Systems Thinking in Communities:

Understanding the Causes of Inactivity, Poor Diet/Nutrition, and Childhood Obesity in Grant County, New Mexico

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Introduction

Healthy Kids, Healthy Communities Grant County (HKHC Grant County) 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 *HKHC Grant County* project was to introduce systems thinking at the community level by identifying the essential parts of the Grant County, New Mexico 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, advocacy organizations) 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.

Grant County, New Mexico: Background and Local Participation

Grant County, located in the southwest corner of New Mexico, is surrounded by natural beauty. Situated amongst the rugged beauty of mountains, forest, and grassland, Grant County is home to Gila National Forest and the Gila and Mimbres Rivers. Grant County's biggest asset also serves as its biggest challenge; poverty, isolation, and a lack of infrastructure to harness the surrounding environment have led to high obesity rates and a lack of access to healthy eating and physical activity opportunities.

Led by the Grant County Community Health Council, organizations and stakeholders have been working in the community to address obesity for many years. Since 2007, the Health Council's Fitness and Nutrition Community Action Committee (FAN-C) has been collaborating to improve healthy eating and physical activity opportunities in area schools, restaurants, parks, and open spaces. Healthy Kids, Healthy Communities funding established a new partnership under the Health Council*, Healthy Kids, Healthy Communities Grant County*. There were over 20 partners initially associated with the partnership; partnership members included non-profit organizations, advocacy groups, county and city government staff, elected officials, and community residents. The partnership established a board that met monthly. The HKHC partnership had strong ties and overlap with FAN-C, but HKHC was created specifically to address childhood obesity in Grant County. Initially, FAN-C acted as a community action group for the HKHC board, under the direction of the first Project Coordinator. FAN-C and HKHC did not merge into one entity because FAN-C focused many of their efforts on the elderly. FAN-C ceased their monthly meetings, in part because of the crossover between members and heavy involvement in HKHC meetings. Significant staff transitions occurred midway through the grant and a new Project Director and Project Coordinator were hired in 2012. The new Project Director, concerned with the crossover and duplication between HKHC and FAN-C, directed the Project Coordinator to begin separating the efforts. Separation of the groups led to changes in involvement for many FAN-C members. As FAN-C reestablished itself, HKHC became a representative within FAN-C. The HKHC partnership no longer conducted full partnership meetings; HKHC staff instead cultivated project-specific relationships with partners and community members.

Healthy Kids, Healthy Communities Grant County's Priorities and Strategies

The partnership and capacity building strategies of HKHC Grant County included:

- **Food Policy Council:** Grant County adopted a resolution in 2010 to establish the Grant County Food Policy Council. In 2013, the council identified three priority areas related to food needs assessment planning, local food production, and water rights.

The healthy eating and active living strategies of HKHC Grant County included:

- **Active Transportation:** HKHC Grant County collaborated to implement environmental changes and update planning documents and zoning code to support active transportation throughout Grant County. The partnership also established a Walking School Bus program to encourage youth to walk to school on a regular basis.
- **Access to Healthy Food:** The partnership collaborated to increase access to healthy food at grocery stores and farmers' markets throughout Grant County. New markets were created and a county-wide accounting system was created to establish food assistance program access at area farmers' markets. HKHC Grant County also partnered with a local grocery store owner to implement healthy check-out lanes at two stores.

For more information on the partnership, please refer to the Grant County case report (http://www.transtria.com/hkhc_case_reports.php).

Systems Thinking in Communities: Grant County, New Mexico

"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 Grant County, New Mexico 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.

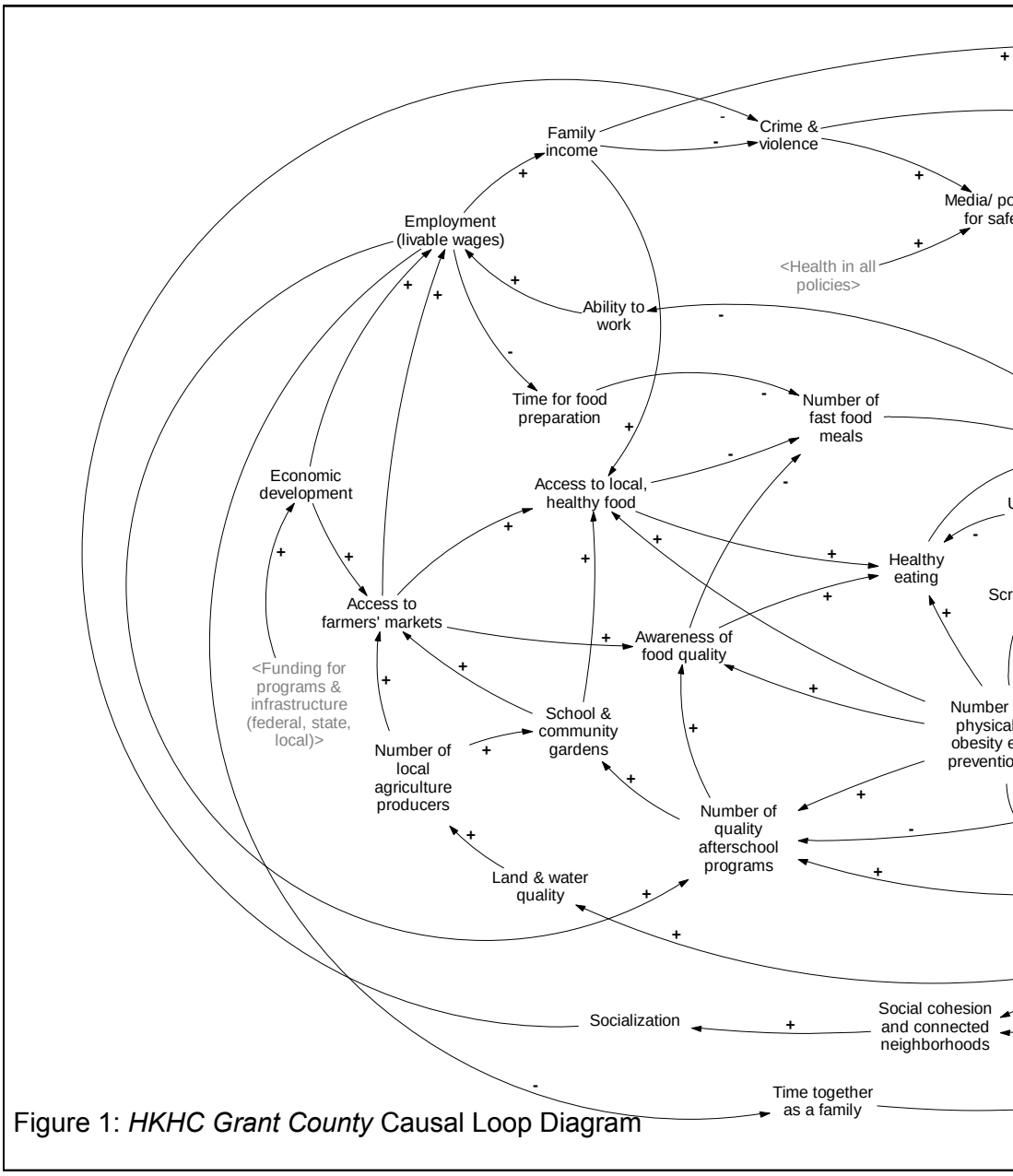
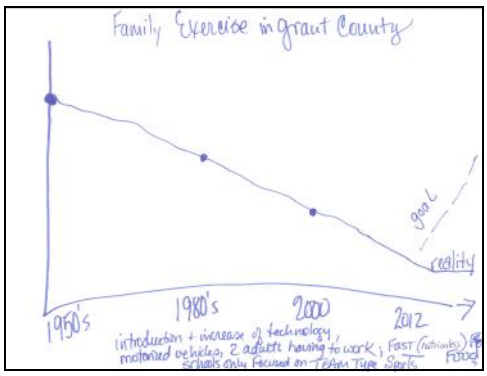


Figure 1: *HKHC Grant County* Causal Loop Diagram

Group Model Building

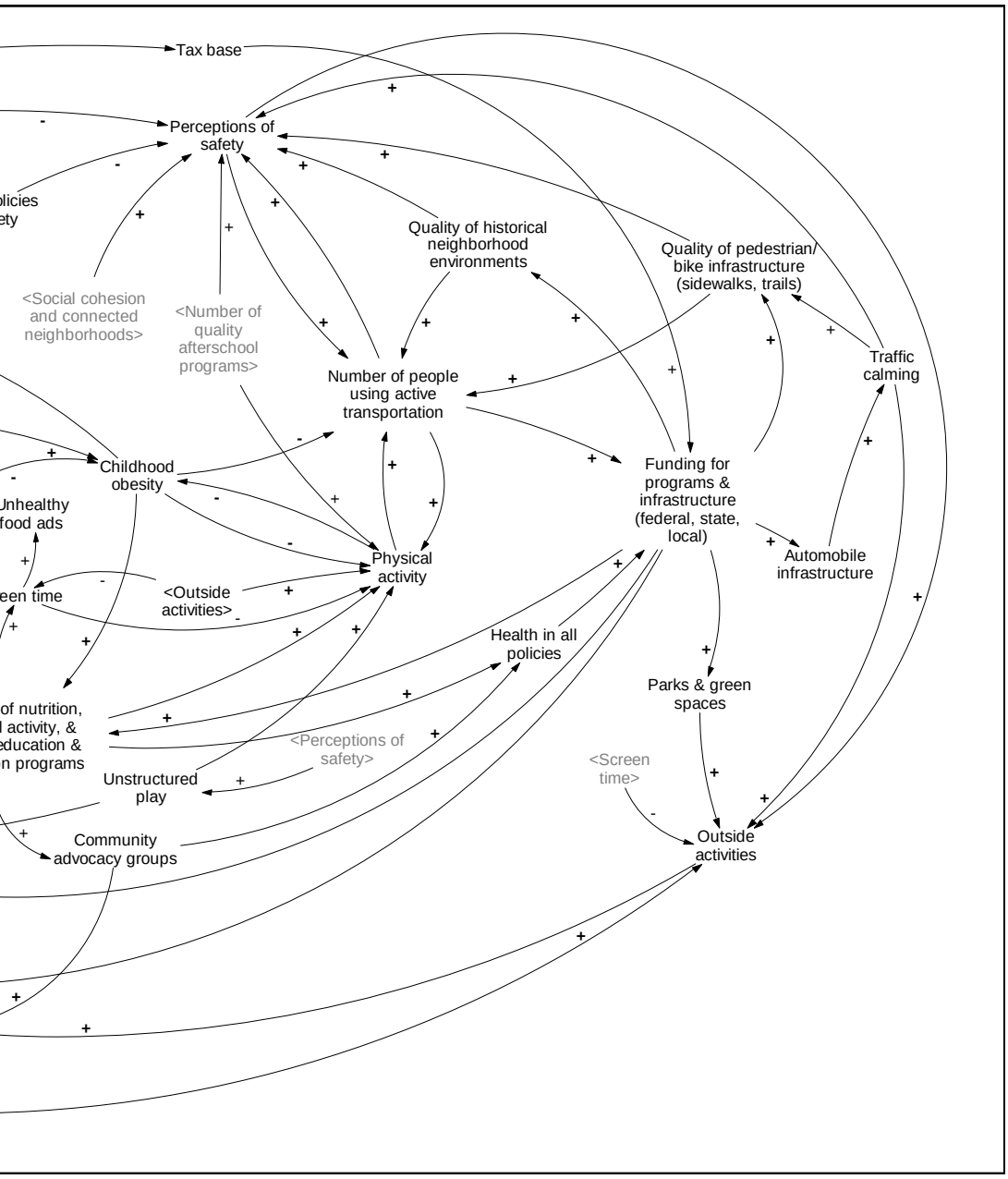
Members of the *HKHC Grant County* partnership participated in a group model building session in October, 2012 and generated this system. also referred to as a causal loop diagram (Figure 1). Participants in the group model building session included community members and representatives from government agencies, and community-based and policy organizations. 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.



Behavior Over Time Graphs

To identify the range of things that affect or are affected by policy, system, and environmental changes in Grant County 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 family exercise, the number of families exercising has decreased

from 1950 to 2012 and the participant hopes that the number of families exercising will increase 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 physical activity in this causal loop diagram. One feedback loop is: physical activity → childhood obesity → the number of nutrition, physical activity, and obesity education and prevention programs → physical activity. A second feedback loop is: physical activity → childhood obesity → the number of people using transportation → physical activity.

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 physical activity. Some variables may increase physical activity while other variables limit physical activity. 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.

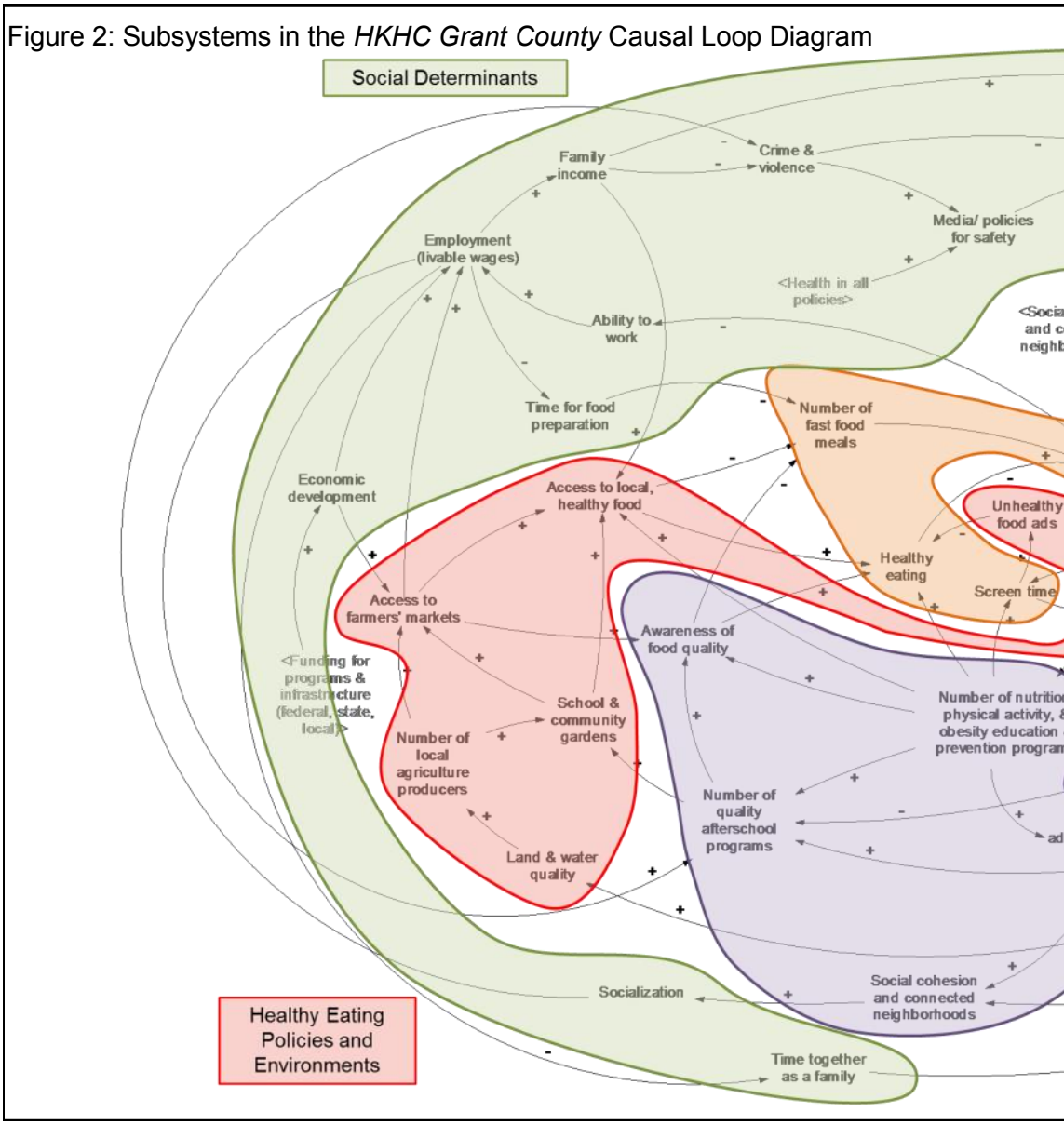
Based on this preliminary work by the *HKHC Grant County* partnership, this "storybook" ties together the behavior over time graphs, the participants' stories and dialogue, and feedback loops from the causal loop diagram to understand the behavior of the system affecting health in Grant County, New Mexico and to stimulate greater conversation related to Grant County'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 Grant County, New Mexico. 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 *HKHC Grant County* Causal Loop Diagram



Healthy Eating Policies and Environments (Red)

The healthy eating policy and environmental subsystem includes food production (e.g., school and community gardens, number of local agriculture producers), food distribution and procurement (e.g., access to local healthy food), and food retail (e.g., access to farmers' markets). During the behavior over time graphs exercise, the participants generated six graphs related to policy or environmental strategies (e.g., access to farmers' markets) or contexts (e.g., land and water quality) that affected or were affected by the work of *HKHC Grant County*. 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 19 graphs related to policy or environmental strategies (e.g., quality of pedestrian/bike infrastructure) or contexts (e.g., automobile infrastructure) that affected or were affected by the partnership's work.

