Systems Thinking in Communities:

Understanding the Causes of Inactivity, Poor Diet/Nutrition, and Childhood Obesity in Denver, Colorado

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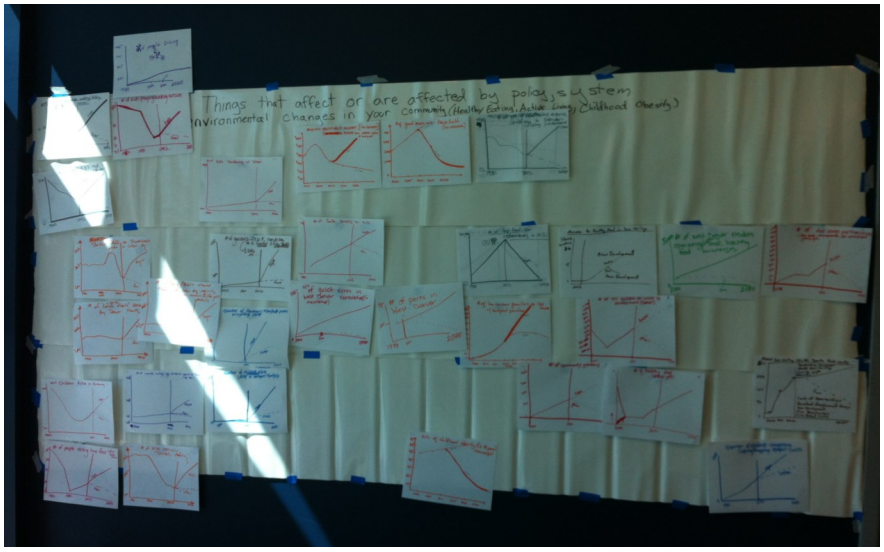

Things that affect or are affected by policy, system
environmental chanaes in your community (Healthy Eating, Active Living, Childhood Obesity)

JAMES

Introduction

The *Denver Healthy Kids, Healthy Communities Coalition* is one of 49 community partnerships participating in the national Healthy Kids, Healthy Communities (HKHC) program of the Robert Wood Johnson Foundation (www.healthykidshealthycommunities.org). The purpose of this Denver HKHC project was to introduce systems thinking at the community level by identifying the essential parts of the Denver, Colorado 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, elected officials, government agencies, community-based organizations, businesses) 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.

Denver, Colorado: Background and Local Participation

The *Denver HKHC Coalition* selected seven pilot neighborhoods located in southwest Denver, including: Westwood, Villa Park, West Colfax, Sun Valley, Barnum, Barnum West, and Valverde. These neighborhoods had high proportions of minority populations and demonstrated high rates of health disparities. The neighborhoods were predominantly Latino, with smaller proportions of Black, Asian, and White populations. With an average income of $34,572 per year, residents were well below the average household income for Denver ($55,129). Approximately 56% of adult residents did not have a high school diploma or G.E.D, and only 7% of residents had a college diploma. It was a young community with 34% of residents under the age of 18. Fourteen percent of the children in these neighborhoods were obese (accessed http://www.piton.org 2008 and Denver Health Status Report 2008).

Partners have been active in addressing high obesity rates in Denver communities since 2006, with funding and resources provided through a Live Well Colorado grant to address neighborhood-level factors affecting healthy eating and active living. The Denver HKHC Coalition came together in 2008 and received funding in 2009. The coalition has expanded and shifted their efforts to include a more regional approach, recognizing that policy, systems, and environmental changes were needed at the municipality level. As a result, additional neighborhoods located in southwest Denver have benefitted from these efforts.

The Denver Health Department was the lead agency for the HKHC project and was physically housed in the hospital system (Denver Health and Hospital Authority), which has operated for over 100 years. Denver Public Health has been instrumental in helping foster empowerment and trust among residents living in Denver Housing Authority locations, leading to more connections to the community in populations often considered more transient.

Denver's HKHC coalition was built on a foundation of closely linked networks and included the following partners: LiveWell Westwood, Westwood Unidos, The Trust for Public Land, Denver Urban Gardens, the Denver Sustainable Food Policy Council, Denver Department of Parks and Recreation, Denver Department of Public Works, Denver Office of Economic Development, Revision International, Denver B-cycle/Denver Bike Sharing, Denver Environmental Health, Groundwork Denver, Padres Unidos, Denver Health and Hospital Authority, Denver Department of Community Planning and Development, Denver Housing Authority, Denver Police Department, City Council District 3, Registered Neighborhood Organizations (four), Residents of West Denver and the Denver Livability Partnership.

Healthy Kids, Healthy Communities Denver's Priorities and Strategies

The partnership and capacity building strategies of *Denver Healthy Kids, Healthy Communities Coalition* included:

- **Community Engagement:** The partnership worked with the city to create a structure to engage residents in the healthy eating and active living policy and environmental change processes. In partnership with Revision International, a non-profit organization that developed a promotora model to hire and train residents in health and gardening, HKHC partners and promotoras continue to provide education and outreach to other residents living in southwest Denver. Partners also identified ways to increase community engagement through work with new partners.
- **Partner Collaboration:** Partners represented various other healthy eating and active living partnerships (e.g., Denver SEEDs, a partnership established to report to the mayor on healthy eating work). Because of the many collaborations in Denver devoted to healthy eating and active living, the Denver HKHC Coalition brought together representatives from each of the existing partnerships in an effort to collaborate and build on the existing initiatives.

The healthy eating and active living strategies of *Denver Healthy Kids, Healthy Communities Coalition* included:

- **Active Transportation (Denver Moves):** Partners completed several activities for this strategy, including: adopting a Denver Complete Streets Policy, revising the Denver Moves plan, adding 25 miles of bike lanes (Denver Public Works striped17 miles of bike lanes and 8 miles of sharrows) in the seven neighborhoods in West Denver, subsidizing costs for Denver Housing Authority (DHA) residents to gain access to the local bike share, securing funding through a federal grant program of HUD and Transportation for the design of Denver's first "Bike Boulevard" to be developed in West Denver, installing Sloan's Lake crosswalk and a 4-way stop, adopting the Decatur Federal Station Area plan, and opening the West Rail offering 12.1 miles of light rail and 11 stations.
- **Parks and Play Spaces:** For their parks work, partners focused on the Weir Gulch and 3800 Alameda Park. Existing asphalt with concrete along Weir Gulch from Alameda to Sheridan was replaced. The master plan study for this corridor was moved up from 2016 to 2013, and Weir Gulch was prioritized for a 2013 master drainage plan study. For 3800 Alameda Park, unused bond money was allocated to construction of the park. Denver Parks and Recreation started construction on 3800 Alameda Park in March 2013 and completed construction in June 2013.
- **Urban Agriculture/Farmers' Markets:** Partners supported creation of a 1-acre urban farm called Ubuntu Urban Farm in the Westwood neighborhood. In addition, a covered hoop house was constructed and crops were planted at Ubuntu Urban Farm. Partners contributed to the development of the Lakewood Dry Gulch community garden and the Valverde community garden, adopting zoning codes with language on the gardens, greenhouses, and mixed-use developments to protect urban agriculture. Partners distributed Community Development Block Grants from the Office of Economic Development to prioritize urban agriculture proposals for neighborhoods in Southwest Denver. The city of Denver demonstrated a commitment to the link between healthy food access and economic development and formed a committee to increase SNAP benefits at farmers' markets.
- **Grocery Stores:** Partners supported the opening of two Mi Pueblo Latin Markets in areas designated as food deserts and the acceptance of Supplemental Nutrition Assistance Program (SNAP) benefits at the markets. The owners of Mi Pueblo set up permanent SNAP recruitment and enrollment booths staffed by Hunger Free Colorado. In addition, the city drafted a zoning code with incentives for food retailers to continue to move into food desert areas, although the zoning policy has not yet been adopted. Finally, partners explored the opportunity to open a food hub and/or community kitchen in southwest Denver, while additional funds are needed to support this effort.

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

Systems Thinking in Communities: Denver, Colorado

"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 Denver, Colorado 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 behavior 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.

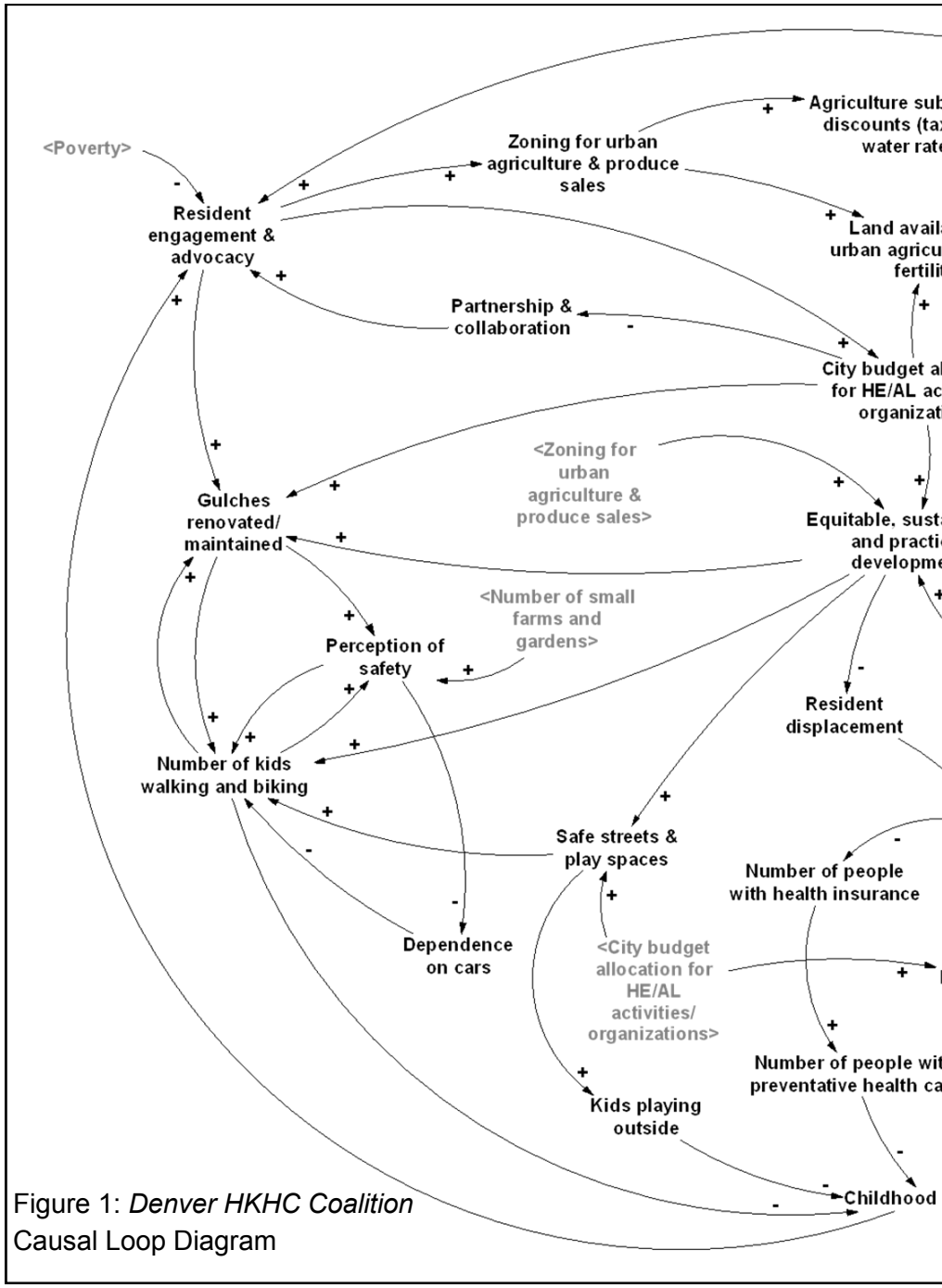


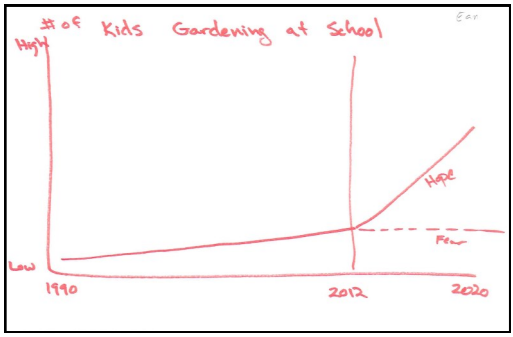
Figure 1: *Denver HKHC Coalition* Causal Loop Diagram

Group Model Building

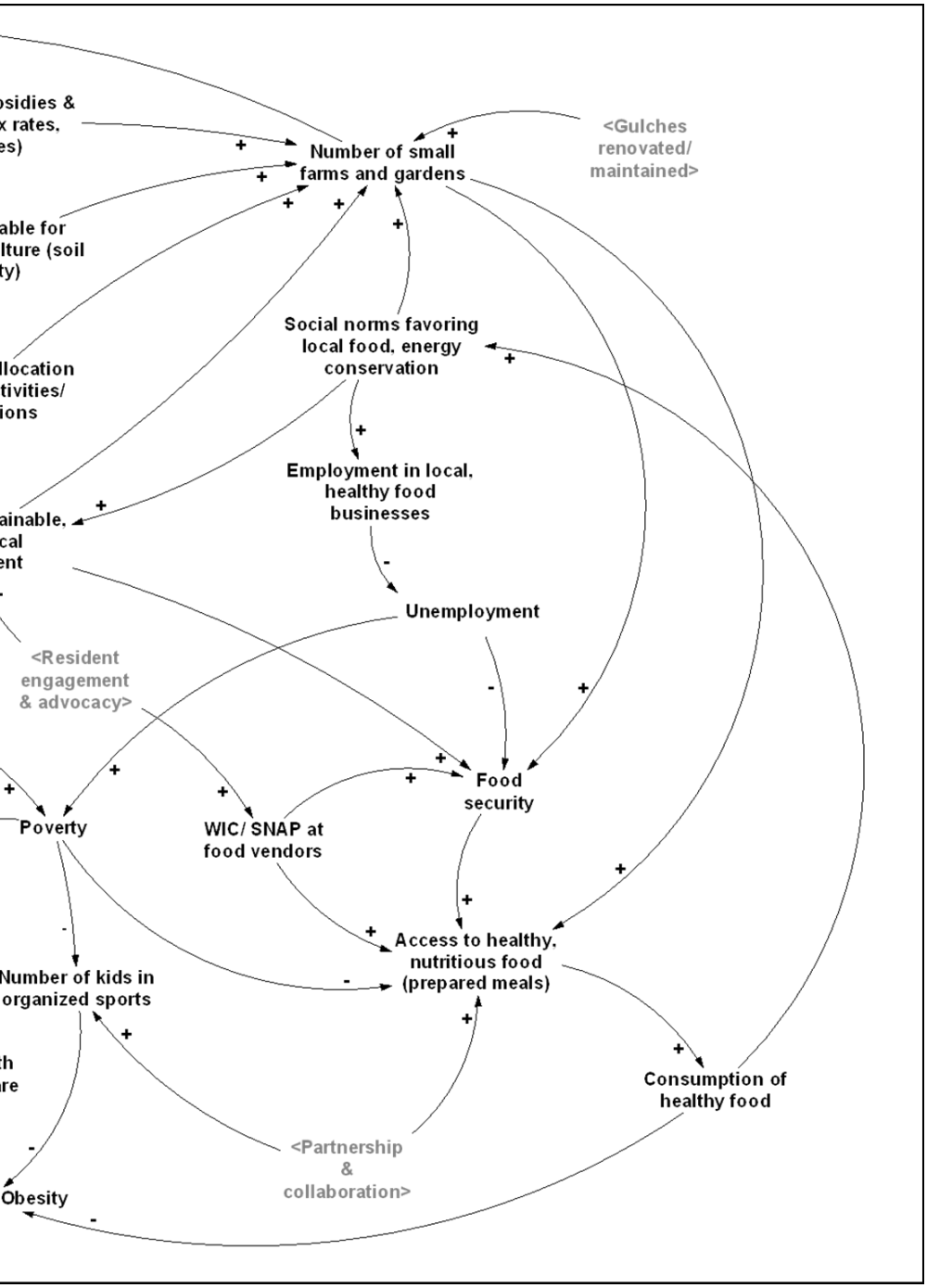
Members of the *Denver HKHC Coalition* partnership participated in a group model building session in August, 2012 and generated this system. also referred to as a causal loop diagram (Figure 1). Participants in the group model building session included representatives of non-profit agencies, local government agencies, and businesses. 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 Denver 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, the number of kids gardening at school has



remained low with a slight increase from 1990 to 2012, and the participant hopes that this increase will rise at a faster rate 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 equitable, sustainable, and practical development in this causal loop diagram. One feedback loop is: equitable, sustainable, and practical development → resident displacement → poverty → resident engagement and advocacy → equitable, sustainable, and practical development . A second feedback loop is: equitable, sustainable, and practical development → food security → access to healthy, nutritious food → consumption of healthy food → social norms favoring local food and energy conservation → equitable, sustainable, and practical development. 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 equitable, sustainable, and practical development. Some variables may increase these development patterns while other variables limit them. 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 *Denver HKHC Coalition* 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 Denver, Colorado and to stimulate greater conversation related to Denver'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 Denver, Colorado. 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.

