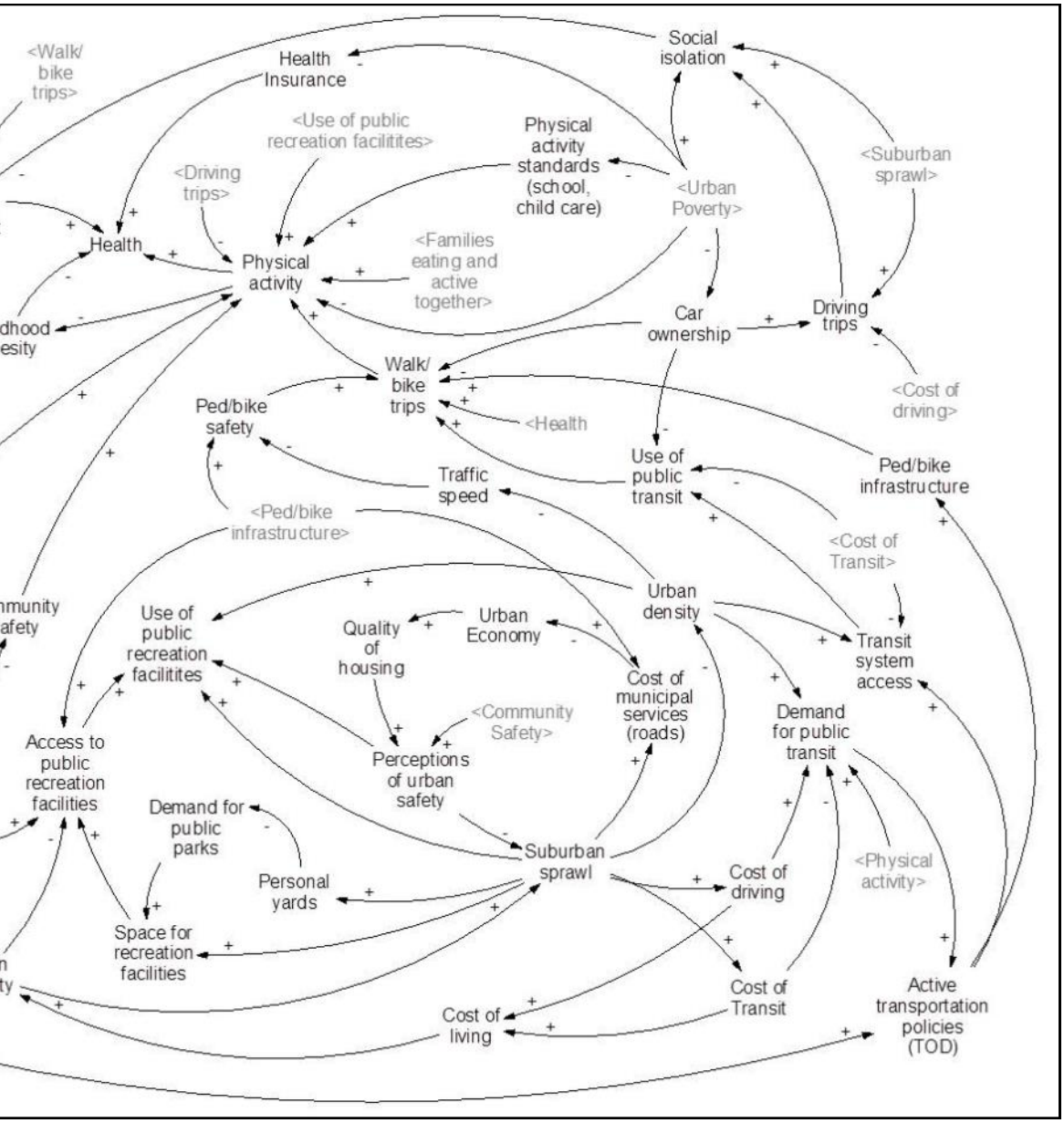
Members of the *Unite 4 Healthy Neighborhoods* partnership participated in a group model building session in October, 2011 and generated this system. also referred to as a causal loop diagram (Figure 1). Participants in the group model building session included residents of the First Ward as well as representatives of local faith-based organizations, non-profit agencies, academic institutions, and advocates. The group model building session had two primary activities: 1) a Behavior Over Time Graph exercise; and 2) a Causal Loop Diagram (or structural elicitation) exercise.



<u>Behavior Over Time Graphs</u>

To identify the range of things that affect or are affected by policy, system, and environmental changes in Columbia related to healthy eating, active living, and childhood obesity, participants designed graphs to name the influences and to illustrate how the influences have changed over time (past, present, and future). In this illustration for neighborhood associations, the number of neighborhood

associations has increased from 2000 to 2011 and the participant hopes that this increase will continue into the future. Each graph is a tool to increase the use of common, specific language to describe *what* is changing in the community as well as *when*, *where*, and *how* it is changing. The graphs capture participants' perceptions of the influence, or variable, and through the graph, the participant tells their story. These perceptions are based on actual data or evidence, or they are part of the participants' lived experience.



Causal Loop Diagram

To examine the relationships among the variables from the behavior over time graphs, participants worked together and with facilitators to develop a causal loop diagram. In Figure 1, the words represent variables of quantities that can increase and decrease over time (i.e., the behavior over time graphs). These variables are influenced by other variables as indicated by the lines with arrows. The lines with arrows represent causal relationships - this is what is known about the system and how it behaves.

For instance, there are many feedback loops influencing or influenced by neighborhood associations in this causal loop diagram. One feedback loop is: neighborhood associations → community gardens and small farms → families eating together → civic/ social engagement → neighborhood associations. A second feedback loop is: neighborhood associations → community safety → perceptions of urban safety → civic/social engagement → neighborhood associations.

What is important to notice in these examples is that there are two different feedback loops interacting simultaneously to influence or to be influenced by neighborhood associations. Some variables may increase community participation in neighborhood associations while other variables limit residents from being part of neighborhood associations. Determining the feedback loop or loops that dominate the system's behavior at any given time is a more challenging problem to figure out, and ultimately, requires the use of computer simulations.

Based on this preliminary work by the *Unite 4 Healthy Neighborhoods* partnership, this "storybook" ties together the behavior over time graphs, the participants' stories and dialogue, and feedback loops from the causal loop diagram to understand the behavior of the system affecting health in Columbia and to stimulate greater conversation related to Columbia's theory of change, including places to intervene in the system and opportunities to reinforce what is working. Each section builds on the previous sections by introducing concepts and notation from systems science.

Causal Loop Diagram for the Childhood Obesity System

The causal loop diagram (CLD) represents a holistic system and several subsystems interacting in Columbia, Missouri. In order to digest the depth and complexity of the diagram, it is helpful to examine the CLD in terms of the subsystems of influence. Because of this project's focus on healthy eating, active living, and childhood obesity, this system draws attention to a number of corresponding subsystems, including: healthy eating policies and environments (red), active living policies and environments (blue), health and health behaviors (orange), partnership and community capacity (purple), and social determinants (green).

From the group model building exercises, several variables and causal relationships illustrated in Figure 2 were identified within and across subsystems. This section describes the subsystems in the CLD.

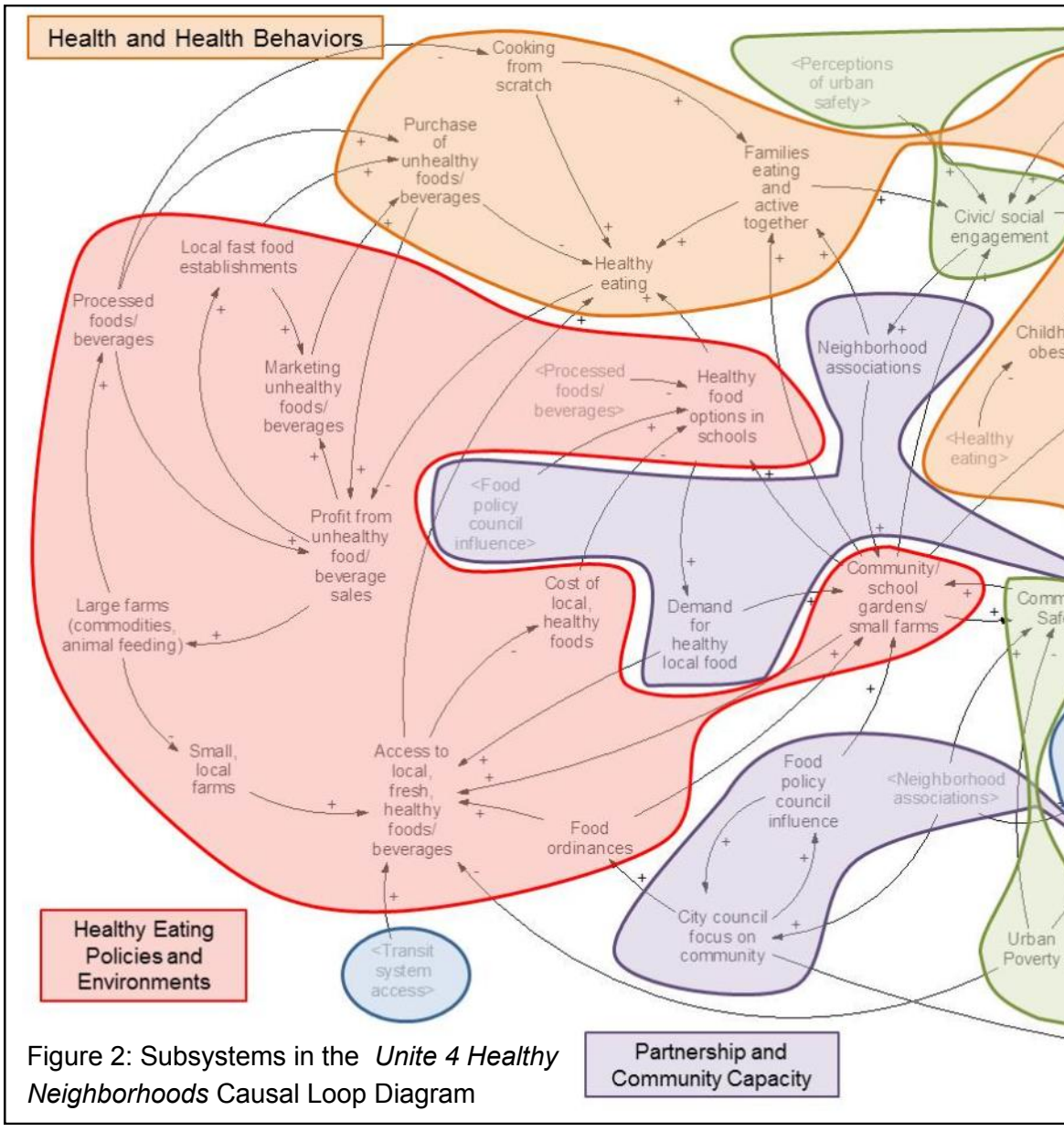


Figure 2: Subsystems in the *Unite 4 Healthy Neighborhoods* Causal Loop Diagram

Healthy Eating Policies and Environments (Red)

The healthy eating policy and environmental subsystem includes food production (e.g., farming), food distribution and procurement (e.g., locally grown foods), and food retail (e.g., food and beverage vendors). During the behavior over time graphs exercise, the participants generated 18 graphs related to policy or environmental strategies (e.g., to increase the number of community gardens and small farms) or contexts (e.g., healthy options are not available in schools) that affected or were affected by the work of *Unite 4 Healthy Neighborhoods*. These variables are included in many feedback loops (example feedback loops are described in the next sections).

Active Living Policies and Environments (Blue)

The active living policy and environmental subsystem includes design, planning, construction, and enforcement or maintenance related to access to opportunities for active transportation and recreation. For this topic, the group model building participants developed 21 graphs related to policy or environmental strategies (e.g., to increase access to public transit) or contexts (e.g., traffic speeds are higher in areas with less urban density) that affected or were affected by the partnership's work.

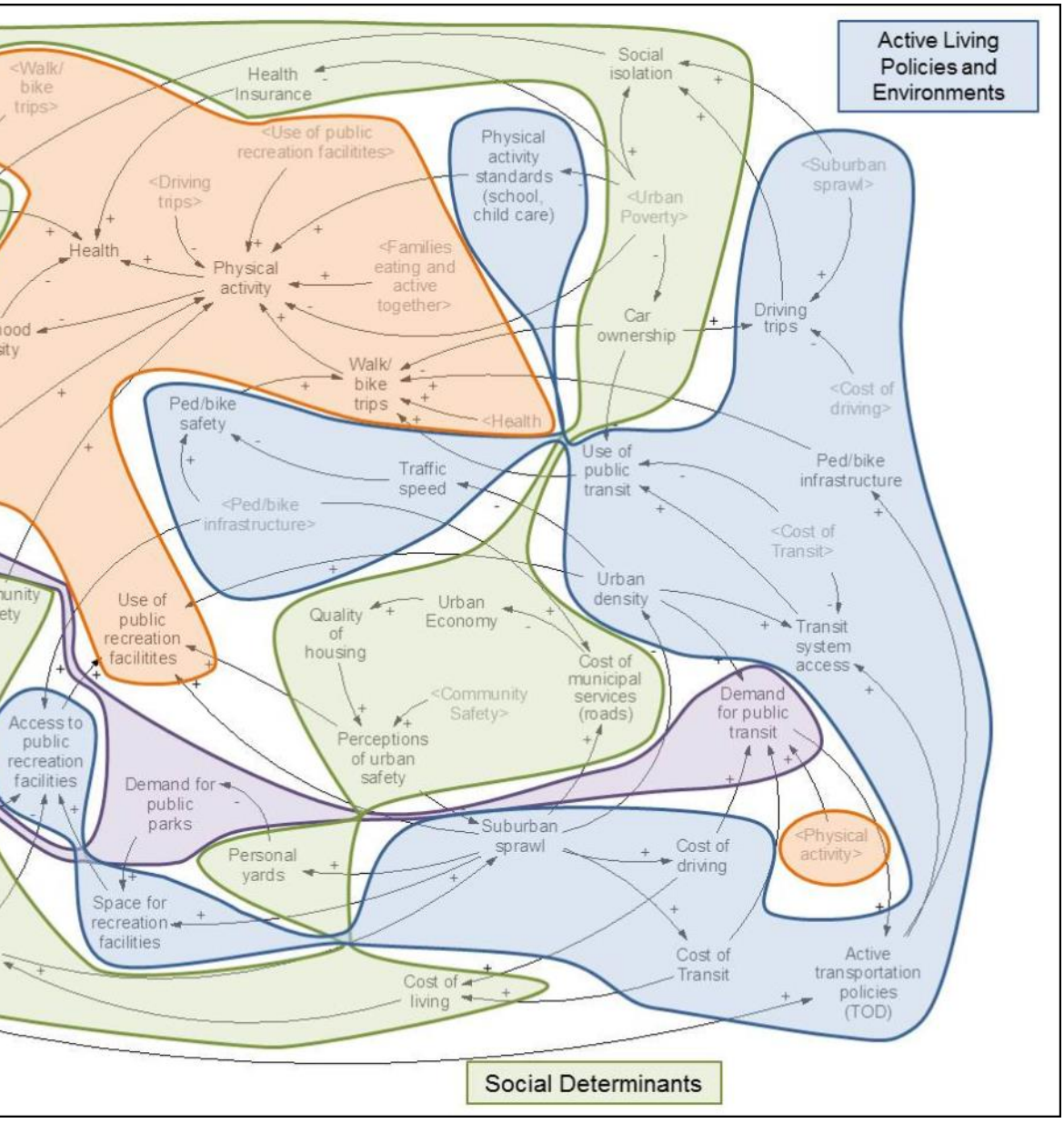
Health and Health Behaviors (Orange)

The subsystem for health and health behaviors includes health outcomes (e.g., obesity), health behaviors

(e.g., healthy eating, physical activity), and behavioral proxies or context-specific behaviors (e.g., use of public transportation, walk trips, purchase of unhealthy foods/beverages, cooking from scratch).

Partnership and Community Capacity

The partnership and community capacity subsystem refers to the ways communities organized and rallied for changes to the healthy eating and active living subsystems. For instance, *Unite 4 Healthy Neighborhoods* worked collaboratively with neighborhood associations to influence their city council's focus on communities. This subsystem also includes community factors outside the partnership that may influence or be influenced by their efforts, such as local demand for healthy food or local demand for public transit.



Social Determinants

Finally, the social determinants subsystem denotes societal conditions (e.g., cost of living, community safety, housing quality) and psychosocial influences (e.g., social isolation, civic/social engagement) in the community that impact health beyond the healthy eating and active living subsystems. In order to achieve health equity, populations and subgroups within the community must have equitable access to these resources and services.

Each one of these subsystems has many more variables, causal relationships (arrows), and feedback loops that can be explored in greater depth by the *Unite 4 Healthy Neighborhoods* partners or by other representatives in Columbia, Missouri. Using this diagram as a starting place, community conversations about different theories of change within subsystems may continue to take place. For instance, these participants identified interest in understanding more about the relationships among the practices of large, corporate farms (e.g., subsidizing commodities, using poor animal feeding practices), the prevalence of processed foods and beverages, and profits from unhealthy food and beverage sales.

The next sections begin to examine feedback loops central to the work of *Unite 4 Healthy Neighborhoods*. In these sections, causal relationships and notations (i.e., arrows, "+" signs, "-" signs) from Figure 2 will be described to increase understanding about how systems thinking and modeling tools can work in communities to increase understanding of complex problems that are continuously changing over time, such as childhood obesity. At the end of this CLD storybook, references to other resources will be provided for those interested in more advanced systems science methods and analytic approaches.

Food Policy Council Feedback Loop

To simplify the discussion about feedback loops, several loops drawn from the *Unite 4 Healthy Neighborhoods* CLD (see Figures 1 and 2) are highlighted in Figures 3-8. While the CLD provides a theory of change for the childhood obesity prevention movement in Columbia, Missouri, each feedback loop tells a story about a more specific change process.

Causal Story for Feedback Loop

Story A: In this case , the story is about the influence of a food policy council (green highlighted loop in Figure 3). Columbia, Missouri does not yet have a formal food policy council. Participants described how a food policy council may increase support for community or school gardens or small farms. In turn, these gardens or farms may create more opportunities for civic or social engagement among residents living near the gardens and small farms. As more residents are engaged in these local communities, they may be more likely to participate in or initiate neighborhood associations. Through these associations, residents may unite their voices in order to increase the focus of city council on community members' needs and assets. As communities prioritize access to healthy foods and beverages, city council may increase their support for a food policy council to assess and work to improve food access in the community.

