Systems Thinking in Communities:

Understanding the Causes of Inactivity, Poor Diet/Nutrition, and Childhood Obesity in Somerville, Massachusetts

This community storybook was developed by Transtria LLC.

Support was provided by the Robert Wood Johnson Foundation.

Acknowledgments

Support for this evaluation was provided by a grant from the Robert Wood Johnson Foundation (#67099). Transtria LLC led the evaluation and dissemination activities from April 2009 to March 2014. Representatives from the Shape Up Somerville partnership actively participated in the evaluation planning, implementation, and dissemination activities.

We are grateful for the collaboration with and support from the Robert Wood Johnson Foundation (Laura Leviton, PhD and Tina Kauh, PhD), the Washington University Institute for Public Health (Ross Brownson, PhD), the Healthy Kids, Healthy Communities (HKHC) National Program Office (Casey Allred; Rich Bell, MCP; Phil Bors, MPH; Mark Dessauer, MA; Fay Gibson, MSW; Joanne Lee, LDN, RD, MPH; Mary Beth Powell, MPH; Tim Schwantes, MPH, MSW; Sarah Strunk, MHA; and Risa Wilkerson, MA), the HKHC Evaluation Advisory Group (Geni Eng, DrPH, MPH; Leah Ersoylu, PhD; Laura Kettel Khan, PhD; Vikki Lassiter, MS; Barbara Leonard, MPH; Amelie Ramirez, DrPH, MPH; James Sallis, PhD; and Mary Story, PhD), the Social System Design Lab at Washington University in St. Louis (Peter Hovmand, PhD), the University of Memphis (Daniel Gentry, PhD), and Innovative Graphic Services (Joseph Karolczak).

Special thanks to the many individuals who have contributed to these efforts from Transtria LLC, including Evaluation Officers (Tammy Behlmann, MPH; Kate Donaldson, MPH; Cheryl Carnoske, MPH; Carl Filler, MSW; Peter Holtgrave, MPH, MA; Christy Hoehner, PhD, MPH; Allison Kemner, MPH; Jessica Stachecki, MSW, MBA), Project Assistants (James Bernhardt; Rebecca Bradley; Ashley Crain, MPH; Emily Herrington, MPH; Ashley Farell, MPH; Amy Krieg; Brandye Mazdra, MPH; Kathy Mora, PhD; Jason Roche, MPH; Carrie Rogers, MPH; Shaina Sowles, MPH; Muniru Sumbeida, MPH, MSW; Caroline Swift, MPH; Gauri Wadhwa, MPH; Jocelyn Wagman, MPH), additional staff (Michele Bildner, MPH, CHES; Daedra Lohr, MS; Melissa Swank, MPH), Interns (Christine Beam, MPH; Skye Buckner-Petty, MPH; Maggie Fairchild, MPH; Mackenzie Ray, MPH; Lauren Spaeth, MS), Transcriptionists (Sheri Joyce; Chad Lyles; Robert Morales; Vanisa Verma, MPH), and Editors (Joanna Bender and Julie Claus, MPH).

Suggested citation:

Brennan L, Sabounchi N, Kemner, A, Burke N, Rioles N. Systems Thinking in Communities: Understanding the Causes of Inactivity, Poor Diet/Nutrition, and Childhood Obesity in Somerville, Massachusetts. 2013. http://www.transtria.com/hkhc. Accessed <Date Accessed>.


10/24/2011

Introduction

Shape Up Somerville 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 *Shape Up Somerville* project was to introduce systems thinking at the community level by identifying the essential parts of the Somerville, Massachusetts 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, representatives from government agencies, elected officials, community-based organizations, businesses, and advocates) 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.

Somerville, Massachusetts: Background and Local Participation

Somerville, Massachusetts has a population of 75,754 and is a dense, diverse, lower-income city adjacent to Boston. It was established as a town in 1842 when it was separated from Charleston. The City of Somerville has a rich history as part of early American culture. The city land was originally a farm and there are many anecdotes of early American history.

Shape Up Somerville is a city wide campaign to increase daily physical activity and healthy eating through programming, physical infrastructure improvements, and policy work. The campaign targets all segments of the community, including schools, city government, civic organizations, community groups, businesses, and other people who live, work, and play in Somerville. This effort began as a community-based research study at Tufts University targeting 1st through 3rd graders in the Somerville Public Schools.

Shape Up Somerville started as a group that came together in the early 2000s to do an analysis of nutrition in Somerville. It evolved into a task force as part of a Tufts University research study, and eventually developed into a steering committee based out of the City of Somerville Health Department. The partnership is comprised of approximately 35 organizations, primarily city departments and community-based organizations, but also including major universities, statewide organizations, schools districts and others. The partnership also receives political support from the Mayor of Somerville, the district state representative, the school superintendent, and the board of aldermen. *Shape Up Somervillle* offers mini-grants to partners to work on specific projects as part of the Healthy Kids, Healthy Communities initiative.

In 2009, the Shape Up Somerville Steering Committee formed, chaired by Mayor Curtatone with representation from relevant City departments, community-based organizations and business community, to set the vision and guide the work of Shape Up Somerville. In 2011, hired a multi-lingual project coordinator dedicated to working on healthy eating and active living work for the Shape Up Somerville partnership.

The *Shape Up Somerville* partnership was previously led by a community member before the city hired a dedicated staff member to take over this role. The project director reports directly to the Mayor. There were some growing pains associated with this change as leadership shifted from the community-based organizations to the city. Shape Up Somerville is still identifying ways to increase community members' participation in partnership activities. The Mayor has been a staunch supporter of the partnership, which he demonstrated by directing city funds to support staff positions.

Through the aid of several grants including Active Living by Design, Healthy Eating by Design, USDA Growing Healthy Grant, Department of Education Professional Evaluation Program, and Tufts University's lead Shape Up Somerville grant, the health department has either been the lead or a key player in childhood obesity prevention efforts.

The partnership and capacity building strategies of *Shape Up Somerville* included:

- **Political Will:** Somerville has had strong support from the city government, including the mayor, for the Shape Up Somerville partnership. Specifically, the mayor has created positions funded by the city to support healthy eating and active living policy, system, and environmental approaches.
- **City/Community Agency/Organization Collaboration:** With Somerville's city government involvement, there has been a lot of investment in collaboration between city agencies and community-based organizations and community residents. Their success has been in large part due to the meaningful collaboration across the city and community organizations through mini-grant opportunities and other efforts.