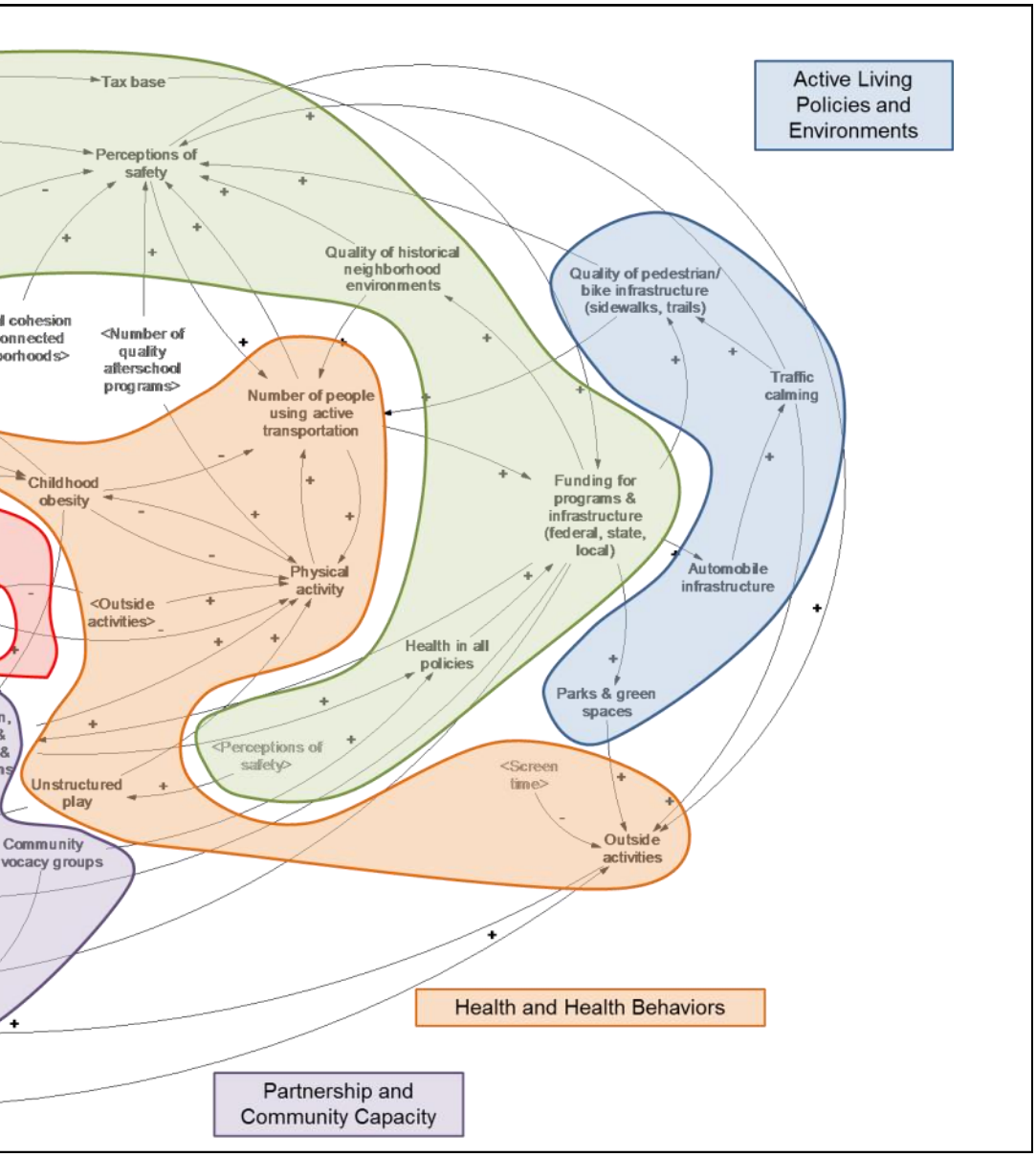
Health and Health Behaviors (Orange)

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., number of fast food meals, unstructured play).

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, *HKHC Grant County* had community advocacy groups that were instrumental in helping to achieve changes in the community. This subsystem also includes community factors outside the partnership that may influence or be influenced by their efforts, such as socialization or social cohesion and connected neighborhoods.



Social Determinants

Finally, the social determinants subsystem denotes societal conditions (e.g., crime and violence, family income, funding for programs and infrastructure) 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 *HKHC Grant County* partners or by other representatives in Grant County, New Mexico. 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 perceptions of safety, number of people using active transportation, and physical activity.

The next sections begin to examine the feedback loops central to the work of *HKHC Grant County.* 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 *HKHC Grant County* CLD (see Figures 1 and 2) are highlighted in Figures 3-9. While the CLD provides a theory of change for the childhood obesity prevention movement in Grant County, New Mexico, 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 Food Policy Council influence on healthy eating (green highlighted loop in Figure 3). Participants described how with an increase in the number of nutrition, physical activity, and obesity education and prevention programs, there is an increase in access to local, healthy foods, which increases healthy eating. In turn, childhood obesity is decreasing which is decreasing the number of nutrition, physical activity, and obesity education and prevention programs.

Story B: While the preceding story reflected a positive scenario for Grant County, New Mexico; the same feedback loop also tells the opposite story. A decrease in the number of nutrition, physical activity, and obesity education and prevention programs, there is a decrease in access to local, healthy foods, which decreases healthy eating. In turn, childhood obesity is increasing which is increasing the number of nutrition, physical activity, and obesity education and prevention programs.

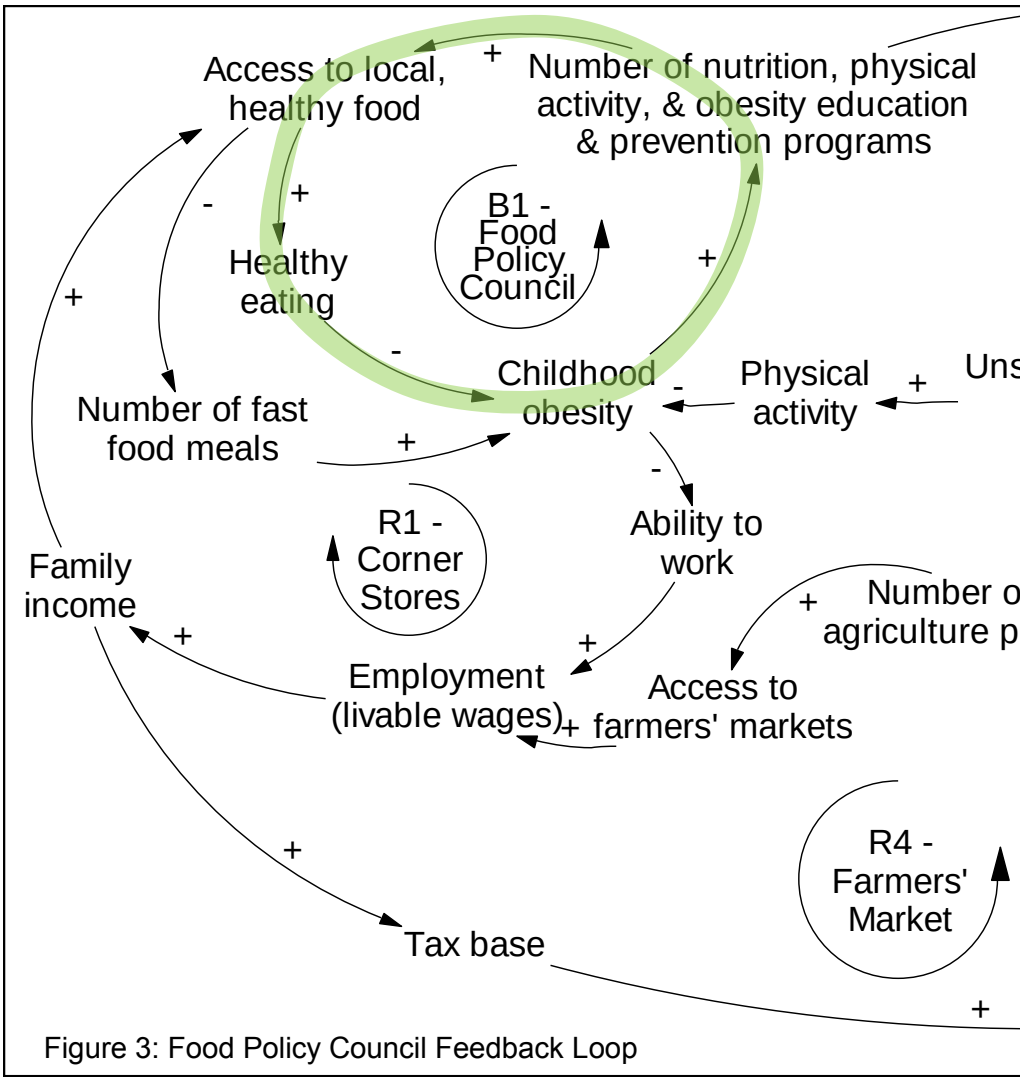


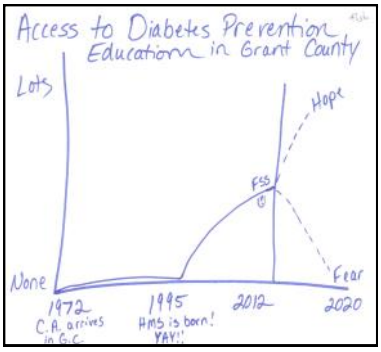
Figure 3: Food Policy Council Feedback Loop

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 — 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 balancing loop, the effect of the variables tend to create more of a stable trend over time, as opposed to one that is

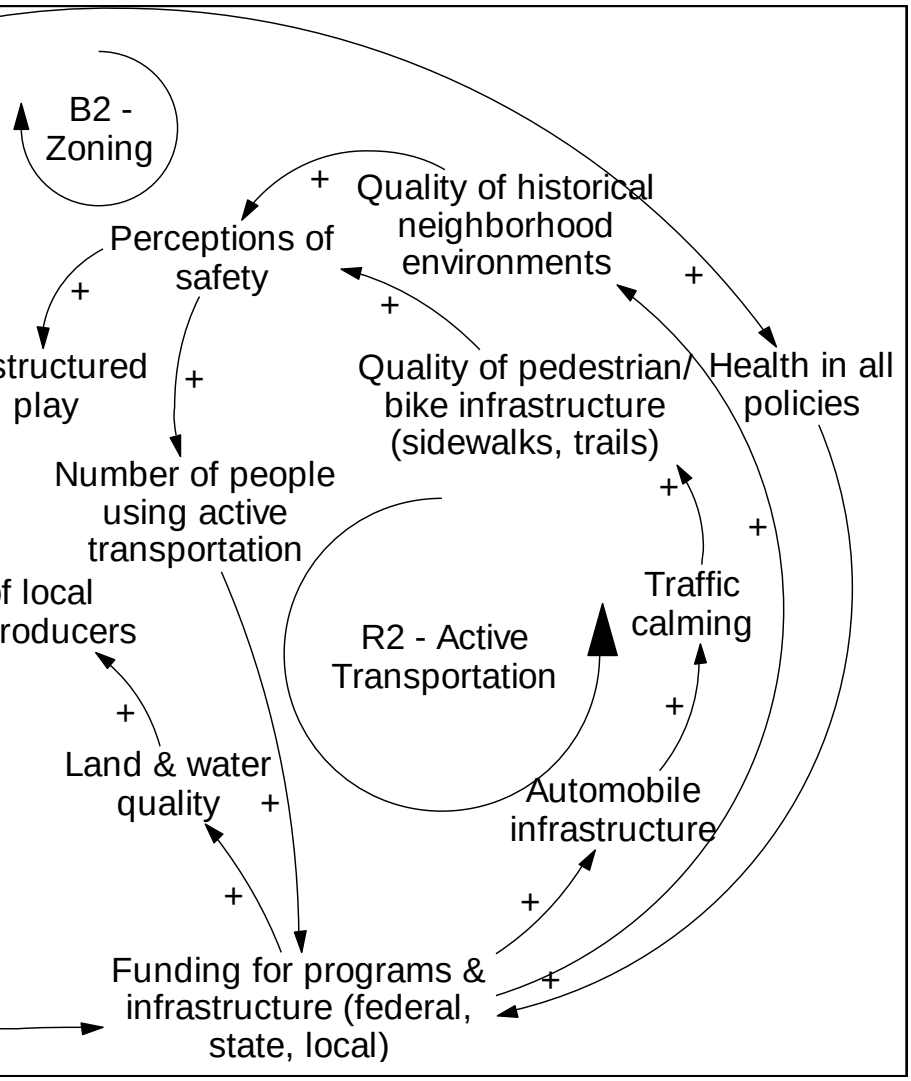
"In the 1920s and early decades, food was higher quality and we didn't have to think about it. I think research and what has happened in the last 10 or 20 years around quality of food affecting health had not really penetrated so much here in Grant County. I do think the activities that we've been doing for the last 3 or 4 years have really raised that awareness, and I think there's a lot of opportunity for that awareness to continue to go up. My concern is that while awareness goes up, access does not. I think lack of access is also a barrier to the awareness; it's really challenging for people to be aware of something that affects their health when they know they're not going to have access to it." (Participant)

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, is considered a balancing loop. This loop has one "-" sign, so it is a balancing loop. Reinforcing loops, with an zero or even number of "-" signs in the loop, are another type of feedback loop and are referenced in the next sections.

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., access to local, healthy food) and others have more delayed effects (e.g., the influence on healthy eating).



In isolation, this balancing 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 the number of nutrition, physical activity, and obesity education and prevention programs likely levels off at some point when there are a number of education and programs. To understand what specifically leads to the leveling off of the number of nutrition, physical activity, and obesity education and prevention programs, it may be helpful for the partners in Grant County, New Mexico to consider other variables that influence or are influenced by the number of nutrition, physical activity, and obesity education and prevention programs. In addition, 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 *HKHC Grant County*</u>

Participants identified the important role a Food Policy Council plays in the number of nutrition, physical activity, and obesity education and prevention programs in Grant County, New Mexico (see behavior over time graph).

From the systems thinking exercises, several insights can inform the ongoing work and structure of the food policy council strategy, 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 has the added benefit of rallying community support for the council.

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

- A strategic focus on understanding the number of nutrition, physical activity, and obesity education and prevention programs that exist in the community and how to create access to those opportunities for residents.