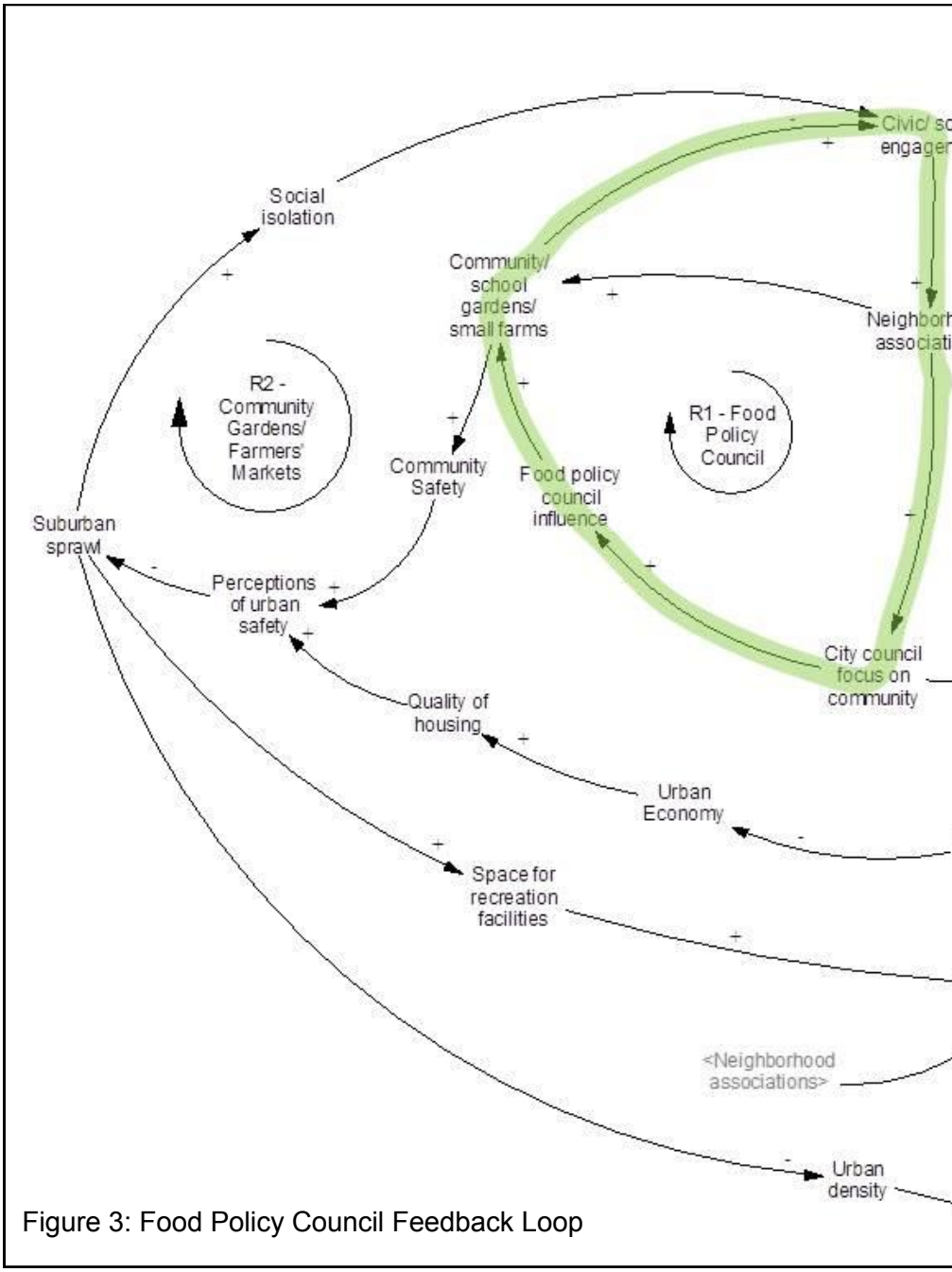


Figure 3: Food Policy Council Feedback Loop

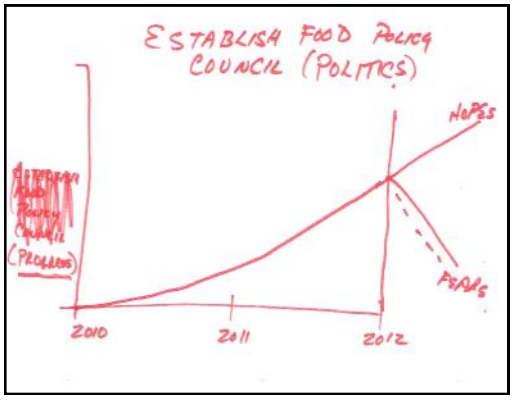
Story B: While the preceding story reflected a positive scenario for Columbia, Missouri, the same feedback loop also tells the opposite story. Without food policy council influence, it may be more difficult to gain support for community gardens and small farms, reducing opportunities for civic and social engagement, limiting participation in or formation of neighborhood associations, leading to less city council focus on communities, and lessening the influence of or support for a food policy council.

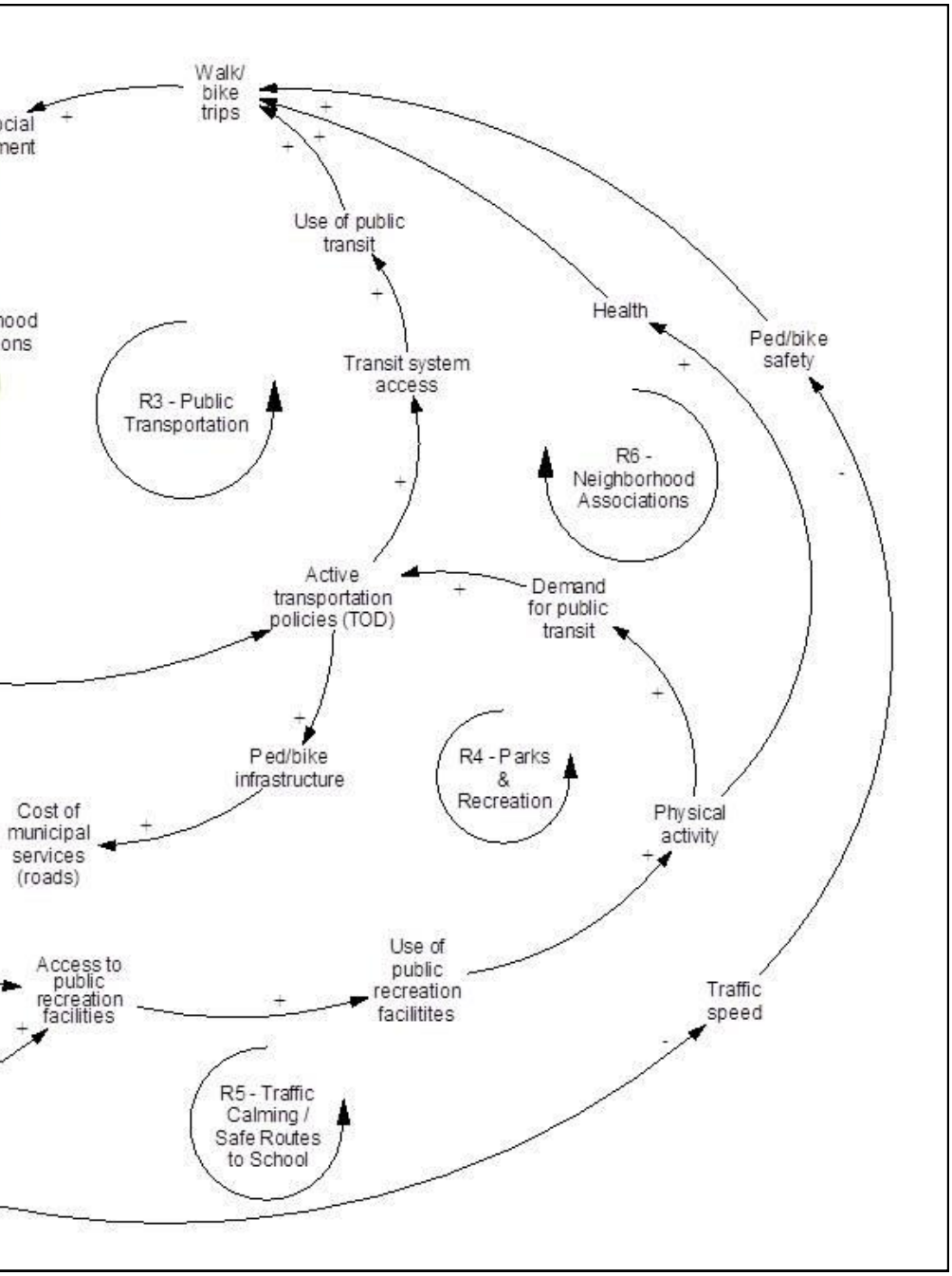
Reinforcing Loop and Notation

These stories — pro and con — represent a reinforcing loop, and the notation in the feedback loop identifies it as a reinforcing loop (see "R1 — Food Policy Council" and green highlighted loop in Figure 3). The words represent variables of quantities that increase and decrease as illustrated in the stories above. These variables change over time and are influenced by other variables as indicated by the arrows. Each arrow represents a causal relationship, and the plus and minus signs on the arrows indicate whether or not the influence of one variable on another variable (1) increases/adds to (plus or "+" sign), or (2) decreases/

removes from the other variable (minus or "-" sign). These signs are referred to as polarities.

In a reinforcing loop, the effect of an increase or decrease in a variable continues through the cycle and returns an increase or decrease to the same variable, respectively. Looking specifically at the "+" or "-" notation, a feedback loop that has zero or an even number of "-" signs, or polarities, is considered a reinforcing loop. This loop has all "+" signs, so it is a reinforcing loop. Balancing loops, with an odd number of "-" signs in the loop, are another type of feedback loop and are referenced in the next sections.





In isolation, this reinforcing loop represents a virtuous cycle in Story A as these assets positively support one another, or a vicious cycle in Story B as these challenges perpetuate a downward spiral. Yet, the influence of a food policy council likely levels off at some point when people in the community have equitable access to healthy foods and beverages. To understand what specifically leads to the leveling off of a food policy council's influence, it may be helpful for the partners in Columbia, Missouri to consider other variables that influence or are influenced by food policy councils. In addition, it is important to remember that this reinforcing loop is only one part of the larger CLD (see Figures 1 and 2), and the other loops and causal relationships can have an impact on the variables in this loop.

<u>System Insights for *Unite 4 Healthy Neighborhoods*</u>

Participants identified an active and growing interest in establishing a food policy council in Columbia, Missouri (see behavior over time graph).

From the systems thinking exercises, several insights can inform the ongoing development and sustainability of the food policy council, including:

- A strategic focus of the food policy council on increasing the number of and/or participation in community and school gardens or small farms can rally community support for the council.
- By focusing on gardens and small farms, the council can stimulate civic engagement and community organizing through neighborhood associations to increase support from city council.

Community/ School Gardens/ Small Farms Feedback Loop

Given the introduction to feedback loops and CLD notation in the previous section, this discussion of the feedback loop highlighted in orange in Figure 4 expands on the concepts and notation, and highlights community and school gardens and small farms.

Causal Story for Feedback Loop

Story A: With more community and school gardens and small farms in urban areas, more residents are out and about in the community, increasing safety. As safety increases (e.g., less interpersonal crime), community members' perceptions of safety also increase. Because more residents feel safe in the community, they are less likely to move to suburban areas. With less suburban sprawl, neighbors are more likely to be in closer contact, reducing social isolation. With less isolation, there is more civic and social engagement that leads to increases in the number of or participation in neighborhood associations. Greater participation in these associations, in turn, can increase the number of or participation in gardens and small farms.

Story B: Alternatively, without urban gardens and farms, safety and perceptions of safety may decline followed by more suburban sprawl, more social isolation, less civic and social engagement, less participation in neighborhood associations, and, ultimately, less support for gardens and farms.

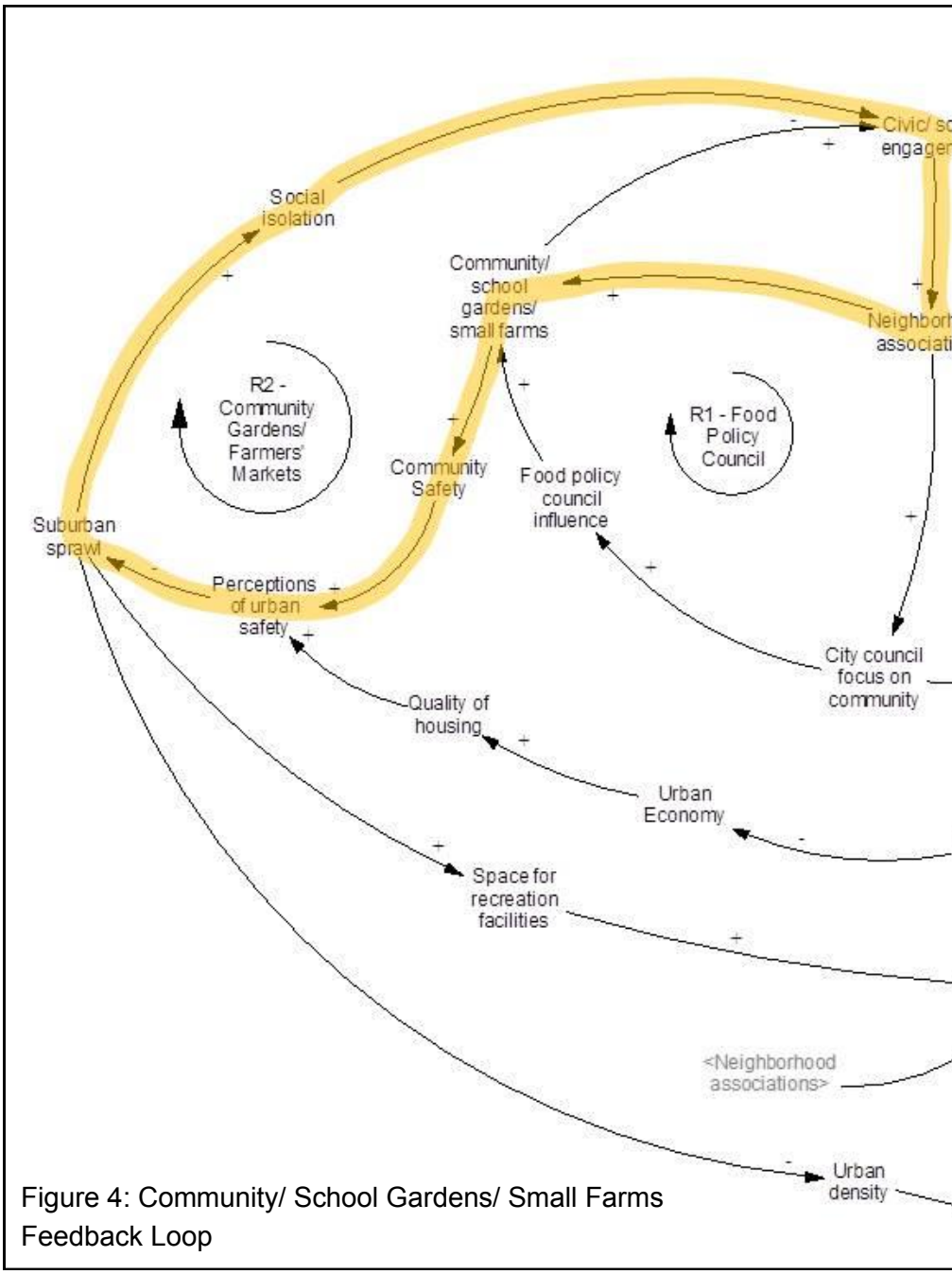


Figure 4: Community/ School Gardens/ Small Farms Feedback Loop

Reinforcing Loop and Notation

Unlike the food policy council loop in Figure 3, this loop does have two "-" signs or polarities; because this is an even number, it is still a reinforcing loop (see R2—Community Gardens/ Farmers' Markets in Figure 4).

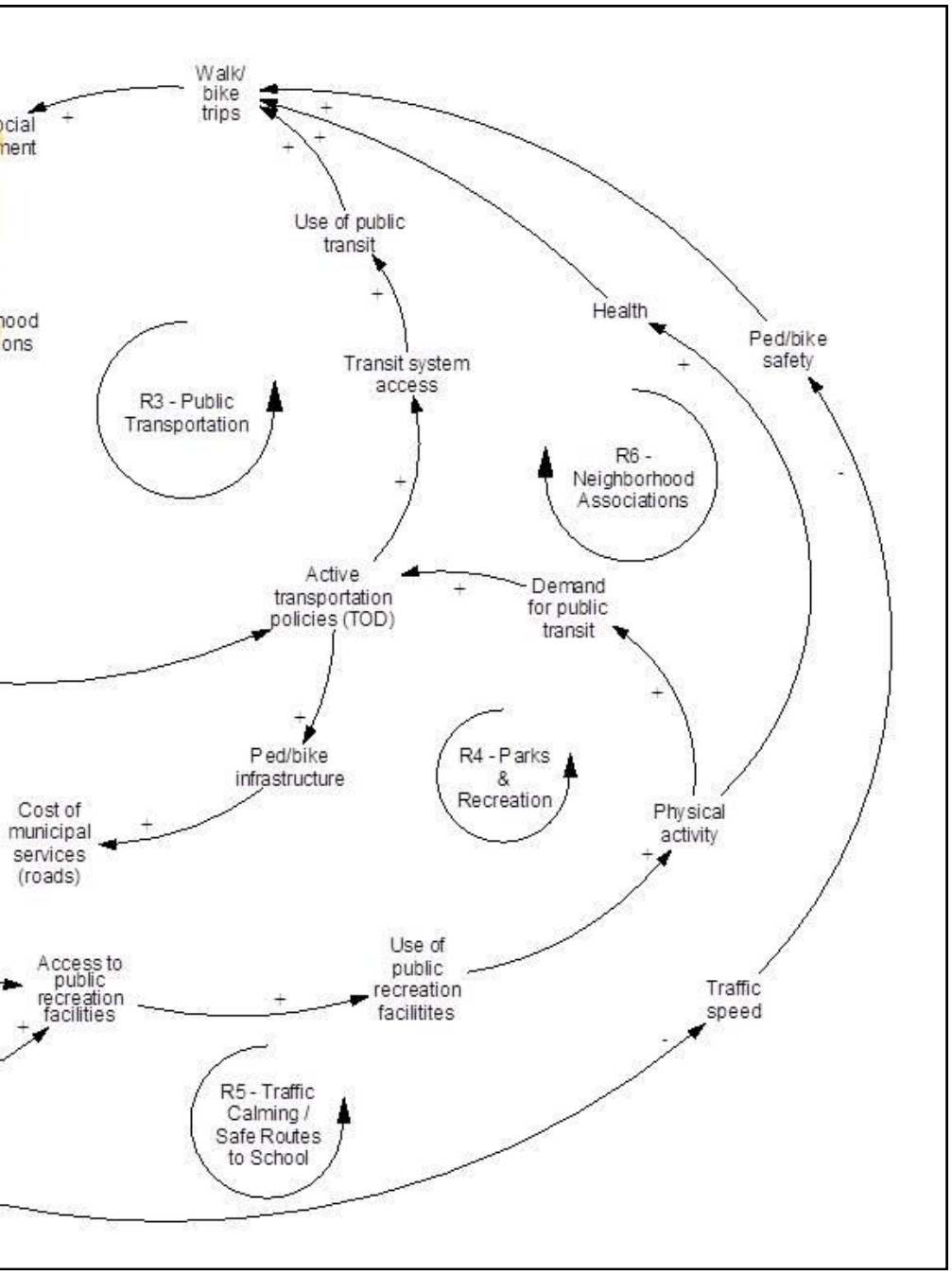
Some of these causal relationships may have more immediate effects (e.g., more people present in community gardens increases safety as there are more "eyes on the street") and other relationships may have delayed effects (e.g., increasing perceived urban safety reduces suburban sprawl). This delayed effect is noted using two hash marks through the middle of the arrow line (not in Figure 4).