The healthy eating and active living strategies of *Shape Up Somerville* included:

- **City/Comprehensive Planning**: The first comprehensive plan for the City of Somerville was designed to be a high-level driving document for implementation of zoning changes or area-specific plans and upgrades. Community members were heavily involved with the design and planning process. In 2012, the Somervision 2010-2030 Comprehensive Plan was adopted and included language on active transportation and food access.
- **Parks and Play Spaces:** Between 2010 and 2011, the city purchased three properties to be permanently dedicated public open spaces. In addition, park renovations occurred at two parks, Albion Park and Grimmons Park. The Open Spaces and Recreation Master Plan was revised in 2009. Partners reached a three-year agreement with the Massachusetts Department of Conservation and Recreation to jointly maintain a recreational complex, including a stadium, auxiliary and baseball fields, tennis and basketball courts, and tot lot, with the city responsible for responding to maintenance needs.
- **Active Transportation**: To further support active transportation, zoning upgrades were adopted for a pedestrian- and bicycle-friendly community. Additionally, other pedestrian and bicycle policies and infrastructure improvements were made, including: new parking ordinances, addition of 21 miles of share the road and bike lane markings, 8 Hubway bike share stations, over 100 bike racks and 10 bike corrals (first-ever on-street bicycle parking in the metro area) throughout the city, a city snow removal committee to ensure that sidewalks are cleared and safe for walking during winter months, and ADA upgrades.
- **Farmers' Markets**: Partners developed a winter farmers' market at the Center for Arts at the Armory and a mobile market in the housing authority. In 2012, the Mystic Mobile Market was expanded from one housing authority location to six locations, including: a second public housing location, a neighborhood school, the Somerville Council on Aging Activity Center, and two municipal buildings. The market was renamed to the 'Somerville Mobile Farmers' Market'. Partners secured EBT terminals at Union Square and Davis Square Farmers' Markets and hired staff to run the EBT machines.
- **Restaurants**: In 2010, partners expanded the Shape Up Approved Healthy Restaurant Initiative from 26 to 36 participating restaurants and added a menu analysis and point of purchase prompts to 21 restaurants. This occurred by partnering with The Welcome Project's restaurant program aimed at supporting immigrant restaurants in Somerville and partners installed signage in all restaurants. In addition, partners developed and implemented healthy kids menus at two Shape Up Approved restaurants. Ultimately, over 60 restaurants participated in the Shape Up Approved healthy restaurant initiative.
- **City Healthy Vending**: Partners identified six municipal building locations with vending machines and re-stocked them with healthy products from Somerville's newly contracted vendor, Vend Natural, including: the central library, city hall and its annex, traffic and parking, the ice rink, and a high school. Partners worked with department representatives in the city and school district to craft a healthy vending purchasing policy.

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

Systems Thinking in Communities: Somerville, Massachusetts

"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 Somerville, Massachusetts 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.

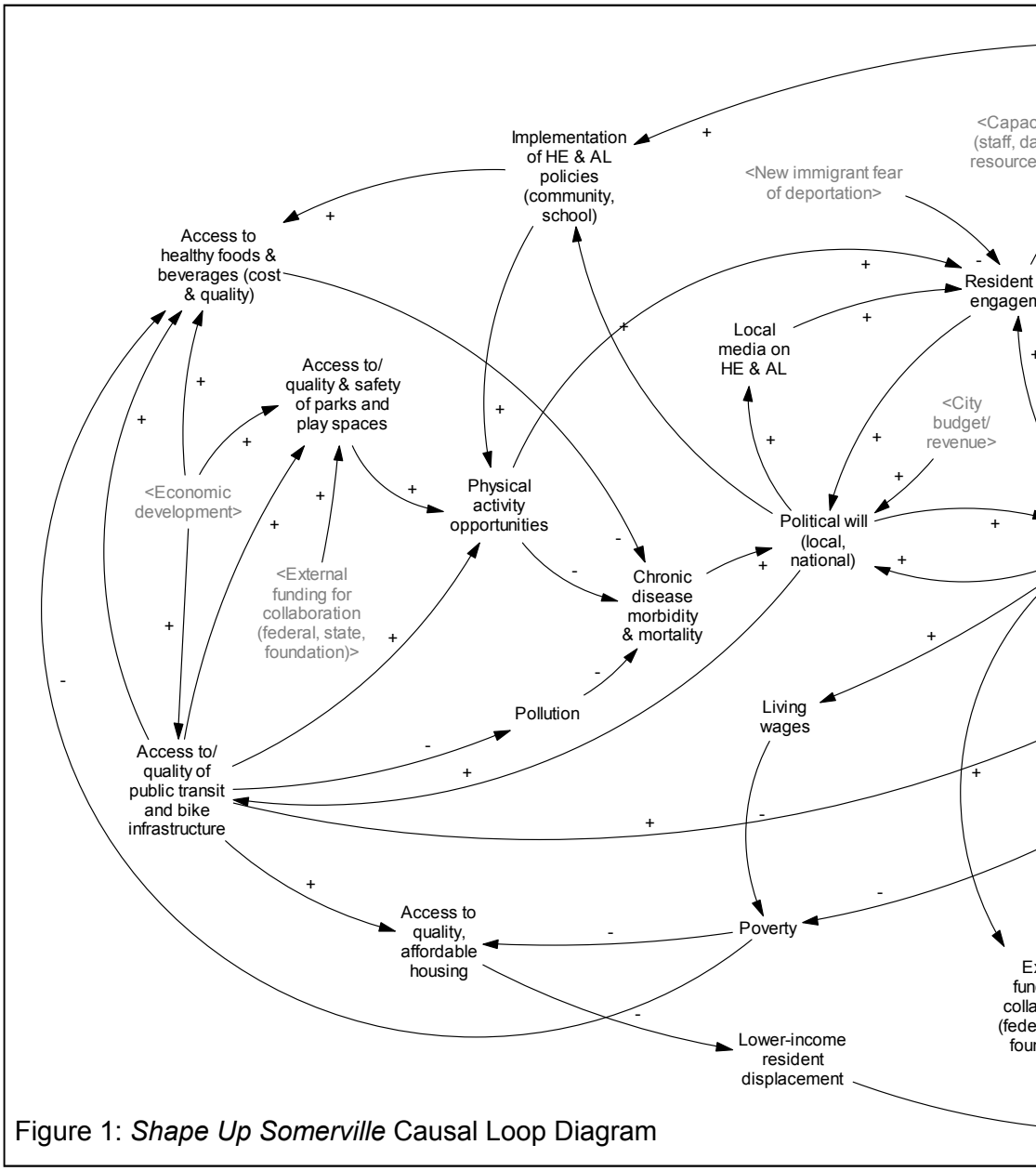
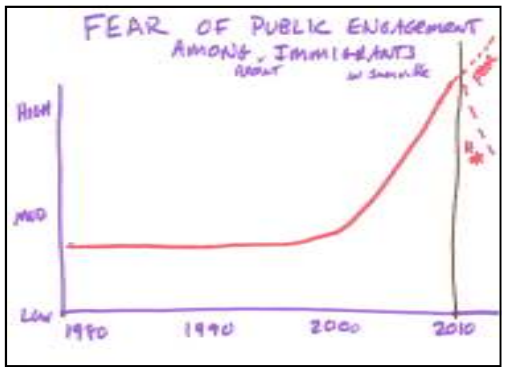