Corner Stores 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 corner stores.

Causal Story for Feedback Loop

Story A: In this case, the story is about corner stores. Grant County partners had several strategies designed to create more access to local, healthy foods and decrease the number of fast food meals, which decreases childhood obesity and increases residents' ability to work. In turn, there is a increase in employment and livable wages, which increases family income and increases access to local, healthy food.

Story B: Alternatively, as there is less access to local, healthy foods, it will increase the number of fast food meals, which increases childhood obesity and decreases residents' ability to work. In turn, there is a decrease in employment and livable wages, which decreases family income and decreases access to local, healthy food.

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—Corner Stores in Figure 4).

Some of these causal relationships may have more immediate effects (e.g., access to local, healthy food influencing number of fast food meals) and other relationships may have delayed effects (e.g., childhood obesity influence on the ability to work). This delayed effect is noted using two hash marks through the middle of the arrow line (not included in Figure 4).

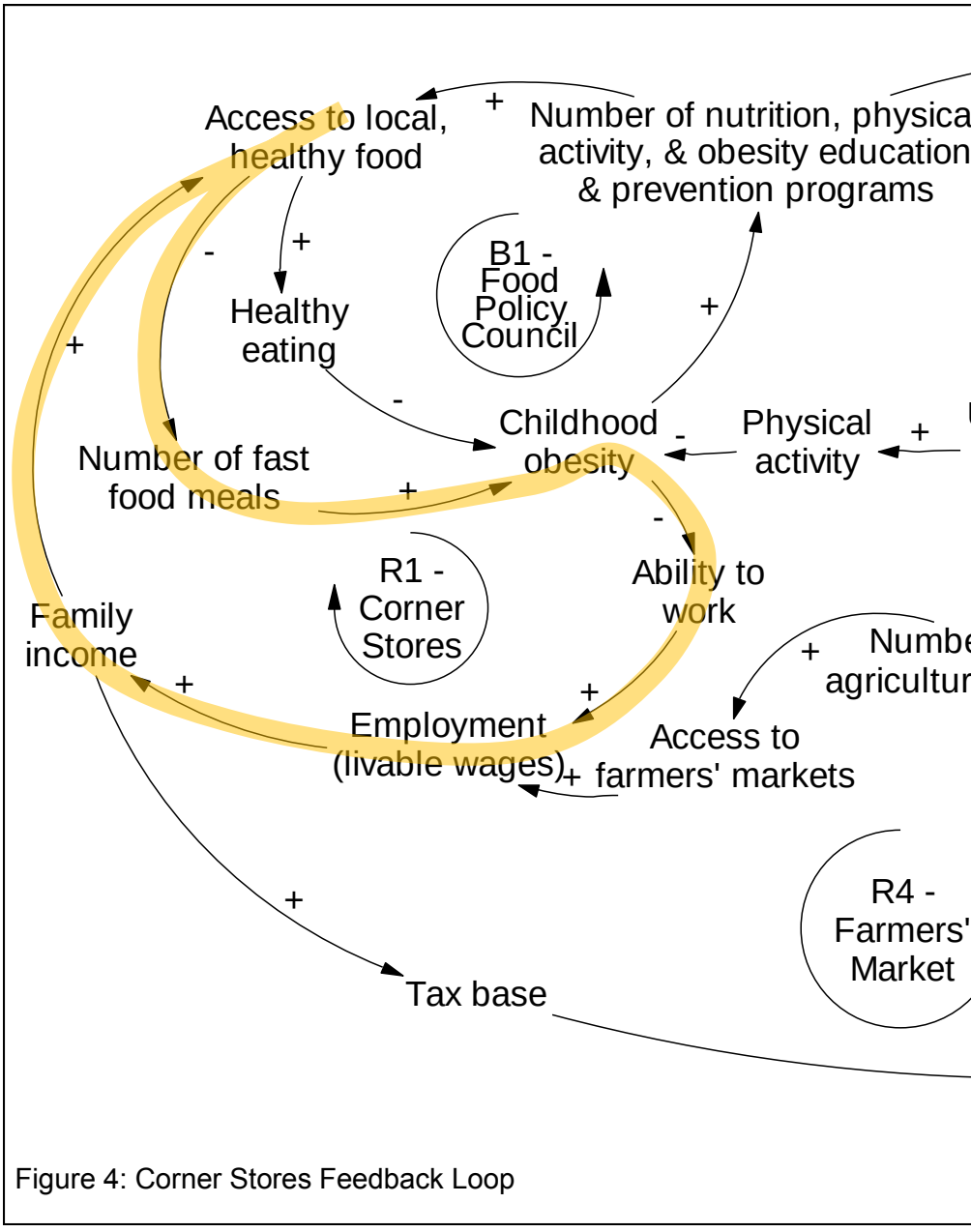


Figure 4: Corner Stores Feedback Loop

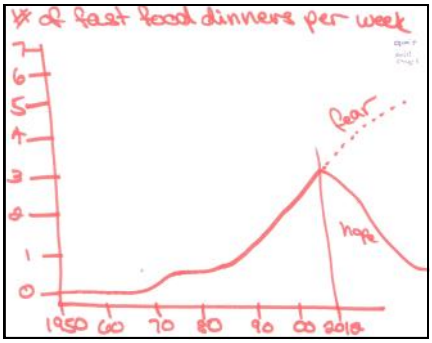
System Insights for *HKHC Grant County*

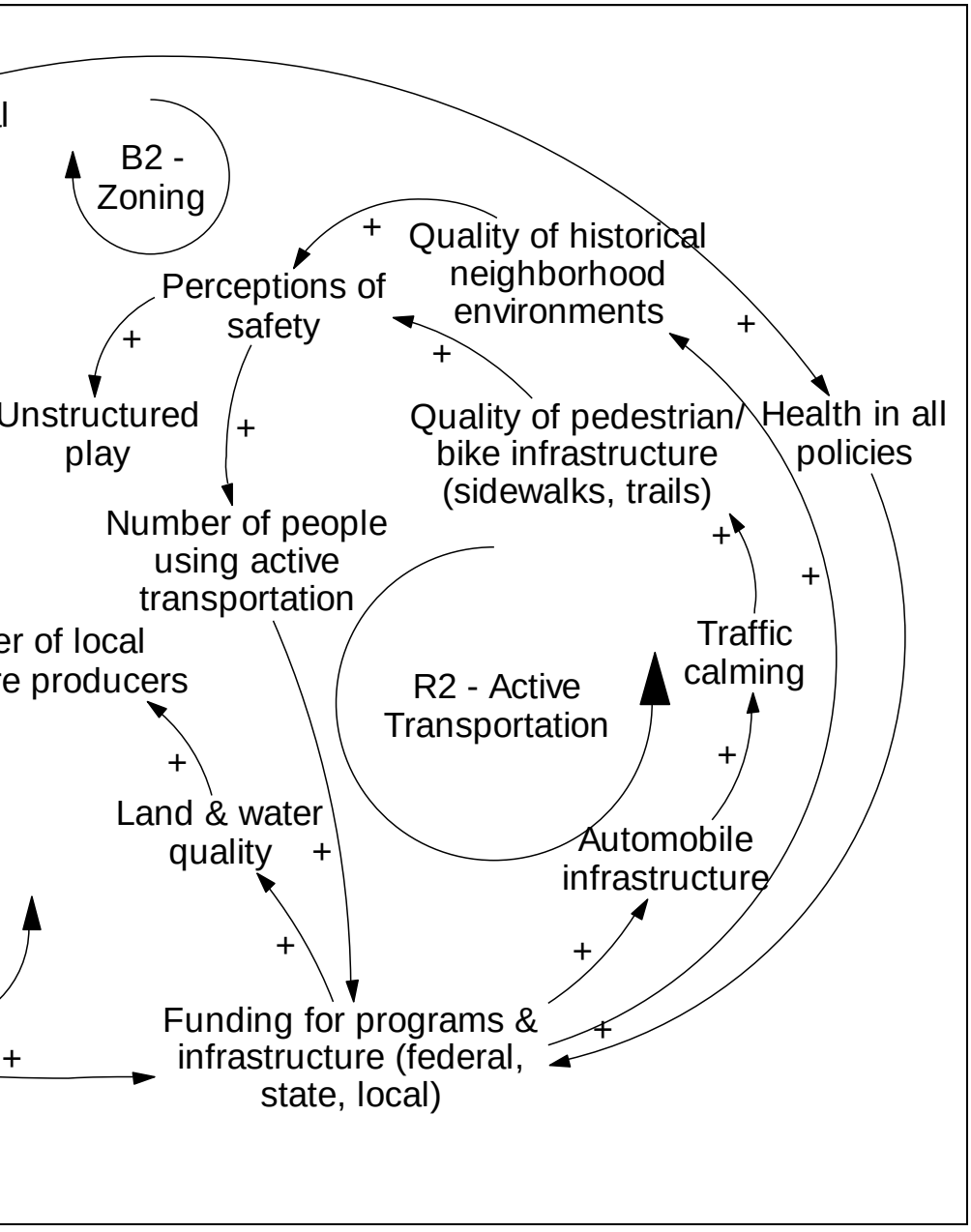
In the behavior over time graphs, participants identified decreasing trends in access to local, healthy foods and increasing trends in the number of fast food dinners per week (see illustrations on next page).

"Unfortunately, in a lot of cases, as family income increases, the number of fast food meals also increases. In a single parent home, where the mother wasn't working before, and then she gets a job, now she has less time to cook and prepare food. If there's less time to prepare food because of a job opportunity, [families] might be consuming more fast food." (Participant)

System insights can inform the partnership's next steps with corner stores, including:

- Similar to fast food restaurants — corner stores are perceived to increase access to unhealthy foods and beverages by people in the community; this presents an opportunity to increase the number of healthy corner stores to change residents' perceptions of these food vendors as providers of healthy food and beverage alternatives.

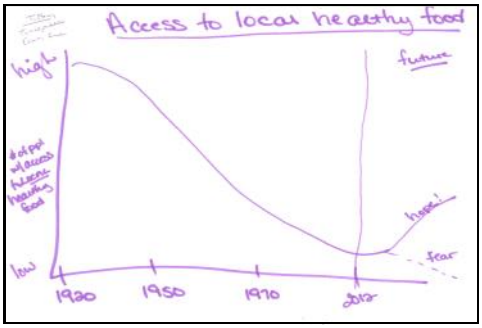




- Unhealthy corner stores contribute to less community safety and to greater consumption of unhealthy foods and beverages; because these safety issues harm the financial stability of the community leading to fewer resources to support access to healthy foods, public safety officials may be good partners to create safer, healthier communities.
- The slight increase in healthy corner stores may be bolstered by advocacy efforts to increase demand for healthy foods and beverages among residents.
- Because increasing access to non-processed foods requires greater food preparation, partners must also build residents' skills and confidence in preparing healthy meals.
- Employment and jobs are an essential ingredient to creating equity (reducing disparities and discrimination), safety, and a stable economy.

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

- What is the proportion of unhealthy food and beverage products to healthy food and beverage products sold by local food vendors (e.g., corner stores)? How do these products differ by cost, product placement within the stores, and marketing or signage in and around the stores?
- Do sales of healthy foods and beverages increase with greater access to these products in the stores? Can the store owners profit from the sale of fresh fruits and vegetables and other healthy foods and beverages?



Active Transportation Feedback Loop

Highlighted in blue in Figure 5, the active transportation feedback loop represents one of the *HKHC Grant County* strategies to increase active living in Grant County, New Mexico.

Causal Story for Feedback Loop

Story A: As there is an increase in the quality of pedestrian/bike infrastructure (sidewalks, trails), it increases the perceptions of safety in the community. When more residents feel safe, it increases the number of people using active transportation. With more people using active transportation, it increases the need for funding for programs and infrastructure, which increases automobile infrastructure. As automobile infrastructure increases, it increases the need for traffic calming devices to be installed in the community, which increases the quality of pedestrian/ bike infrastructure (sidewalks, trails).

Story B: Alternatively, as there is a decrease in the quality of pedestrian/bike infrastructure (sidewalks, trails), it decreases the perceptions of safety in the community. When more residents do not feel safe, it decreases the number of people using active transportation. As less people are using active transportation, it decreases the need for funding for programs and infrastructure, which decreases automobile infrastructure. As automobile infrastructure decreases, it decreases the need for traffic calming devices to be installed in the community, which decreases the quality of pedestrian/bike infrastructure (sidewalks, trails).

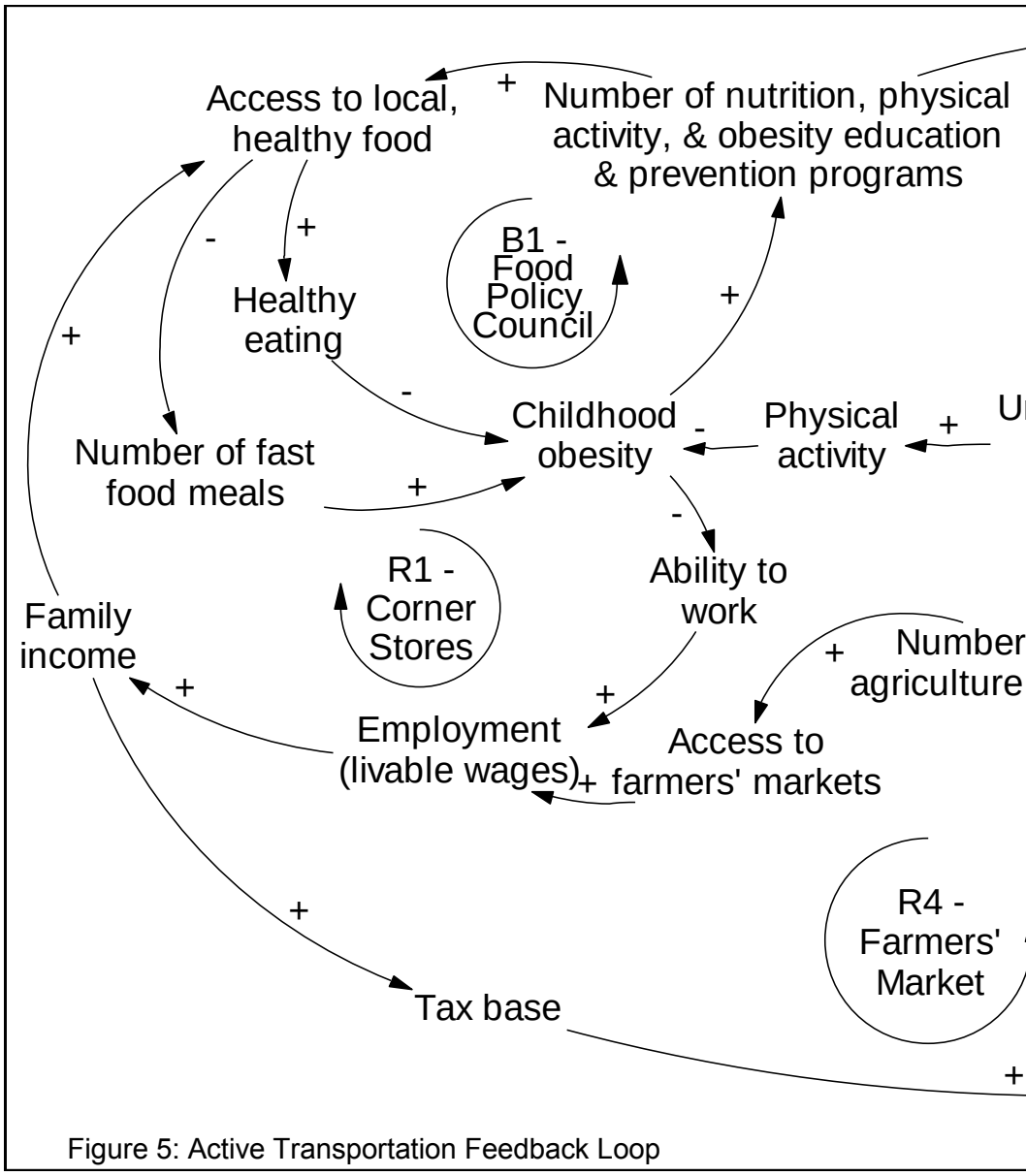


Figure 5: Active Transportation Feedback Loop

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., traffic calming devices influencing the quality of pedestrian/bike infrastructure), and, potentially, delayed effects (e.g., quality of pedestrian/bike infrastructures influence on perceptions of safety).