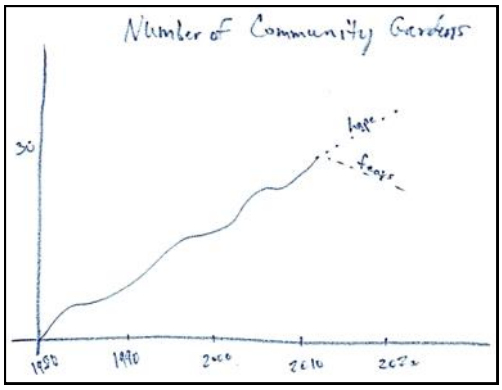
System Insights for *Unite 4 Healthy Neighborhoods*

In the behavior over time graphs, participants identified increasing trends in the number of community and school gardens as well as the number of youth gardening programs (see illustrations on next page).

System insights can inform the partnership's next steps with community and school gardens and small farms, including:

- Connecting urban gardeners and small farmers with neighborhood watch groups or local law enforcement may accelerate or improve neighborhood safety efforts.
- Similarly, gardens and programs for youth occurring outside the school day provide safe, constructive activities with supervision.

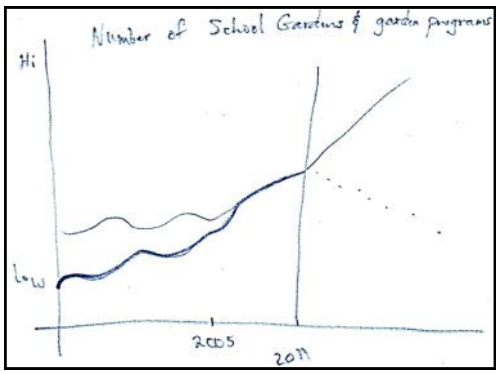




- Urban gardens and farms can increase neighborhood revitalization and limit or reverse suburban sprawl as residents feel less vulnerable to crime or violence in urban areas.
- By drawing residents back into more dense, urban neighborhoods, the gardens and farms can help to minimize geographic isolation in suburban dwellings.
- Because social interaction is an integral part of community or school gardens and farms, these places may also serve to inform or organize residents, particularly through neighborhood associations.

In addition to these insights, systems thinking can also help to pose key questions for assessment and evaluation, including:

- What is the optimal number of school or community gardens or farms for a neighborhood or urban area?
- What is the optimal frequency of participation in gardens or farms?
- Does participation in gardens or farms predict social outcomes (e.g., perceptions of neighborhood safety, civic engagement)?



"It seems like the number of school gardens and garden programs is increasing now and it's certainly better to increase a lot more, not only for the health of the kids who are working on the garden but also for those who get to [benefit from the produce]." (Participant)

Public Transportation Feedback Loop

Highlighted in light blue in Figure 5, the public transportation feedback loop represents one of the *Unite 4 Healthy Neighborhoods* strategies to increase active living in Columbia, Missouri.

Causal Story for Feedback Loop

Story A: As transit system access increases, more residents are able to get to transit stations or stops from their homes and to get to destinations of interest (e.g., school, work, entertainment). When more people are using public transit, there will also be increases in the numbers of people walking or biking to and from the transit stations or stops to their homes or other community destinations. With more pedestrians and bicyclists (as opposed to drivers), there are more opportunities to interact with other community residents on sidewalks, streets, or transit. As these social or civic interactions increase, people may be more likely to form or participate in neighborhood associations, which, in turn, can increase the city council's focus on communities. In this case, the council's influence may increase policies supporting active transportation modes to further increase access to transit as well as pedestrian and bicycle facilities.

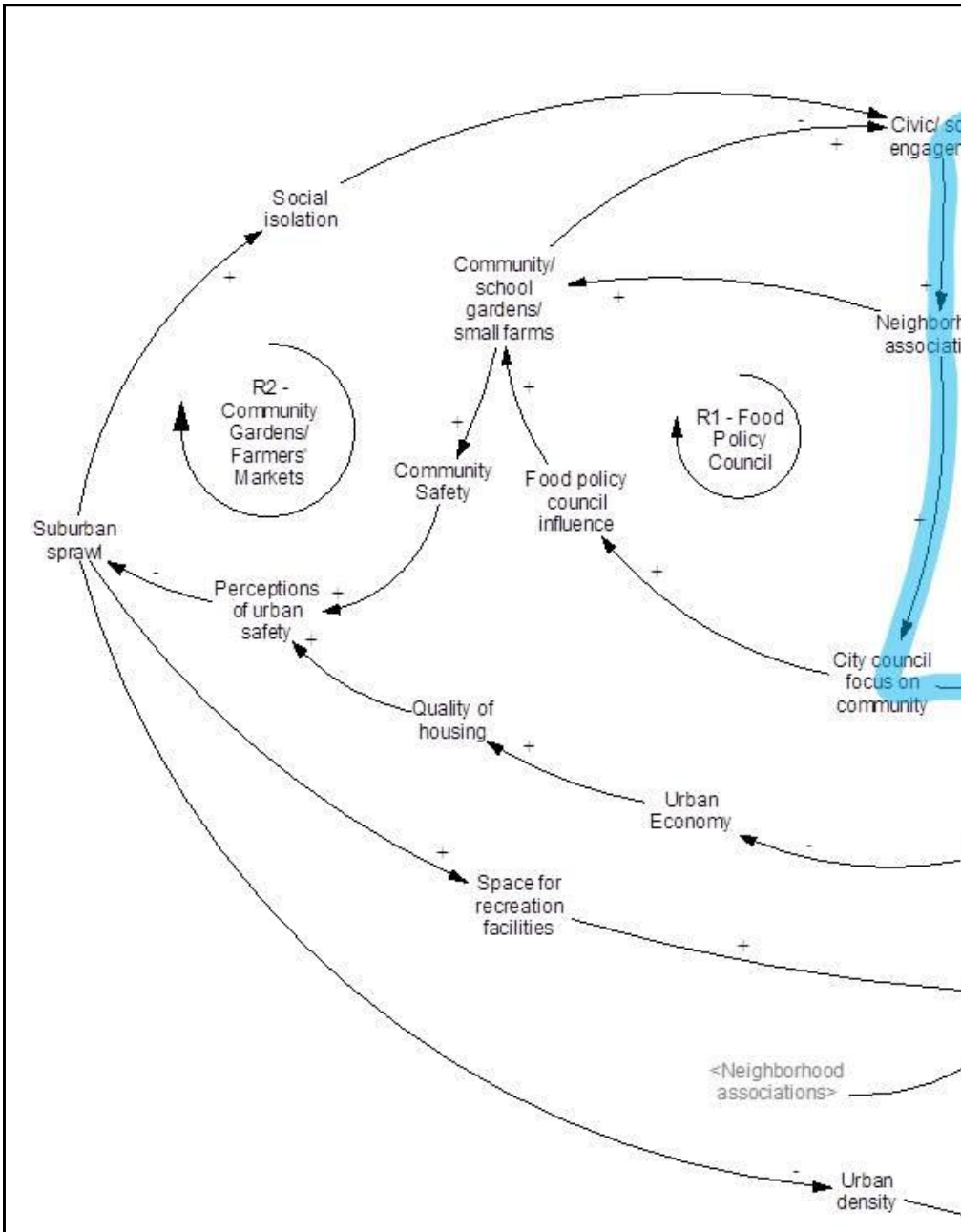


Figure 5: Public Transportation Feedback Loop

Story B: Without access to transit, residents may depend on their cars or other personal vehicles for transportation. In some cases, residents may not own a vehicle, so their mobility is restricted to destinations within walking distance. Because most residents own vehicles, the total number of walking and biking trips is likely to decrease. With people in their vehicles, there are fewer opportunities to interact with their fellow community residents and, therefore, less of a chance that residents will participate in neighborhood associations. This, in turn, diminishes the residents' influence on city council and decreases the potential for policies to increase access to transit, as residents will be more concerned about their vehicles, convenient parking, and quality roads.

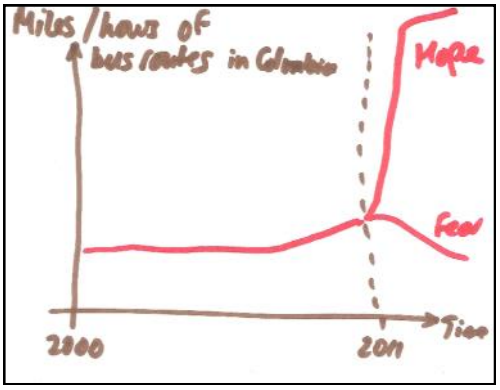
Reinforcing Loop and Notation

Similar to the previous loops, this one also represents a reinforcing loop (all "+" signs). In addition, it includes causal relationships representing more immediate effects (e.g., the use of public transit increases walk or bike trips), and, potentially, delayed effects (e.g., more or better active transportation policies increase transit system access throughout Columbia).

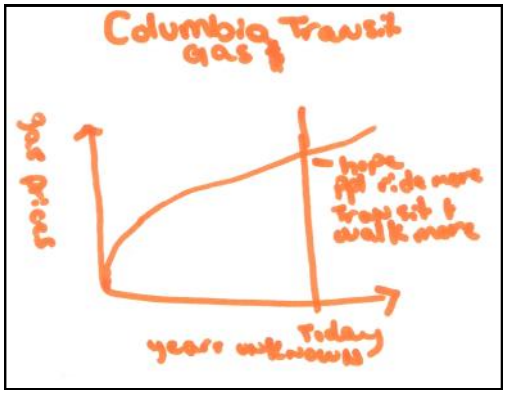
System Insights for *Unite 4 Healthy Neighborhoods*

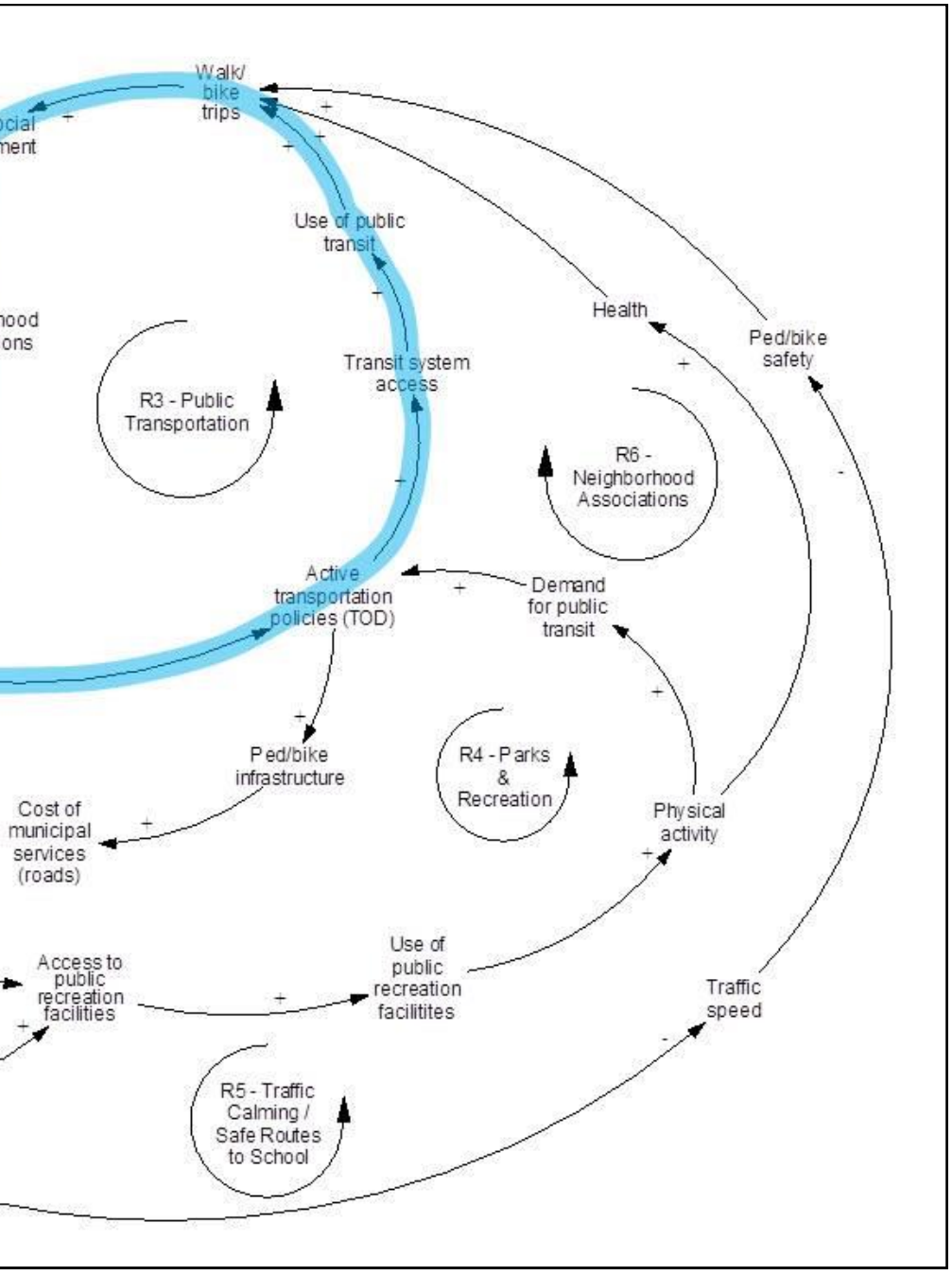
In the behavior over time graphs exercise, participants described that the miles of bus routes, and the

associated time on the bus along these routes, has been relatively stable over time. Yet, participants want more of a network of shorter routes to improve accessibility and to reduce time spend in transit (see illustration on miles/hours of bus routes in Columbia).

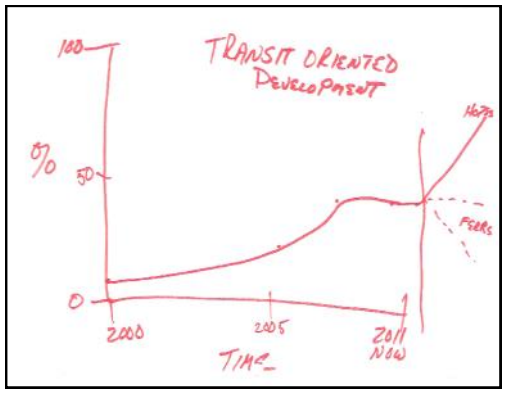


Participants also identified one of the primary barriers for public transit, gas prices. Because the bus is the primary form of public transportation, the costs of public transit services have risen steadily with the increasing gas prices (see illustration on Columbia transit gas costs).





While these challenges present a bleak picture of public transportation in Columbia, participants also identified an increase in the amount of transit-oriented development in the area from very little in 2000 to nearly half of the new development projects by 2007-2008, yet this increasing trend leveled off and participants hope to see a continued increase in this development pattern into the future (see illustration on transit-oriented development).



System insights for the partnership's public transportation efforts include:

- Building civic networks among current transit users, pedestrians, and bicyclists to organize community and city council support through neighborhood associations can improve policies for active transportation.
- Designing a public transit system with more, shorter routes is desired, yet the shorter-term costs (e.g., more buses) will need to be considered alongside the longer-term costs and savings (e.g., vehicle maintenance, increased ridership, gas prices).

Parks and Recreation Feedback Loop

In purple in Figure 6, the parks and recreation feedback loop represents another one of the *Unite 4 Healthy Neighborhoods* strategies to increase active living in Columbia, Missouri. This loop is a little more complex than some of the preceding loops and it doesn't even look like a loop.

Causal Story for Feedback Loop

Story A: With increased access to public recreation facilities, such as parks, recreation centers, playgrounds, fields, and courts, more residents in Columbia will use these facilities, increasing their physical activity, and, in turn, improving their health. As residents are more healthy, they may be able to walk and bike more in the community, and these trips may increase opportunities for engagement with other residents. With increased engagement, people may be more inclined to participate in neighborhood associations. Organized neighborhood associations may prioritize parks and recreation facilities as they provide many benefits to neighborhoods, including places to be active and green spaces with trees, plants, flowers, or public art.

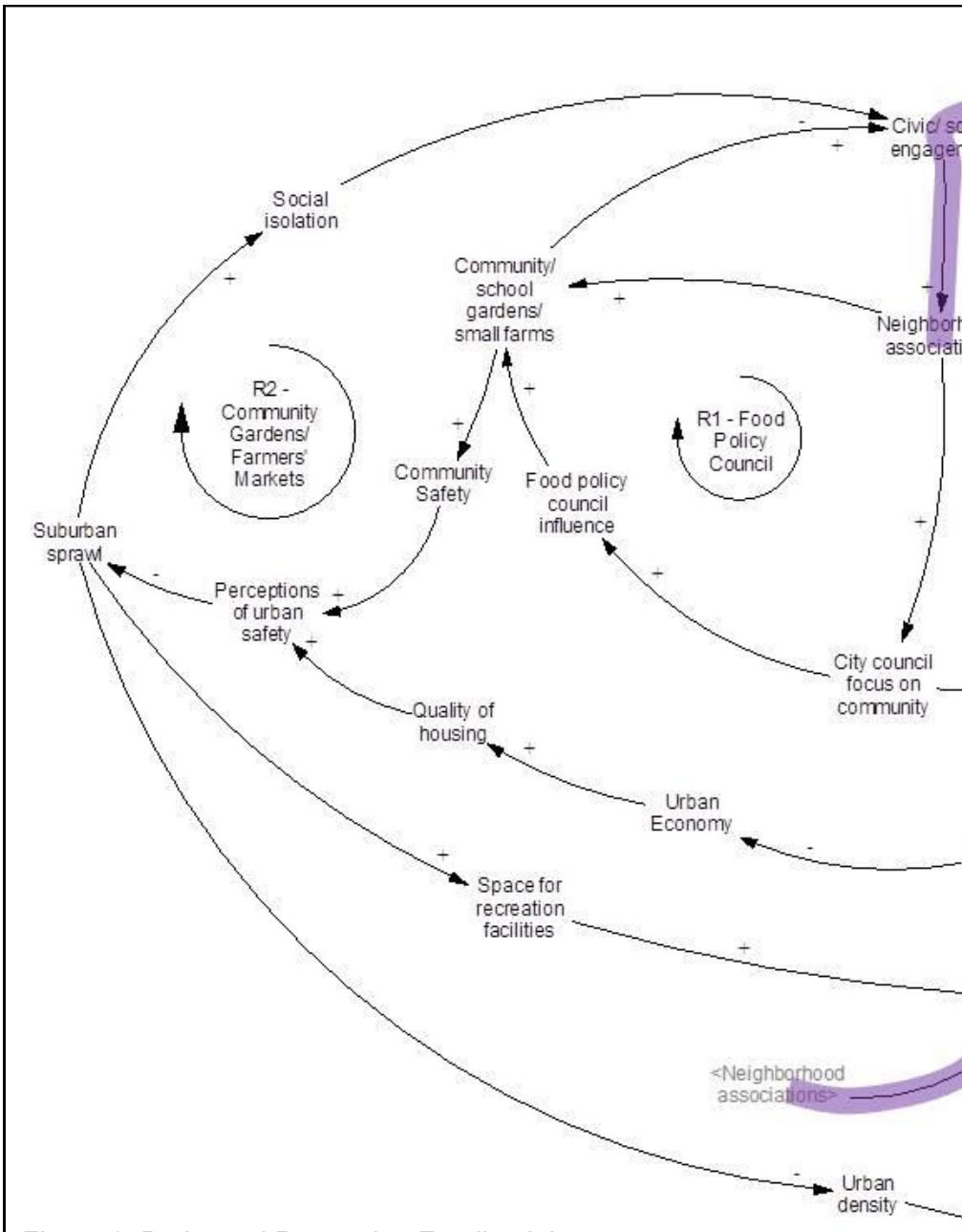


Figure 6: Parks and Recreation Feedback Loop

Story B: Alternatively, residents who don't have access to recreation facilities may get less physical activity and experience increased risk for poor health. Illness and disability may prevent residents from walking and biking in the community, minimizing their opportunities for social or civic engagement. Without these interactions, residents may be less likely to organize through neighborhood associations to work toward increased access to public recreation facilities.