Figure 1: *Shape Up Somerville* Causal Loop Diagram

Group Model Building

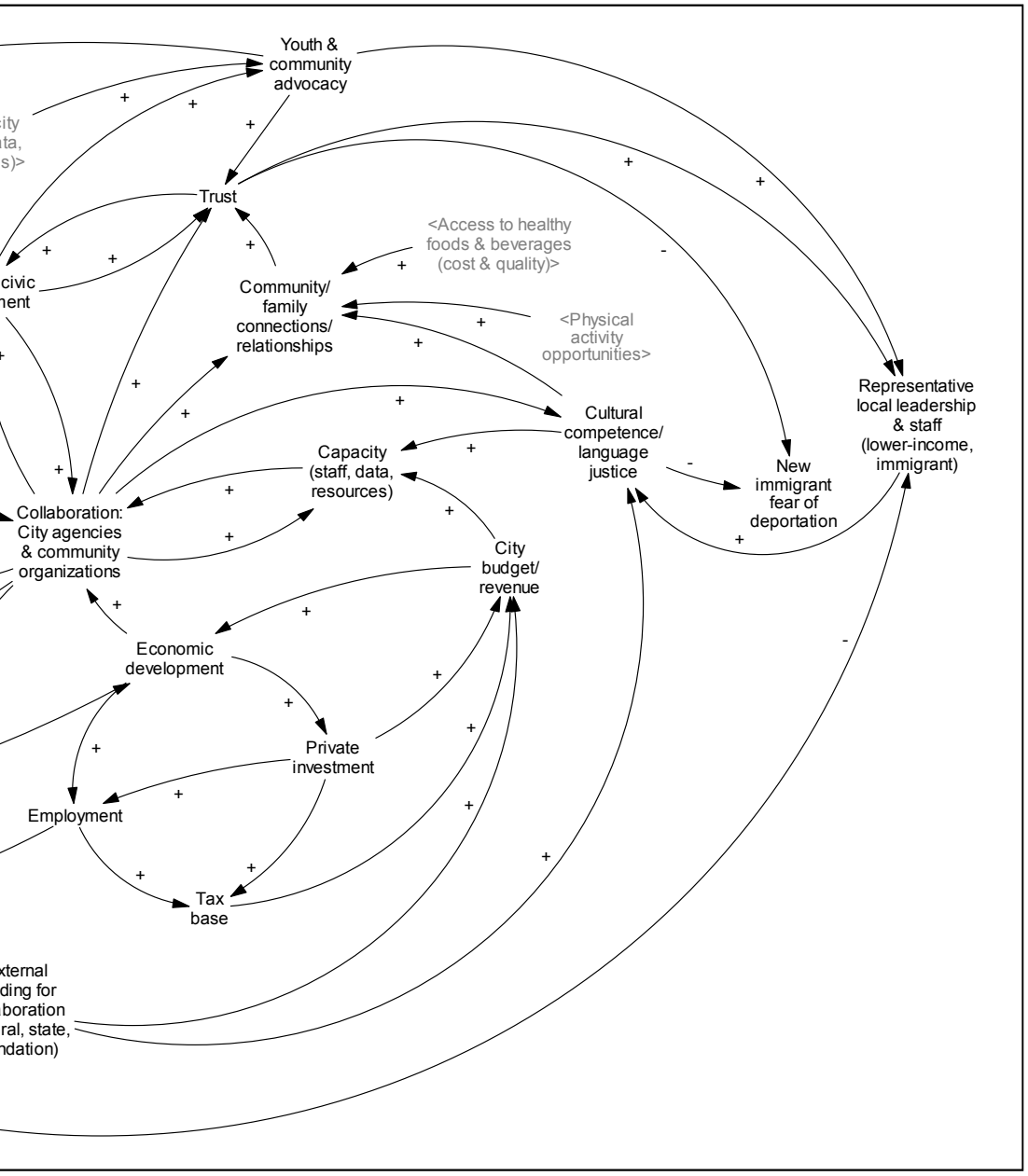
Members of the *Shape Up Somerville* partnership participated in a group model building session in October, 2011 and generated this system, also referred to as a causal loop diagram (Figure 1). Participants in the group model building session included residents, representatives from government agencies, elected officials, community-based organizations, businesses, and advocates. The group model building session had two primary activities: 1) a Behavior Over Time Graph exercise; and 2) a Causal Loop Diagram (or structural elicitation) exercise.



Behavior Over Time Graphs

To identify the range of things that affect or are affected by policy, system, and environmental changes in Somerville, Massachusetts 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 fear of public

engagement among recent immigrants in Somerville, the level of fear has increased from 1980 to 2010 and the participant hopes that these fears of engagement will decrease 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 resident civic engagement in this causal loop diagram. One feedback loop is: resident civic engagement → youth and community advocacy → trust → resident civic engagement. A second feedback loop is: resident civic engagement → political will (local, national) → local media on healthy eating and active living → resident civic engagement.

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 resident civic engagement. Some variables may increase resident civic engagement while other variables limit resident civic engagement. 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 *Shape Up Somerville* 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 Somerville, Massachusetts and to stimulate greater conversation related to Somerville'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 Somerville, Massachusetts. 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.