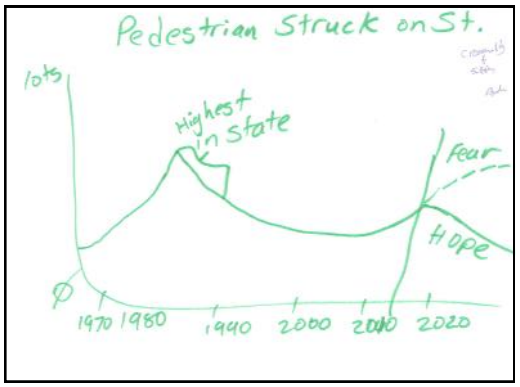
System Insights for *HKHC Grant County*

In the behavior over time graphs exercise, participants described an increase and then a drop

"When I started working with infrastructure, what we found is that local governments weren't really tapping into their resources to do any of the improvements within the area for accessibility or just having potable water, those kinds of things. And we started to see a decrease in funds from the state level with regards to funding those types of projects as a result of the downturn in the economy." (Participant)

and now an increase again in pedestrian crashes (i.e., pedestrian struck on street) since 1970 to 2013 with the fear that pedestrian crashes will continue to increase (see illustration at the

top right). Participants also identified an increase in feet of sidewalks and trails in Grant County between 1929 and 1212 with a hope that sidewalks and trails will continue to increase (see illustration on bottom right).

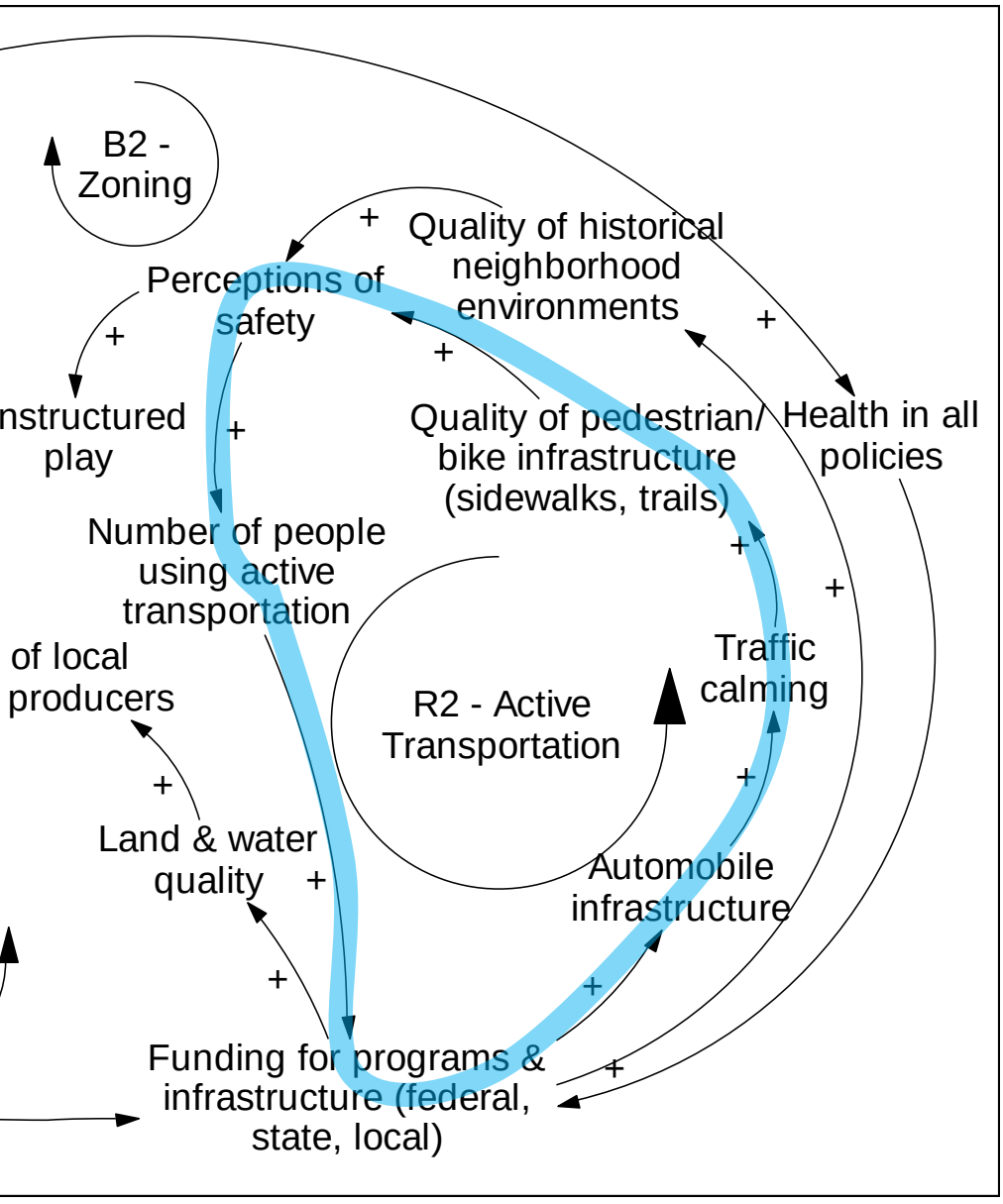


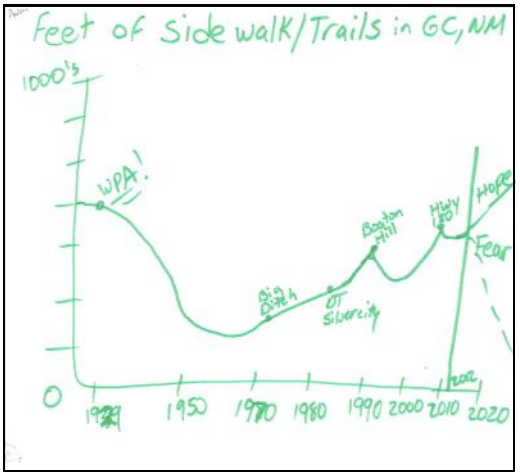
System insights for the partnership's active transportation efforts include:

- Increasing perceptions of safety plays a major role in maintaining and increasing active transportation opportunities.
- Infrastructure for pedestrians and bicyclists increases the number of families being active together; sidewalks and bike lanes — along with traffic calming and other safety measures — create opportunities for families to choose active rather than sedentary transportation modes.

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

- How does community safety in a rural community influence the use of active transportation opportunities? What types of renovation or maintenance strategies help to increase residents' perceptions of safety?
- How do residents' perceptions of safety influence their use of motorized vehicle for transportation?
- What streets have accommodations for pedestrians, bicyclists, and drivers? Are they safe for all users? What is still needed (e.g., traffic calming measures, more sidewalks and bike lanes)?





Farmers' Markets Feedback Loop

Highlighted in red in Figure 6, the farmers' markets feedback loop represents one of the *HKHC Grant County* strategies to increase healthy eating in Grant County, New Mexico.

Causal Story for Feedback Loop

Story A: With more access to farmers' markets, it increases employment (livable wages) for farmers and vendors working at the farmers' markets. As employment for farmers increases, their family income increases and increase the tax base for the community. As the tax base increases, there is more funding available for programs and infrastructure. As more funding is available, it increase land and water quality, and in turn, increases the number of local agriculture producers as more quality land and water is available. Finally, as there are more local agriculture producers, it increases access to farmers' markets.

Story B: Alternatively, with less access to farmers' markets, it decreases employment (livable wages) for farmers and vendors working at the farmers' markets. As employment for farmers decreases, their family income decreases and decrease the tax base for the community. As the tax base decreases, there is less funding available for programs and infrastructure. As less funding is available, it decreases land and water quality, and in turn, decreases the number of local agriculture producers as less quality land and water is available. Finally, as there are less local agriculture producers, it decreases access to farmers' markets.

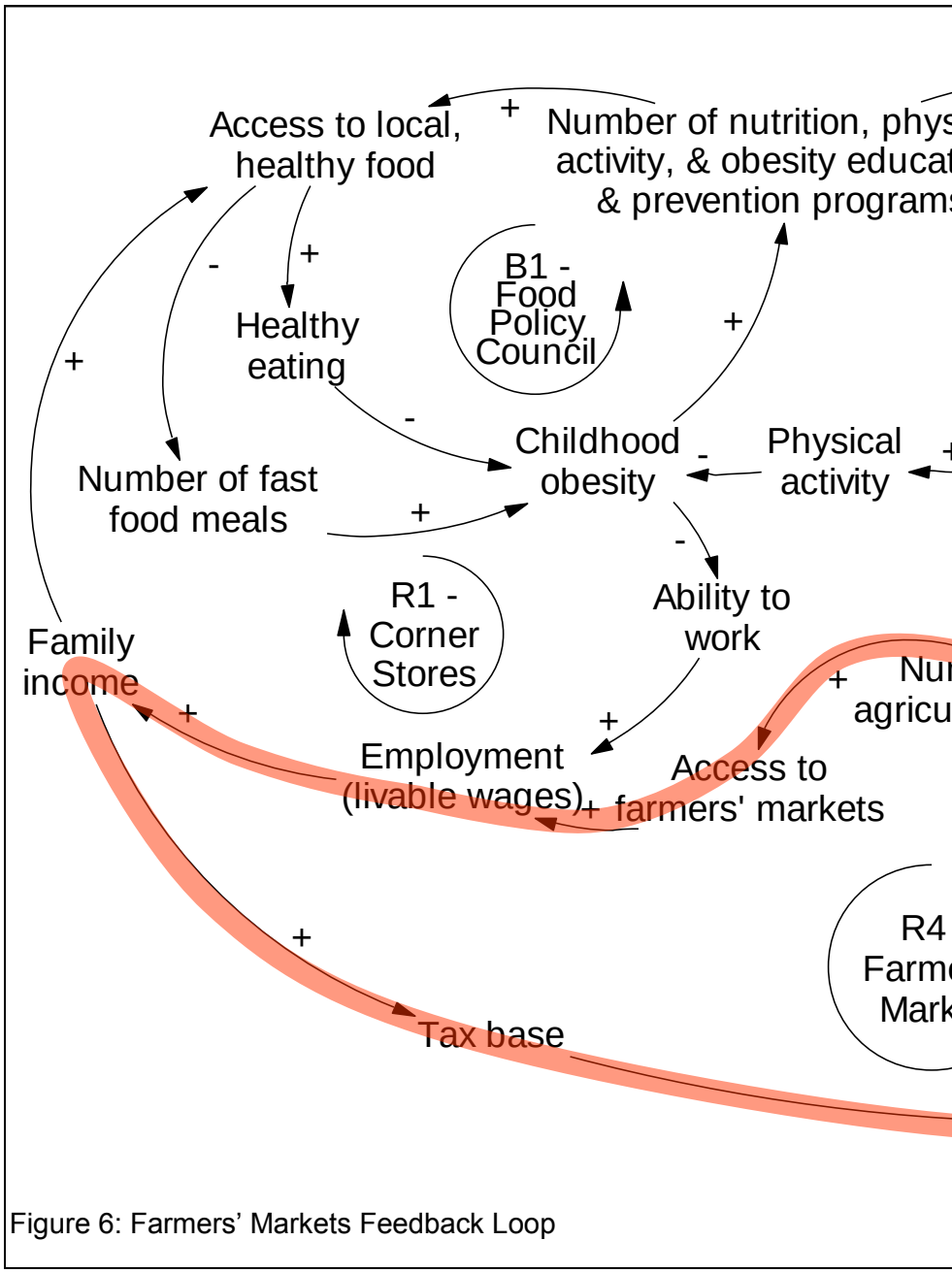


Figure 6: Farmers' Markets Feedback Loop

Reinforcing Loop and Notation

Similar to the previous loops (see Figure 4 & 5), this is a reinforcing loop (all "+" signs). In addition, it includes causal relationships representing more immediate effects (e.g., number of local agriculture producers influence on access to farmers' markets), and, potentially, delayed effects (e.g., tax base influence on funding for programs and infrastructure).

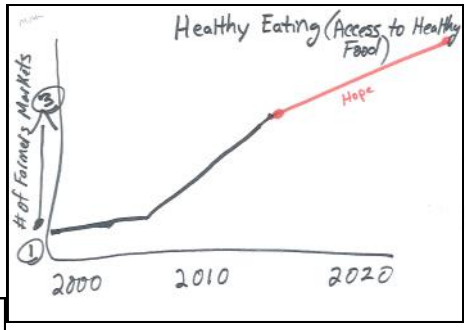
System Insights for *HKHC Grant County*

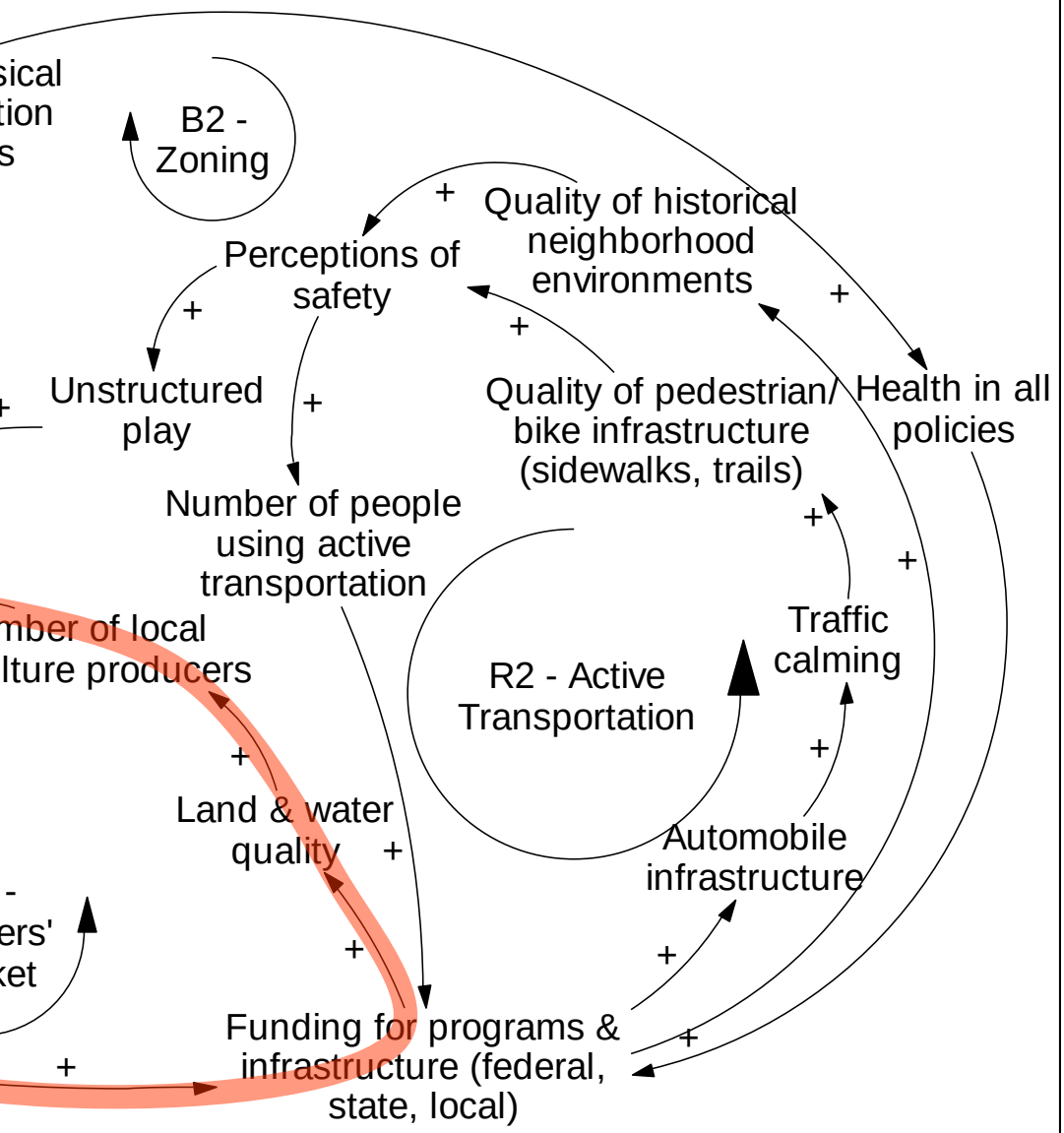
In the behavior over time graphs exercise, participants described an increase in access to healthy foods

"The Silver City area potentially has access to local food without a farmers' market; local in terms of state-grown food. But other areas, like Gila, doesn't necessarily have access to local food in town, unless there is a farmers' market." (Participant)

since 2000 with the hope that access to healthy foods will continue to increase (see illustration at the top right). Additionally, participants also described an increase in access to local foods since January 2009 with the hope that access to local foods will continue to increase (see illustration at the bottom right).