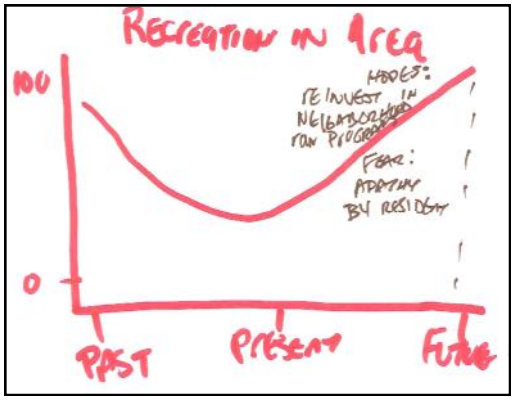
Reinforcing Loop and Notation

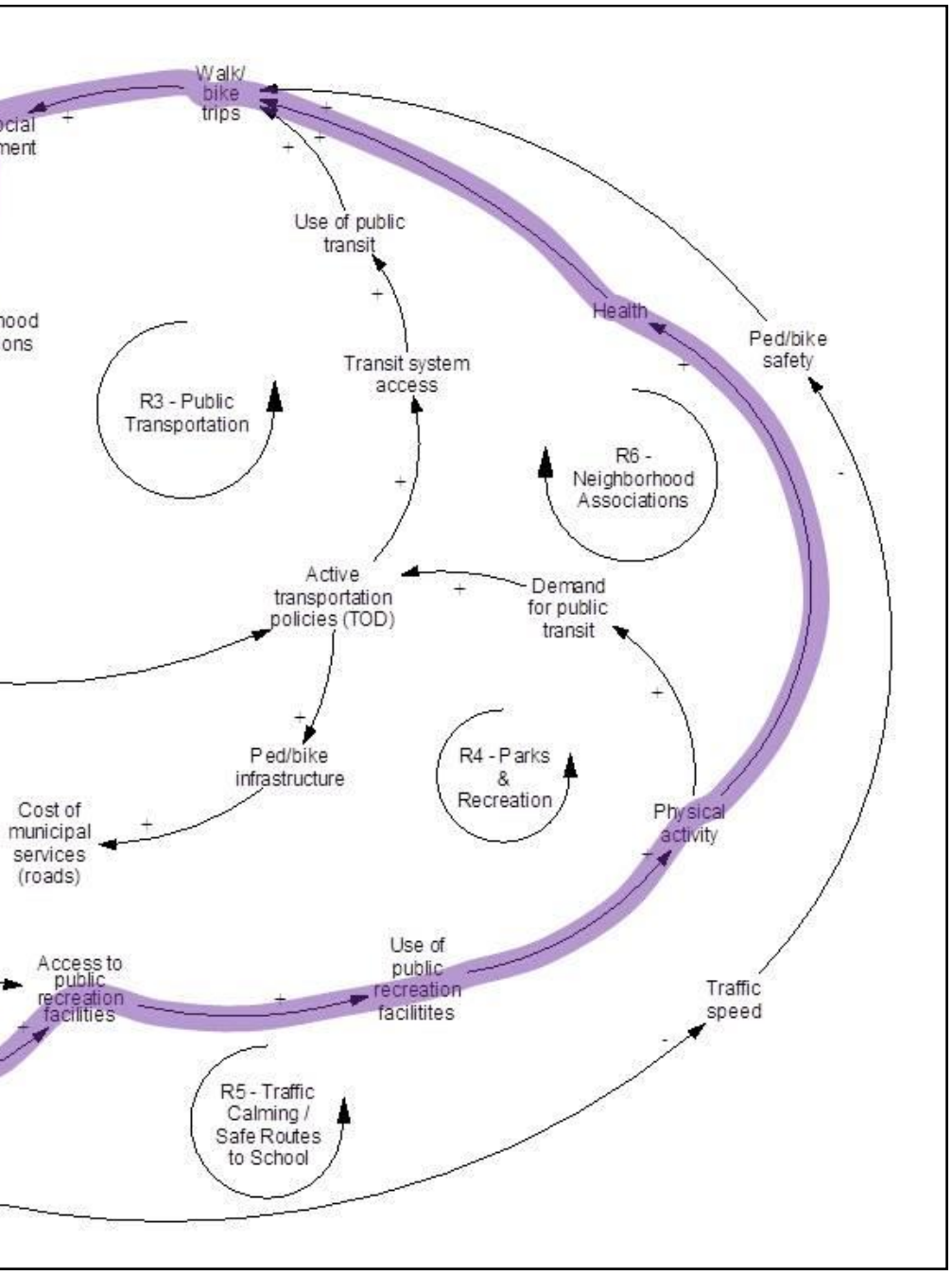
Given that this loop has all "+" signs, or polarities, on the arrows, it represents another reinforcing feedback loop. Yet, this loop, unlike the previous loops, is disconnected. Because this loop crosses over several of the other loops, it uses a shadow variable to keep the image from getting too messy with lots of overlapping loops. The shadow variable for neighborhood associations is presented in gray text with brackets on either side to show that it "shadows," or duplicates, the original neighborhood associations variable. This loop also reflects causal relationships with more immediate effects (e.g., access to recreation facilities increases use of recreation facilities), and more delayed effects (e.g., neighborhood associations influence on increased access to recreation facilities).

System Insights for *Unite 4 Healthy Neighborhoods*

During the behavior over time graphs exercise, participants identified that recreation has been declining

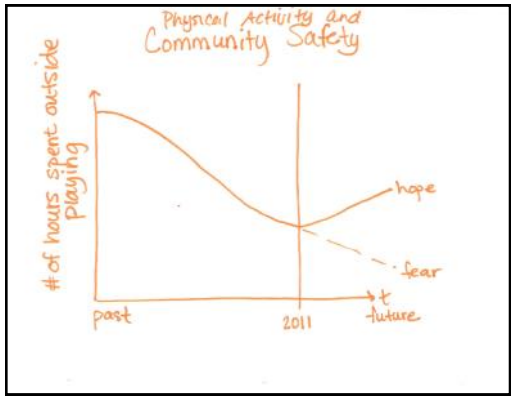
steadily, with the hope that it will increase once again (see illustration on recreation in area). Another participant attributed the declining number of hours playing outside to community safety as well (see illustration on physical activity and community safety). At the same time, the use of the recreation center by underserved families has been increasing (see illustration on ARC usage for underserved populations). While the recreation center may not help to address the hours of outside play, it appears to increase recreation in underserved families.





System insights for the partnership's parks and recreation efforts include:

- Designating places for public recreation is a high priority in Columbia, including indoor and outdoor facilities.
- Addressing community safety is necessary step to support use of outdoor recreation facilities.
- By focusing on public recreation facilities, neighborhood associations can increase the health of their members and beautify their neighborhoods.



Some key questions for assessment and evaluation are also suggested, for example:

- What are the optimal numbers and types of public recreation facilities for a neighborhood or urban area?
- What facilities are used by what groups in the community (e.g., children, adolescents, people in poverty)?
- How does community safety influence the use of public recreation facilities?

Traffic Calming/ Safe Routes to School Feedback Loop

The loop highlighted in red in Figure 7 represents two of the *Unite 4 Healthy Neighborhoods* strategies that go hand-in-hand to increase active living in Columbia, Missouri, traffic calming and safe routes to school.

Causal Story for Feedback Loop

Story A: Lower traffic speeds increase safety for pedestrians and bicyclists who are sharing the streets with cars and other motorized vehicles. With greater safety, more residents can walk or bike to destinations in the community (e.g., work, school, entertainment). As noted previously, the increases in walking and biking lead to more opportunities for social or civic interactions and engagement that may increase participation in neighborhood associations. Through efforts such as community and school gardens, neighborhood associations can help to increase community safety that may keep people in their current residences and reduce suburban sprawl. Thus, urban density increases or remains higher, and with a higher concentration of people, residences, and destinations, there is a need for lower traffic speeds to prevent injuries.

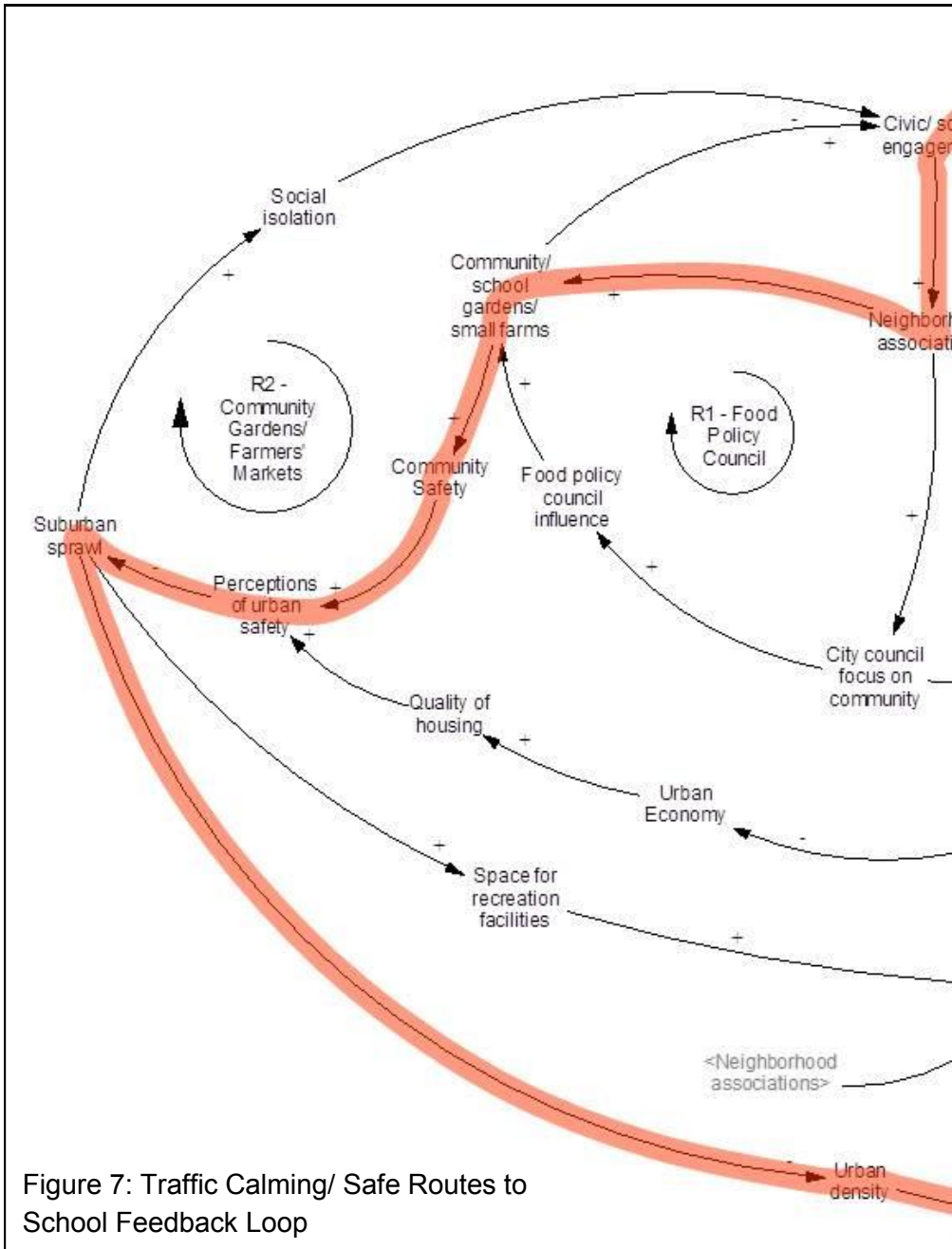


Figure 7: Traffic Calming/ Safe Routes to School Feedback Loop

Story B: On the other hand, higher traffic speeds are often found on the main roads connecting suburban neighborhoods and these driving behaviors reduce pedestrian and bike safety along these roads, making walking and biking trips difficult. Therefore, neighbors have fewer opportunities to interact and organize neighborhood associations that can work toward community safety and residents may be inclined to move even further from the urban center, and consequently reducing density.

Reinforcing Loop and Notation

Even though this loop has four "-" signs or polarities, it is still an even number that represents a reinforcing loop. Both shorter-term causal relationships (e.g., greater pedestrian and bike safety increases walking and biking trips) and delayed effects (e.g., declining suburban sprawl increases urban density) are displayed in this loop.

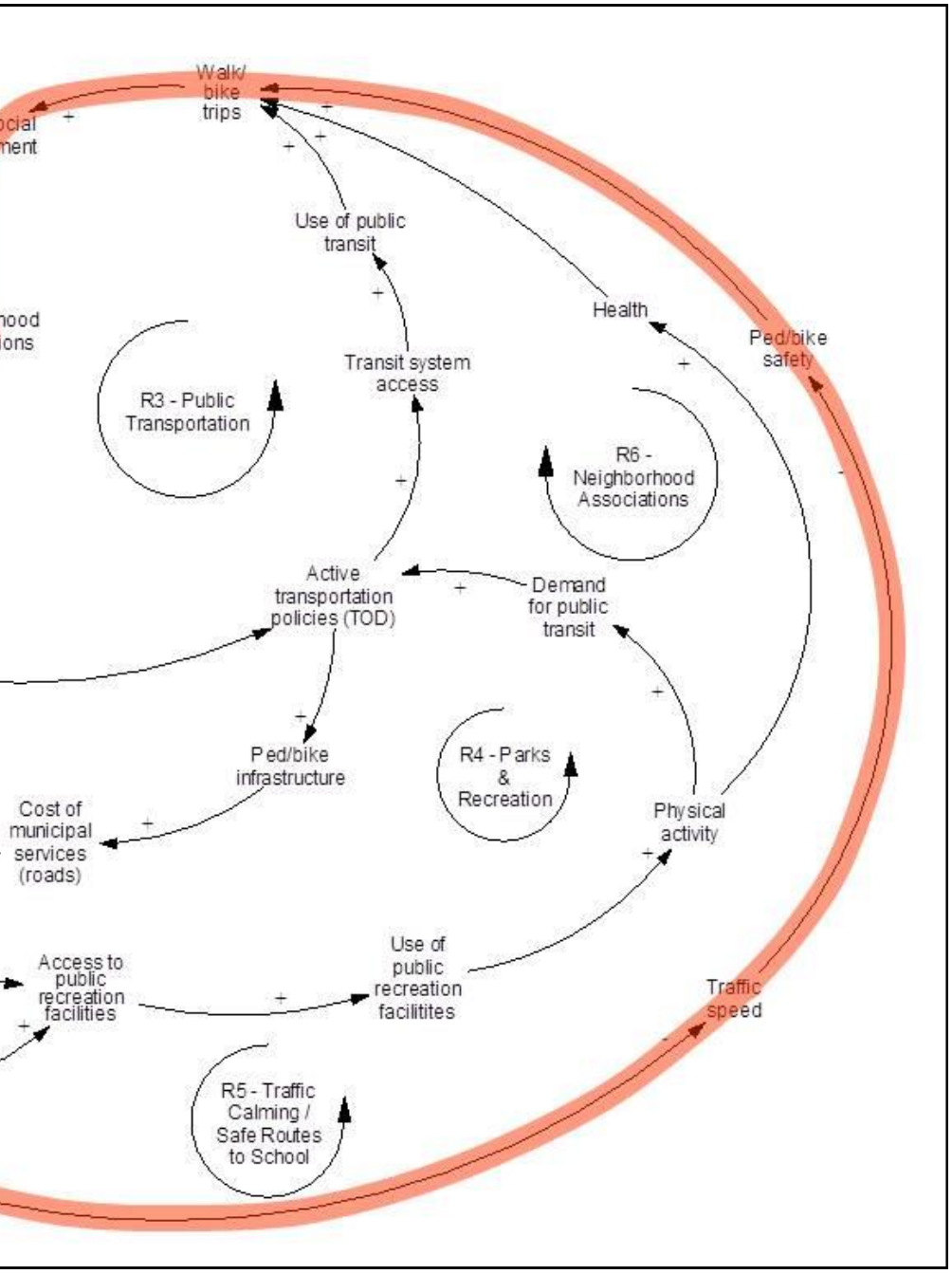
System Insights for *Unite 4 Healthy Neighborhoods*

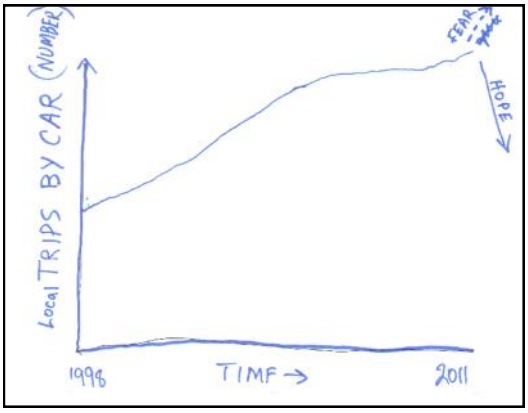
Participants in the behavior over time graphs exercise identified a high and relatively steady increase in local trips made car (see illustration on local trips by car). In contrast, participants agreed that the number of children walking to school has declined at a rapid pace until these trips nearly disappeared; however, most recently, there has been an increasing trend in trips on foot (see illustration on number of kids walking to

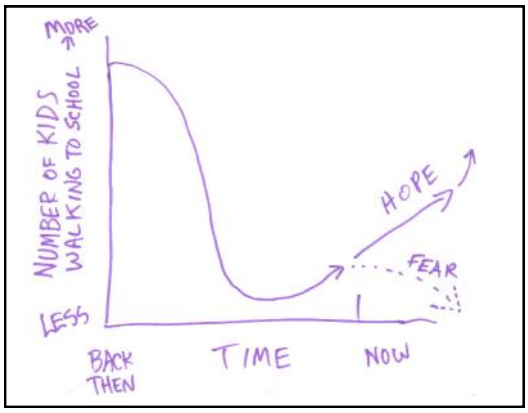
school). With respect to children biking to school, the trend appears to be fairly stable, with a very low percentage of students biking to school; yet, similar to walking, these trips are recently starting to increase (see illustration on kids biking to Smithton school).

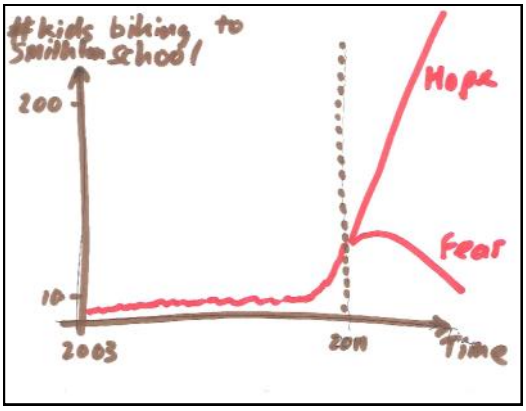
System insights for the partnership's traffic calming and safe routes to school efforts include:

- Recent efforts to increase walking and biking to school appear to influence a small, but growing number of students in schools. Yet, nearly all local trips are made by car.