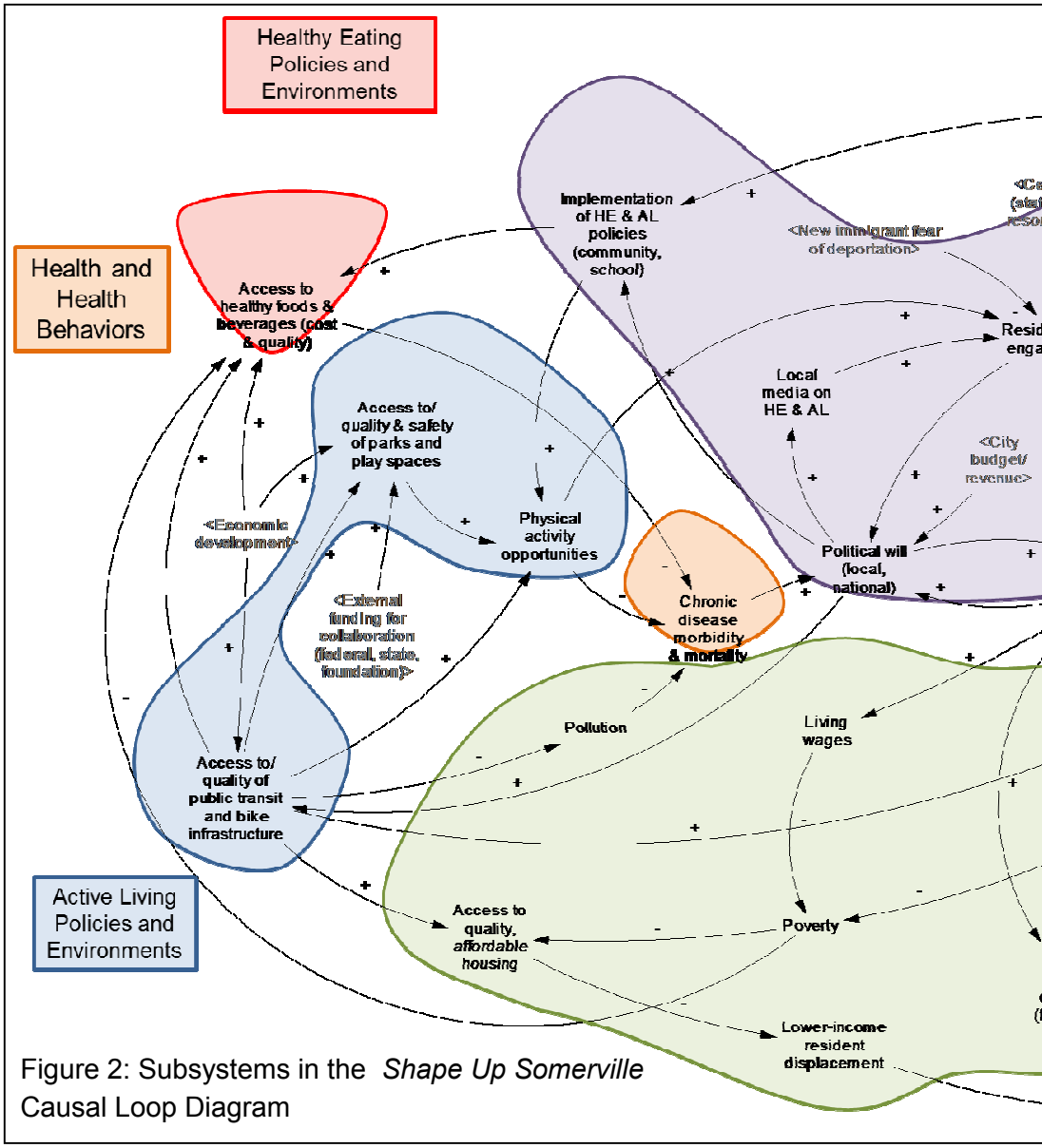


Figure 2: Subsystems in the *Shape Up Somerville* Causal Loop Diagram

<u>Healthy Eating Policies and Environments (Red)</u>

The healthy eating policy and environmental subsystem includes food production, food distribution and procurement, and food retail (e.g., access to healthy foods and beverages). During the behavior over time graphs exercise, the participants generated 9 graphs related to policy or environmental strategies or contexts that affected or were affected by the work of *Shape Up Somerville* . The variables represent participants' conversations from the behavior over time graph and causal loop diagram exercises.

<u>Active Living Policies and Environments (Blue)</u>

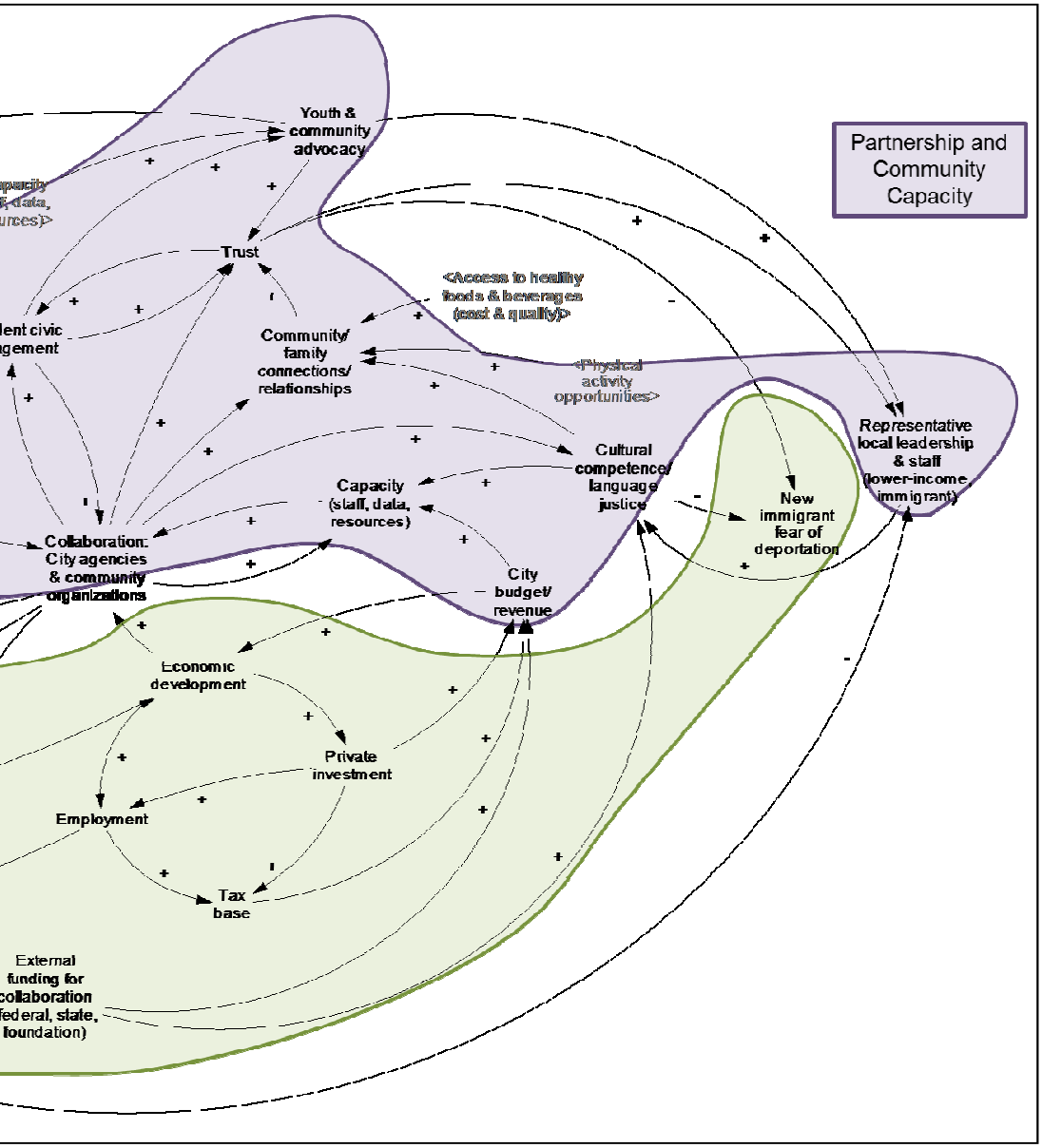
The active living policy and environmental subsystem includes design, planning, construction, and enforcement or maintenance related to access to opportunities for active transportation and recreation. For this topic, the group model building participants developed 12 graphs related to policy or environmental strategies (e.g., access to/ quality and safety of parks and play spaces) or contexts that affected or were affected by the partnership's work.