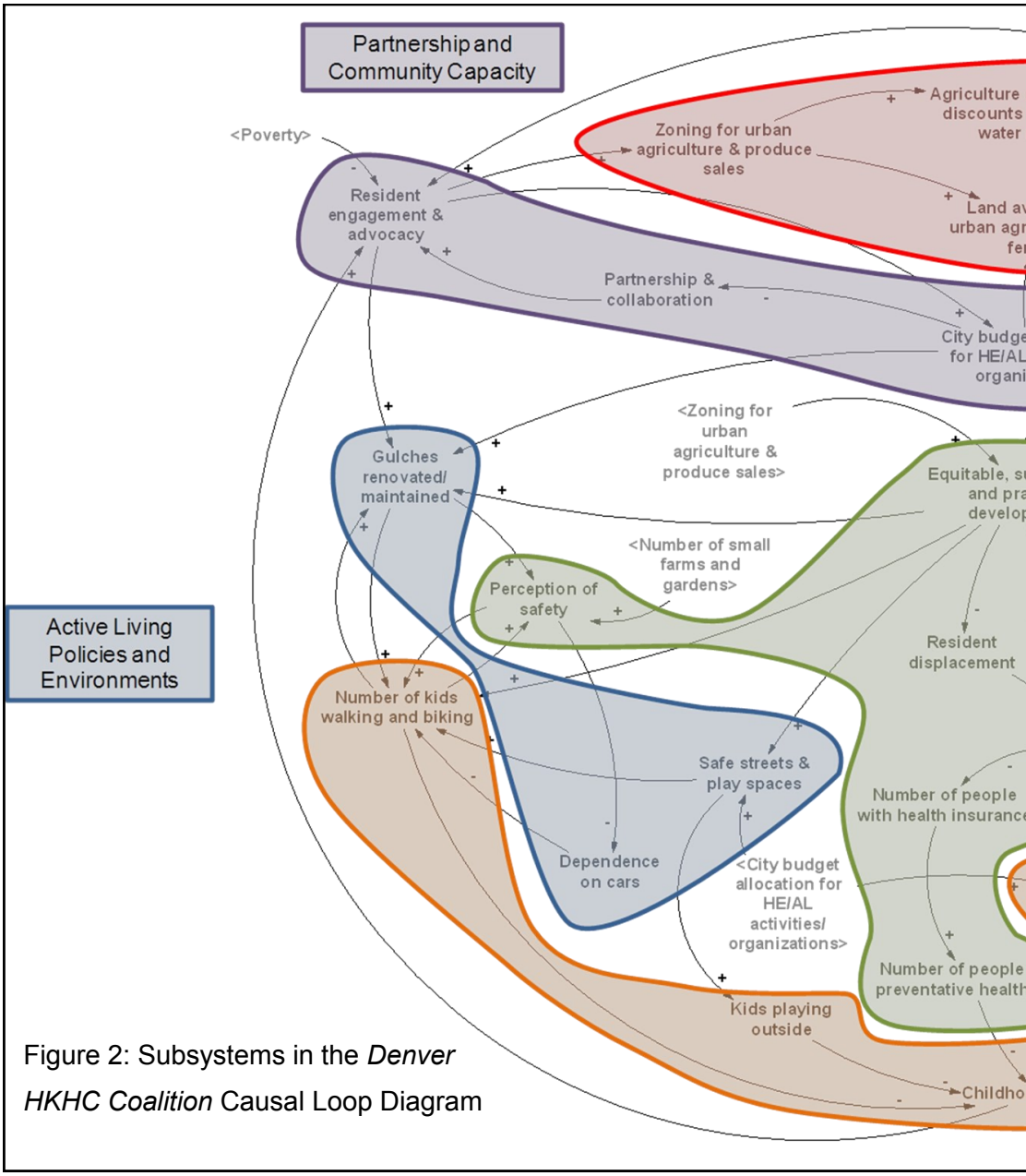


Figure 2: Subsystems in the *Denver HKHC Coalition* Causal Loop Diagram

Healthy Eating Policies and Environments (Red)

The healthy eating policy and environmental subsystem includes food production (e.g., small farms and gardens), food distribution and procurement (none represented), and food retail (e.g., WIC/SNAP at food vendors). During the behavior over time graphs exercise, the participants generated 13 graphs related to policy or environmental strategies (e.g., zoning for urban agriculture and produce sales) or contexts (e.g., land available for urban agriculture) that affected or were affected by the work of *Denver HKHC Coalition.* The variables represent participants' conversations from the behavior over time graph and causal loop diagram exercises.

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 six graphs related to policy or environmental strategies (e.g., gulches renovated/maintained) or contexts (e.g., dependence on cars) that affected or were affected by the partnership's work.

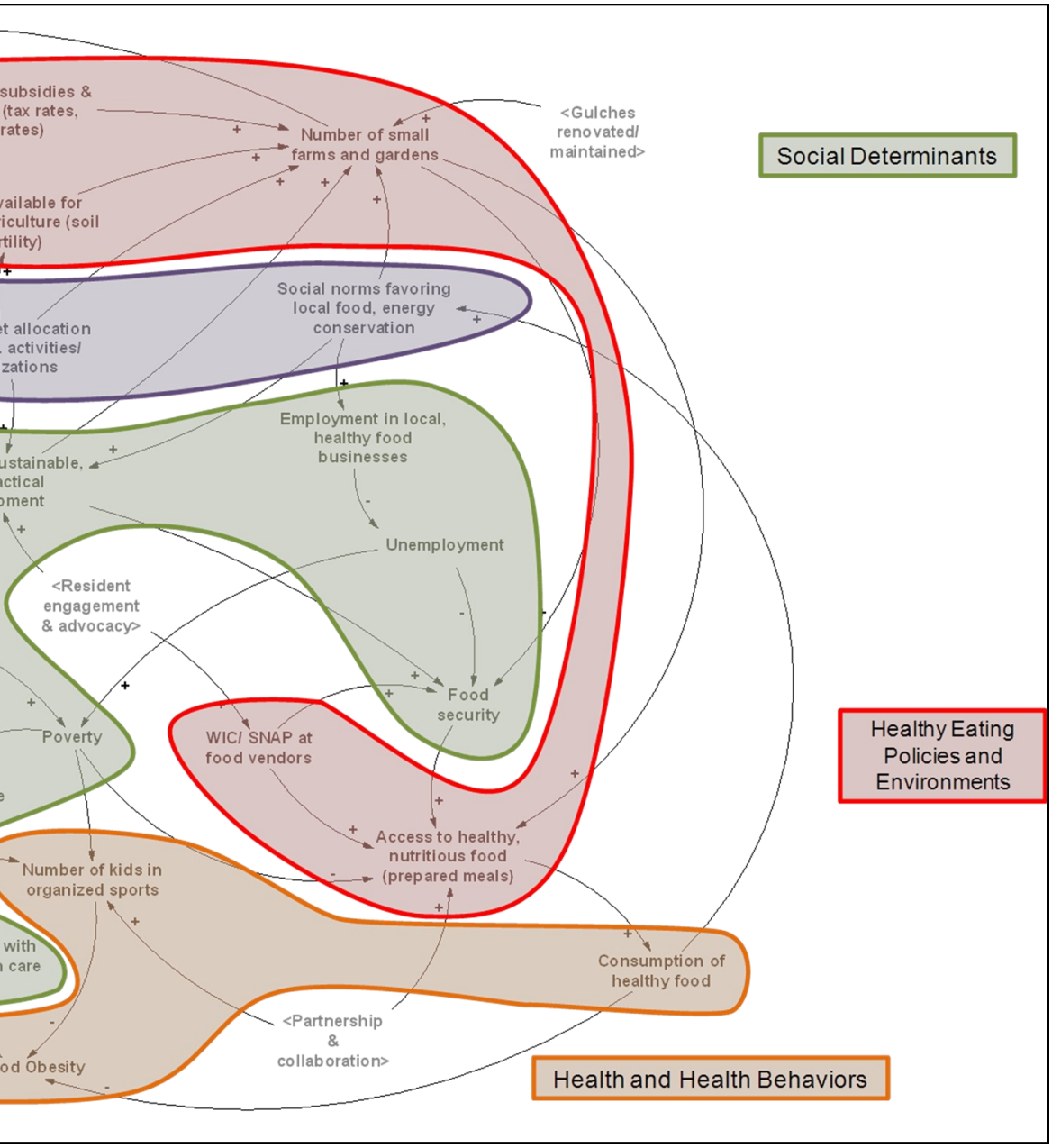
Health and Health Behaviors (Orange)

The subsystem for health and health behaviors includes health outcomes (e.g., childhood obesity), health behaviors (e.g., consumption of healthy food, number of kids walking and biking), and behavioral proxies

or context-specific behaviors (e.g., kids playing outside, number of kids in organized sports).

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, the *Denver HKHC Coalition* developed a promotora model to provide education and outreach to other residents living in southwest Denver. This subsystem also includes community factors outside the partnership that may influence or be influenced by their efforts, such as city budget allocation to healthy eating or active living or social norms favoring local food and energy conservation.



Social Determinants

Finally, the social determinants subsystem denotes societal conditions (e.g., uemployment, poverty, health insurance) and psychosocial influences (e.g., perceptions of safety) 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.

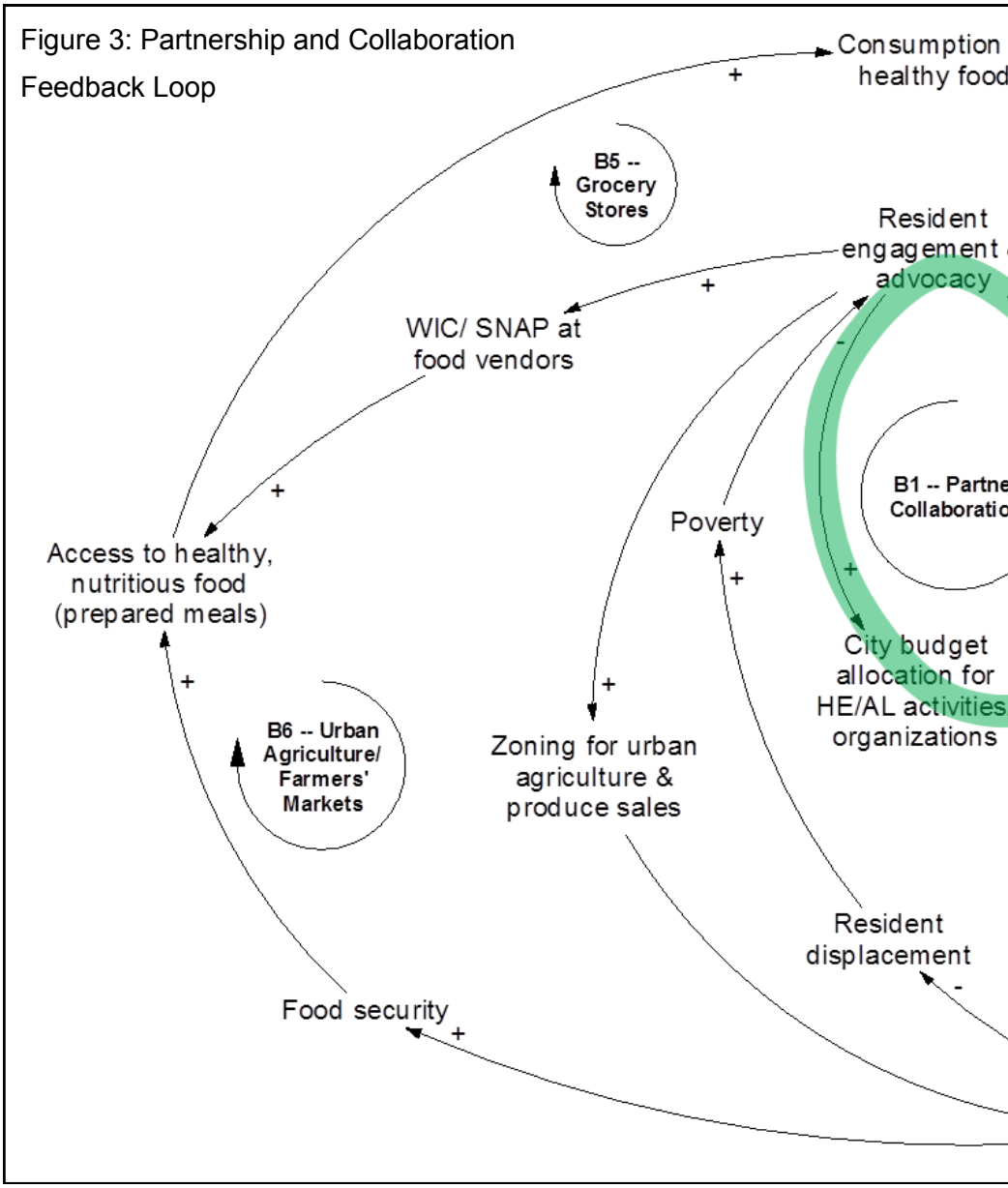
Each one of these subsystems has many more variables, causal relationships (arrows), and feedback loops that can be explored in greater depth by the *Denver HKHC Coalition* partners or by other representatives in Denver, Colorado. Using this CLD as a starting place, community conversations about different theories of change within subsystems may continue to take place. For instance, these participants identified interest in understanding more about the relationships among zoning policies, agriculture subsidies, and small, urban farms.

The next sections begin to examine the feedback loops central to the work of the *Denver HKHC Coalition*. 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.

Partnership and Collaboration Feedback Loop

To simplify the discussion about feedback loops, several loops drawn from the *Denver HKHC Coalition* 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 Denver, Colorado, each feedback loop tells a story about a more specific change process.

Figure 3: Partnership and Collaboration Feedback Loop



Causal Story for Feedback Loop

Story A: In this case , the story is about partnership and collaboration (green highlighted loop in Figure 3). The Denver HKHC Coalition had many partnerships represented within it. Participants described how their partnership and collaboration increased resident engagement and advocacy, helping them to increase city budget allocations to healthy eating and active living activities and organizations. Yet, as these funds increase, the individuals and organizations with funding may operate more independently working on their funded projects. This minimizes time or motivation to engage with other partners or to develop opportunities for collaboration.

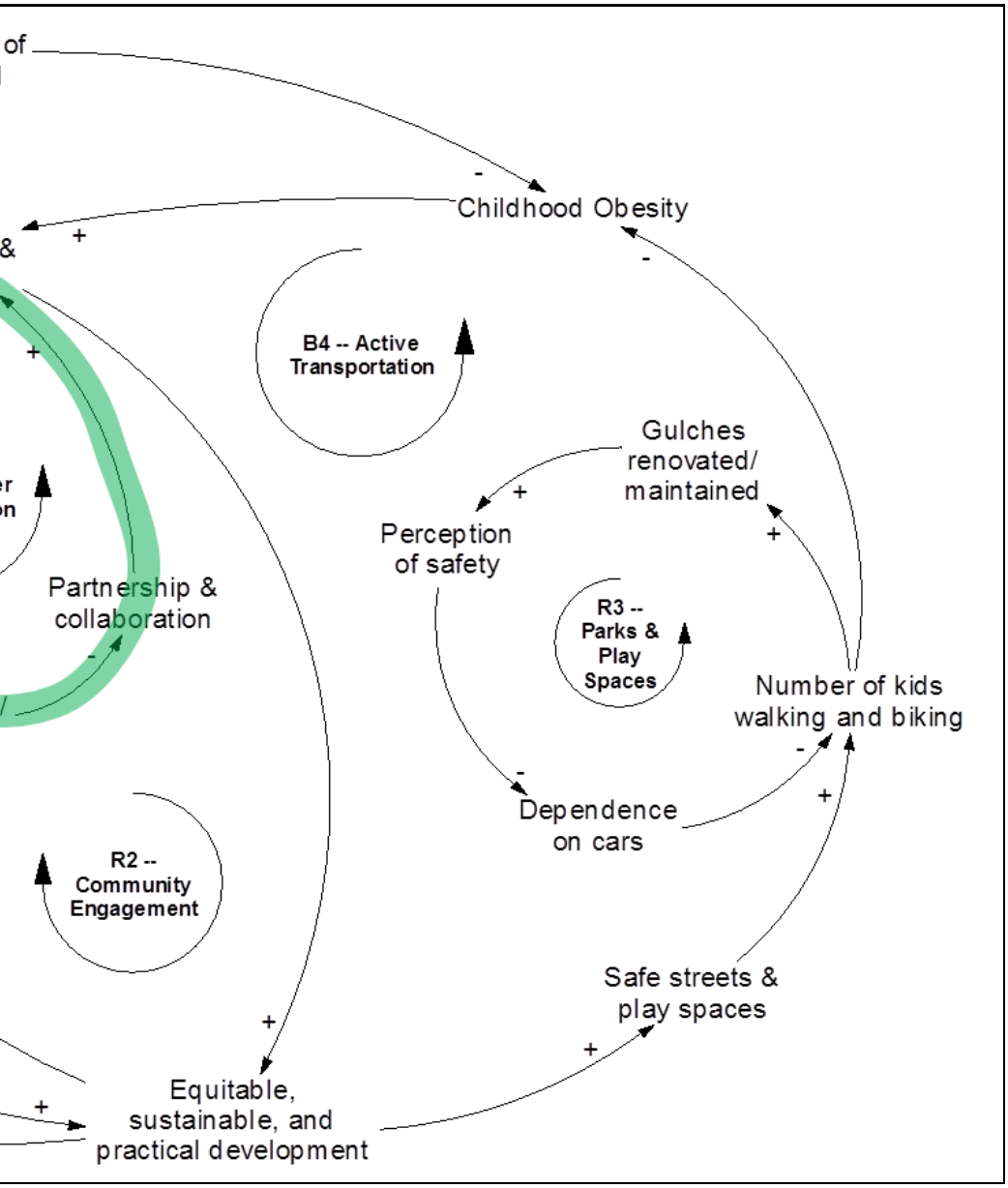
Story B: The preceding story reflected one scenario for Denver suggested by this feedback loop. The same feedback loop also tells the opposite story. Without partnership and collaboration, fewer residents are engaged or participate in advocacy efforts. In turn, less of the city budget is allocated to healthy eating and active living activities and organizations. Consequently, individuals and organizations may increase work with partners to collaborate and share skills, resources, and capacities to keep the work going without funding.