- Students may gain social benefits from interacting with other students, parents, school staff, or neighbors while walking and biking to school.
- Increasing perceptions of urban safety may play a major role in maintaining urban density and increasing active transportation.

Some key questions for assessment and evaluation are also suggested, for example:

- What types of trips are made by car, bike, and foot in Columbia?
- What streets have accommodations for pedestrians, bicyclists, and drivers? Are they safe for all users?
- What is the rate of sprawl in Columbia (i.e., how many residents are moving from urban neighborhoods to suburban neighborhoods)?

Neighborhood Associations Feedback Loop

Neighborhood associations have appeared in every loop examined thus far, so this variable plays a key role in Columbia's theory of change as a whole (see Figures 1 and 2). One additional loop, highlighted in dark blue in Figure 8, represents another one of the *Unite 4 Healthy Neighborhoods* approaches to improve community health through neighborhood associations.

Causal Story for Feedback Loop

Story A: With more neighborhood associations and greater participation in these organizations, the communities — with collective voices — can have greater influence on city council and associated policy decisions. For instance, active transportation policies can increase pedestrian and bicycle infrastructure in Columbia. Build out of this infrastructure increases municipal service costs and detracts from local revenue available for other services, capital improvements, or resources. If the urban economy is spread too thin, the quality of services and resources, such as public housing, typically show a corresponding decline. Public housing that is not well-maintained can lead to less perceived safety and residents moving to other neighborhoods. Living in suburban communities may lead to greater social isolation (i.e., less interaction among neighbors) and less civic or social engagement. As a result, residents may be less likely to form or participate in neighborhood associations.

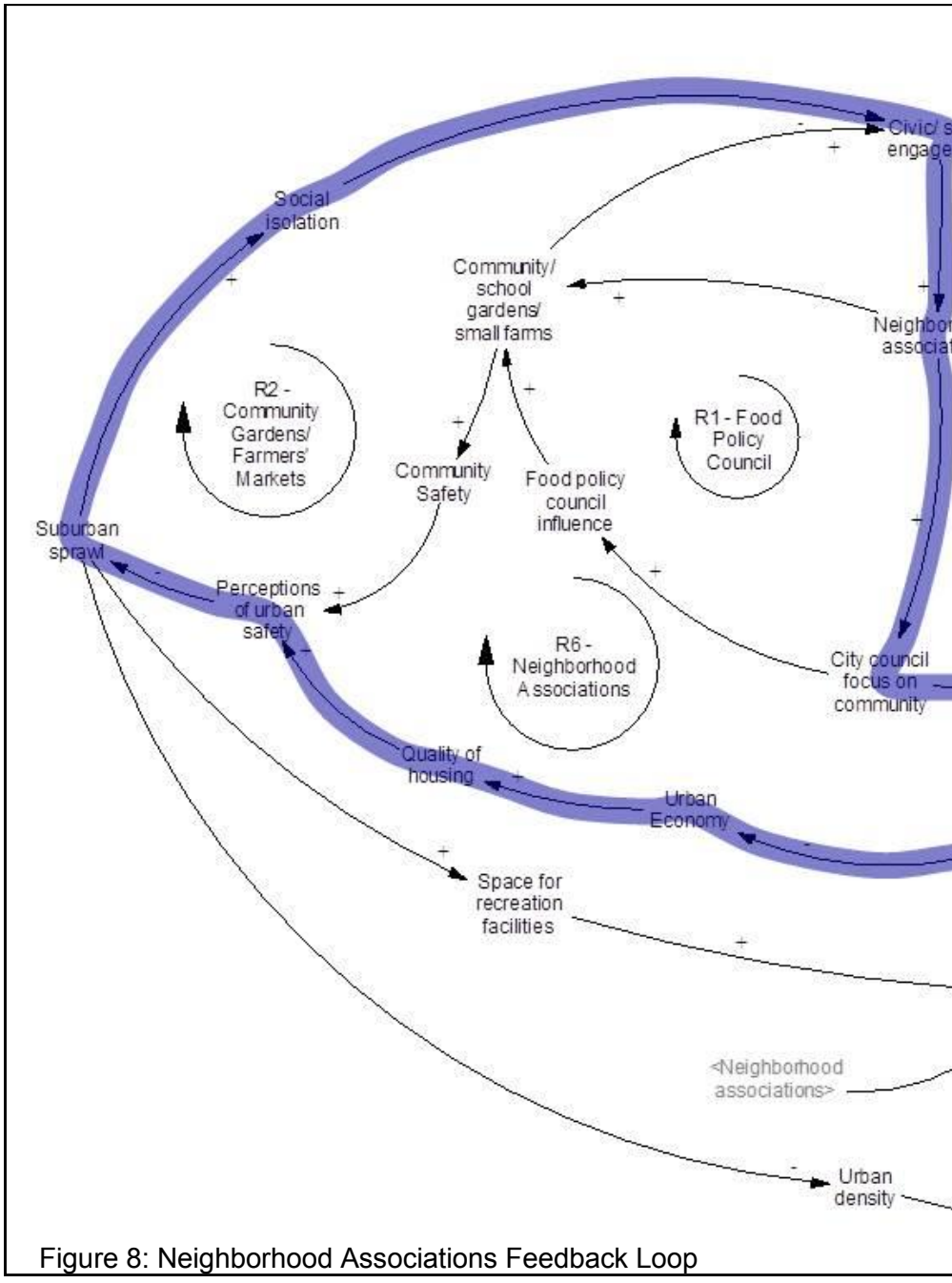


Figure 8: Neighborhood Associations Feedback Loop

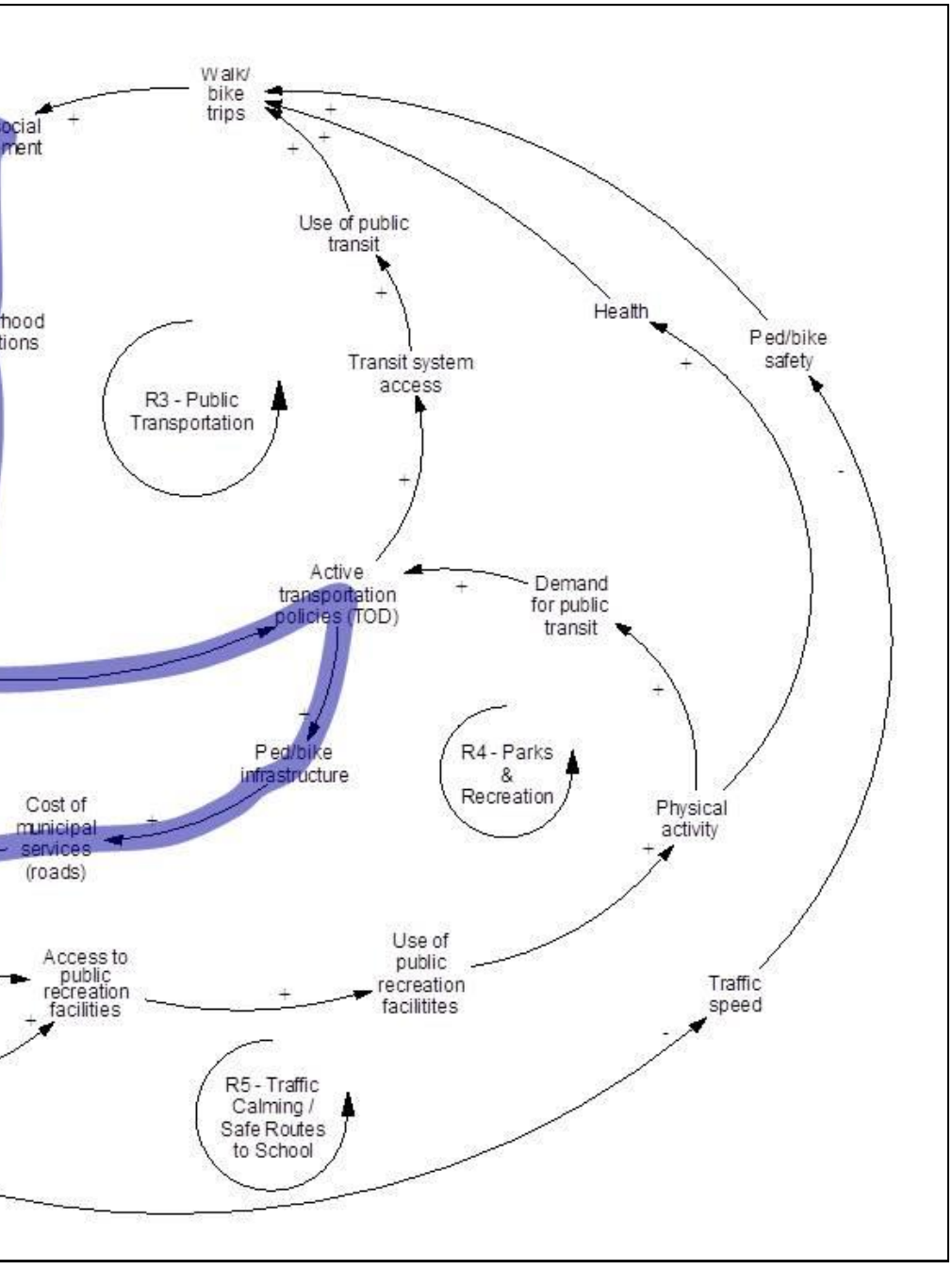
Story B: Without neighborhood associations, residents may have less of a united voice and influence on city council and polices supporting active transportation. With less infrastructure under construction, there are fewer costs and less demand on the local economy, leaving more resources for public housing. Better public housing increase the likelihood of residents leaving the neighborhood, reducing social isolation in the suburbs and maintaining or increasing resident engagement locally, with neighborhood associations as one vehicle for these interactions.

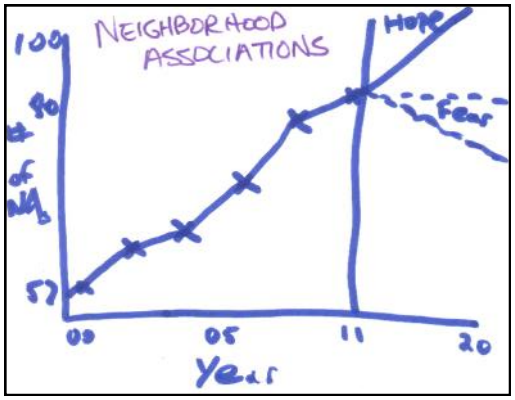
Balancing Loop and Notation

Unlike the previous loops, this one has three "-" signs or polarities on the arrows, suggesting it is a balancing loop. As indicated by the name, balancing loops tend to create more of a stable trend over time, as opposed to one that is continually increasing or decreasing. Some of the causal relationships have more immediate effects (e.g., resident social or civic engagements leading to participation in neighborhood association) and others have more delayed effects (e.g., the influence of the economy on the quality of public housing).

Story A provides a good illustration of the reason why it is not advantageous to separate the feedback loops

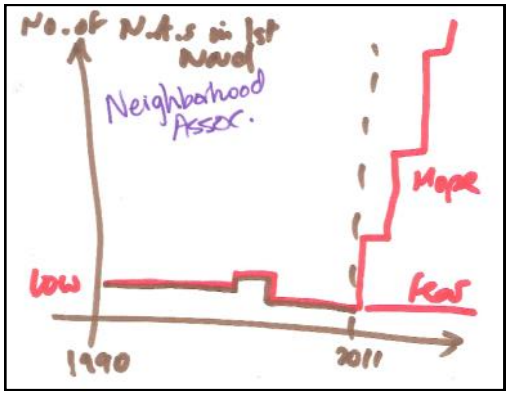
from the causal loop diagram. For instance, while the cost of building pedestrian and bike infrastructure may require a city budget allocation, it typically costs much less than new road construction or road maintenance. In this case, examining this loop without the context of the other variables and loops may lead to inappropriate conclusions.





System Insights for *Unite 4 Healthy Neighborhoods*

In general, participants in the behavior over time graphs exercise reported a steady increase in neighborhood associations in Columbia (see illustration on neighborhood associations). However, in the First Ward, the number has remained very low with a little increase more recently that appeared to fall off again (see illustration on number of neighborhood associations in First Ward).



System insights for the partnership's neighborhood association are plentiful, including:

- Neighborhood associations may be more difficult to organize in lower-income urban neighborhoods.
- Neighborhood associations may also be more difficult to form and sustain in sprawling suburban communities.

"I grew up involved in neighborhoods all my life. It was just our way of life. And, I grew up in the inner city. My mom was always involved with the neighbors. We always had neighbors at barbeques. We always talked about everything in the neighborhood. I got corrected by neighborhood parents. And, it dropped substantially as I got older. But, it wasn't just parents involved in neighborhoods; it was families involved in neighborhoods. I would like even though it's dropped dramatically, I would like to see a revival in the efforts of neighborhood associations and I would like to think that right now we're on the up. We're coming up." **(Participant)**

Opportunities for Systems Thinking in Columbia, Missouri

This storybook provided an introduction to some basic concepts and methods for systems thinking at the community level, including: causal loop diagrams, variables and shadow variables, causal relationships and polarities, reinforcing feedback loops, and balancing feedback loops, among others. For the *Unite 4 Healthy Neighborhoods* partners, this storybook also summarized the healthy eating, active living, partnership and community capacity, social determinants, and health and health behaviors subsystems in the Columbia causal loop diagram as well as six specific feedback loops corresponding to the partnership's primary strategies.

This causal loop diagram reflects a series of conversations among partners and residents from 2011 to 2013. Some discussions probed more deeply into different variables through the behavior over time graphs exercise, or causal relationships through the causal loop diagram exercise. Partners even conducted a survey to further examine some of the variables and relationships in the causal loop diagram.

This represented a first attempt to collectively examine the range of things that affect or are affected by policy, system, and environmental changes in Columbia, Missouri to promote healthy eating and active living as well as preventing childhood overweight and obesity.

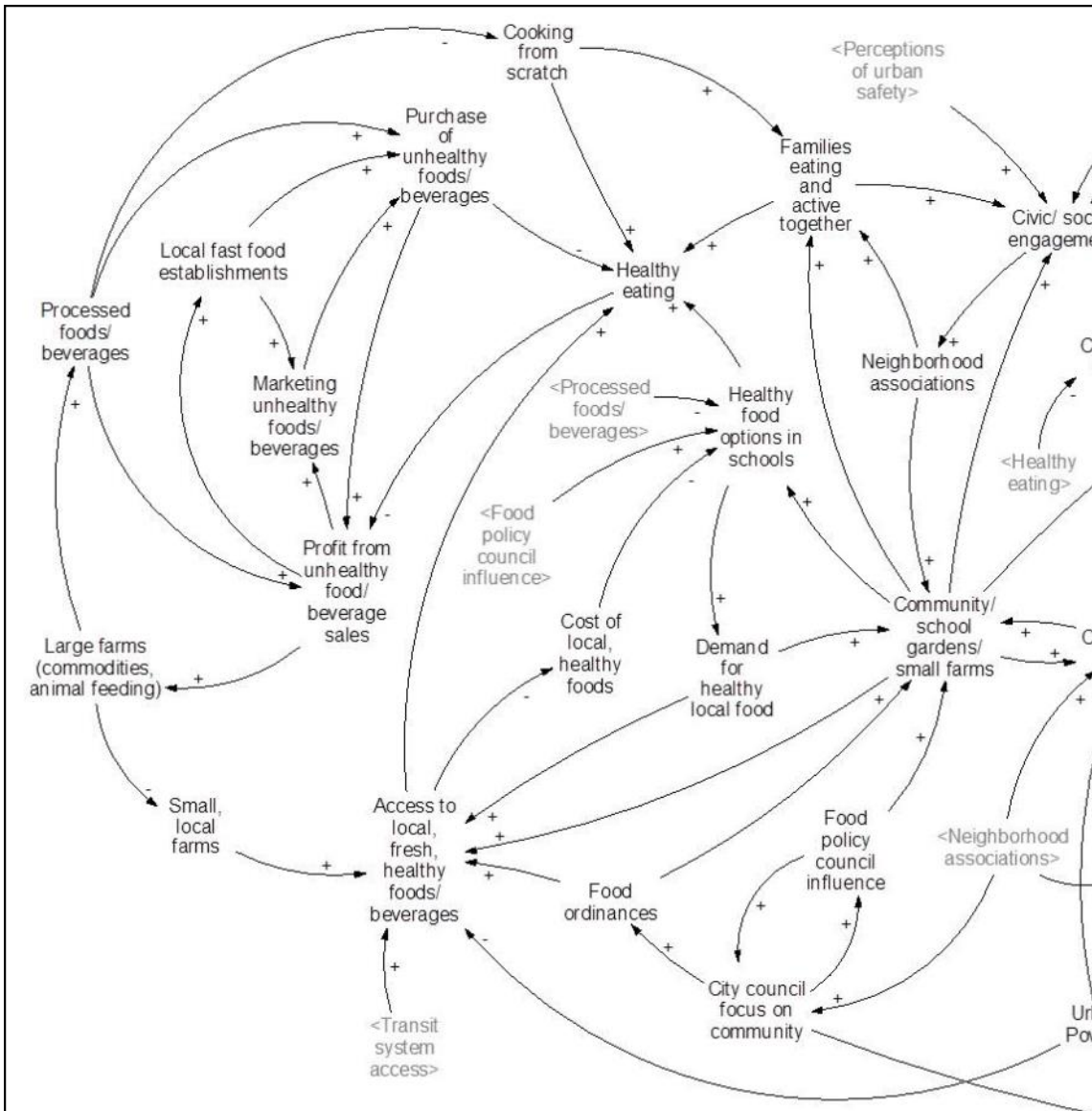


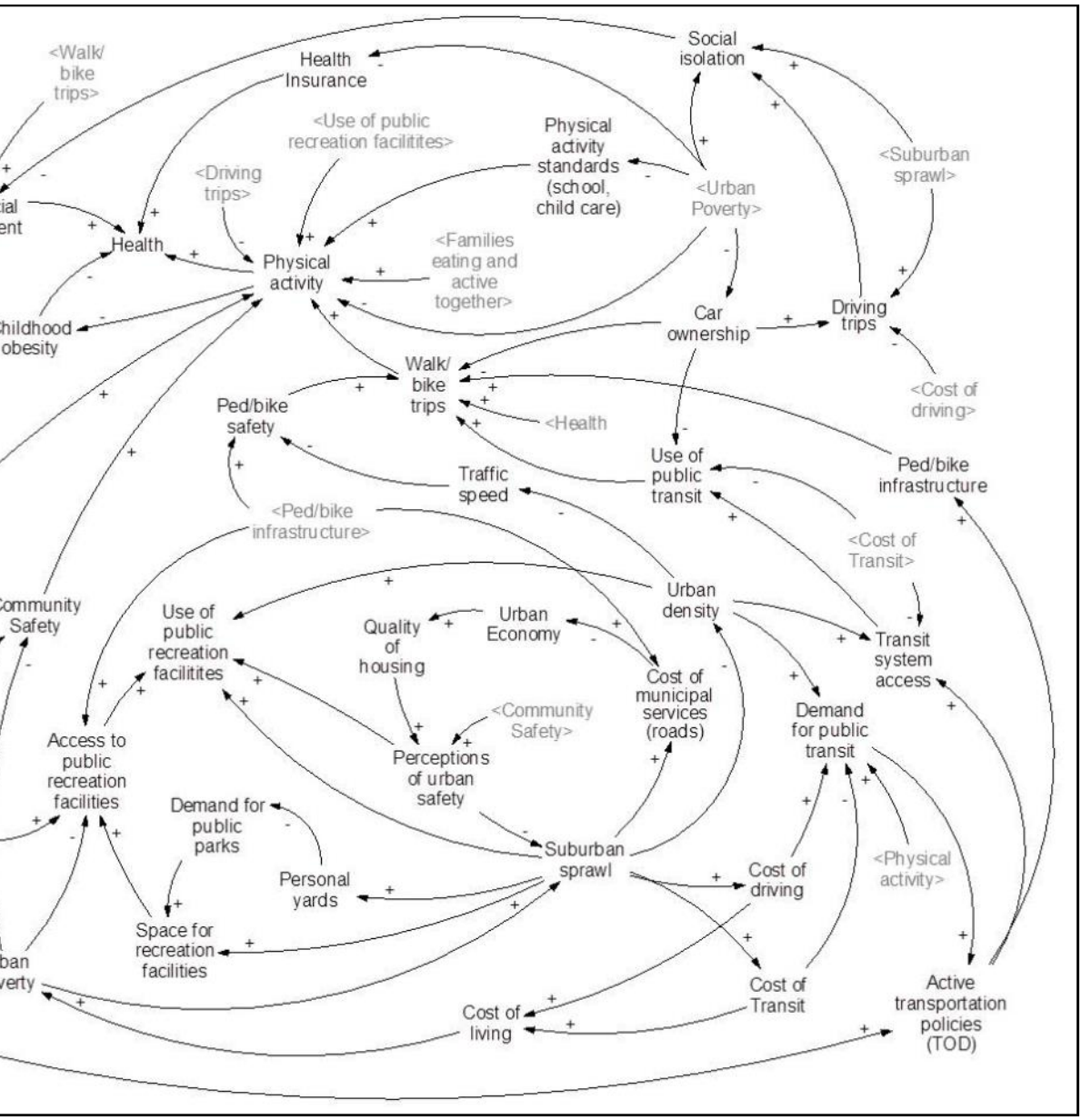
Figure 9: *Unite 4 Healthy Neighborhoods* Causal Loop Diagram