<u>Health and Health Behaviors (Orange)</u>

The subsystem for health and health behaviors includes health outcomes (e.g., obesity, chronic disease morbidity and mortality), health behaviors (e.g., healthy eating, physical activity), and behavioral proxies or context-specific behaviors.

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, *Shape Up Somerville* had a great deal of success because of the strong collaboration between city agencies and community organizations. This subsystem also includes community factors outside the partnership that may influence or be influenced by their efforts, such as representative local leadership and staff (lower-income and immigrant populations) or trust among people in the community.



Social Determinants

Finally, the social determinants subsystem denotes societal conditions (e.g., pollution, poverty, access to quality, affordable housing) and psychosocial influences (e.g., new immigrant fear of deportation) 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 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 *Shape Up Somerville* partners or by other representatives in Somerville, Massachusetts. 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 capacity (staff, data, resources), collaboration between city agencies and community organizations, external funding for collaboration, and cultural competence/ language justice.

The next sections begin to examine the feedback loops central to the work of *Shape Up Somerville*. 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.

Collaboration Feedback Loop

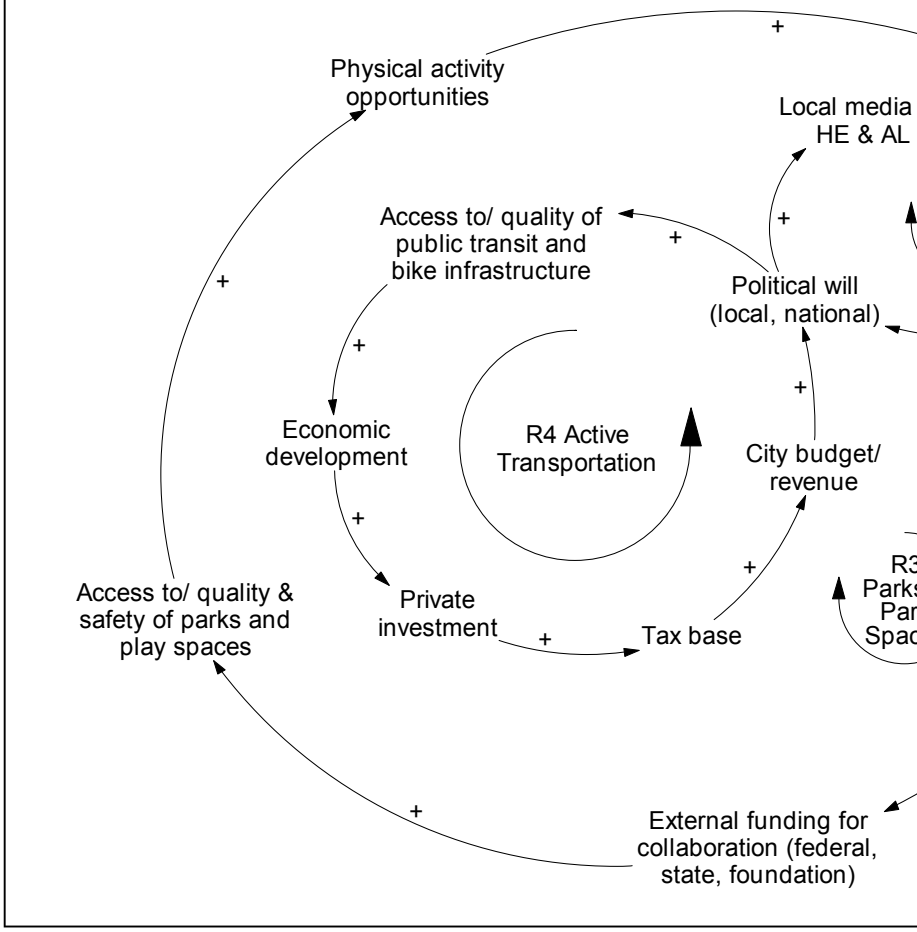
To simplify the discussion about feedback loops, several loops drawn from the *Shape Up Somerville* CLD (see Figures 1 and 2) are highlighted in Figures 3-7. While the CLD provides a theory of change for the childhood obesity prevention movement in Somerville, Massachusetts, each feedback loop tells a story about a more specific change process.

Causal Story for Feedback Loop

Story A: In this case , the story is about the collaboration between city agencies and community organizations (green highlighted loop in Figure 3). Somerville, Massachusetts built upon this foundation to carry out their work on different healthy eating and active living strategies. Participants described how the increase in collaboration across agencies and organizations improved cultural competence and language justice in working with different populations in Somerville. In turn, greater cultural competence and language justice increased the capacity of the agencies and organizations (e.g., staff skills, resources to serve different populations). With these improvements in capacity, the collaboration increased in the quality of the existing partnerships or with new partners.

Story B: While the preceding story reflected a positive scenario for Somerville, Massachusetts, the same feedback loop also tells the opposite story. Less collaboration across agencies and organizations leads to less cultural competence and language justice. With fewer cultural competence skills and resources, the capacity of the agencies and organizations to serve diverse populations in Somerville is also diminished. Less agency and organization capacity results in less collaboration potential.