Balancing Loop and Notation

These stories represent a balancing loop, and the notation in the feedback loop identifies it as a balancing loop (see "B1 — Partnership & Collaboration" 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

"It's not just one thing that would move the needle on [childhood obesity] and that's really where partnership collaboration really comes to bear... like where we can bring in the city, we can bring in institutions, non-profits, for-profits, different types of models that have a small piece to the same puzzle. But, when we get everyone in the same room, and I think that's something we've all talked about, we really can start to move the needle on something huge like that." **(Participant)**

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 balancing loop, the effect of the variables tend to create more of a stable trend over time, as opposed to one that is continually increasing or decreasing. This effect continues through the cycle and returns a stabilizing influence to the original variable, respectively.



Looking specifically at the "+" or "-" notation, a feedback loop that has an odd number of "-" signs, or polarities in the loop, is considered a balancing loop. Reinforcing loops, with zero or an even number of "-" signs, are another type of feedback loop and these are referenced in the next sections.

It is important to remember that this balancing 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 *Denver HKHC Coalition*</u>

From the systems thinking exercises, several insights can inform how partners continue to move forward with partnership and collaboration, including:

- Strategic partnerships to engage residents in advocacy initiatives can help to stimulate support and funding from city government agencies.
- Financial resources for healthy eating and active living activities and organizations may disincentivize collaboration unless the funds are specifically designed to support partnerships.

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

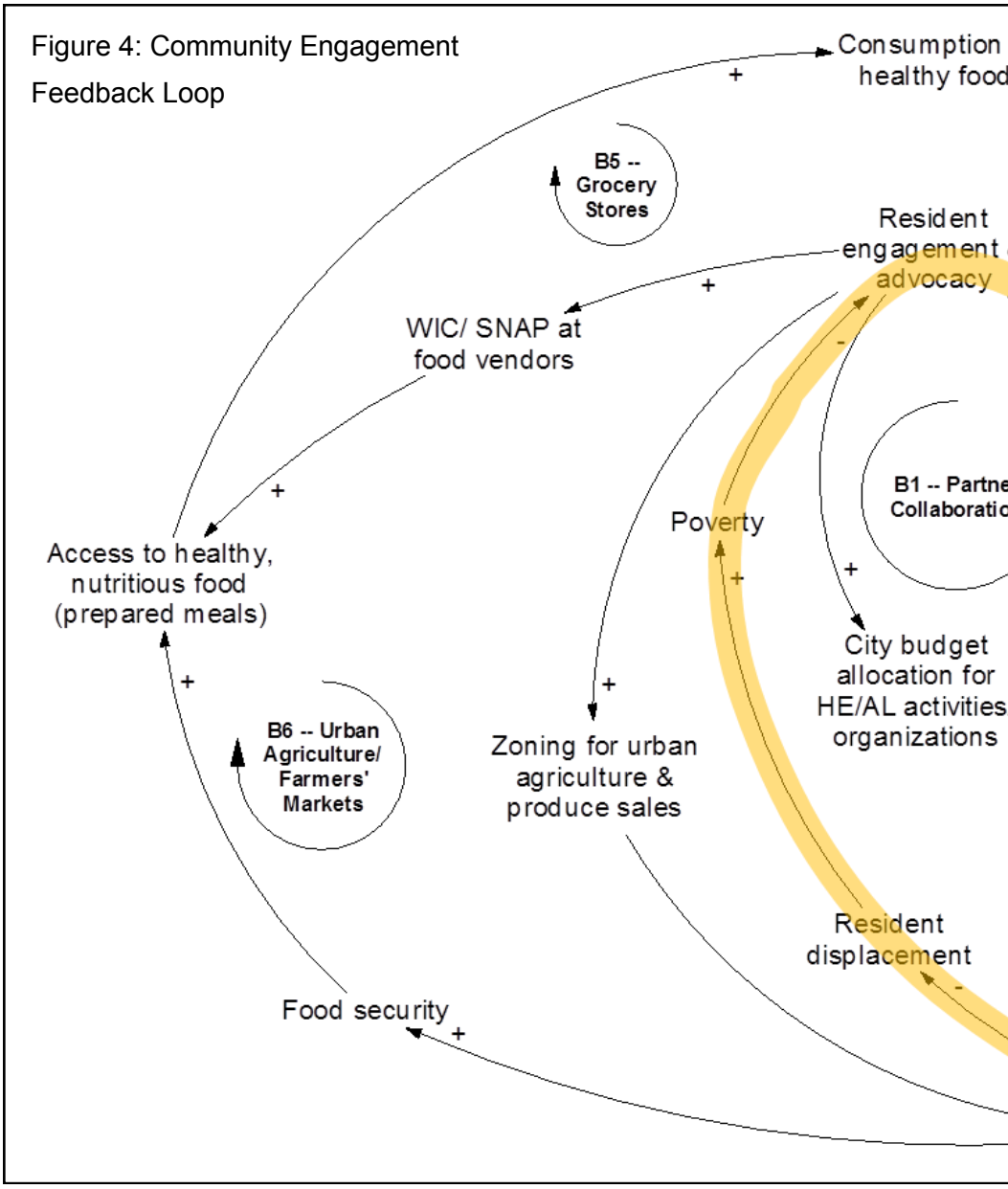
- What types of partnerships increase resident engagement and participation in advocacy?
- What are successful funding structures to incentivize partnership and collaboration?

"We only have city budget, we don't have other kinds of funding or resources, so this will just represent what I'm saying. But, I think that as resources or city budget allocation for HEAL activities go down, we see an increase in partnership collaboration. So, the fewer resources we have, we often collaborate more and to reverse that — not always, not always, I don't want to make a general statement — but sometimes when we have more resources, we're less inclined to collaborate because we don't need to quite as much." **(Participant)**

Community Engagement 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 engagement.

Figure 4: Community Engagement Feedback Loop



Causal Story for Feedback Loop

Story A: In this case , the story is about community engagement. Denver partners had several strategies to engage residents and involve them in advocacy (e.g., training promotoras, partnering with multiple individuals and organizations). Participants described how resident engagement and advocacy have helped to increase equitable, sustainable, and practical developments that reduce resident displacement and the perpetuation of poverty. With less poverty, partners anticipate greater resident engagement and advocacy for healthy eating and active living.

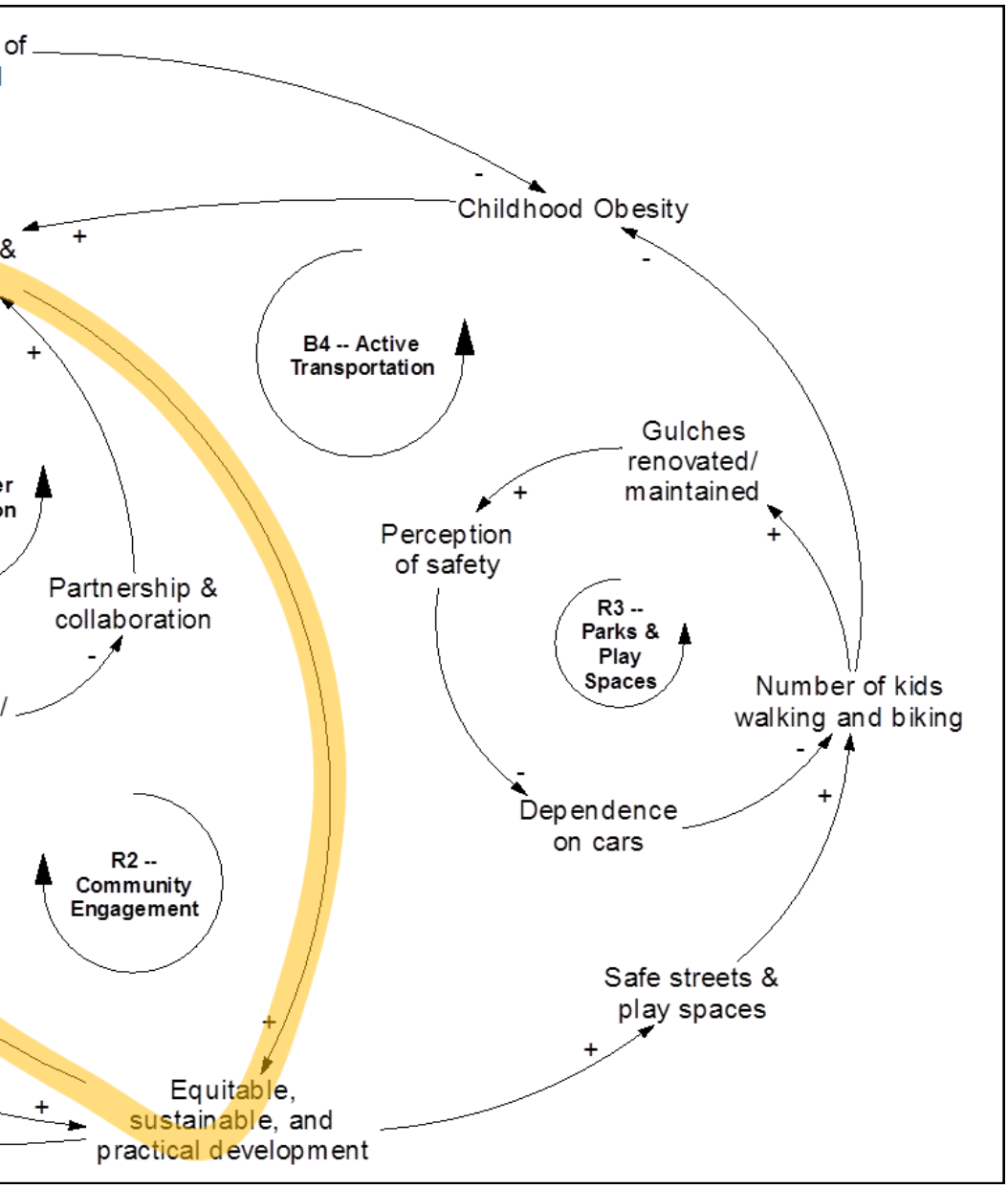
Story B: While the preceding story reflected a positive scenario for Denver, the same feedback loop also tells the opposite story. Without resident engagement and advocacy, fewer developments that are equitable, sustainable, and practical get constructed, leaving development patterns that often result in resident displacement that continues the cycle of poverty. Individuals in poverty may have greater constraints on their time and resources interfering with their engagement in healthy eating and active living initiatives.

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 “R2 — Community Engagement”). 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. This feedback loop has two “-” signs, or polarities, so it is considered a reinforcing loop.

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 resident engagement and advocacy likely levels off at some point when most of the community is represented in decision-making and/or implementation of the initiatives. To understand what specifically leads to the leveling off of resident engagement and advocacy, it may be helpful for the partners in Denver, Colorado to consider other variables that influence or are influenced by this variable, such as the loop on partnership and collaboration.

In addition, some of these causal relationships may have more immediate effects (e.g., the effects of residents' advocacy efforts on equitable, sustainable, and practical development) and other relationships may have delayed effects (e.g., the influence of these development patterns on resident displacement and poverty). This delayed effect is noted using two hash marks through the middle of the arrow line (not shown in Figure 4).



<u>System Insights for *Denver HKHC Coalition*</u>

From the systems thinking exercises, several insights can inform the ways that Denver partners work with residents as part of their initiatives, including:

- Building relationships with developers who prioritize equity, sustainability, and practicality (e.g., mixed-income housing, greater population density, mixed commercial and residential land uses) can improve residents' stability, both geographically and economically.
- With deeper roots in the community, residents may have more time and feel more confident voicing their concerns and opinions to civic leaders in order to improve or maintain healthy eating and active living assets in the community.
- When these types of developments demonstrate success in model communities, they can be translated into new or improved developments throughout the region.

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

- What are the characteristics of residents that are more or less engaged in advocacy or community initiatives to support healthy eating and active living?
- What are indicators associated with developments that support equity? Sustainability? Practicality?
- What are the ways that residents can interact with civic leaders in order to influence guidelines for new developments?

"There's going to be a lot of development that's going to be coming in here within the next five years with the light rail coming through here, so there's the hope that new development will bring [healthy food] in, and there's also the fear that new development will not bring [healthy food] in and displace, not only displace residents, but who knows what it's going to look like around here ." **(Participant)**

Parks and Play Spaces Feedback Loop

Highlighted in blue in Figure 5, the parks and play spaces feedback loop represents one of the *Denver HKHC Coalition's* strategies to increase active living in Denver, Colorado.

Causal Story for Feedback Loop

Story A: Within the parks and play spaces domain, Denver partners focused on improvements to the Weir Gulch and construction of Alameda Park. With respect to the gulches renovated or maintained in Denver, participants discussed how these improvements increased residents' perceptions of safety. As their perceptions of safety increased, they became less dependent on their cars as their only mode of transportation because the gulches allowed them to walk or ride their bikes to and from different destinations in the area. With more people out of their vehicles and a greater number of kids using the gulches, there were more improvements to the gulches.

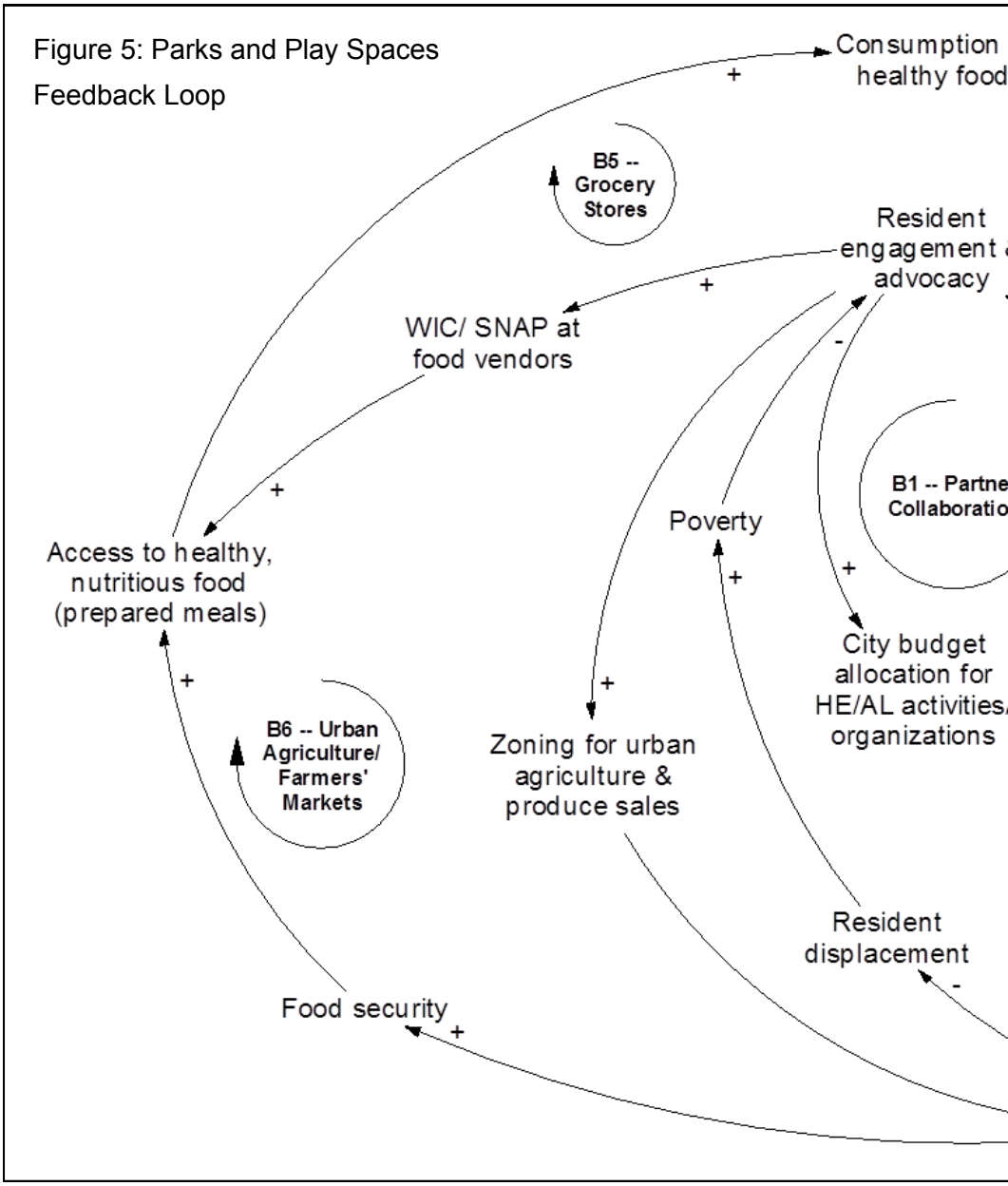


Figure 5: Parks and Play Spaces Feedback Loop

Story B: Alternatively, gulches that remain in disrepair diminish residents perceptions of safety and increase their reliance on cars as their primary mode of transportation. This dependence on cars reduces the number of kids walking and biking as well as the demand for improvements to the gulches.