Yet, there are several limitations to this storybook, including:

- the participants represent a sample of the *Unite 4 Healthy Neighborhoods* partners (organizations and residents) as opposed to a representative snapshot of government agencies, community organizations, businesses, and community residents;
- the behavior over time graphs and the causal loop diagram represent perceptions of the participants in these exercises (similar to a survey or an interview representing perceptions of the respondents);
- the exercises and associated dialogue took place in brief one- to two-hour sessions, compromising the group's capacity to spend too much time on any one variable, relationship, or feedback loop; and
- the responses represent a moment in time so the underlying structure of the diagram and the types of feedback represented may reflect "hot button" issues of the time.

Much work is yet to be done to ensure that this causal loop diagram is accurate and comprehensive, for example:

- having conversations to discuss existing feedback loops to ensure that the appropriate variables and relationships are represented accurately;
- reviewing the behavior over time graphs (see also Appendix F) to confirm that the trends reflect common perceptions among residents and compare these trends to actual data;
- revisiting variables removed because they were not part of feedback loops, including faith-based organizations, youth advocacy, busy lifestyle, technology, affluence, gas prices, globalization of food production, and government subsidies; and
- starting new conversations about other variables (behavior over time graphs exercise) or relationships (causal loop diagram exercise) to add to this diagram.



In addition, different subgroups in Columbia may use this causal loop diagram to delve in deeper into some of the subsectors (e.g., healthy eating, active living) or feedback loops, creating new, more focused causal loop diagrams with more specific variables and causal relationships.

Use of more advanced systems science methods and analytic approaches to create computer simulation models is another way to take this early work to the next level. The references section includes citations for resources on these methods and analytic approaches, and it is necessary to engage professional systems scientists in these activities.

Please refer to the Appendices for more information, including:

- Appendix A: Behavior over time graphs generated during site visit
- Appendix B: Photograph of the original version of the *Unite 4 Healthy Neighborhoods* Causal Loop Diagram
- Appendix C: Original translation of the causal loop diagram into Vensim PLE
- Appendix D: Revised causal loop diagram in Vensim PLE based on survey feedback from partners
- Appendix E: Transcript translation of the causal loop diagram into Vensim PLE
- Appendix F: Behavior over time graphs not represented in the storybook

References for Systems Thinking in Communities:

Group model building handbook:
Hovmand, P., Brennan L., & Kemner, A. (2013). Healthy Kids, Healthy Communities Group Model Building Facilitation Handbook. Retrieved from http://www.transtria.com/hkhc.

Vensim PLE software for causal loop diagram creation and modification:
Ventana Systems. (2010). Vensim Personal Learning Edition (Version 5.11A) [Software]. Available from http://vensim.com/vensim-personal-learning-edition/

System dynamics modeling resources and support:
Andersen, D. F. and G. P. Richardson (1997). "Scripts for group model building." System Dynamics Review 13(2): 107-129.

Hovmand, P. (2013). Community Based System Dynamics. New York, NY: Springer.

Hovmand, P. S., et al. (2012). "Group model building "scripts" as a collaborative tool." Systems Research and Behavioral Science 29: 179-193.

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Meadows, D. (1999). Leverage points: places to intervene in a system. Retrieved from http://www.donellameadows.org/archives/leverage-points-places-to-intervene-in-a-system/

Richardson, G. P. (2011). "Reflections on the foundations of system dynamics." System Dynamics Review 27 (3): 219-243.

Rouwette, E., et al. (2006). "Group model building effectiveness: A review of assessment studies." System Dynamics Review 18(1): 5-45.

Sterman, J. D. (2000). Business dynamics: Systems thinking and modeling for a complex world. New York, NY: Irwin McGraw-Hill.

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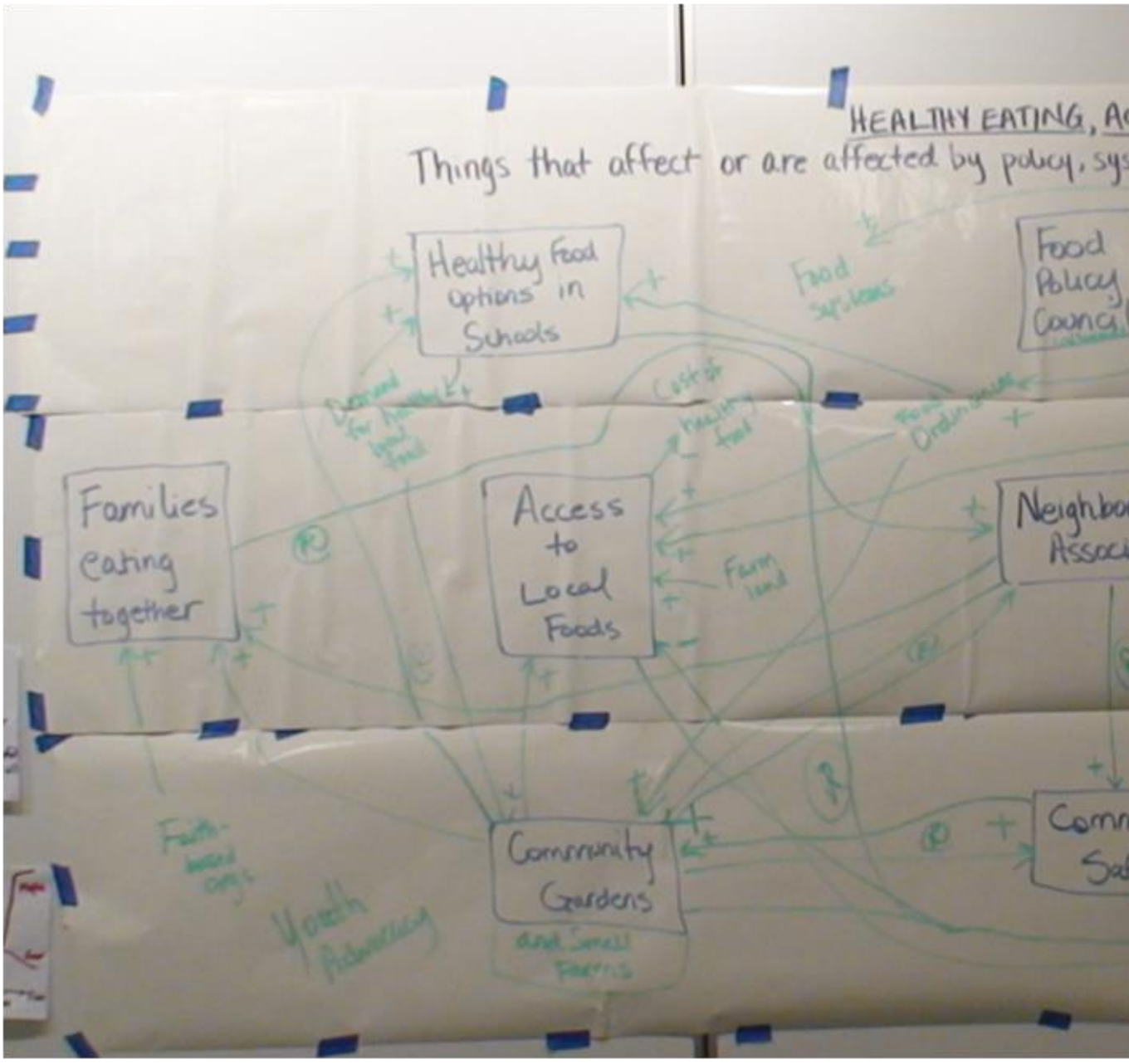
Vennix, J. (1996). Group model building. New York, John Wiley & Sons.

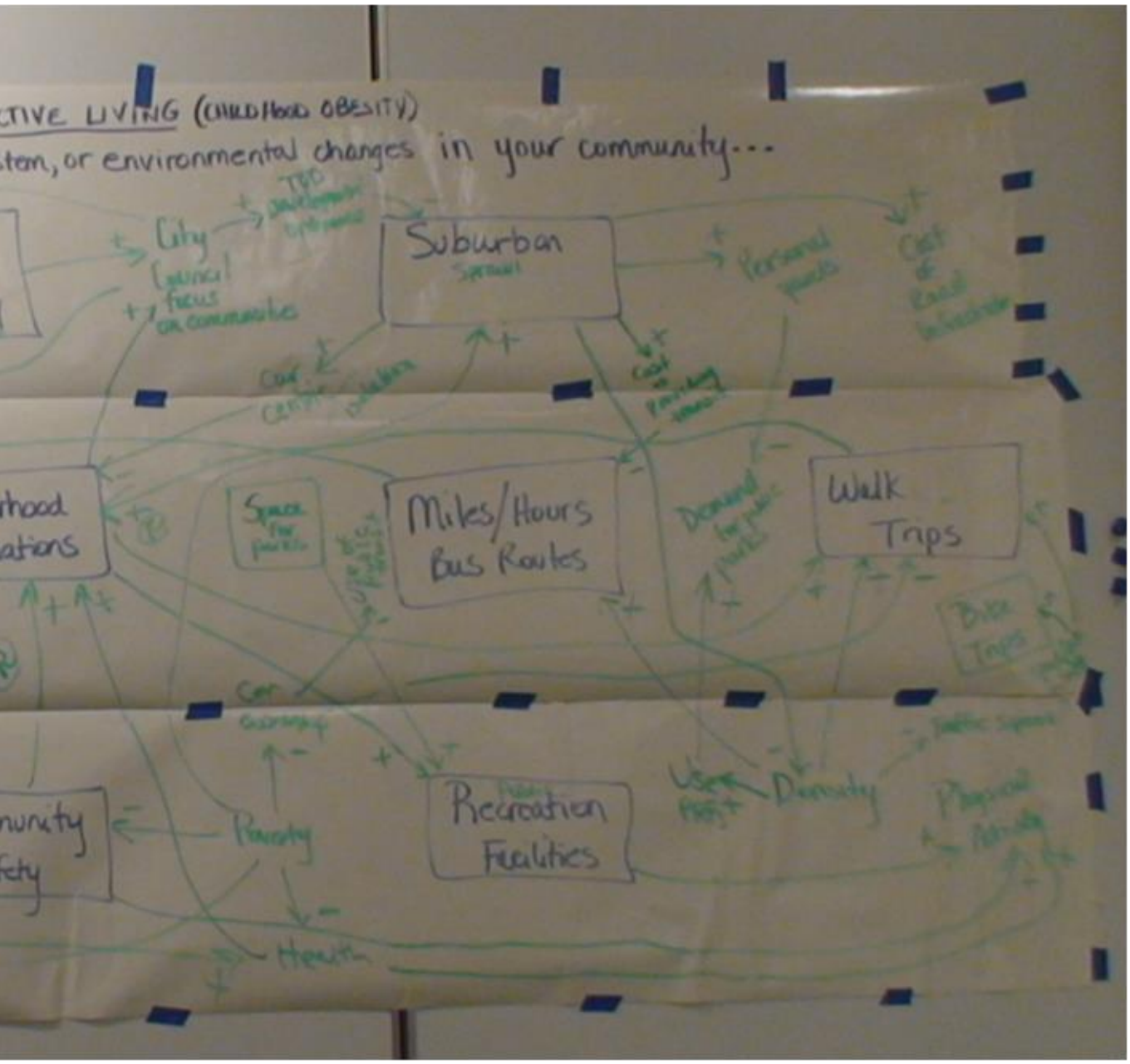
Zagonel, A. and J. Rohrbaugh (2008). Using group model building to inform public policy making and implementation. Complex Decision Making. H. Qudart-Ullah, J. M. Spector and P. I. Davidsen, Springer-Verlag: 113-138.

Appendix A: Behavior Over Time Graphs Generated during Site Visit

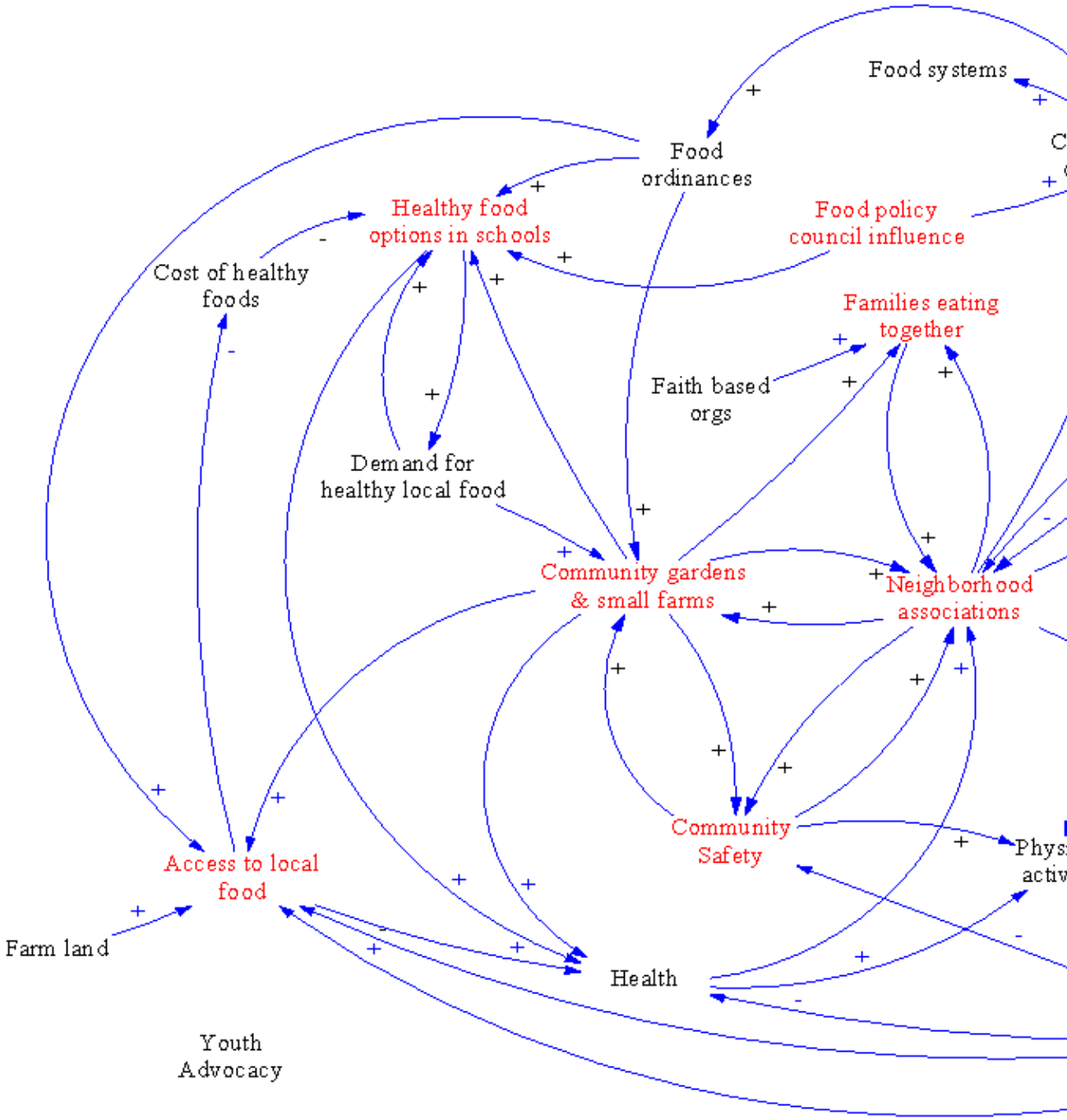
Columbia, Missouri: *Unite 4 Healthy Neighborhoods*	
Categories	**Number of Graphs**
Active Living Behavior	15
Active Living Environments	6
Funding	0
Healthy Eating Behavior	5
Healthy Eating Environments	13
Marketing and Media Coverage	1
Obesity and Long Term Outcomes	0
Partnership & Community Capacity	5
Policies	2
Programs & Promotions (Education and Awareness)	4
Social Determinants of Health	6
Insufficient data for coding	1
Total Graphs	**58**