Figure 3: Collaboration Feedback Loop



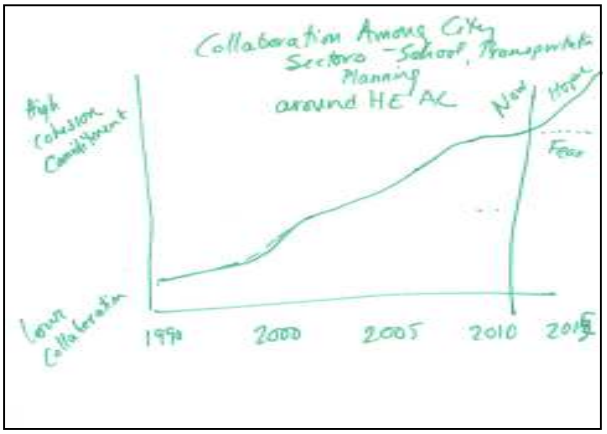
Reinforcing Loop and Notation

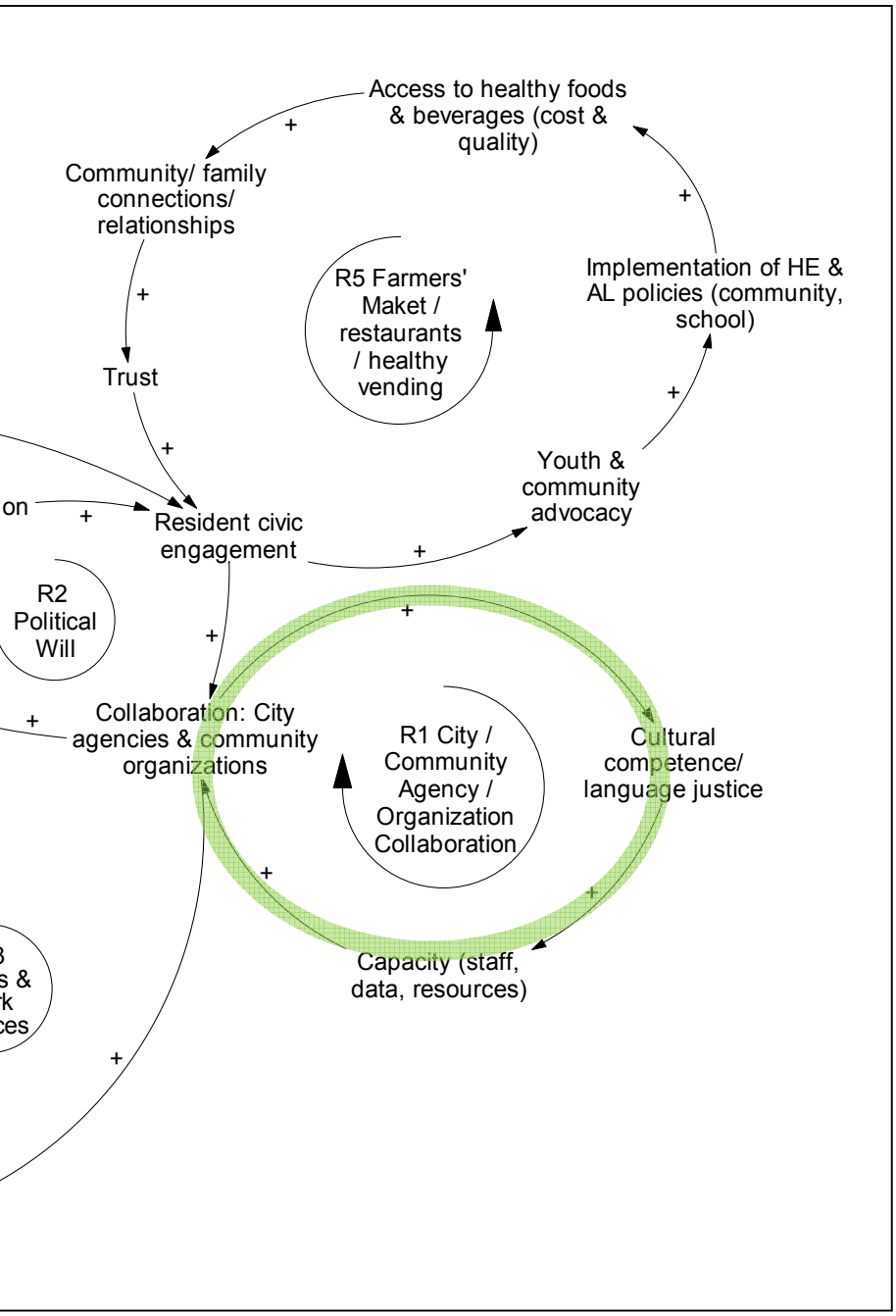
These stories — pro and con — represent a reinforcing loop, and the notation in the feedback loop identifies it as a reinforcing loop (see "R1 — City/ Community Agency/ Organization Collaboration" and green highlighted loop in Figure 3). The words represent variables of quantities that increase and decrease as illustrated in the stories above. These variables change over time and are influenced by other variables as indicated by the arrows.

"Community engagement is getting people to participate in the policies and environmental changes... not as activists, or being part of the project, but actually buying into the culture shift, the change, supporting what's coming out of programs... is how I looked at community engagement. So, with all that, I think collaboration with city agencies, community organization goes up to local, regional, national levels." (Participant)

Each arrow represents a causal relationship, and the plus and minus signs on the arrows indicate whether or not the influence of one variable on another variable (1) increases/adds to (plus or "+" sign), or (2) decreases/removes from the other variable (minus or "-" sign). These signs are referred to as polarities.

In a reinforcing loop, the effect of an increase or decrease in a variable continues through the cycle and returns an increase or decrease to the same variable, respectively. Looking specifically at the "+" or "-" notation, a feedback loop that has zero or an even number of "-" signs, or polarities, is considered a reinforcing loop. Balancing loops, with an odd number of "-" signs in the loop, are another type of feedback loop not represented in the loops for Somerville.





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 collaboration of city agencies and community organizations likely levels off at some point when most relevant partners have been engaged. To understand what specifically leads to the leveling off of this collaboration, it may be helpful for the partners in Somerville, Massachusetts to consider other variables that influence or are influenced by the collaboration. In addition, it is important to remember that this reinforcing loop is only one part of the larger CLD (see Figures 1 and 2), and the other loops and causal relationships can have an impact on the variables in this loop.

<u>System Insights for *Shape Up Somerville*</u>

Participants identified a dramatic increase in collaboration in Somerville, Massachusetts since 1990 (see behavior over time graph).

From the systems thinking exercises, several insights can inform efforts to continue to increase or sustain collaboration, including:

- Creating opportunities to increase the cultural competency of agency and organization staff (e.g., training and technical assistance) and resources to support language justice (e.g., translation and interpretation services) to engage non-traditional partners, including those who may not speak English.
- Collecting, analyzing, and applying data to understand differences in populations in Somerville with respect to access to resources, fears of civic engagement, and other relevant concerns.