Reinforcing Loop and Notation

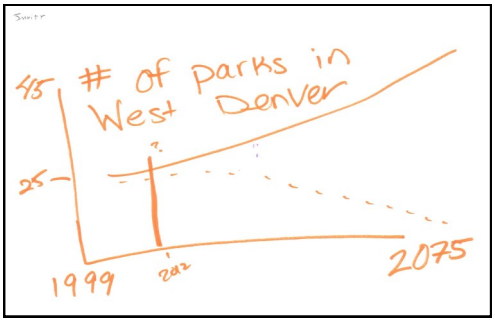
Similar to the previous loop in Figure 4, this loop does have two "-" signs or polarities; because this is an even number, it is a reinforcing loop (see R3—Parks and Play Spaces in Figure 4).

Some of these causal relationships may have more immediate effects (e.g., the influence of the number of kids walking and biking on the renovation and maintenance of the gulchers) and other relationships may have delayed effects (e.g., how residents' perceptions of safety affect their dependence on cars). Again, delayed effects are noted using two hash marks through the middle of the arrow line (not included here).

Story A provides a good illustration of the reason why it is not advantageous to separate the feedback loops from the causal loop diagram (see Figures 1-2). For instance, while the renovation and maintenance of gulches may have an influence on the number of kids walking and biking, many other factors influence

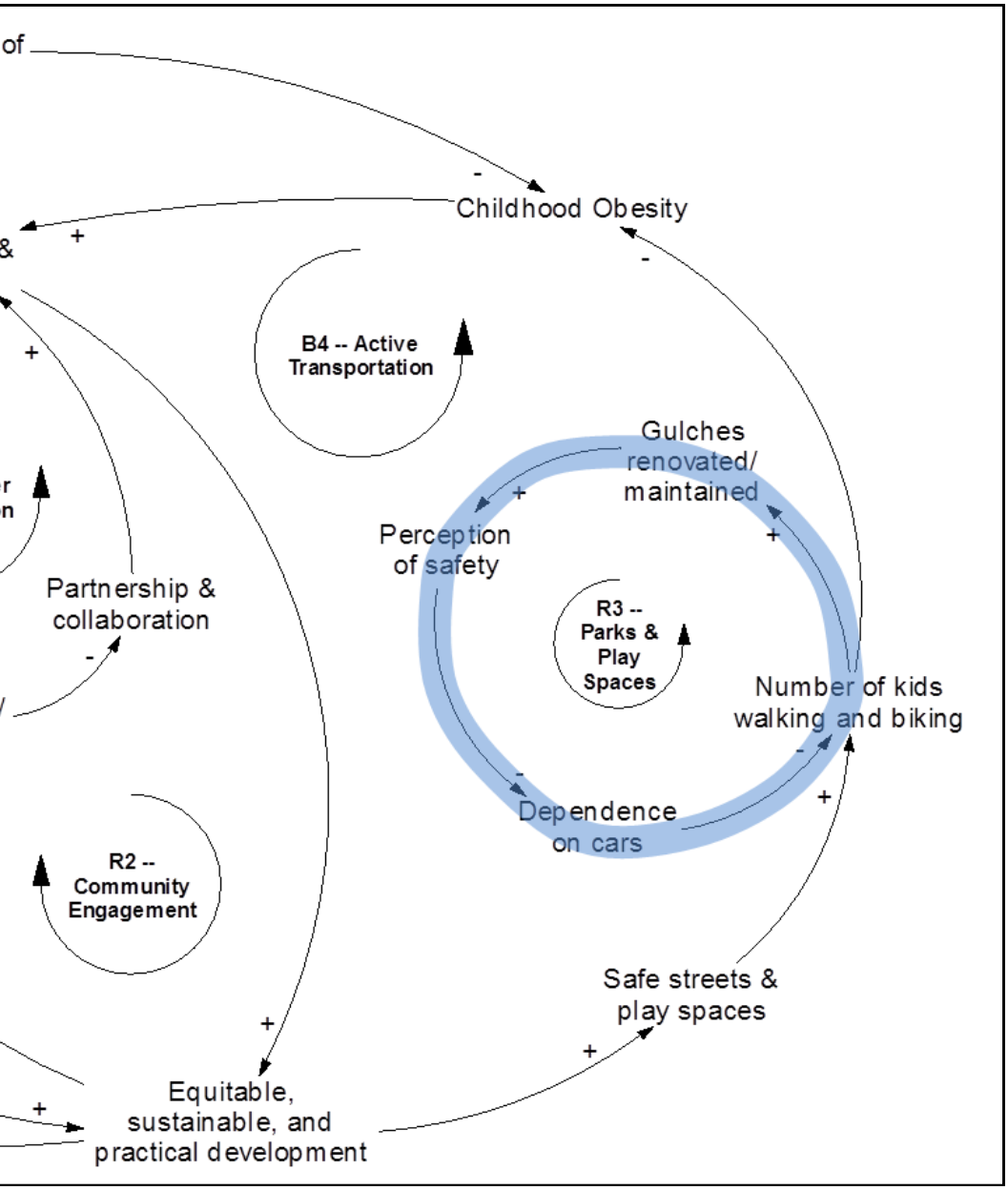
"The number of kids walking and biking would increase the perception of safety in the gulches if you saw more residents on the gulches. So, I think that the actual action of participation would prove that kind of safety measure has been implemented." **(Participant)**

the amount of kids walking and biking. In this case, examining this loop without the context of the other variables and loops may lead to inappropriate conclusions.



System Insights for *Denver HKHC Coalition*

In the behavior over time graphs, participants identified slight increases in the number of parks in West Denver since 1999 with the hope that these parks will nearly double into the future (see illustration at the top right). Participants also identified a steady increase in the percentage of acres of gulches renovated or maintained in West Denver (bottom right).

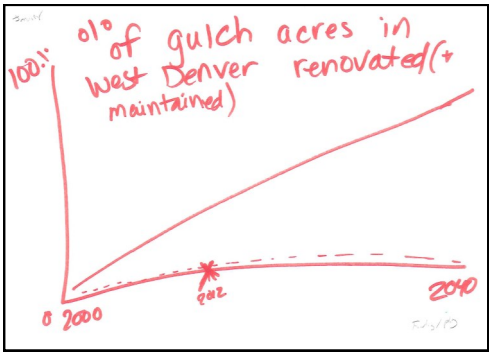


System insights can inform the partnership's next steps with parks and play spaces, including:

- A greater number of well-maintained parks and gulches can increase physical activity in West Denver.
- Efforts to highlight improvements to the gulches can help to increase residents' perceptions of safety in the community, and these perceptions strongly influence parents' decisions to allow their kids to use the gulches for walking and bicycling.
- Identification of the gulches as pathways supporting safe walking and bicycling commutes can help to reduce residents' driving trips and the amount of time kids spend sedentary in vehicles.

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

- Who lives within a one– or two–mile radius of parks or gulches in West Denver? Who does not?
- What types of renovation or maintenance strategies help to increase residents' perceptions of safety? Why?
- How do residents' perceptions of safety influence their use of motorized vehicle for transportation?



Active Transportation (Denver Moves) Feedback Loop

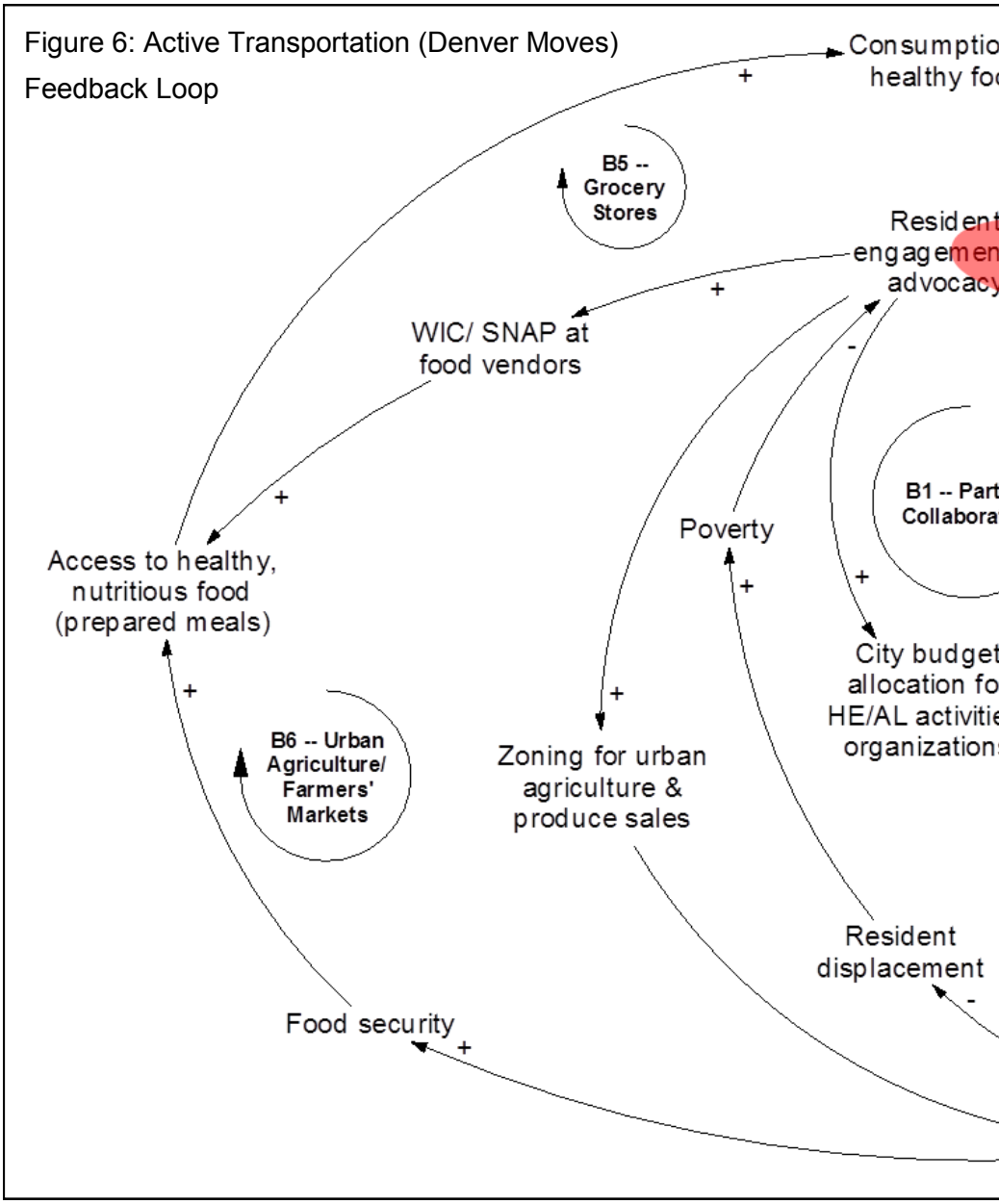
The loop for active transportation highlighted in red in Figure 6 represents another one of the *HKHC Denver Coalition's* strategies to increase active living.

Causal Story for Feedback Loop

Story A: As part of *Denver Moves*, partners worked on policies and planning documents (e.g., Complete Streets) as well as environmental changes (e.g, bike lanes, sharrows, crosswalks, light rail). As the number of safe streets increases, more kids are walking and biking. These increases in physical activity help to reduce rates of childhood obesity. With fewer overweight and obese children, residents can spend less time advocating for greater support for safe streets. This decreased need for advocacy also reduces the need for new developments that are equitable, sustainable, and practical, given that these developments — along with safe streets — are already in existence.

Story B: On the other hand, the lack of safe streets reduces the number of kids walking and biking, with less activity resulting in greater rates of overweight and obesity. Higher rates of obesity raise residents' engagement in advocacy efforts to have more equitable, sustainable, and practical developments that support safe streets.

Figure 6: Active Transportation (Denver Moves) Feedback Loop



Reinforcing Loop and Notation

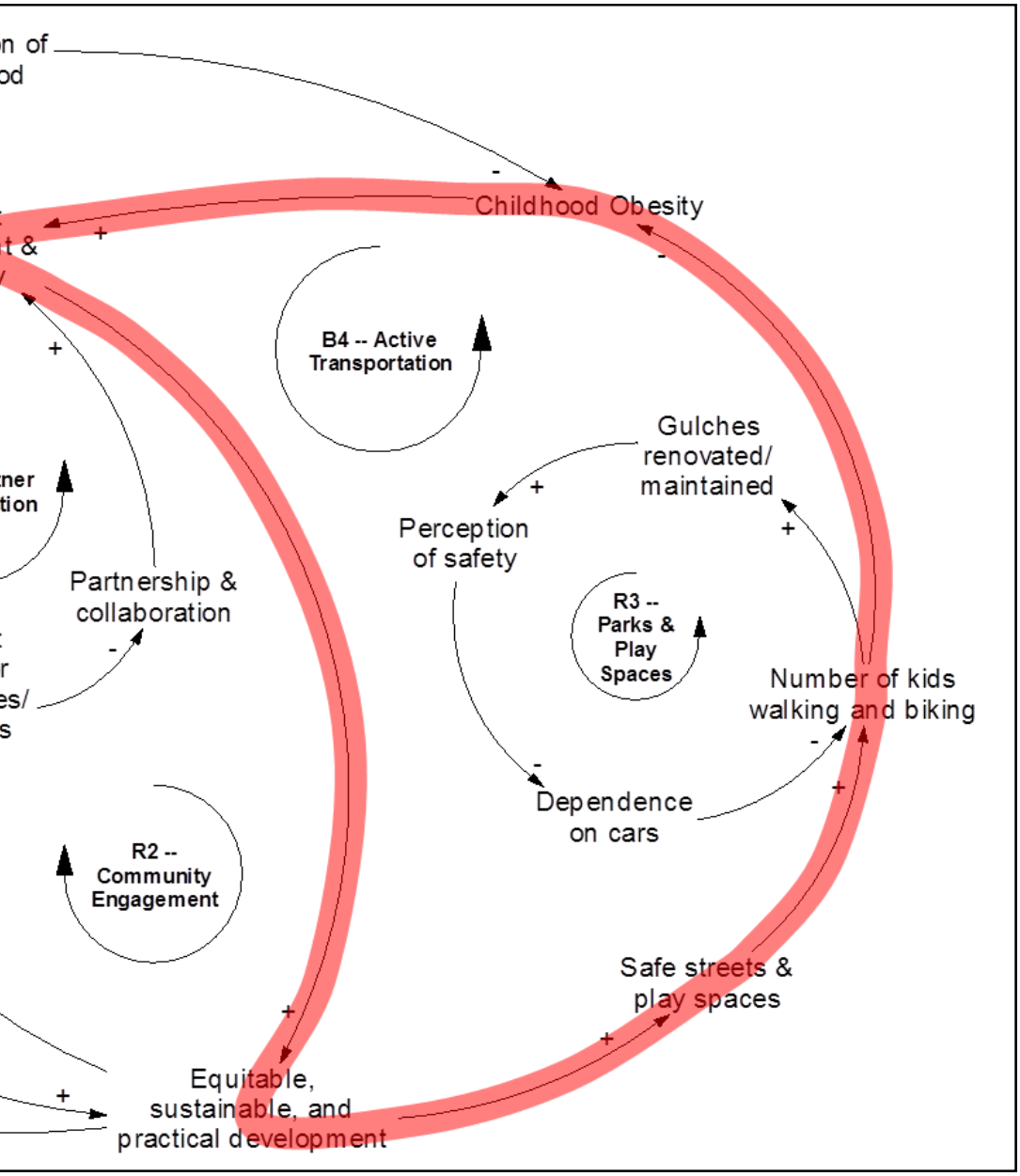
Similar to first loop (see Figure 3), this is a balancing loop (one "-" sign). In addition, it includes causal relationships representing more immediate effects (e.g., the influence of safe streets on kids walking and biking behaviors), and, potentially, delayed effects (e.g., how childhood obesity rates are affected by kids walking and biking behaviors). The hash marks for this delayed effect are not shown here.

In Figures 1 and 2, this loop is disconnected (e.g., the connection from resident engagement and advocacy to equitable, sustainable, and practical development is not a direct connection). In order to prevent loops from crossing over other loops, these figures use shadow variables to keep the image from getting too messy. Resident engagement and advocacy has a shadow variable (shown in Figures 1-2) and it is presented in gray text with brackets on either side to show that it "shadows," or duplicates, the original variable.

"We became more car dependent and both parents working outside of the household and unsafe streets, things like that, we've seen a decrease in children walking or biking to school." **(Participant)**

System Insights for *Denver HKHC Coalition*

In the behavior over time graphs exercise, participants described a steady increase in the number of safe streets for kids since 1990, with the hope that this increase continues into the future (see top right). However, participants also described a steady decline in the proportion of kids walking and biking to school since 1990 from 60% to 30%, with the hope of reversing this trend into the future (see bottom right).

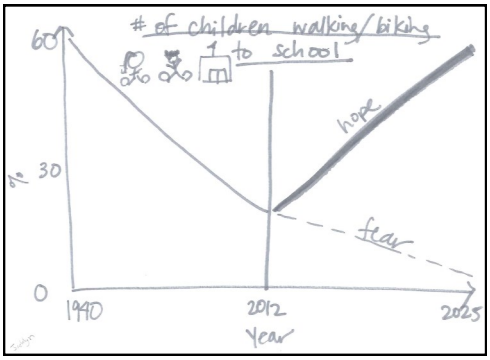


System insights for the partnership's active transportation efforts include:

- Developers have a strong influence on the proportion of safe streets for kids in the community and residents may be able to work with these developers on design principles to encourage safe streets as part of equitable, sustainable, and practical development strategies.
- Higher rates of childhood obesity may help to increase resident engagement and attention to this issue. As rates of obesity decline, it may be difficult to maintain these advocacy efforts in order to sustain improvements that have been made over time

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

- The feedback loop in Figure 6 shows that more safe streets helps to increase the number of kids walking and biking to school. Yet, data from the behavior over time graphs suggest that kids are not walking and biking to school more, despite the increases in safe streets. What is the relationship between these variables and how do they influence one another? What other variables may be influencing this causal relationship?
- What is a "safe street" for kids? What policies, facilities, and amenities need to be in place for kids to walk or bike safely (e.g., speed limits, bike lanes, street lighting, crosswalk treatments)?