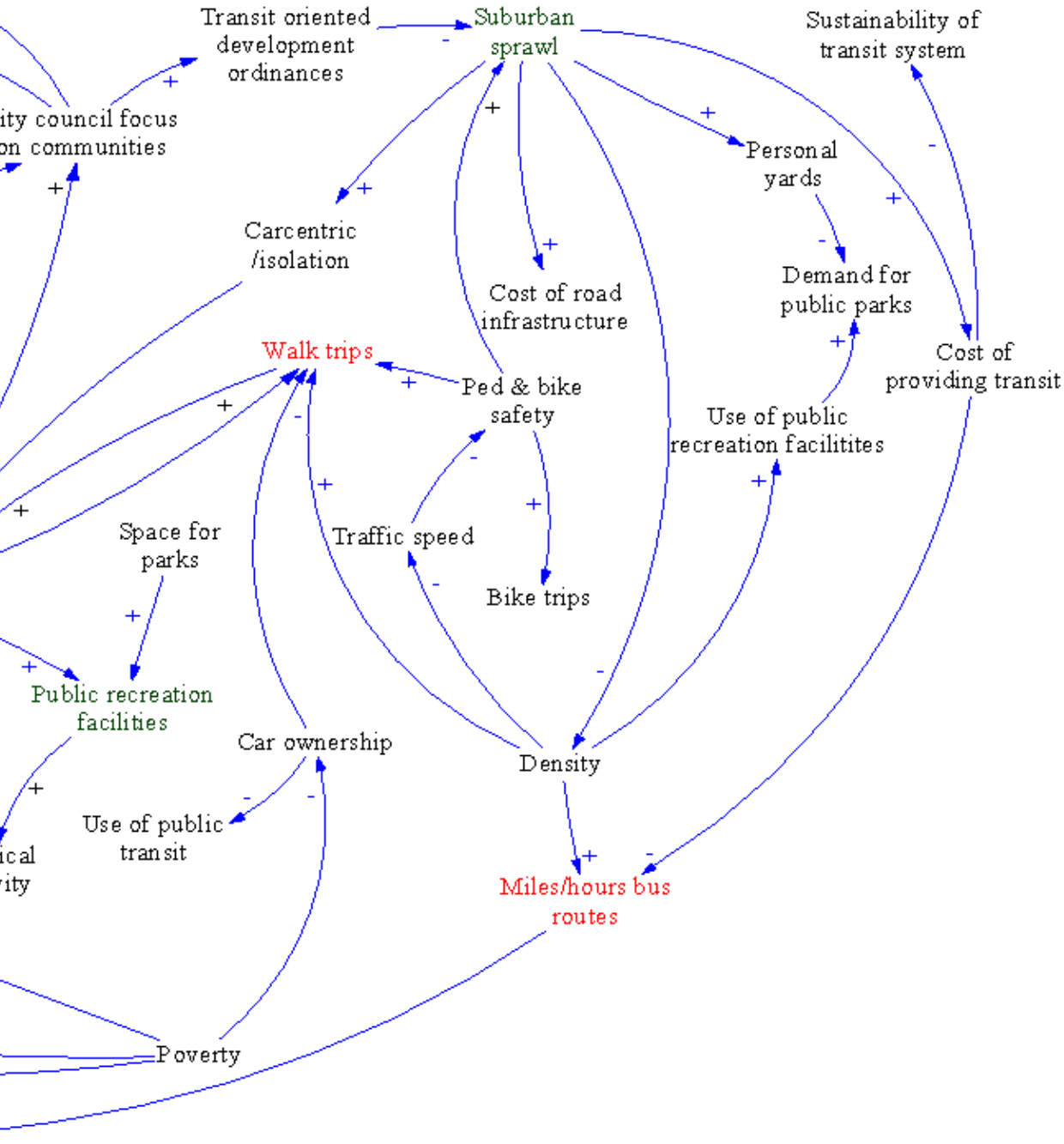
Appendix B: Photograph of the Original Version of the *Unite 4 Healthy Neighborhoods* Causal Loop Diagram



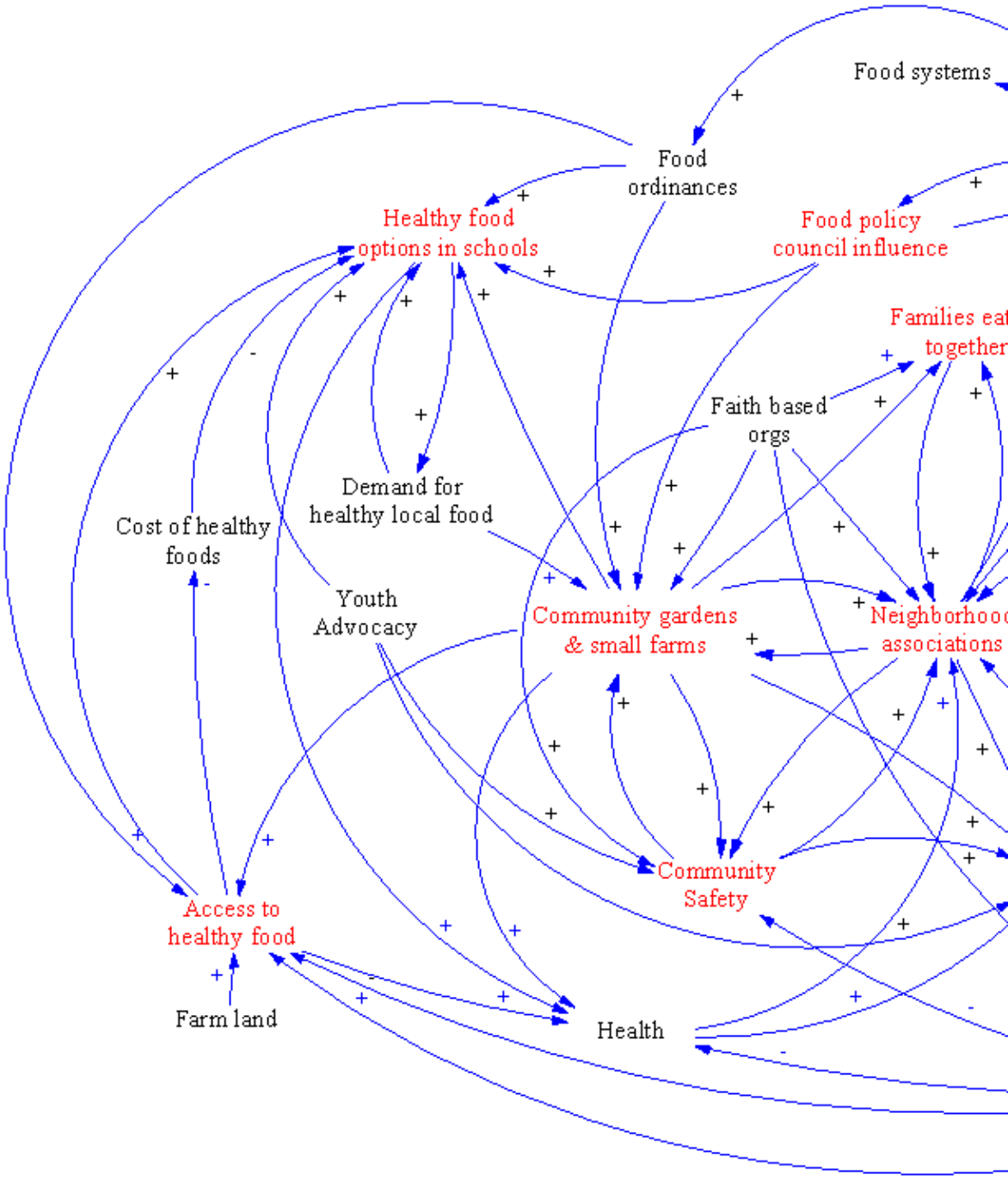

CTIVE LIVING (CHILDHOOD OBESITY)
tem, or environmental changes in your community...
City
Suburban
Personal
Miles/Hours
Bus Routes
Walk
Trips
Space
Recreation
Facilities
Density
Poverty
Health

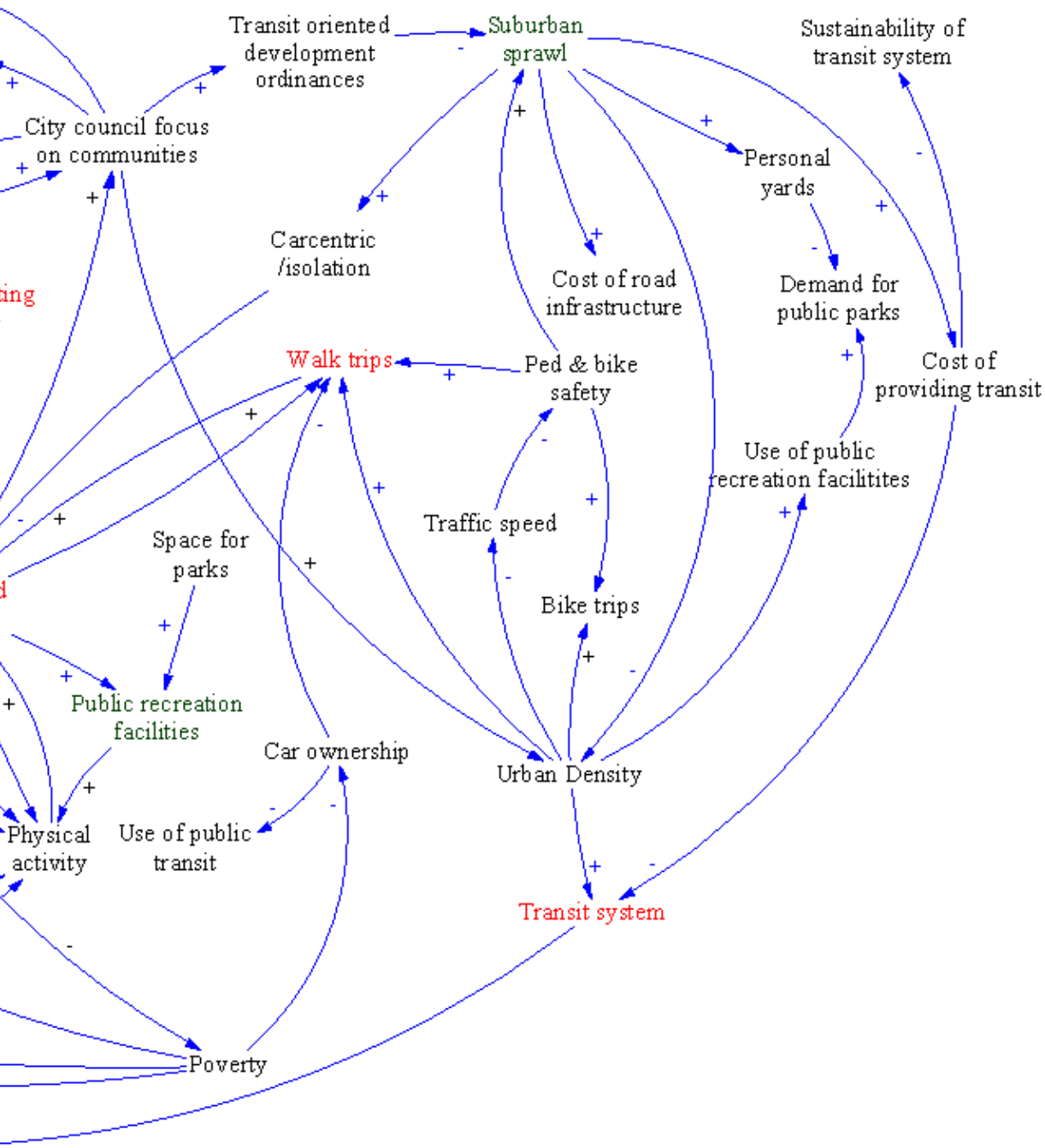
Appendix C: Original Translation of the Causal Loop Diagram into Vensim PLE



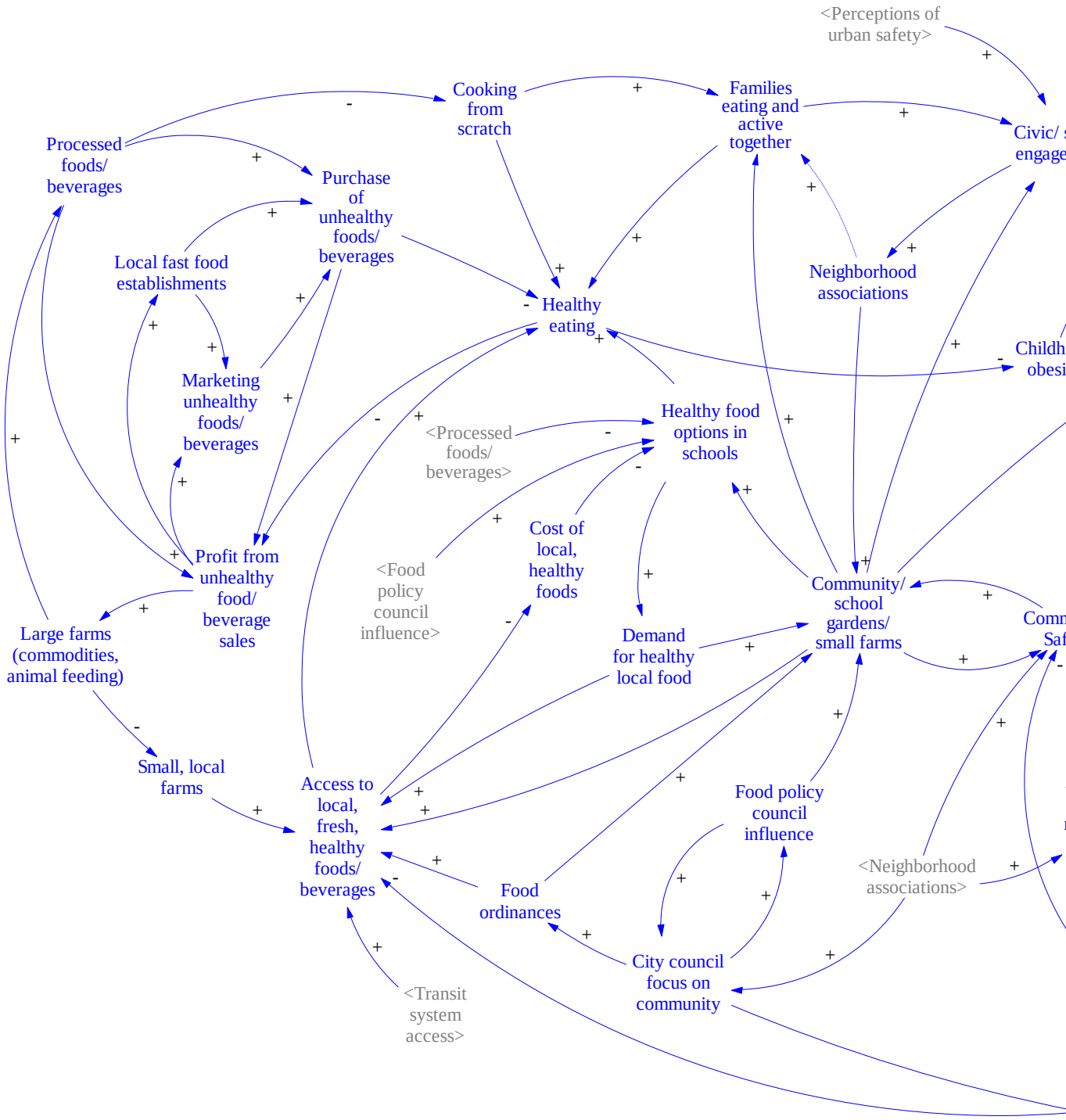

Transit oriented development ordinances
Suburban sprawl
Sustainability of transit system
ity council focus on communities
Personal yards
Carcentric /isolation
Cost of road infrastructure
Demand for public parks
Walk trips
Ped & bike safety
Cost of providing transit
Use of public recreation facilitites
Space for parks
Traffic speed
Bike trips
Public recreation facilities
Car ownership
Density
Use of public transit
ical
ity
Miles/hours bus routes
Poverty

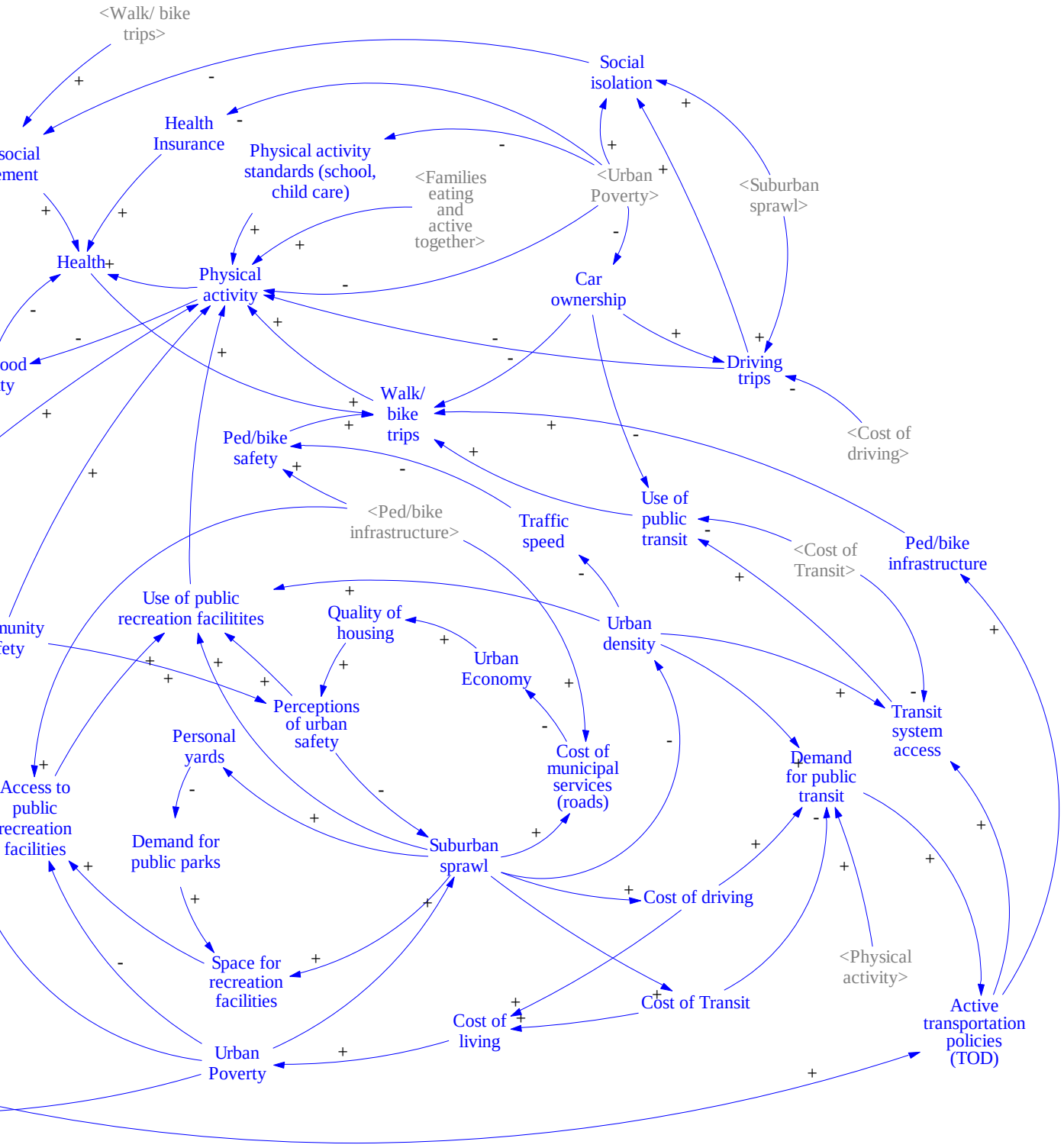
Appendix D: Revised Causal Loop Diagram in Vensim PLE Based on Survey Feedback from Partners



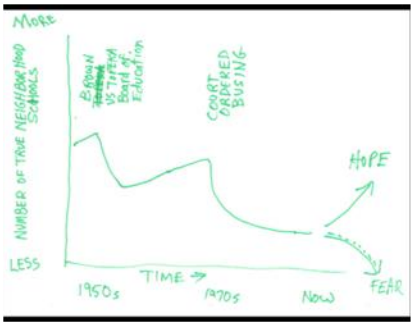

Transit oriented development ordinances
Suburban sprawl
Sustainability of transit system
City council focus on communities
Personal yards
Carcentric /isolation
Cost of road infrastructure
Demand for public parks
Walk trips
Ped & bike safety
Cost of providing transit
Use of public recreation facilitites
Traffic speed
Space for parks
Bike trips
Public recreation facilities
Car ownership
Urban Density
Physical activity
Use of public transit
Transit system
Poverty