System insights can inform the partnership's next steps with farmers' markets efforts, including:

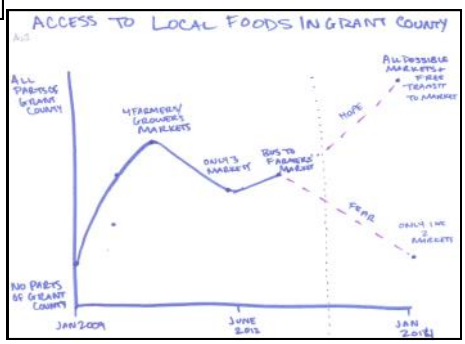




- Farmers' markets have the benefit of increasing a sense of community and providing employment opportunities for farmers and vendors. Often times, farmers and vendors need to have multiple jobs to making a livable wage and through expanding and enhancing the farmers' markets, it can provide more family income to allow farmers and vendors to possibly rely on wages from farming.
- The inclusion of partners with funds or other in-kind resources (e.g., volunteers, space, equipment) and a focus on funding sources that may be sustainable over time (e.g., annual city budget allocation) improves the longevity of these initiatives over time.

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

- How far do Grant County residents need to travel to access healthy foods through farmers' markets?
- What are the primary drivers of the relatively high income disparities in the community? What subpopulations tend to have lower incomes and what subpopulations tend to have higher incomes? What jobs (e.g., farmers), if any, are accessible to these different populations?



Zoning Feedback Loop

Highlighted in yellow in Figure 7, the zoning feedback loop represents one of the *HKHC Grant County* strategies to increase active living in Grant County, New Mexico.

Causal Story for Feedback Loop

Story A: Higher quality of historical neighborhood environments increases the perceptions of safety for residents in the community. As perceptions of safety increase, more youth are participating in unstructured play in the streets, alleys, or other open areas. With more unstructured play, it increases physical activity, and in turn, reduces childhood obesity. As there is a decrease in childhood obesity, there is a decrease in the number of nutrition, physical activity, and obesity education and prevention programs, which decreases health in all policies and decreases funding for programs and infrastructure. Finally decreasing the quality of historical neighborhood environments.

Story B: Alternatively, less quality of historical neighborhood environments decreases the perceptions of safety for residents in the community. As perceptions of safety decrease, less youth are participating in unstructured play in the streets, alleys, or other open areas. With less unstructured play, it decreases physical activity, and in turn, increases childhood obesity. As there is an increase in childhood obesity, there is an increase in the number of nutrition, physical activity, and obesity education and prevention programs, which increases health in all policies and increases funding for programs and infrastructure. Finally increasing the quality of historical neighborhood environments.

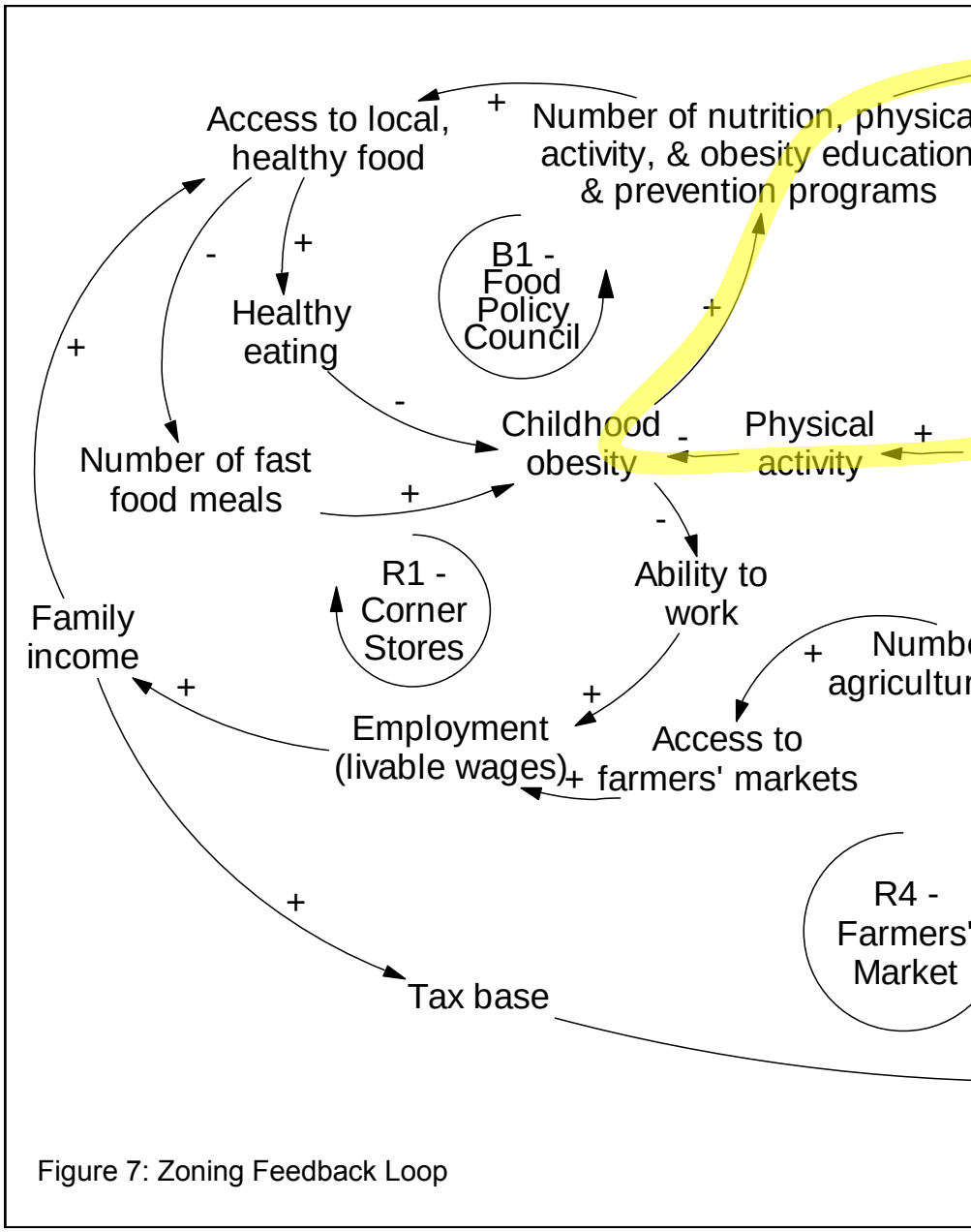


Figure 7: Zoning Feedback Loop

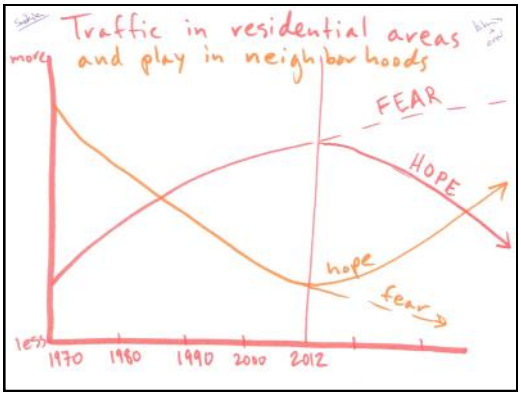
Balancing Loop and Notation

Similar to the first loop (see Figure 3), this is a balancing loop (one "-" sign). 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.

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

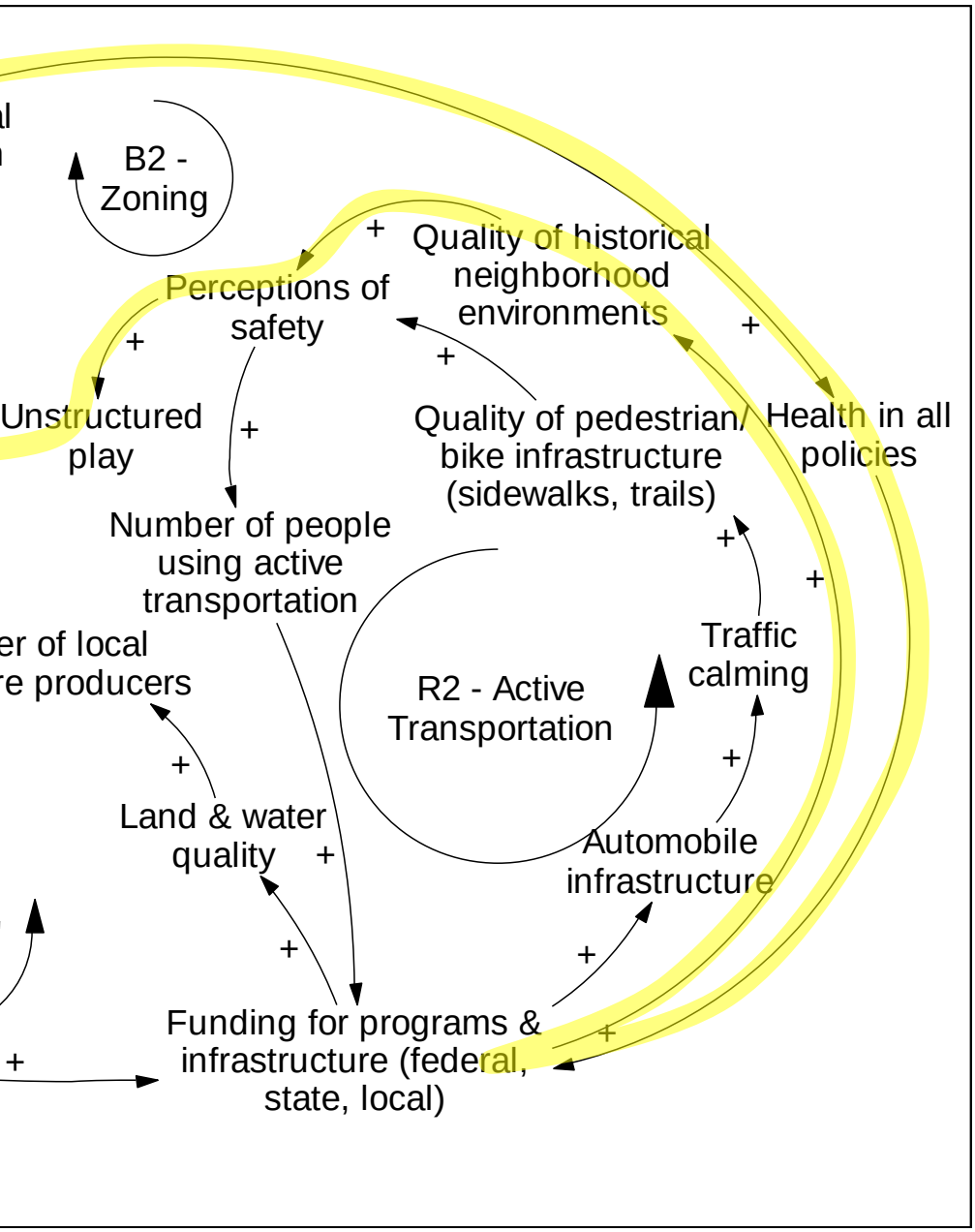
"The Silver City area potentially has access to local food without a farmers' market; local in terms of state-grown food. But other areas, like Gila, doesn't necessarily have access to local food in town, unless there is a farmers' market." (Participant)

effects (e.g., unstructured plays influence on physical activity) and others have more delayed effects (e.g., health in all policies).



System Insights for *HKHC Grant County*

In the behavior over time graphs exercise, participants described decrease in play in neighborhood since 1970 with the hope that play in neighborhoods would continue to increase (see illustration at the top right). Additionally, participants also described an increase in the number of healthy policies related to childhood obesity since 2010 with the hope that healthy policies will continue to increase (see illustration at the bottom right).

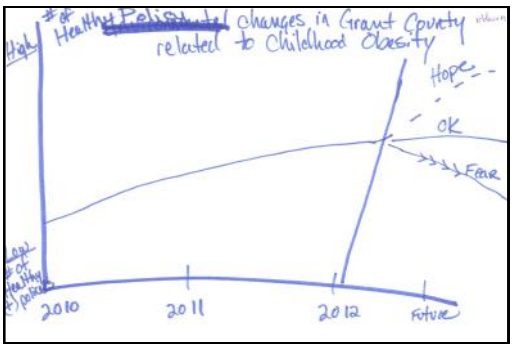


System insights for the partnership's zoning efforts include:

- Maintaining the quality of historical neighborhoods and environments improves perceptions of safety and support active living environments (e.g., play areas and active transportation).
- Building partnerships and relationships with developers who prioritize equity, sustainability, and practicality (e.g., mixed-income housing, greater population density, mixed commercial and residential land uses) improves residents' stability, both geographically and economically.

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

- What are some ways that residents can interact with civic leaders in order to influence policy and environmental change?
- What are some ways to assess empowerment in the community generally and specifically with respect to health in all policies?



Opportunities for Systems Thinking in Grant County, New Mexico

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 *HKHC Grant County* partners, this storybook also summarized the healthy eating, active living, partnership and community capacity, social determinants, and health and health behaviors subsystems in the Grant County 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.