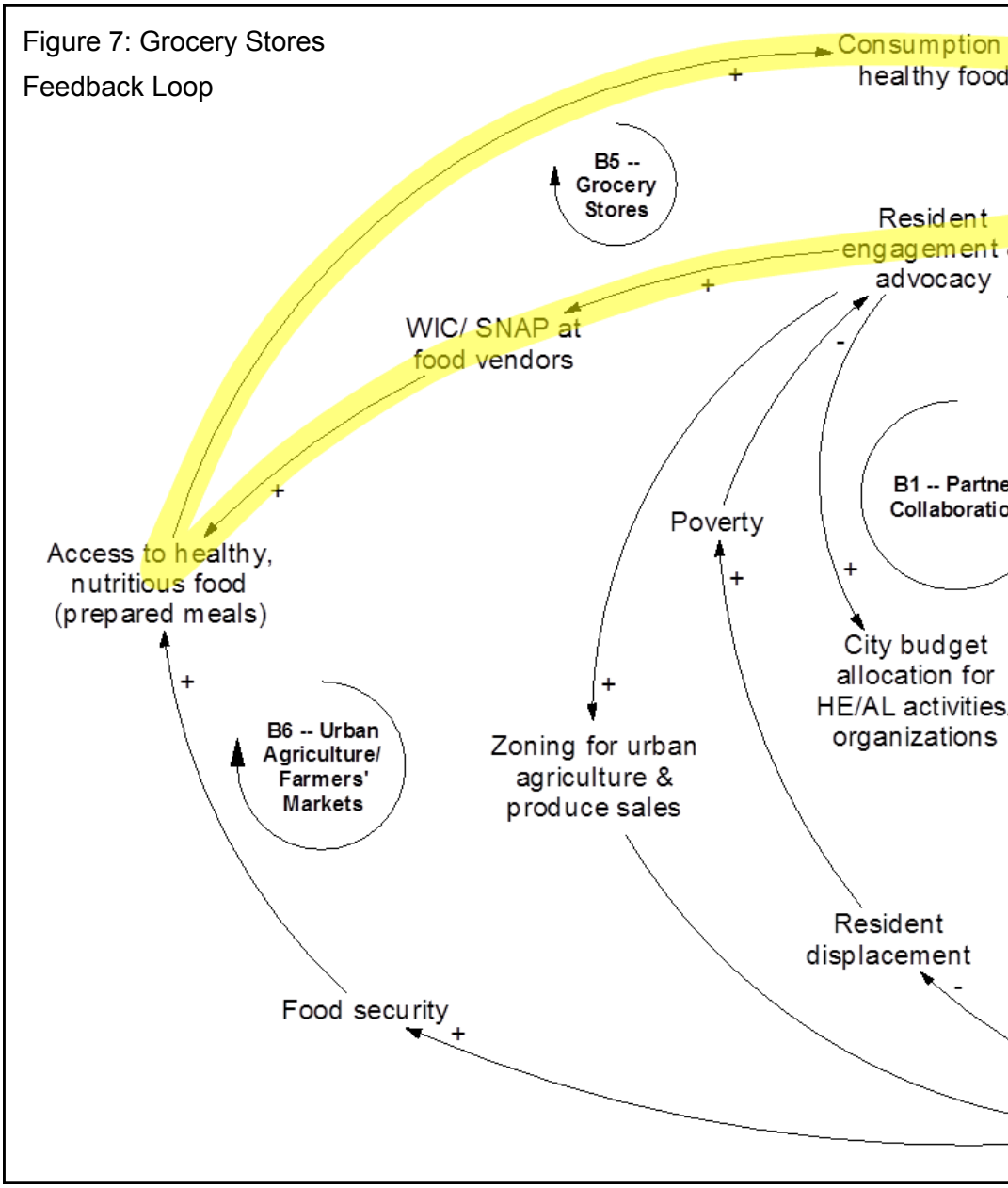
Grocery Stores Feedback Loop

The yellow loop in Figure 7 reflects the grocery stores strategy implemented by the *HKHC Denver Coalition* as one of the primary strategies to increase healthy eating in Denver, Colorado.

Causal Story for Feedback Loop

Story A: Denver partners supported the opening of two markets in areas designated as food deserts and the acceptance of Supplemental Nutrition Assistance Program (SNAP) benefits at the markets. Increasing the acceptance of WIC and SNAP vouchers at markets and constructing new markets increase local residents' access to healthy, nutritious foods, particularly in food deserts. In turn, these efforts help to increase consumption of healthy foods by local residents. As consumption improves, rates of childhood overweight and obesity decline, reducing the need for advocacy for more markets — particularly those accepting WIC and SNAP vouchers — in areas where these markets are already established.

Figure 7: Grocery Stores Feedback Loop



Story B: Yet, without the markets or acceptance of WIC and SNAP benefits in the markets, access to healthy, nutritious food decreases and residents are less likely to consume these foods. With poorer nutrition, rates of overweight or obese children increases and parents and other residents are more likely to engage in advocacy efforts to increase access to healthy, nutritious food.

Reinforcing Loop and Notation

This is another balancing loop (one "-" sign). Similar to the other loops, it includes causal relationships representing more immediate effects (e.g., the influence of WIC and SNAP benefits on access to healthy, nutritious food) as well as more delayed effects not depicted here (e.g., how consumption of healthy food affects childhood obesity).

System Insights for *Denver HKHC Coalition*

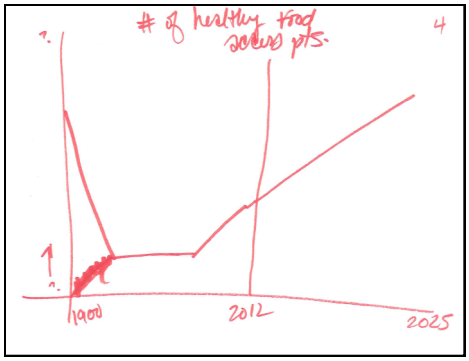
With the behavior over time graphs, participants illustrated how the number of healthy food access points dropped off significantly after 1900, leveled off for a number of years, and began to increase again before 2012, with the hope that this increase will continue into the future (graph on top right of next page). For

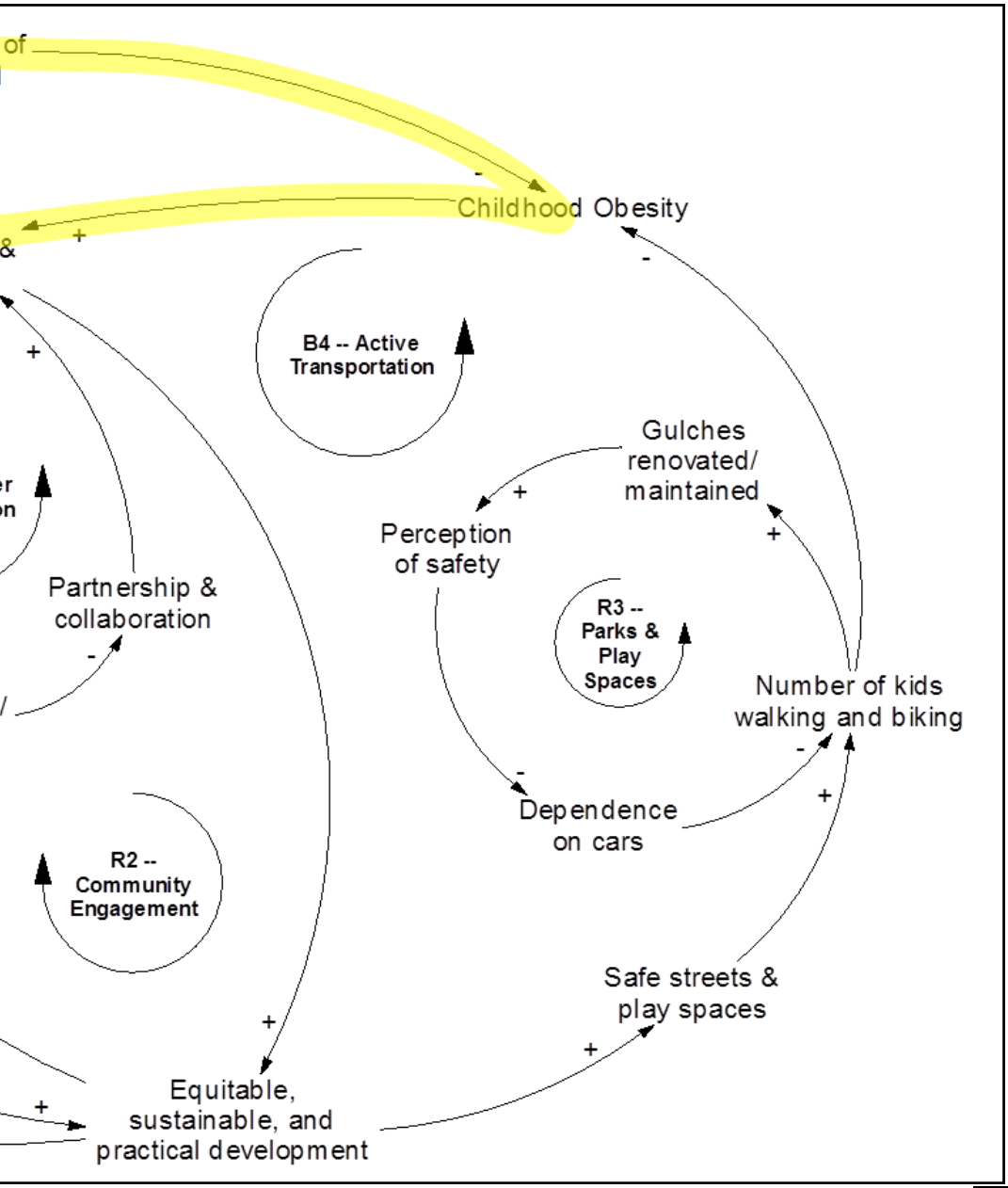
"We can come together and get EBT at the market so that's our first engagement, but if the community doesn't know, if there's not that awareness, then the program isn't going to succeed." **(Participant)**

vendors accepting SNAP benefits, participants showed that this is a more recent improvement and only a handful of vendors participate in this program to date, with the hope that this participation will increase dramatically into the future (see bottom right).

System insights for the partnership's grocery stores efforts include:

- Understanding the history of Denver (i.e., having a high number of healthy food access points) and the reasons for the dramatic decline over the last century may help to fuel insights and approaches to continue to increase access to healthy, nutritious food for these residents.

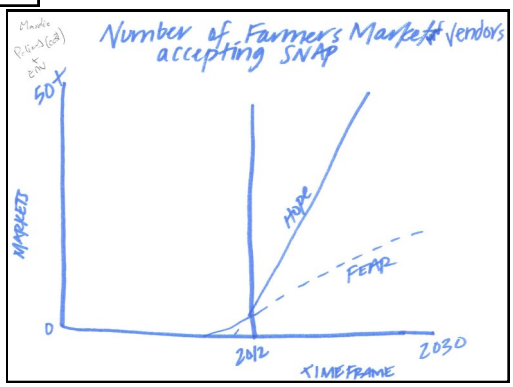




- With the low numbers of food vendors accepting SNAP benefits, strategies to engage residents in advocacy initiatives to demonstrate demand for these services in the community may push this agenda forward.
- At the same time, residents need to be made aware of the food vendors accepting WIC or SNAP benefits so that vendors view these services as a good investment of their time and effort (see quote at the bottom of the previous page).

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

- How many food vendors (e.g., grocery stores, farmers' markets, corner stores) have EBT machines and accept SNAP benefits? Accept WIC vouchers?
- How many residents are WIC or SNAP recipients? What is the average distance residents have to transport themselves in order to purchase foods and beverages using SNAP benefits or WIC vouchers?
- In what ways have residents engaged in advocacy efforts to increase the total number of food vendors accepting WIC or SNAP? How have residents influenced decision-makers?



Urban Agriculture/Farmers' Markets Feedback Loop

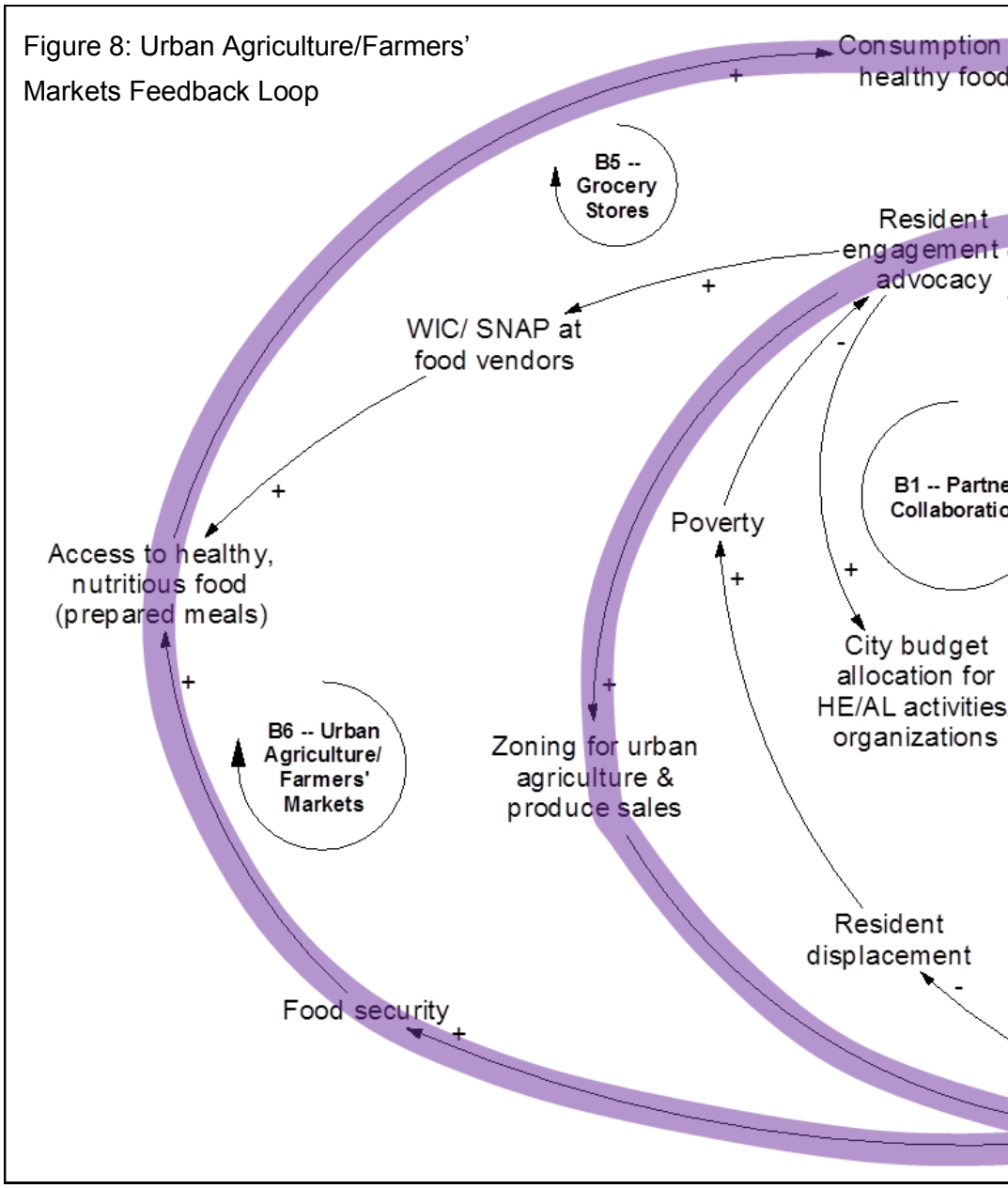
Another strategy to increase healthy eating in Denver, Colorado involves urban agriculture and produce sales in farmers' markets. This strategy is highlighted in purple in Figure 8.

Causal Story for Feedback Loop

Story A: Denver partners supported creation of a 1-acre urban farm as well as a covered hoop house in the Westwood neighborhood as well as a couple of community gardens. In order to protect urban agriculture, zoning codes were adopted with language on the gardens, greenhouses, and mixed-use developments. Zoning policies for urban agriculture and produce sales increase equitable, sustainable, and practical development patterns that help to increase food security and access to healthy, nutritious food. With improved access, residents consume more healthy foods and the rates of childhood obesity decrease, which minimizes the need for resident advocacy efforts and new zoning policies.

Story B: Alternatively, the lack of zoning policies to support urban agriculture and produce sales limits the associated development patterns supporting greater food security and increased access to healthy, nutritious food. In turn, fewer people consume healthy foods and rates of childhood overweight and obesity increase due to poor nutrition. These rates stimulate parents and other residents to engage in advocacy efforts to develop and adopt zoning policies to reverse this downward spiral.