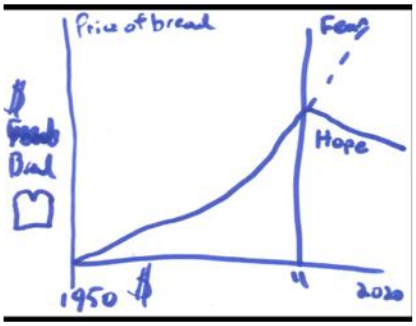
Appendix E: Transcript Translation of the Causal Loop Diagram into Vensim PLE

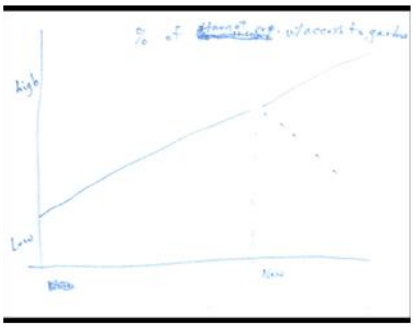


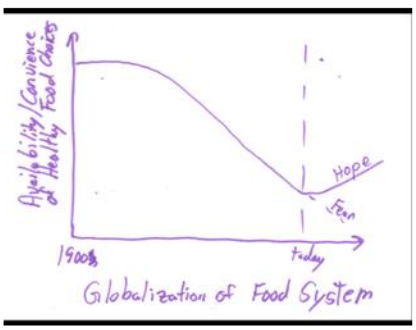

<Walk/ bike trips>
Social isolation
Health Insurance
Physical activity standards (school, child care)
<Families eating and active together>
<Urban Poverty>
<Suburban sprawl>
Health
Physical activity
Car ownership
Driving trips
Walk/ bike trips
Ped/bike safety
<Cost of driving>
<Ped/bike infrastructure>
Traffic speed
Use of public transit
Ped/bike infrastructure
<Cost of Transit>
Use of public recreation facilitites
Quality of housing
Urban density
Urban Economy
Perceptions of urban safety
Transit system access
Personal yards
Cost of municipal services (roads)
Demand for public transit
Access to public recreation facilities
Demand for public parks
Suburban sprawl
Cost of driving
Space for recreation facilities
<Physical activity>
Cost of Transit
Cost of living
Active transportation policies (TOD)
Urban Poverty

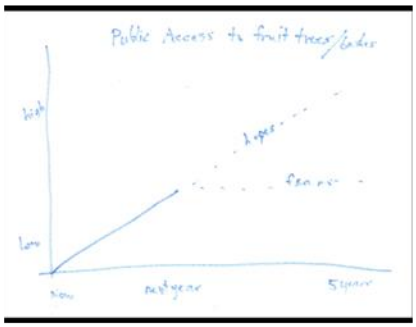
Appendix F: Behavior Over Time Graphs not Represented in the Storybook

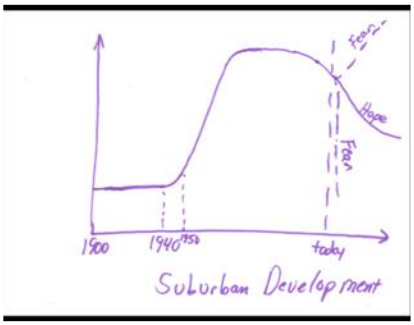


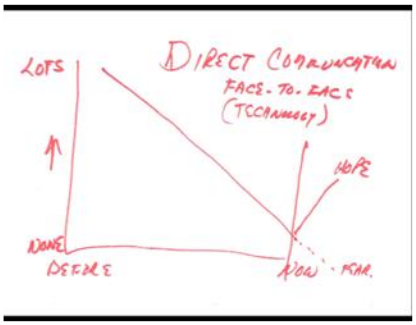


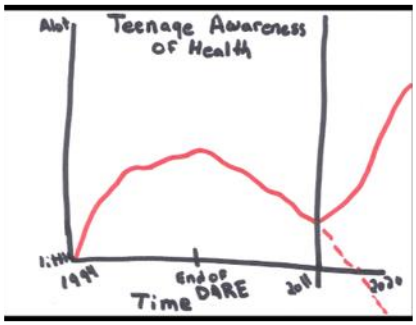


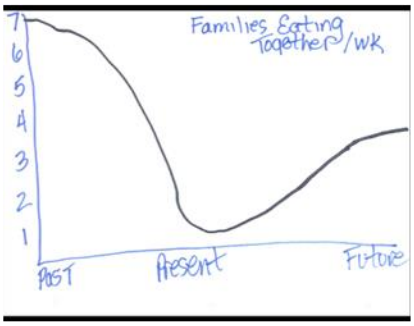


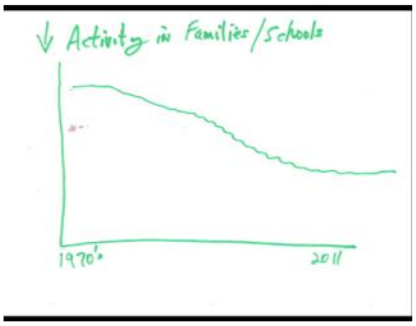


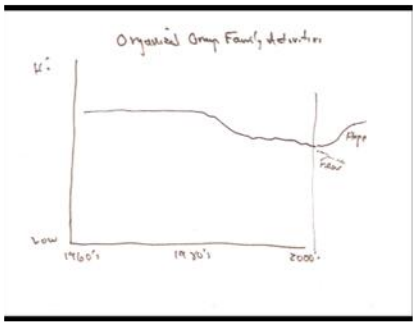


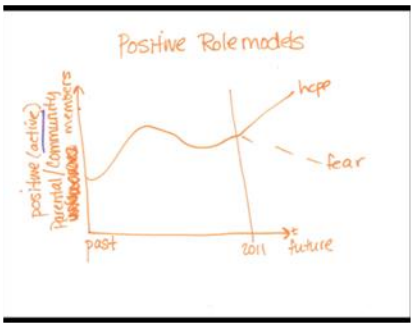


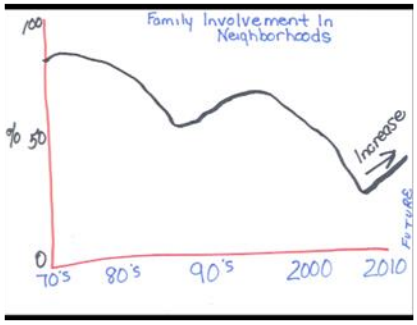


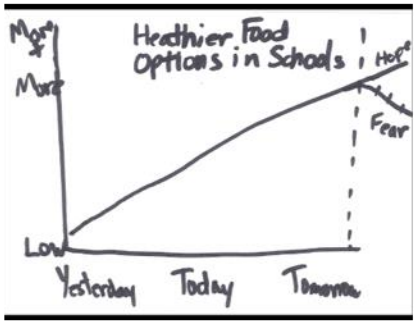


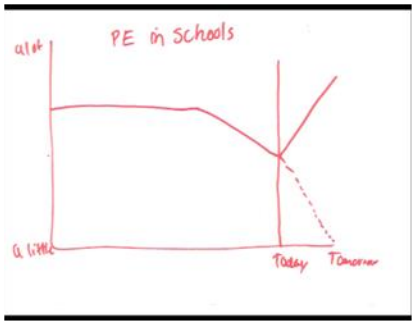


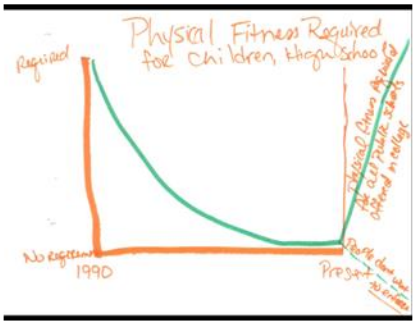


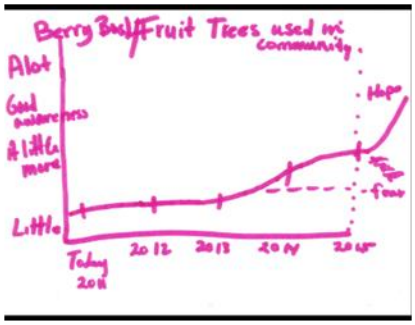


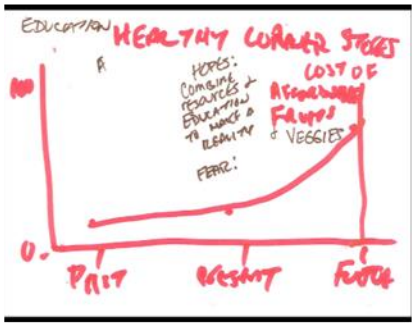


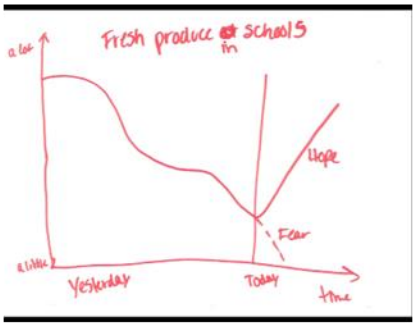


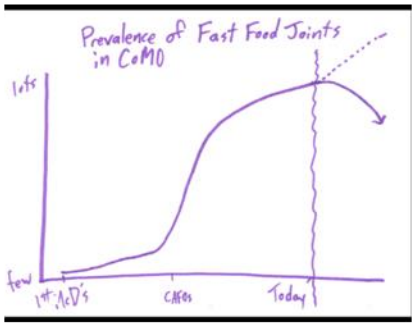

PE in Schools
alot
a little
Today
Tomorrow

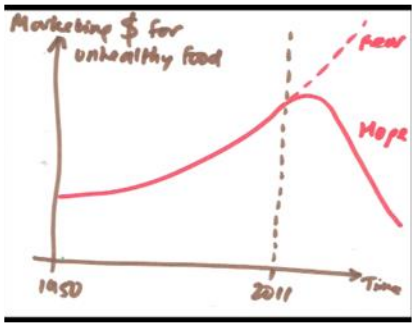

Physical Fitness Required for Children, High School
Required
No Requirement
1990
Present

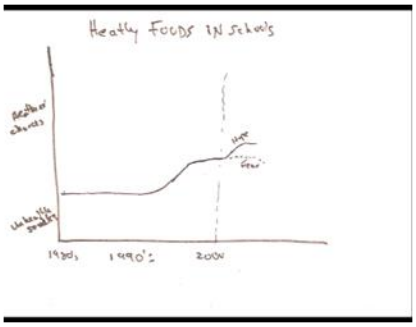

Berry Bush/Fruit Trees used in community.
Alot
Good awareness
A little more
Little
Hope
Fear
Today 2011
2012
2013
2014
2015

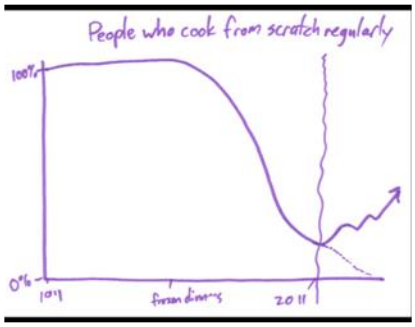

EDUCATION
HEALTHY CORNER STORES
HOPES: COMBINE RESOURCES & EDUCATION TO MAKE A REALITY
FEAR:
COST OF AFFORDABLE FRUITS & VEGGIES
0
PAST
PRESENT
FUTURE

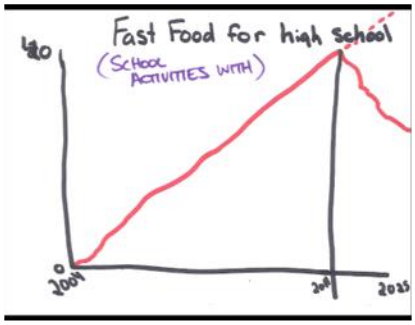

Fresh produce in schools
a lot
a little
Hope
Fear
Yesterday
Today
time

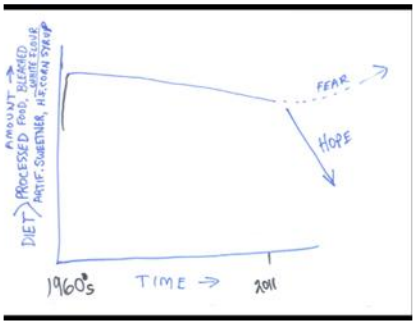

Prevalence of Fast Food Joints in CoMO
lots
few
1st McD's
CAFES
Today

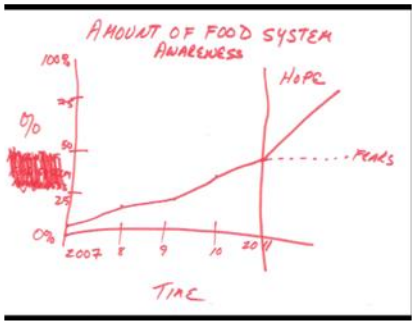

Marketing $ for unhealthy food
Fear
Hope
1950
2011
Time

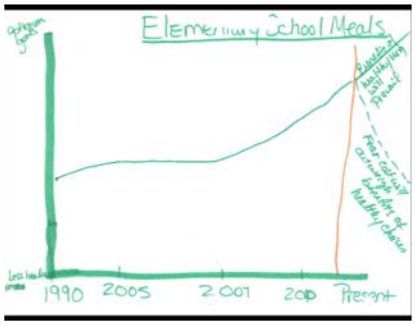

Heathy Foods in Schools
Hope
Fear
1980s
1990's
2000

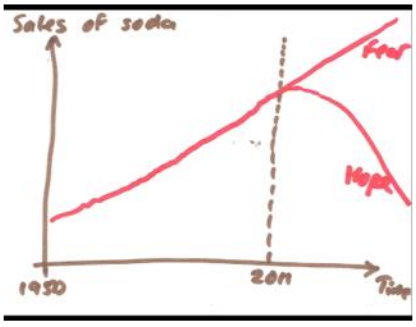

People who cook from scratch regularly
100%
0%
1911
frozen dinners
2011

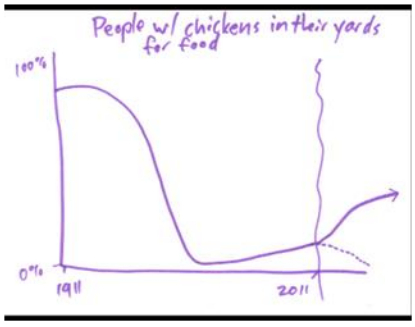
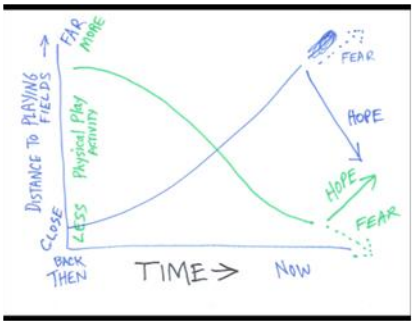
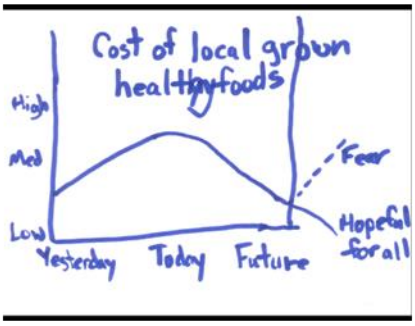
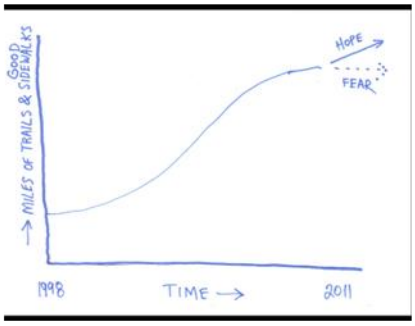
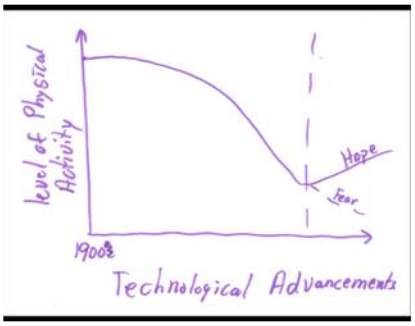
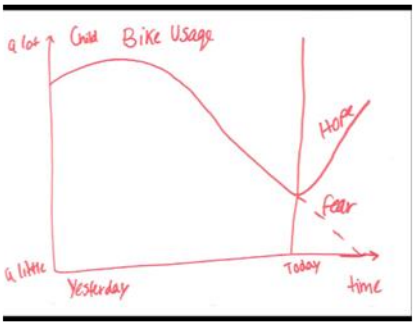
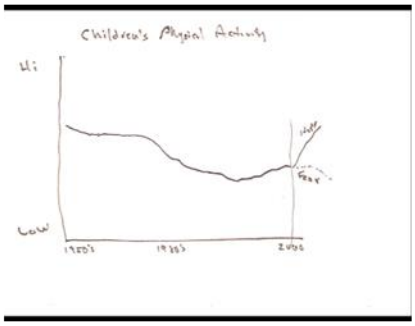
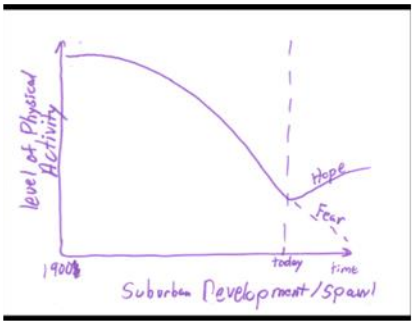
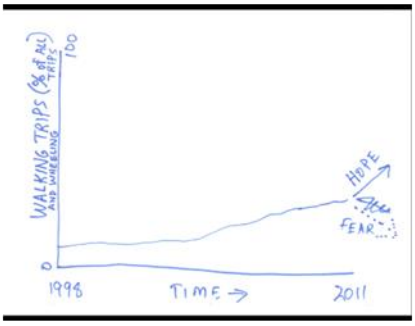
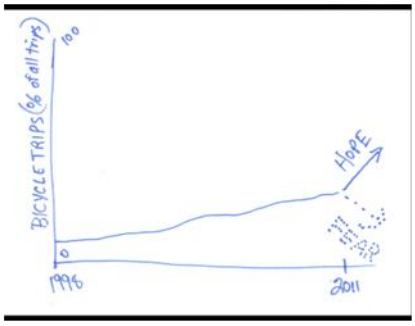

Fast Food for high school
(SCHOOL ACTIVITIES WITH)
0
2004
2025


AMOUNT
DIET
PROCESSED FOOD, BLEACHED WHITE FLOUR
ARTIF. SWEETNER, H.F. CORN SYRUP
FEAR
HOPE
1960's
TIME
2011


AMOUNT OF FOOD SYSTEM AWARENESS
100%
%
0%
HOPE
FEARS
2007
8
9
10
2011
TIME


Elementary School Meals
1990
2005
2007
2010
Present


Sales of soda
Fear
Hope
1950
2011
Time


People w/ chickens in their yards for food
100%
0%
1911
2011

Appendix F (continued): Behavior Over Time Graphs not Represented in the Storybook