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

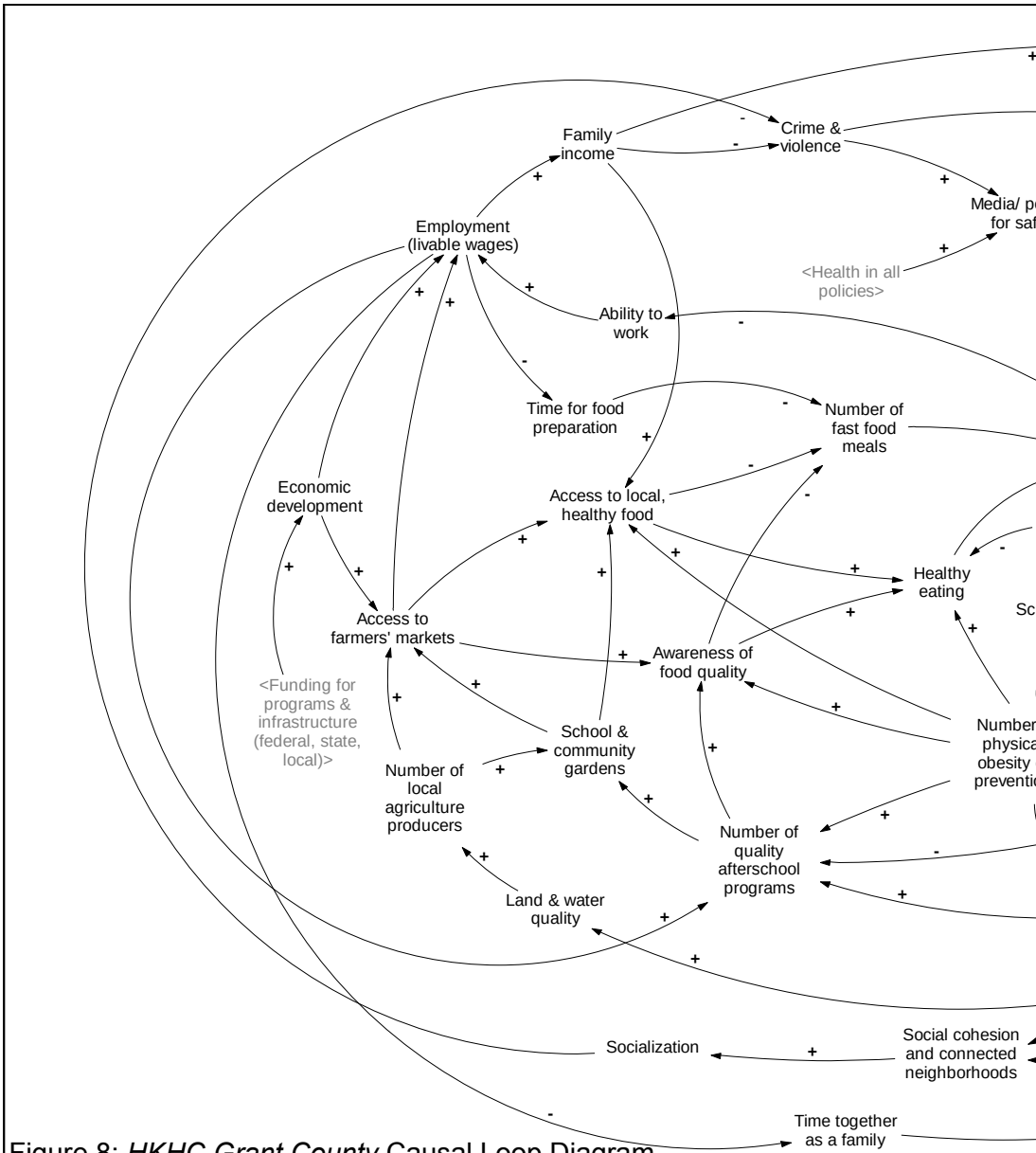


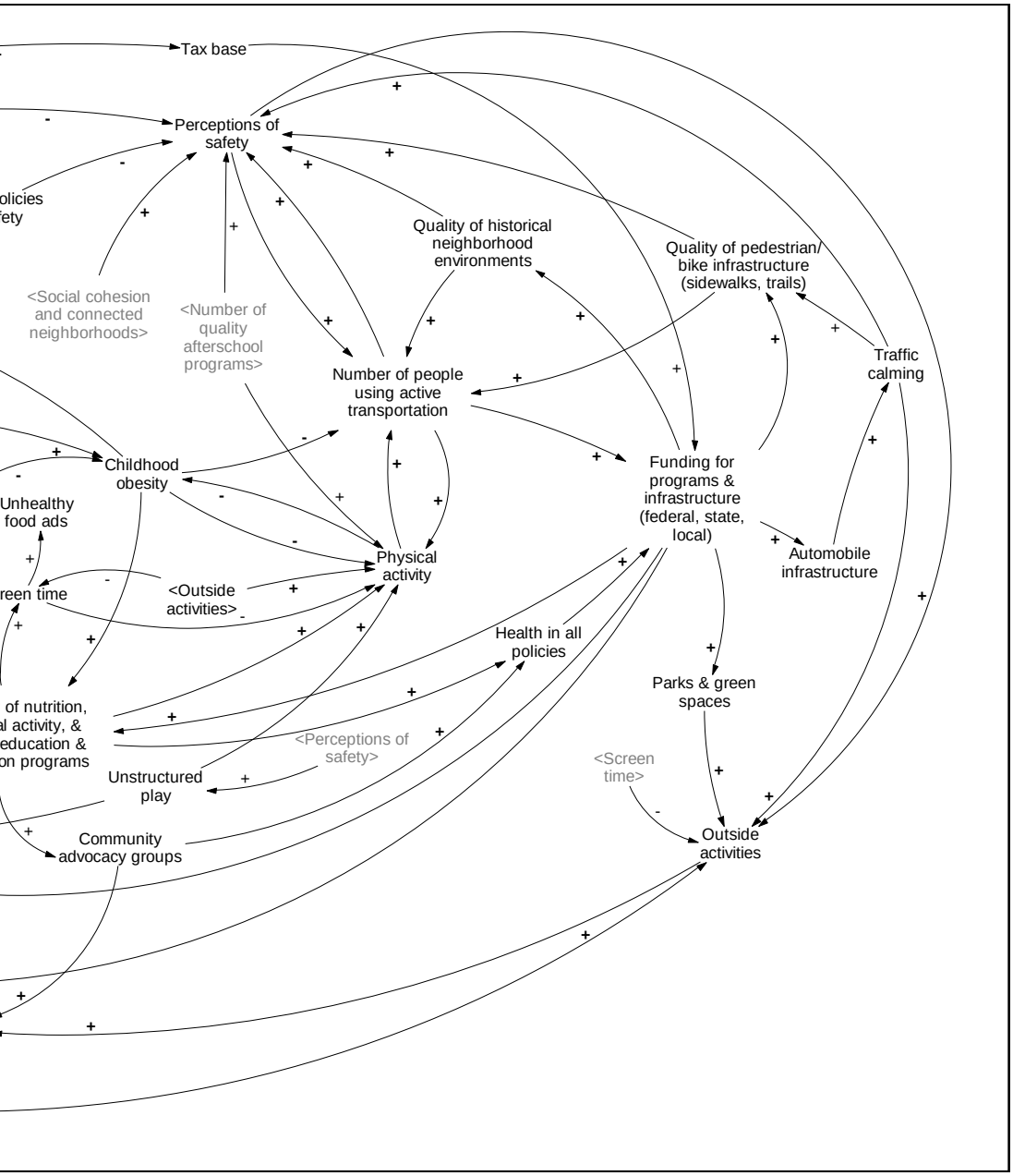
Figure 8: *HKHC Grant County* Causal Loop Diagram

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

- the participants represent a sample of the *HKHC Grant County* 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 feedback loops, including price of gas, suburban sprawl, lower-income housing, governmental regulation of food, healthy school foods and beverages, national food distribution system, school academic requirements & regulations, sugar consumption, school physical activity (recess, PE), school options for athletics (adult activities), traffic trips by automobile (work, school), number of kids riding bus to school, positive roles modes, injuries & fatalities, access to public transportation; 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 Grant County 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 *HKHC Grant County* 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.

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

Institute of Medicine (2012). An integrated framework for assessing the value of community-based prevention. Washington, DC, The National Academies Press.

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/

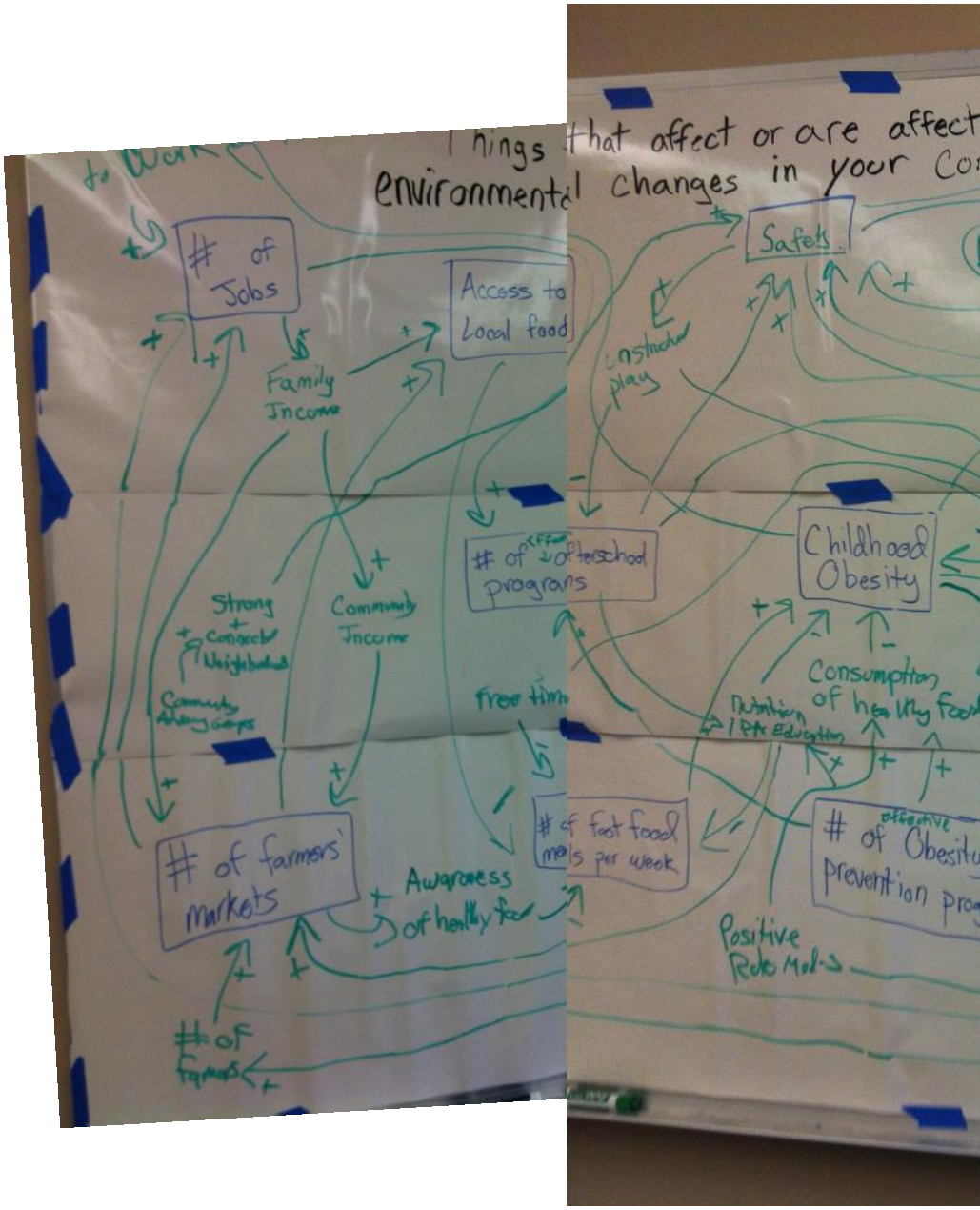
Vennix, J. (1996). Group model building. New York, John Wiley & Sons.

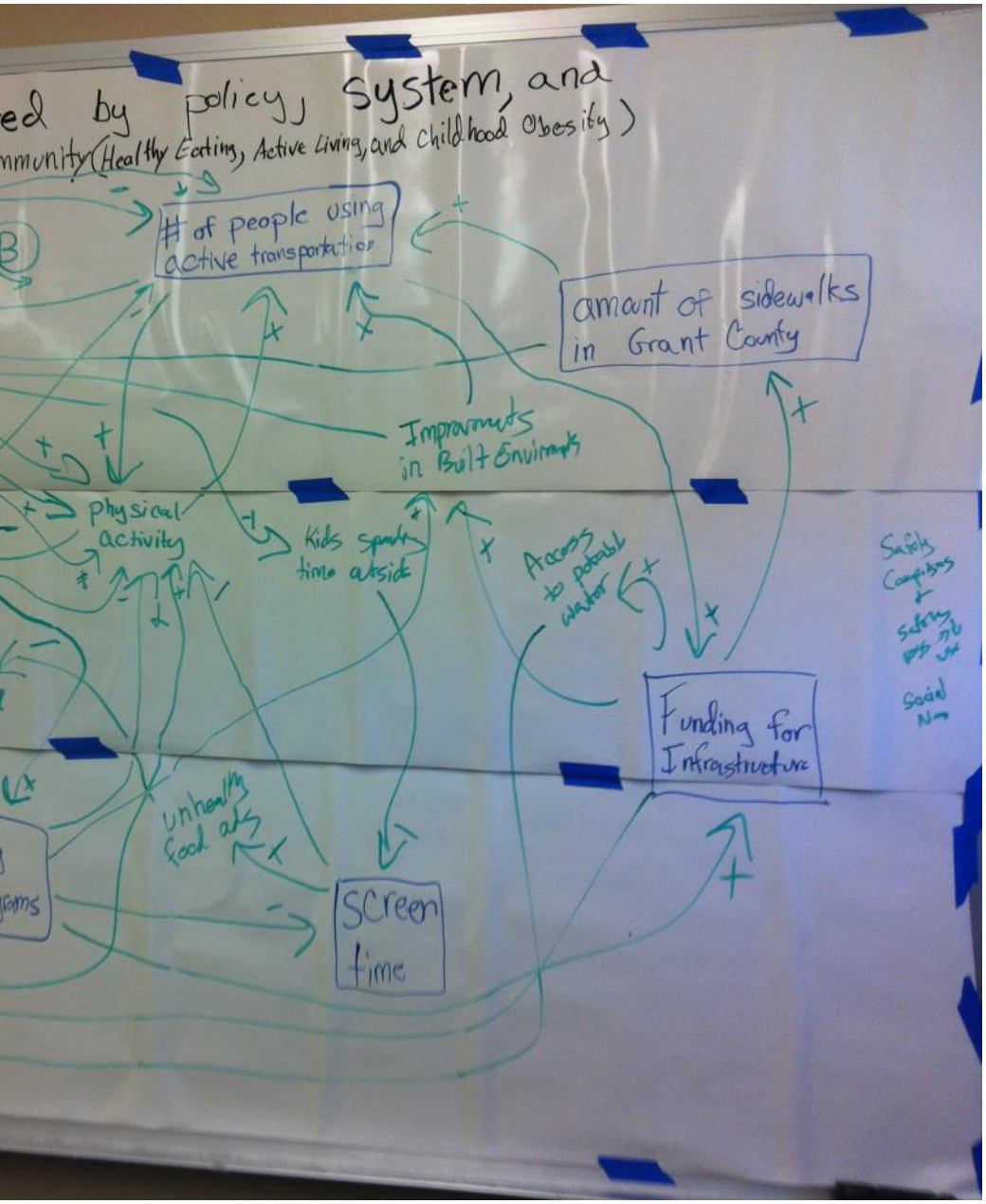
Zagonel, A. and J. Rohrbaugh (2008). Using group model building to inform public policy making and implementation. Complex Decision Making. H. Qudart-Ullah, J. M. Spector and P. I. Davidsen, Springer-Verlag: 113-138.