Political Will Feedback Loop

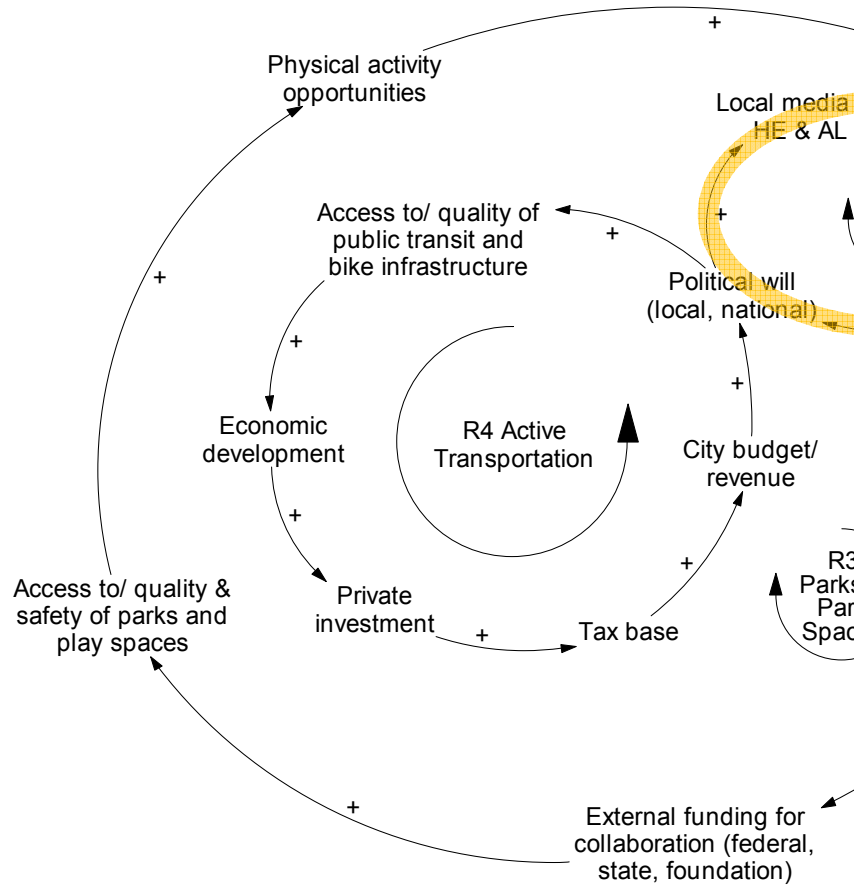
Given the introduction to feedback loops and CLD notation in the previous section, this discussion of the feedback loop highlighted in orange in Figure 4 expands on the concepts and notation, and highlights the strategy to increase political will.

Causal Story for Feedback Loop

Story A: As there is more political will — both locally and nationally — for increasing healthy eating and active living and reducing childhood obesity, there is more local media (e.g., newspaper articles, TV or radio spots) promoting healthy eating and active living. With this increased media attention, residents become more aware of the issues and are more likely to get engaged in the civic discussions and decision-making (e.g., voting, voicing concerns to city council). The increased civic engagement can help to reinforce existing collaboration or stimulate new collaboration that will further increase political will to create change in Somerville.

Story B: On the other hand, the lack of political will to drive policy and environmental changes to support healthy eating and active living deters media attention to these issues, thereby diminishing residents' awareness and engagement to create positive change. With less resident engagement, collaboration is more difficult as agencies may be responding to a number of public concerns, spreading personnel and resources across issues. In this scenario, it is more difficult to increase political will and policy-maker interest in healthy eating, active living, and childhood obesity.

Figure 4: Political Will Feedback Loop



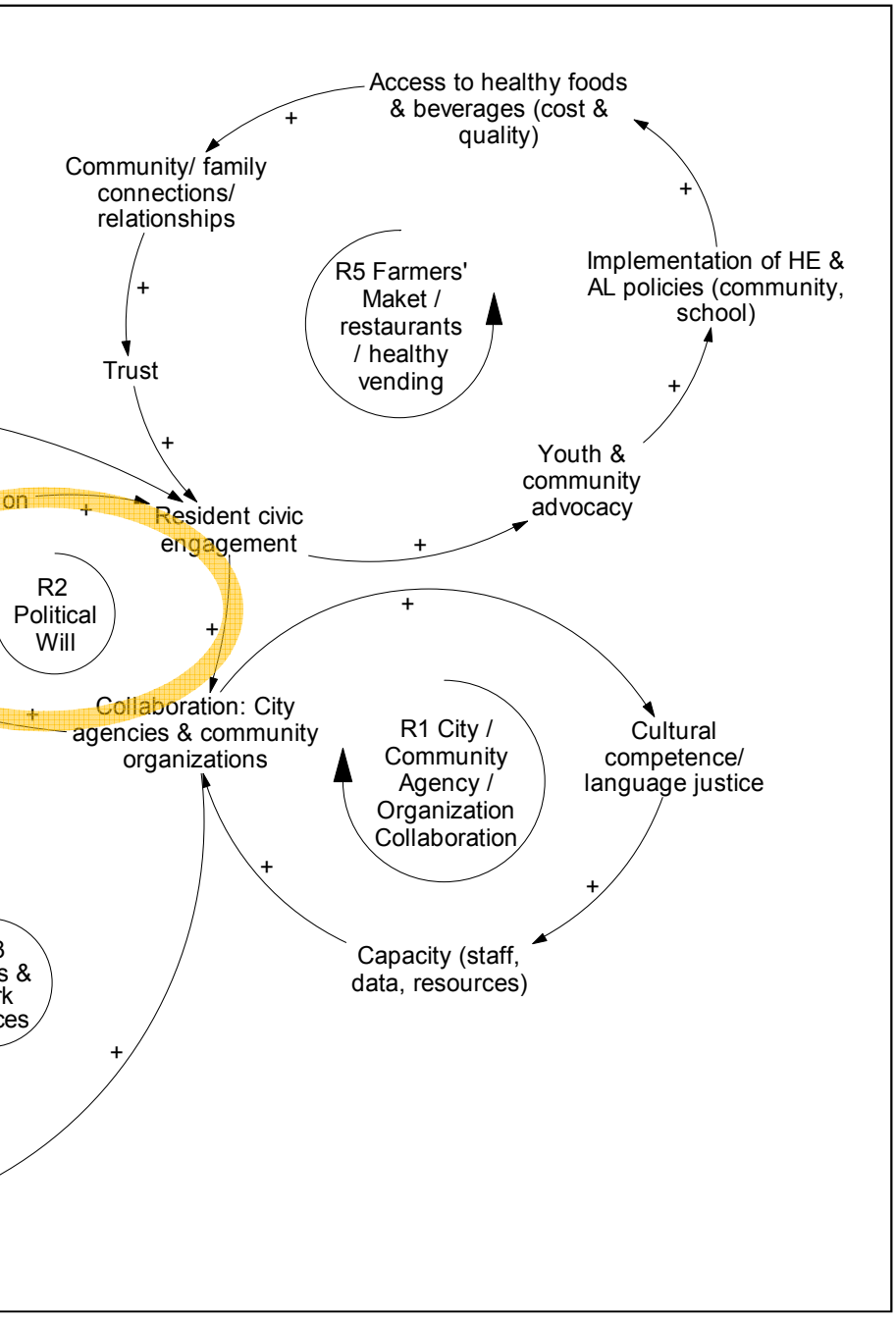
Reinforcing Loop and Notation

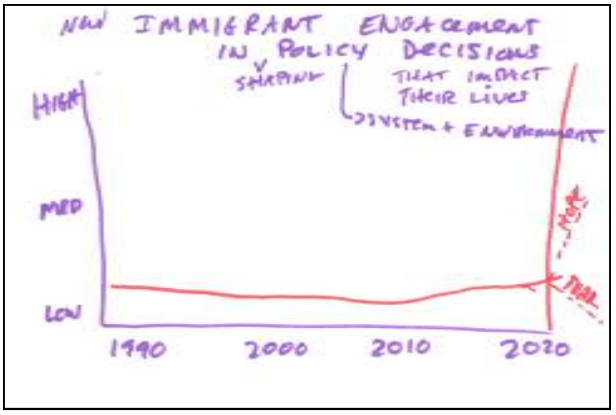
Similar to the previous strategy, this loop is a reinforcing loop (see R2— Political Will in Figure 4). Some of these causal relationships may have more immediate effects (e.g., political will increases local media attention to healthy eating and active living) and other relationships may have delayed effects (e.g., the impact of local media on resident civic engagement). This delayed effect is noted using two hash marks through the middle of the arrow line (not included in Figure 4).