Figure 8: Urban Agriculture/Farmers' Markets Feedback Loop



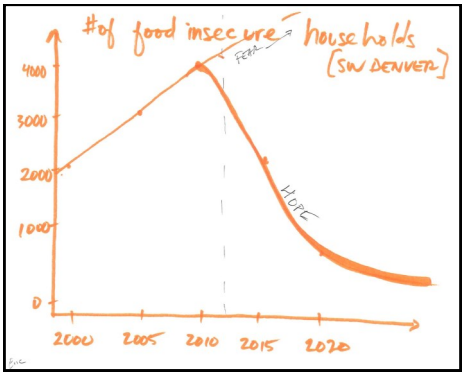
Reinforcing Loop and Notation

Similar to most of the previous loops, this one is also a balancing loop (one "-" sign). This loop has causal relationships representing more immediate effects (e.g., the influence of zoning policies for urban agriculture and produce sales on equitable, sustainable, and practical development), and, potentially, delayed effects (e.g., the influence of these development patterns on food security).

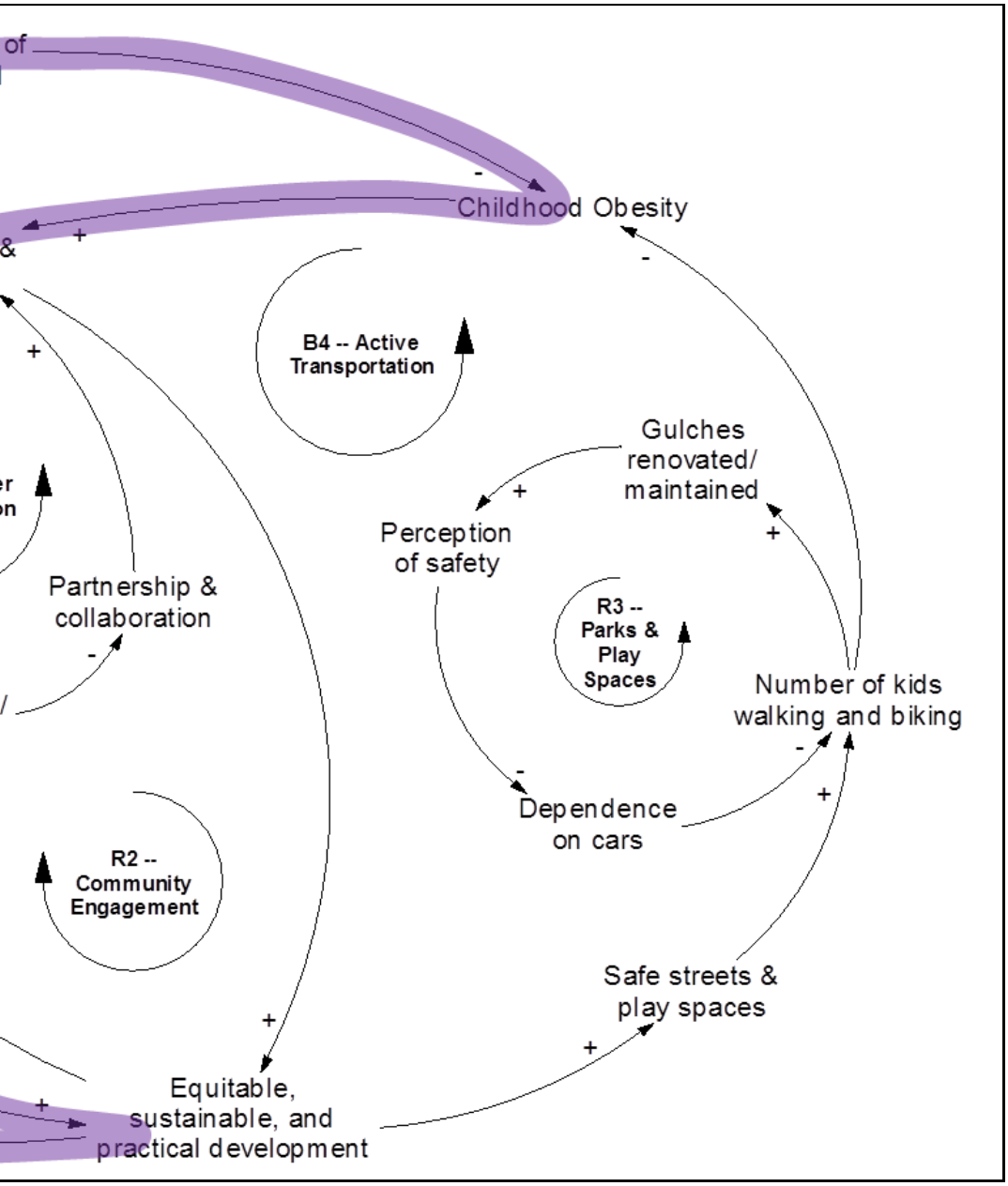
"The number of farms and gardens in low-income communities directly affects their overall food security, whereas if there's a change in any of the global food and food prices go up, that's then affecting, I guess you would say, equitable development or equitable access…" **(Participant)**

System Insights for *Denver HKHC Coalition*

In the behavior over time graphs exercise, participants described how the number of food insecure households in Southwest Denver has been

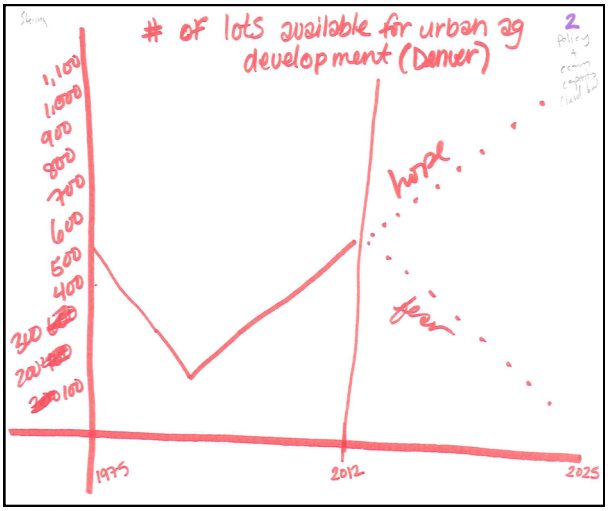


increasing since 2000 with a recent shift in direction of the trend and a hope that this shift continues to decline into the future (see top right). Participants also described how the number of lots available for urban agriculture in Denver declined after 1975 with a turnaround in the 80's or early 90's and the hope that this shift will continue to increase into the future.



System insights for the partnership's urban agriculture/ farmers' markets efforts include:

- Demand for increased food security and the availability of lots for urban agriculture create the "perfect storm" to create a food production, distribution, and sales system that serves the whole population.
- Collaboration across planners working on zoning policy development, developers working on equitable, sustainable, and practical development patterns, and residents describing their needs in the community can increase the momentum of these initiatives.



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

- What is the proportion of the population that is food insecure? How much produce is required to meet the demands of this population?
- What is the potential for local food production given the urban lots available for agriculture?
- What development patterns will sustain the ability to meet these food production requirements into the future?

Opportunities for Systems Thinking in Denver, Colorado

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 *Denver HKHC Coalition* partners, this storybook also summarized the healthy eating, active living, partnership and community capacity, social determinants, and health and health behaviors subsystems in the Denver, Colorado causal loop diagram as well as six specific feedback loops corresponding to the partnership's primary strategies.

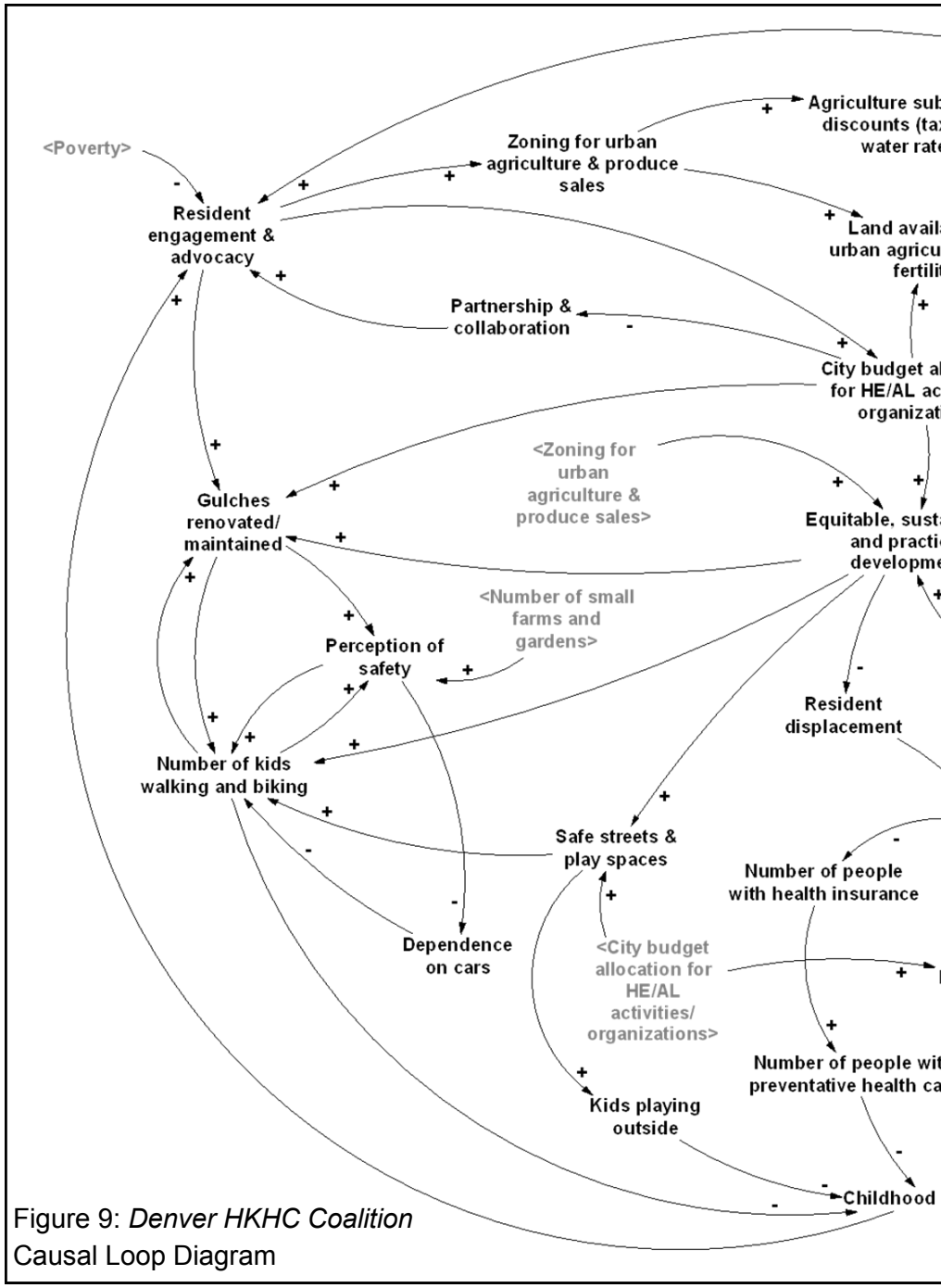


Figure 9: *Denver HKHC Coalition* Causal Loop Diagram

This causal loop diagram reflects a series of conversations among partners and residents from 2012 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.

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

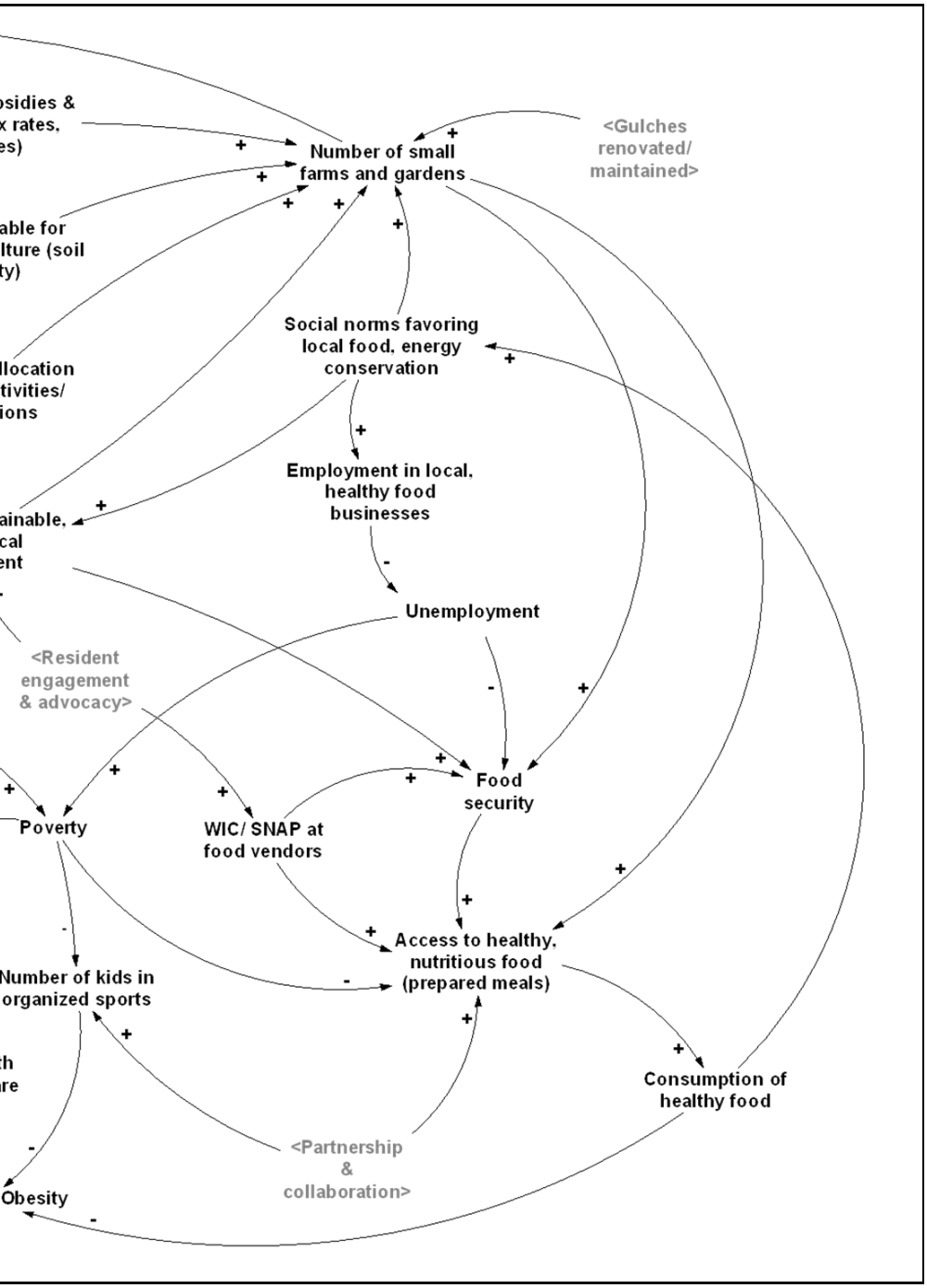
Yet, there are several limitations to this storybook, including:

- the participants represent a sample of the *Denver HKHC Coalition* 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 E) 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 any feedback loops, including ER visit, youth character development, drought/ lack of water retention, livable wage jobs, demand for services, number of parks, crime, quality school PE and recess, social media, private sector dollars, both parents working outside household, number of fast food restaurants, healthy meals in local institutions, concern about origin of food, consumption of locally grown foods; 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 Denver, Colorado 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 *Denver HKHC Coalition* Causal Loop Diagram
- Appendix C: Original translation of the causal loop diagram into Vensim PLE
- Appendix D: Transcript translation of the causal loop diagram into Vensim PLE
- Appendix E: 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.

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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.

System Dynamics in Education Project. (1994). Road maps: A guide to learning system dynamics. Retrieved from http://www.clexchange.org/curriculum/roadmaps/

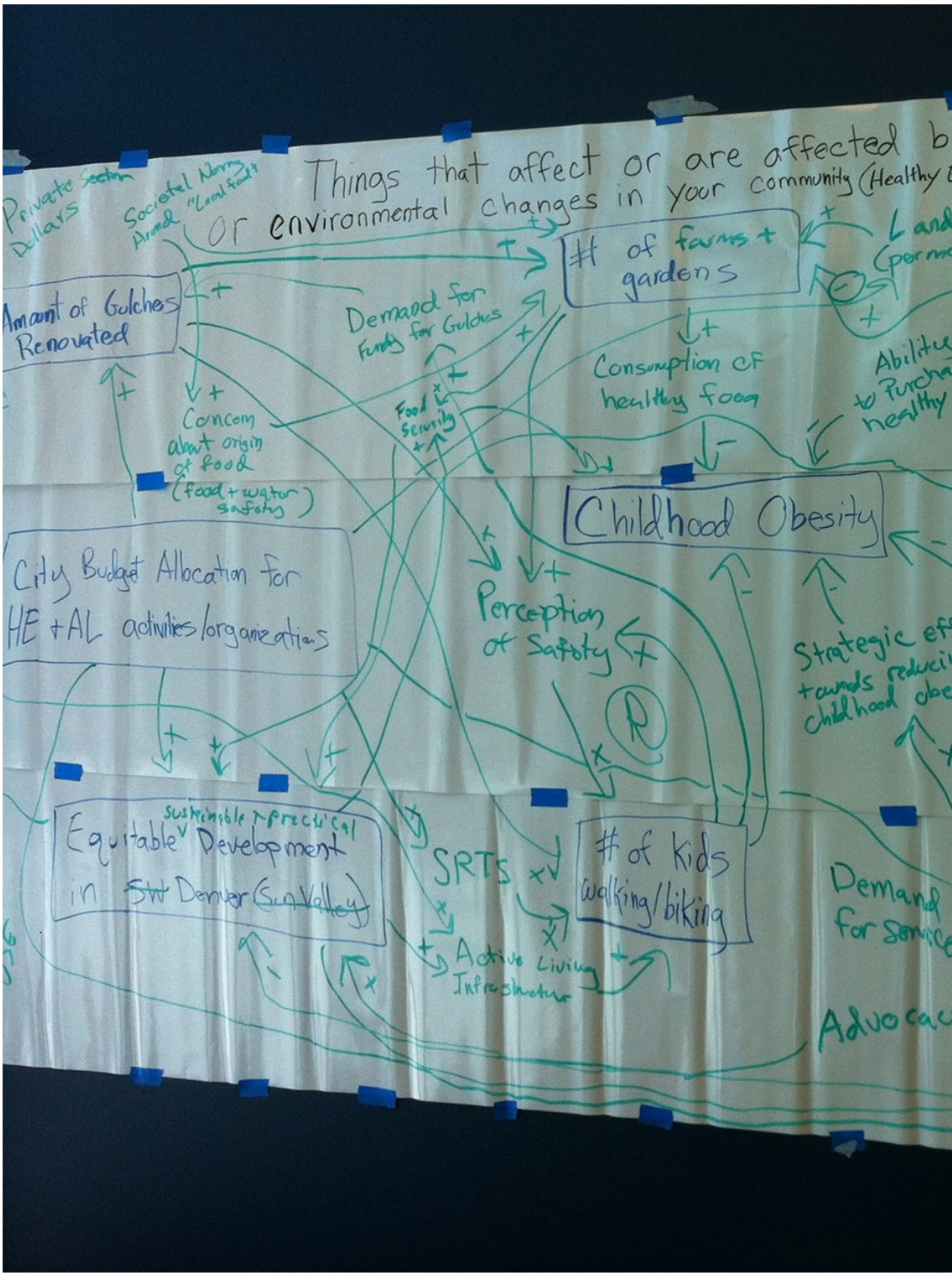
Vennix, J. (1996). Group model building. New York, John Wiley & Sons.