Appendix A: Behavior Over Time Graphs Generated during Site Visit

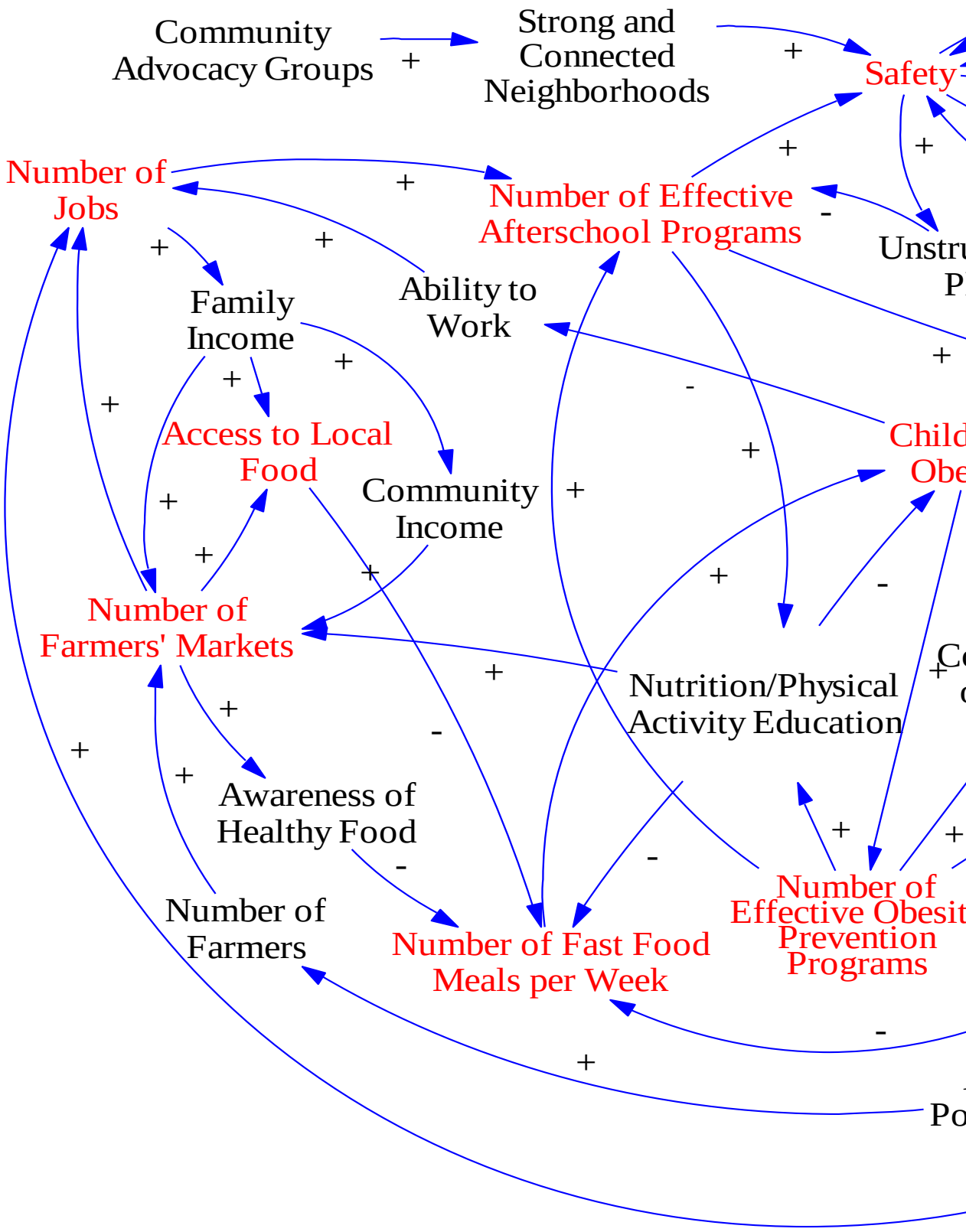
Grant County, New Mexico: *Healthy Kids, Healthy Communities Grant County*	
Categories	**Number of Graphs**
Active Living Behavior	12
Active Living Environments	7
Funding	1
Healthy Eating Behavior	2
Healthy Eating Environments	4
Marketing and Media Coverage	0
Obesity and Long Term Outcomes	2
Partnership & Community Capacity	0
Policies	6
Programs & Promotions (Education and Awareness)	3
Social Determinants of Health	3
Total Graphs	**40**

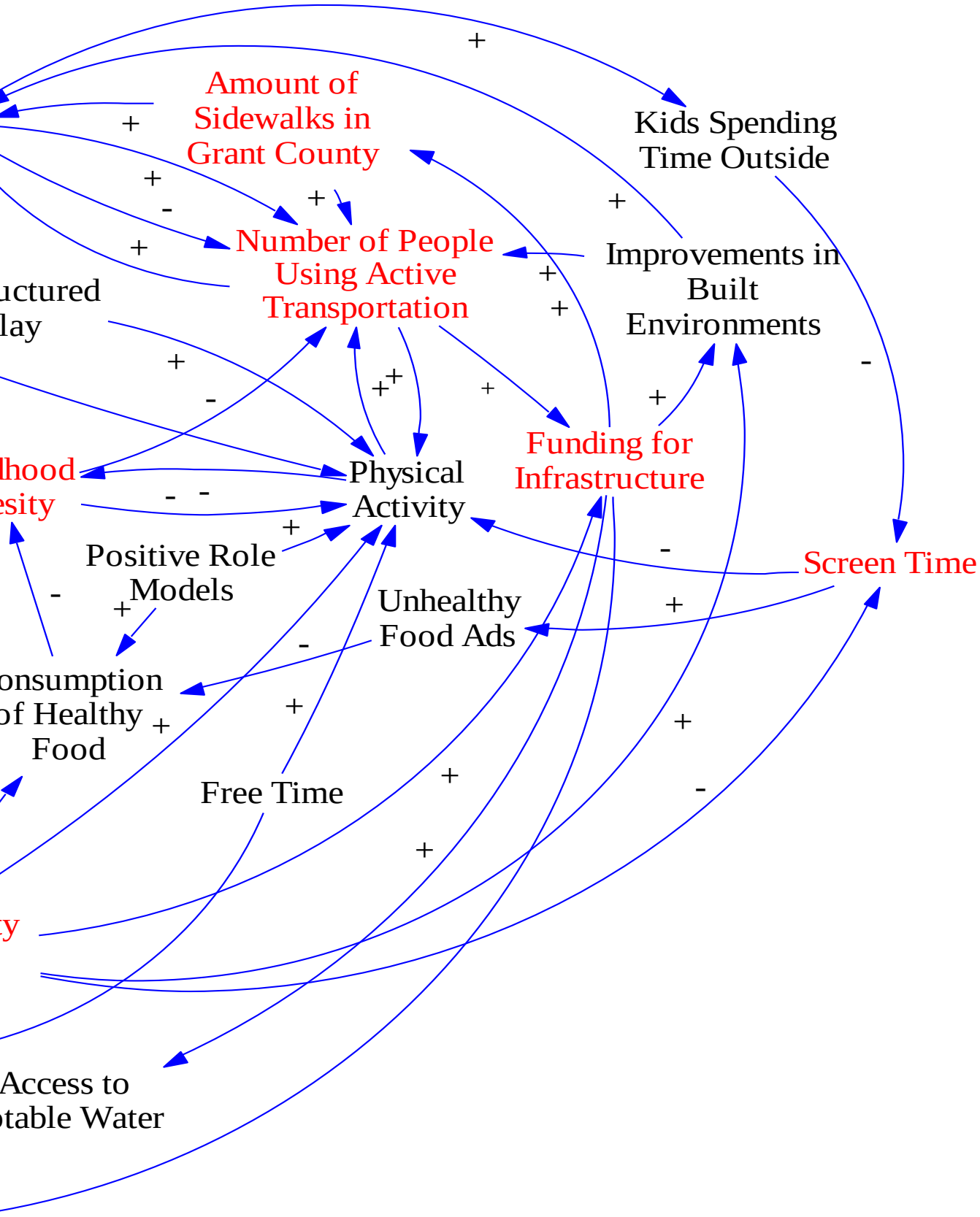
Appendix B: Photograph of the Original Version of the *HKHC Grant County* Causal Loop Diagram



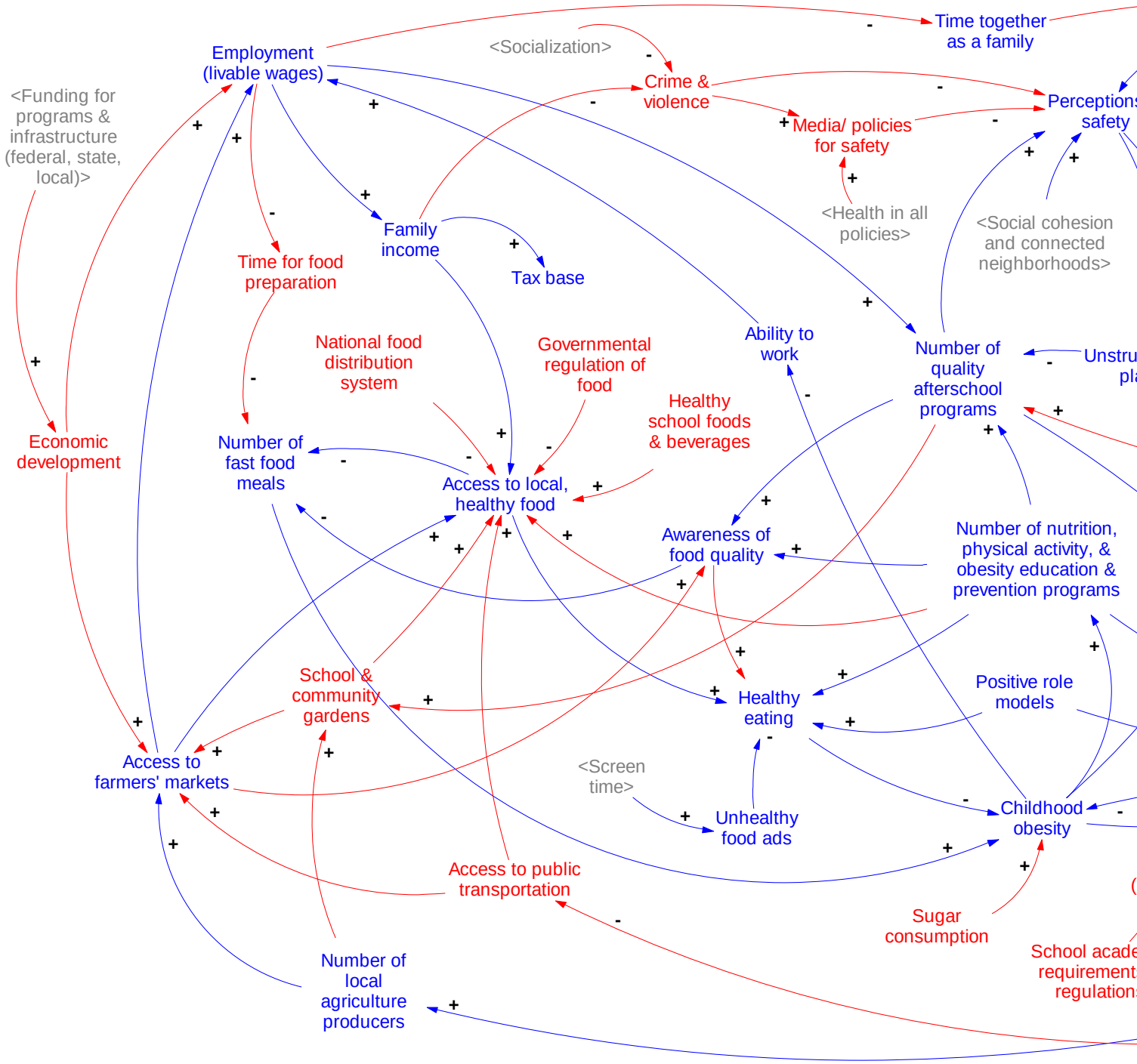

ed by policy, system, and
mmunity (Healthy Eating, Active Living, and Childhood Obesity)
# of people using active transportation
amount of sidewalks in Grant County
Improvments in Built Environments
physical activity
Kids spend time outside
Access to potable water
Safety Complaints
Funding for Infrastructure
unhealthy food ads
Screen time

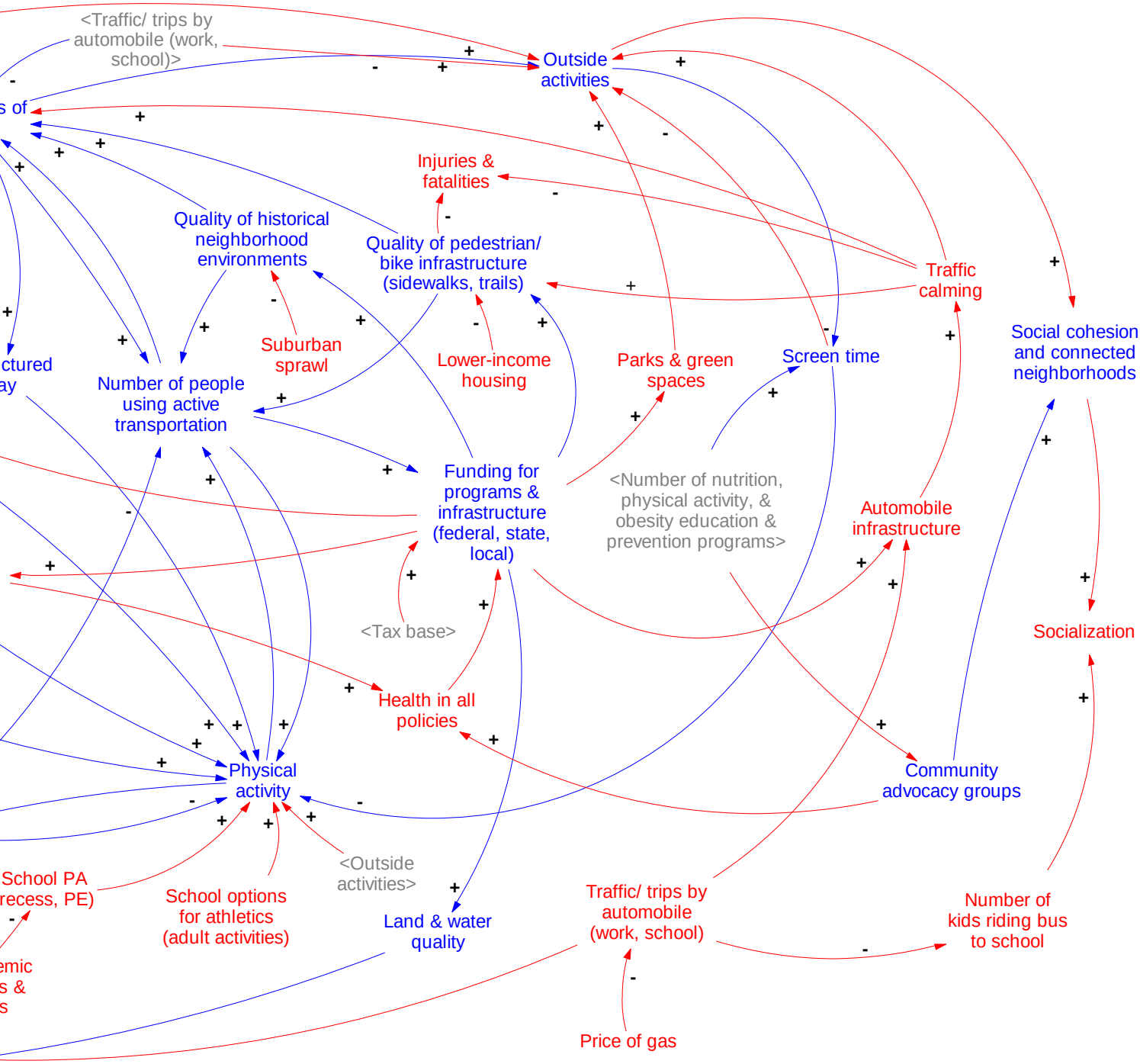
Appendix C: Original Translation of the Causal Loop Diagram into Vensim PLE



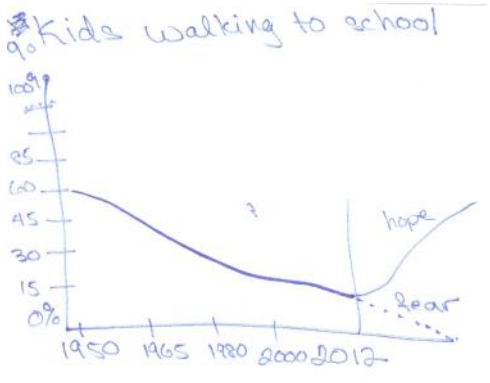

Amount of Sidewalks in Grant County
Kids Spending Time Outside
Number of People Using Active Transportation
Improvements in Built Environments
uctured lay
Funding for Infrastructure
lhood esity
Physical Activity
Positive Role Models
Screen Time
Unhealthy Food Ads
onsumption of Healthy Food
Free Time
Access to otable Water

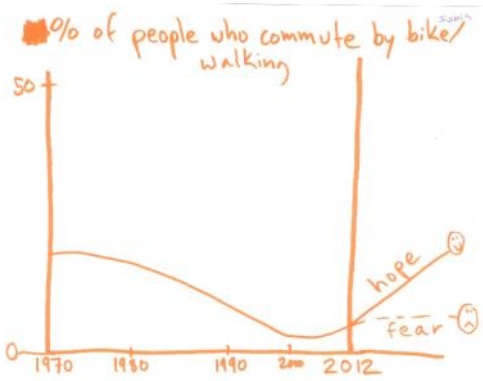
Appendix D: Transcript Translation of the Causal Loop Diagram into Vensim PLE

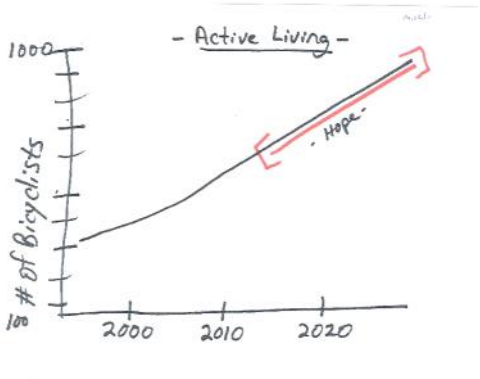


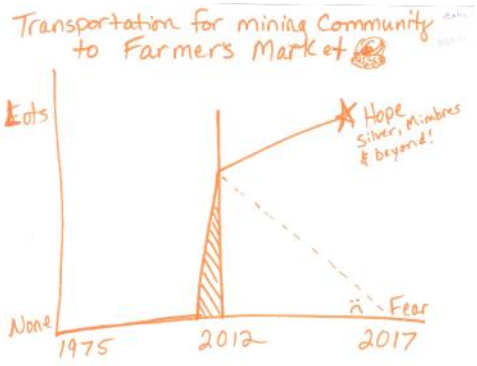

<Traffic/ trips by automobile (work, school)>
Outside activities
s of
Injuries & fatalities
Quality of historical neighborhood environments
Quality of pedestrian/ bike infrastructure (sidewalks, trails)
Traffic calming
Social cohesion and connected neighborhoods
ctured ay
Suburban sprawl
Lower-income housing
Parks & green spaces
Screen time
Number of people using active transportation
Funding for programs & infrastructure (federal, state, local)
<Number of nutrition, physical activity, & obesity education & prevention programs>
Automobile infrastructure
<Tax base>
Socialization
Health in all policies
Physical activity
Community advocacy groups
School PA recess, PE)
School options for athletics (adult activities)
<Outside activities>
Land & water quality
Traffic/ trips by automobile (work, school)
Number of kids riding bus to school
emic s & s
Price of gas

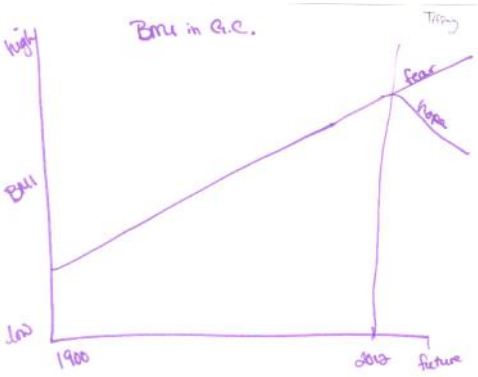
Appendix E: Behavior Over Time Graphs not Represented in the Storybook

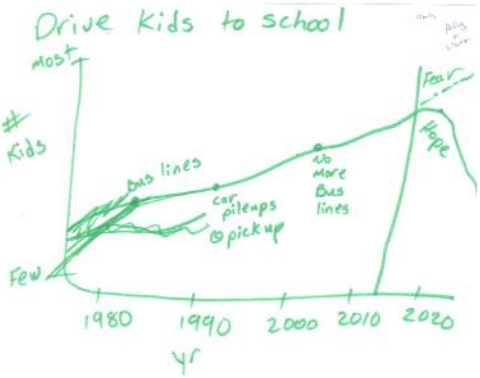


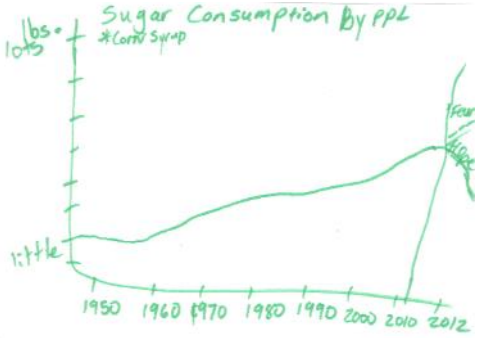


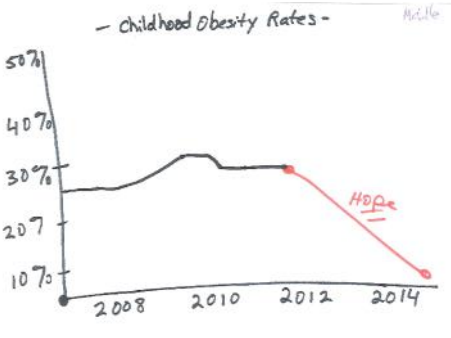


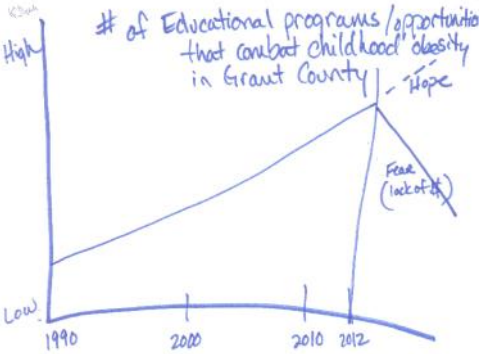


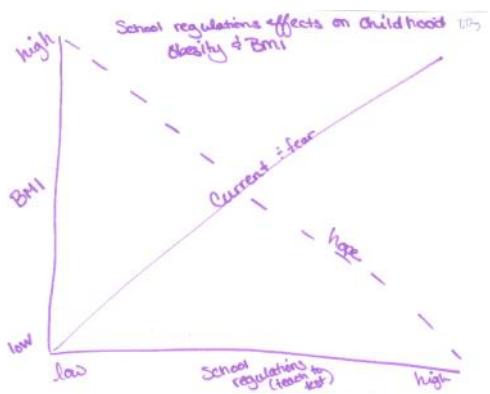


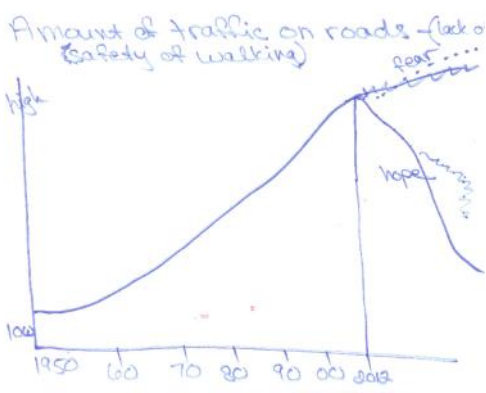


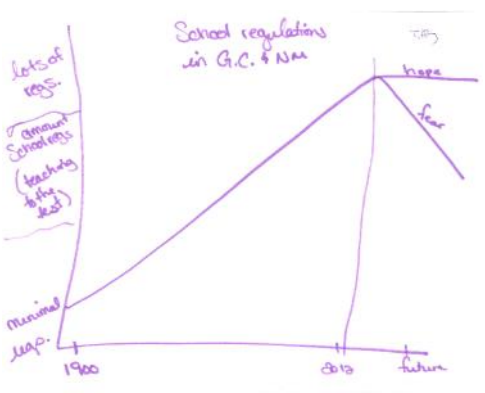


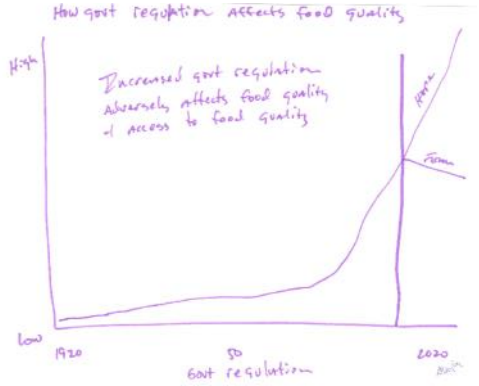


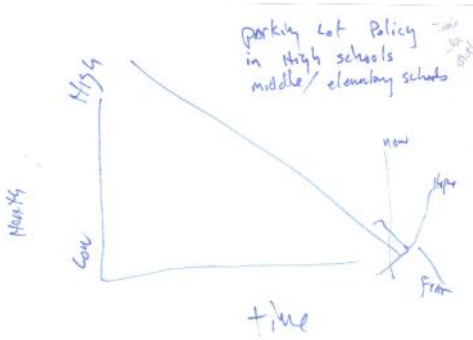


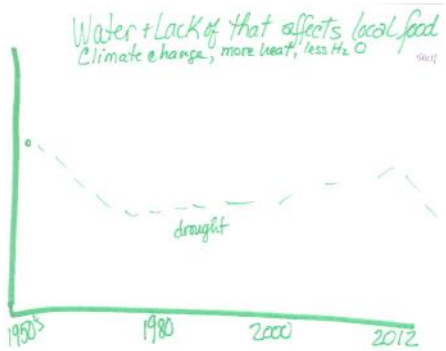


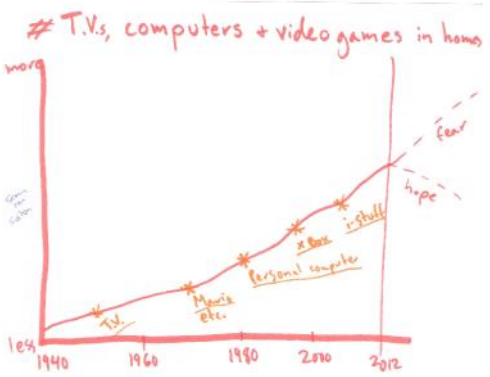




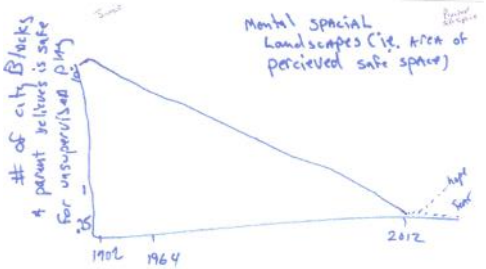

How govt regulation Affects food quality
Increased govt regulation Adversely affects food quality & access to food quality
High
Low
1920
50
2020
Govt regulation
Fear
Hope

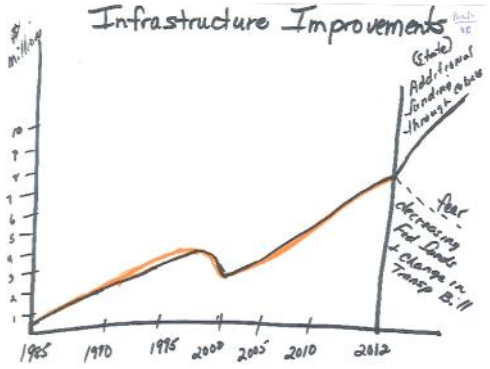

parking Lot Policy in High schools middle/ elementary schools
High
Low
Now
Hope
Fear
time

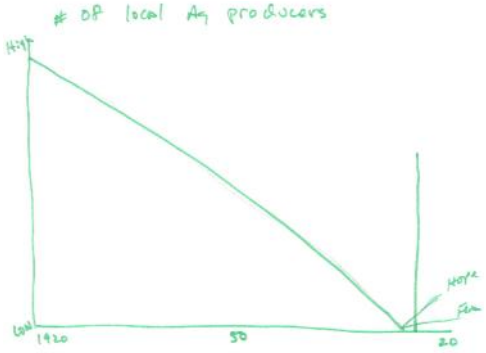

Water + Lack of that affects local food
Climate change, more heat, less H2O
drought
1950's
1980
2000
2012


T.V.s, computers + video games in homes
more
less
1940
1960
1980
2000
2012
T.V.
Movies etc.
Personal computer
X Box
i-stuff
Fear
hope

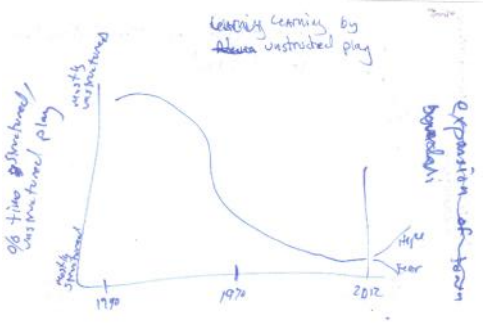

% of Streets w/ Sidewalks
% of Streets w/ Sidewalk
1900
1910
1920
1930
1940
1960
1980
2000
Hope
Fear

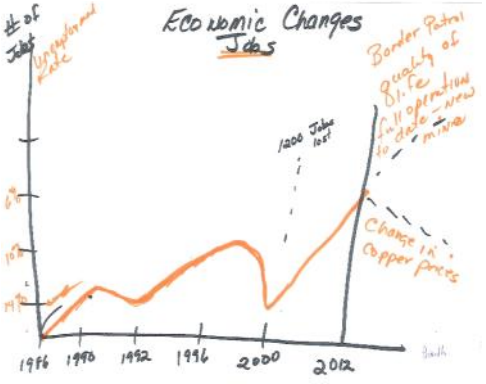

# of city Blocks a parent believes is safe for unsupervised play
Mental spacial Landscapes (ie. area of percieved safe space)
1902
1964
2012
hope
fear

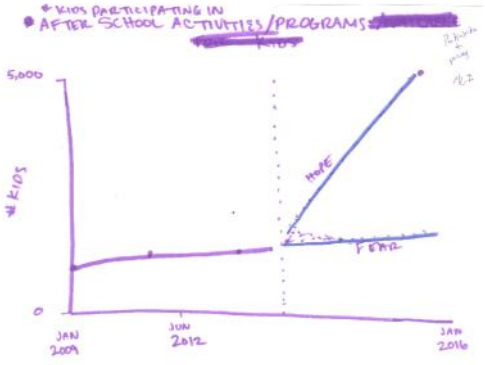

Infrastructure Improvements
$ in Millions
(State) Additional Funding above Inflation
Year decreasing Fed funds + change in Transp. Bill
1965
1970
1975
2000
2005
2010
2012


# of local Ag producers
High
Low
1920
50
Hope
Fear


# of Hours per person in Active Living in GC MT
Hours
0
1
2
3
4
5
6
7
1950
1960
1970
1980
1990
2000
2010
2020
Video Games
PC
Internet
Cell Phones
CutPE Funding
Hope
Fear


Lessening Learning by Adverse unstructured play
% time @ Structured/ unstructured play
mostly structured
mostly unstructured
1970
1970
2012
Hope
Fear
Boundaries
Expansion of boundaries


# of Jobs
Economic Changes
Jobs
Unemployment Rate
Border Patrol
Quality of life
Full operation to date - new mine
1200 Jobs lost
Change in Copper Prices
1986
1988
1992
1996
2000
2012


KIDS PARTICIPATING IN AFTER SCHOOL ACTIVITIES/PROGRAMS
KIDS
5,000
0
Hope
FEAR
JAN 2009
JUN 2012
JAN 2016

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