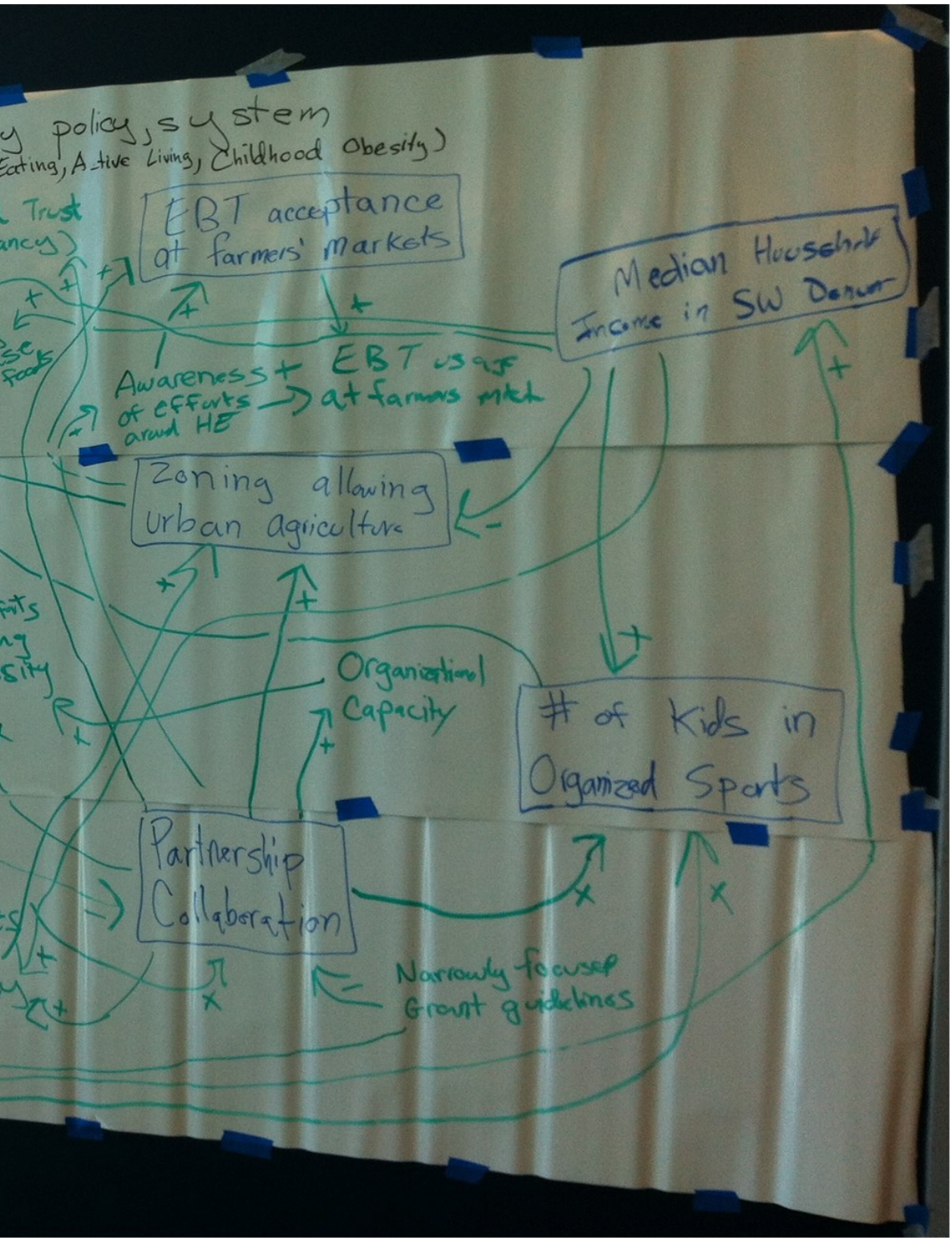
Zagonel, A. and J. Rohrbaugh (2008). Using group model building to inform public policy making and implementation. Complex Decision Making. H. Qudart-Ullah, J. M. Spector and P. I. Davidsen, Springer-Verlag: 113-138.

Appendix A: Behavior Over Time Graphs Generated during Site Visit

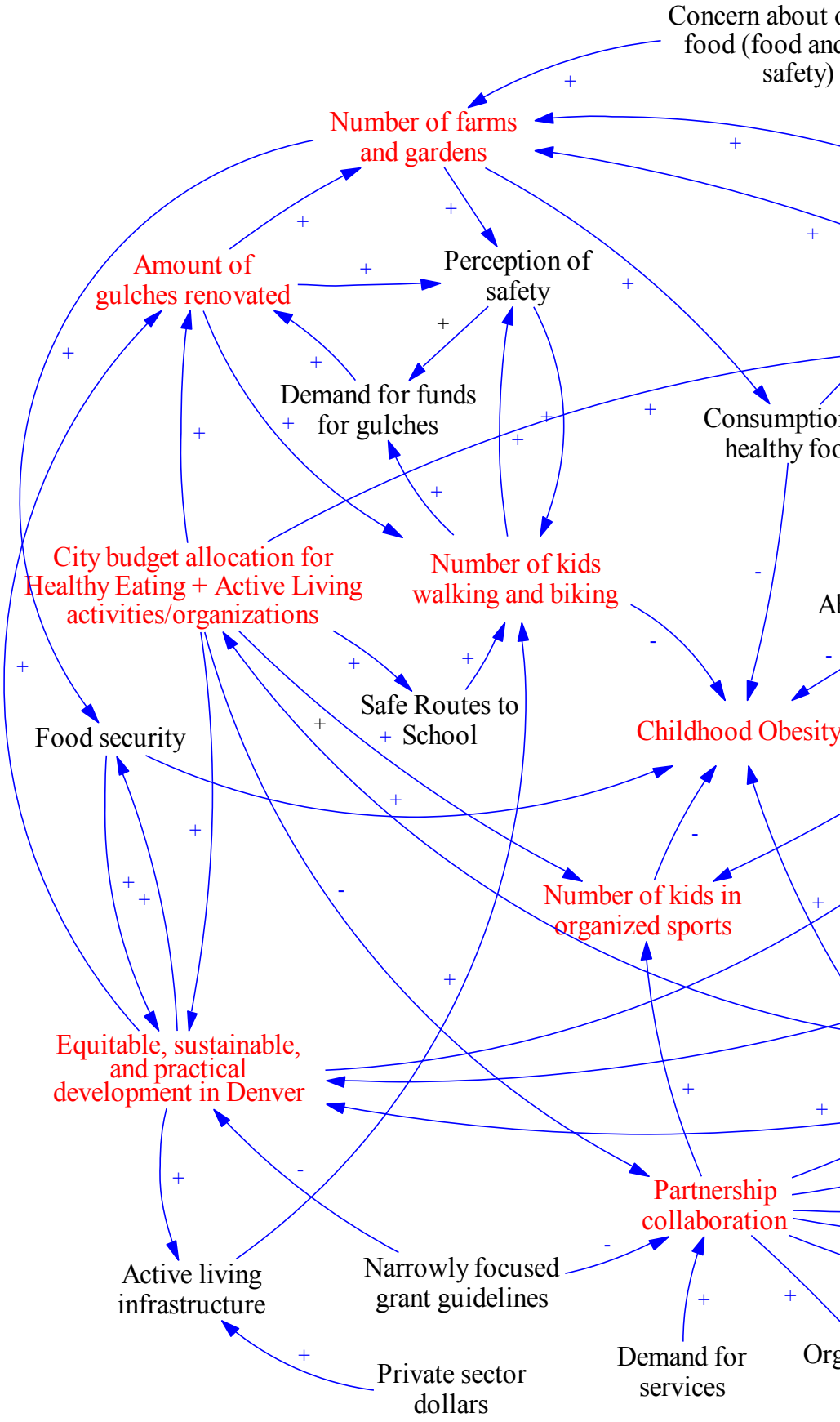
Denver, Colorado: *Denver Healthy Kids, Healthy Communities Coalition*	
Categories	**Number of Graphs**
Active Living Behavior	4
Active Living Environments	2
Funding	0
Healthy Eating Behavior	6
Healthy Eating Environments	7
Marketing and Media Coverage	0
Obesity and Long Term Outcomes	1
Partnership & Community Capacity	3
Policies	5
Programs & Promotions (Education and Awareness)	1
Social Determinants of Health	4
Total Graphs	**33**

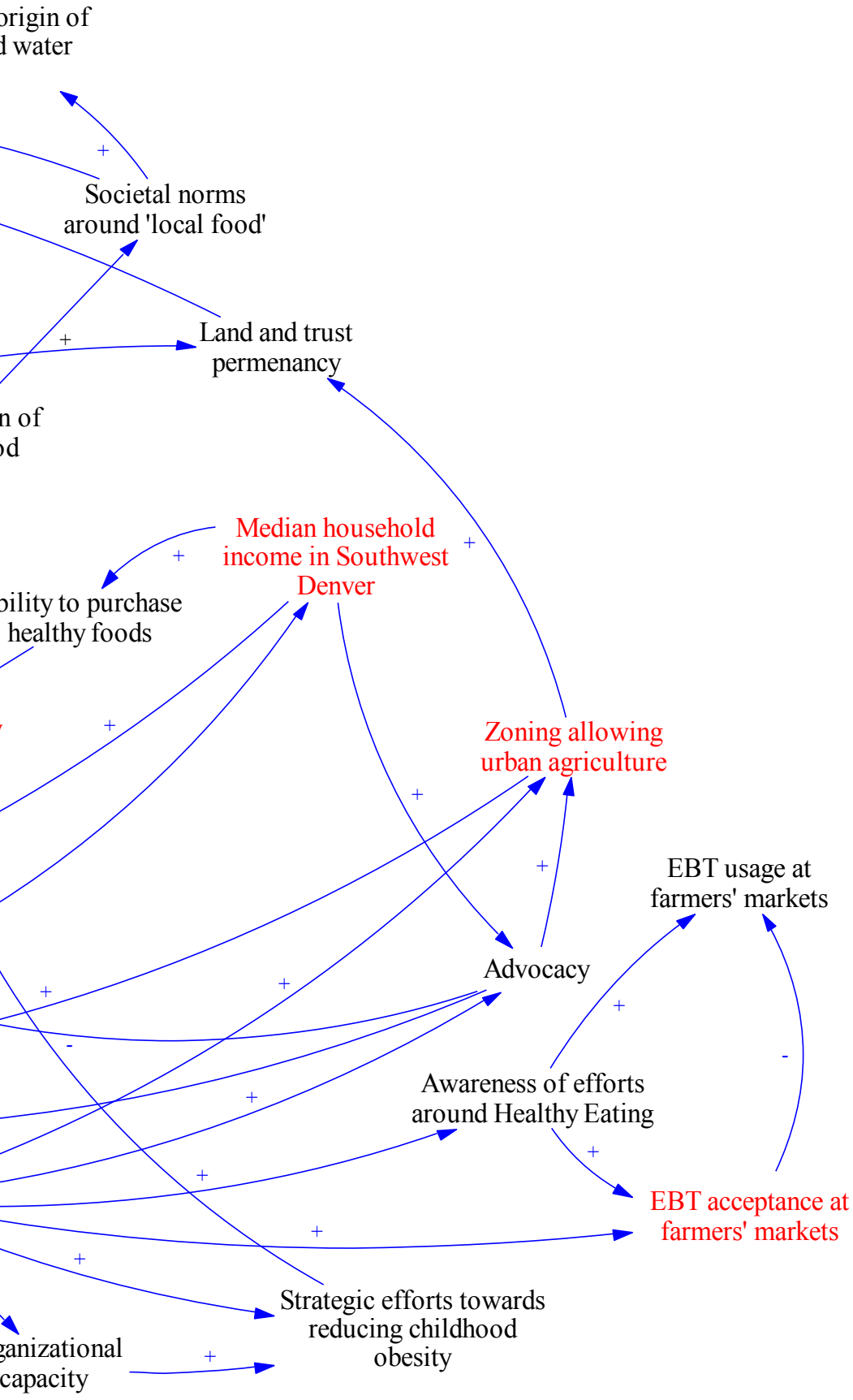
Appendix B: Photograph of the Original Version of the *Healthy Kids, Healthy Communities Denver* Causal Loop Diagram



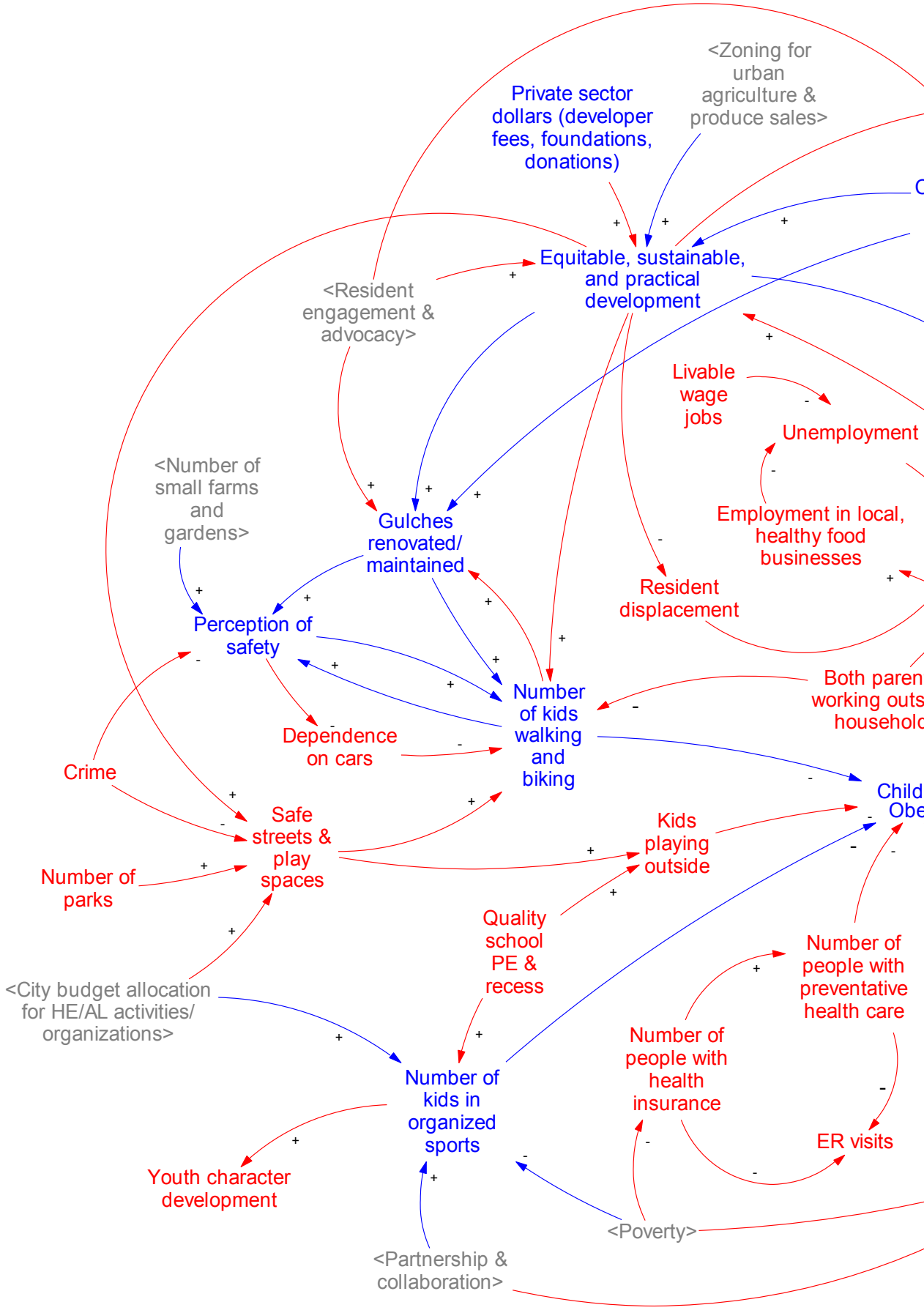

y policy, system
Eating, Active Living, Childhood Obesity)
Trust
ancy)
EBT acceptance at farmers' markets
Median Household Income in SW Denver
Awareness of efforts arund HE
EBT usage at farmers mkts
Zoning allowing urban agriculture
Organizational Capacity
# of Kids in Organized Sports
Partnership Collaboration
Narrowly focused Grant guidelines

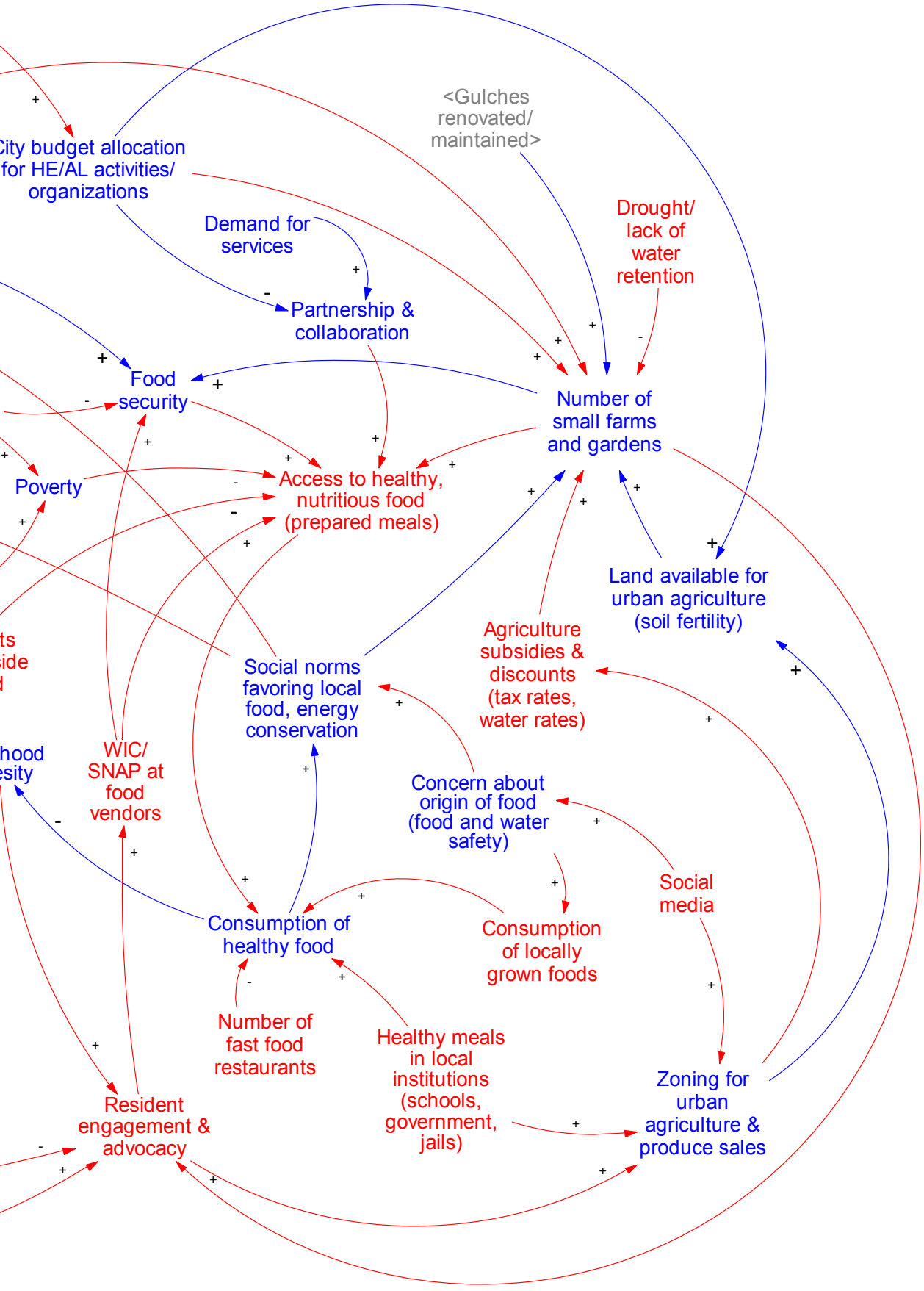
Appendix C: Original Translation of the Causal Loop Diagram into Vensim PLE



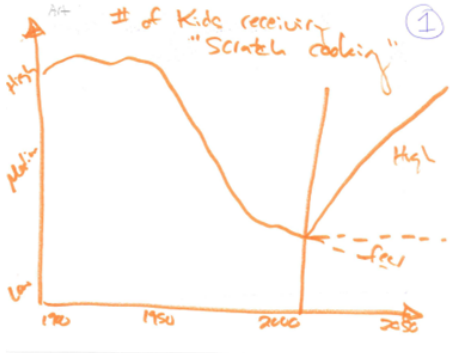

origin of
d water
Societal norms
around 'local food'
Land and trust
permenancy
n of
od
Median household
income in Southwest
Denver
bility to purchase
healthy foods
Zoning allowing
urban agriculture
EBT usage at
farmers' markets
Advocacy
Awareness of efforts
around Healthy Eating
EBT acceptance at
farmers' markets
Strategic efforts towards
reducing childhood
obesity
ganizational
capacity

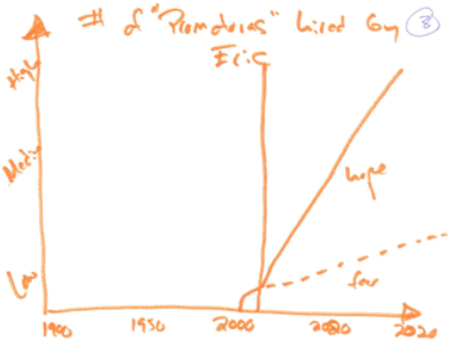
Appendix D: Transcript Translation of the Causal Loop Diagram into Vensim PLE

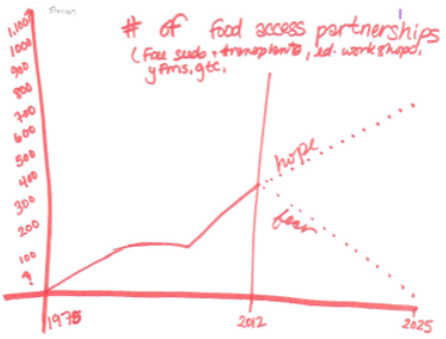


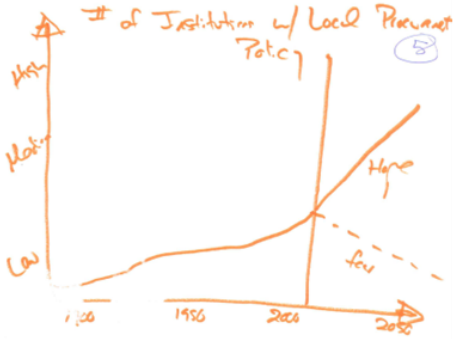

City budget allocation for HE/AL activities/ organizations
<Gulches renovated/ maintained>
Drought/ lack of water retention
Demand for services
Partnership & collaboration
Food security
Number of small farms and gardens
Poverty
Access to healthy, nutritious food (prepared meals)
Land available for urban agriculture (soil fertility)
Agriculture subsidies & discounts (tax rates, water rates)
Social norms favoring local food, energy conservation
WIC/ SNAP at food vendors
Concern about origin of food (food and water safety)
Social media
Consumption of healthy food
Consumption of locally grown foods
Number of fast food restaurants
Healthy meals in local institutions (schools, government, jails)
Zoning for urban agriculture & produce sales
Resident engagement & advocacy

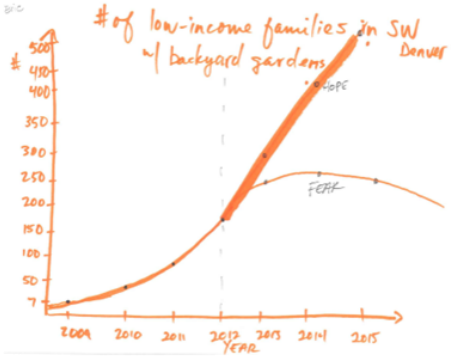
Appendix E: Behavior Over Time Graphs not Represented in the Storybook

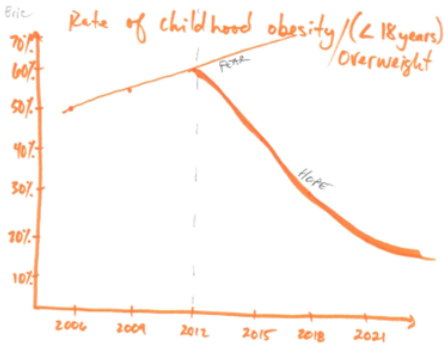


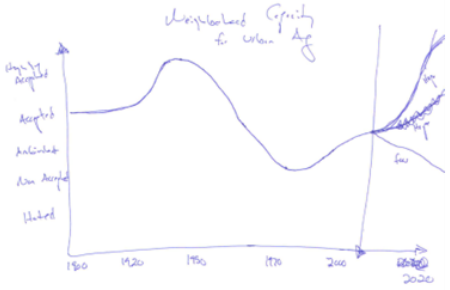


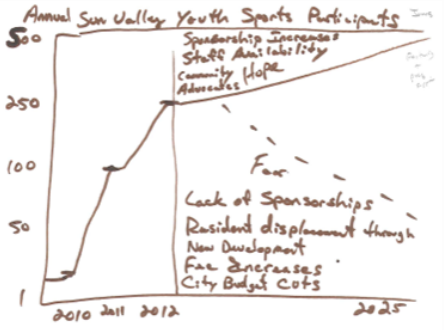


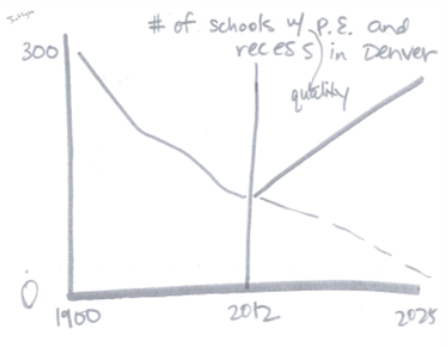


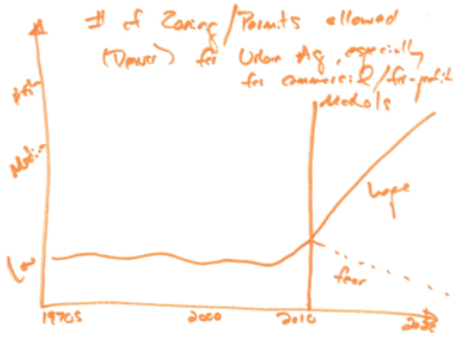


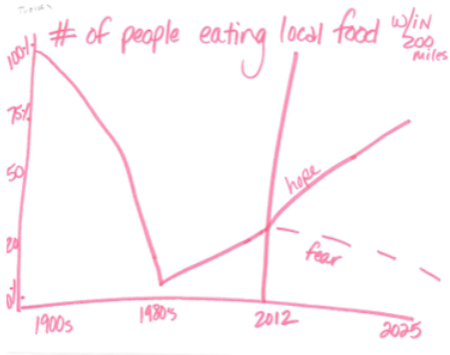


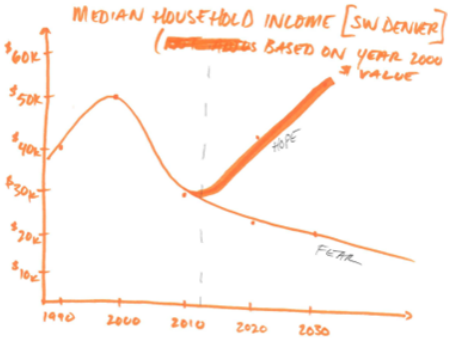




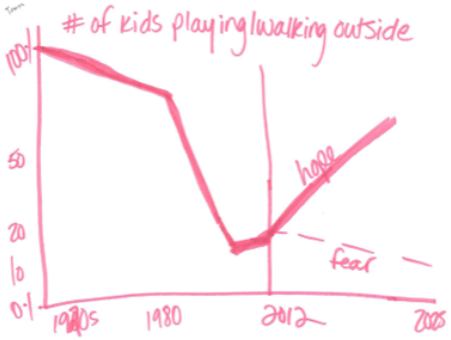


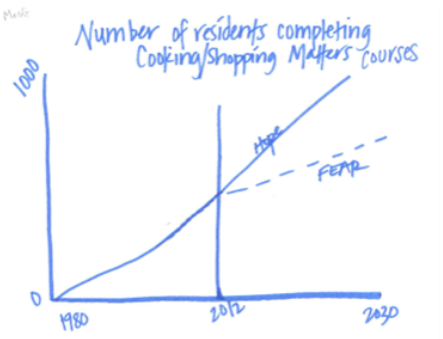


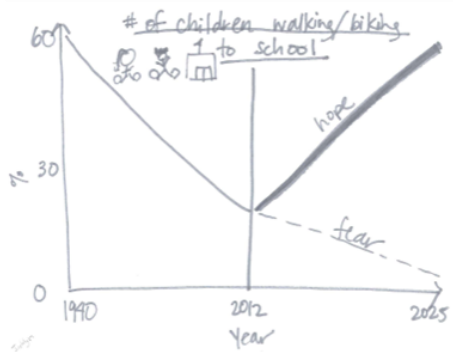


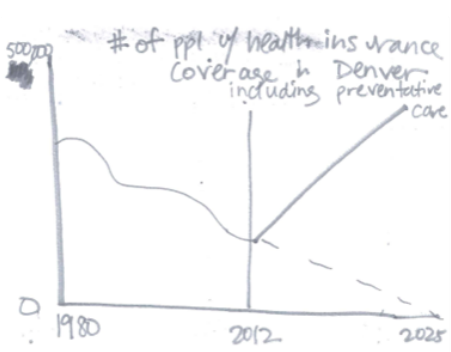

MEDIAN HOUSEHOLD INCOME [SW DENVER]
BASED ON YEAR 2000 $ VALUE
$60K
$50K
$40K
$30K
$20K
$10K
HOPE
FEAR
1990
2000
2010
2020
2030

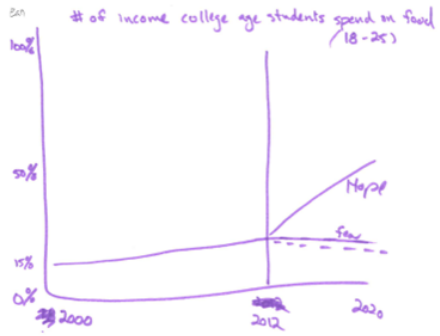
Number of residents using SNAP at farmers Markets
100%
0%
hope
FEAR
1980
2012
2025

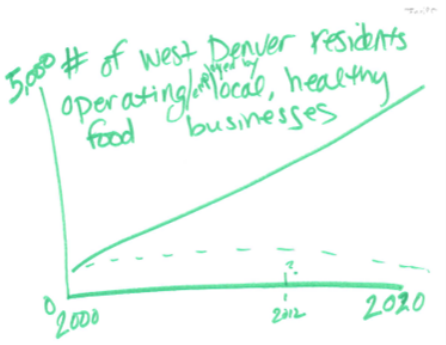

# of kids playing/walking outside
100
50
20
10
0
hope
fear
1980
2012
2025


Number of residents completing Cooking/Shopping Matters courses
1000
0
hope
FEAR
1980
2012
2030


# of children walking/biking to school
60
30
0
hope
fear
1990
2012
2025
Year

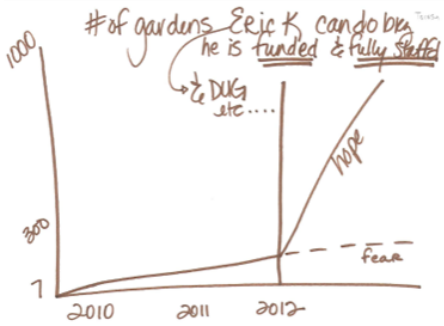

# of ppl of health insurance Coverage in Denver including preventative care
500,000
0
1980
2012
2025

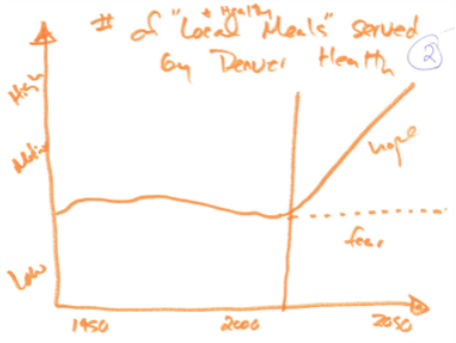

# of income college age students spend on food (18-25)
100%
50%
15%
0%
Hope
fear
2000
2012
2020


5000
# of West Denver residents operating/offered by local, healthy food businesses
0
2000
2012
2020

Number of Farmers Market Vendors accepting SNAP
50
MARKET
0
hope
FEAR
2012
2030
TIMEFRAME

300,000
# of fast food restaurants in U.S.
0
hope
1920
2012
2025


# of gardens Eric K can do bc he is funded & fully staffed
& DUG etc....
1000
300
1
hope
Fear
2010
2011
2012


of "Local Meals" served by Denver Health
(2)
High
Medium
Low
hope
fear
1950
2000
2050