"Communication and perception of the city government ties into grassroots organizations feeling like they have a voice, and then people who actually make the policies and change the system are getting on board and they're actually saying, 'yes, we agree, we want to do this, we want to lead by example and make our community as healthy and happy as possible'. Slowly and steadily, once you have an ear of someone who can change policy, you're going in the right direction." (Participant)

System Insights for *Shape Up Somerville*

In the behavior over time graphs, participants identified a steady trend of low engagement of new immigrants in policy decisions that impact their lives since 1990 as well as an increase in the number of local media pieces on healthy eating, active living, and childhood obesity (see illustrations at the top and bottom right).



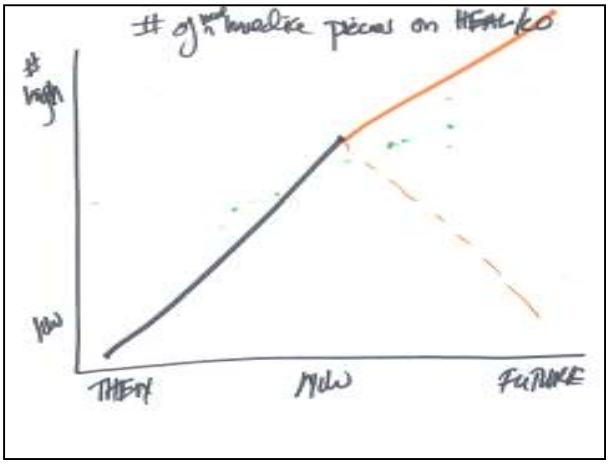


System insights can inform the partnership's next steps to increase local political will, including:

- Developing strategies to increase resident civic engagement, particularly among new immigrants or other populations relatively unrepresented in the public sector in Somerville.
- Working to increase local media pieces in different formats or publications to reach non-English-speaking populations to raise their awareness of healthy eating, active living, and childhood obesity issues.
- Forging new collaborations with city agency representatives or community organization leaders to generate more political will in various sectors of the community for those whose voices are currently not well represented.

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

- How does awareness and civic engagement related to healthy eating, active living, and childhood obesity differ according to various subpopulations in Somerville?



- What indicators of political will have led to successes in drawing local media attention to healthy eating, active living, and childhood obesity in Somerville?
- How does awareness of these issues lead to greater civic engagement and collaboration among agencies and organizations (e.g., tipping points)?

Parks and Play Spaces Feedback Loop

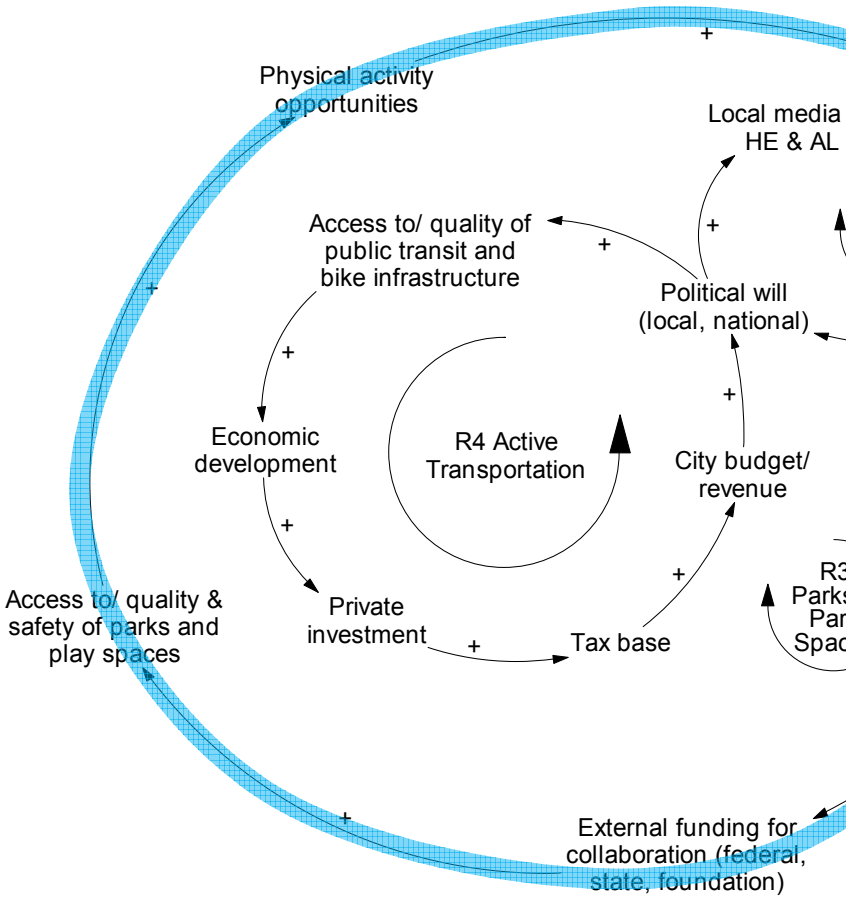
Highlighted in blue in Figure 5, the parks and play spaces feedback loop represents one of the *Shape Up Somerville* strategies to increase active living in Somerville, Massachusetts.

Causal Story for Feedback Loop

Story A: Greater access to quality, safe parks and play spaces leads to more opportunities for residents to be physically active. As residents are more active out in the community, there are also more opportunities for folks to interact with fellow community residents and potentially increase their civic engagement through these relationships. As noted previously, greater resident civic engagement increases collaboration among city agencies and community organizations. In turn, this collaboration may lead to more external funding to support this work that provides resources to further improve access to quality, safe parks and play spaces.

Story B: Alternatively, less access to parks and play spaces minimizes opportunities for residents to be active out in the community, reducing social interactions that can lead to greater resident civic engagement. Fewer residents engaged motivates less collaboration among city agencies and community organizations. With less collaboration, fewer external funding opportunities may present themselves, resulting in diminished resources to support access to parks and play spaces.

Figure 5: Parks and Play Spaces Feedback Loop



Reinforcing Loop and Notation

Like previous loops, this one also represents a reinforcing loop (all "+" signs). In addition, it includes causal relationships representing more immediate effects (e.g., access to parks and play spaces increases physical activity opportunities), and, potentially, delayed effects (e.g., residents physically active in the community becoming more civically engaged).

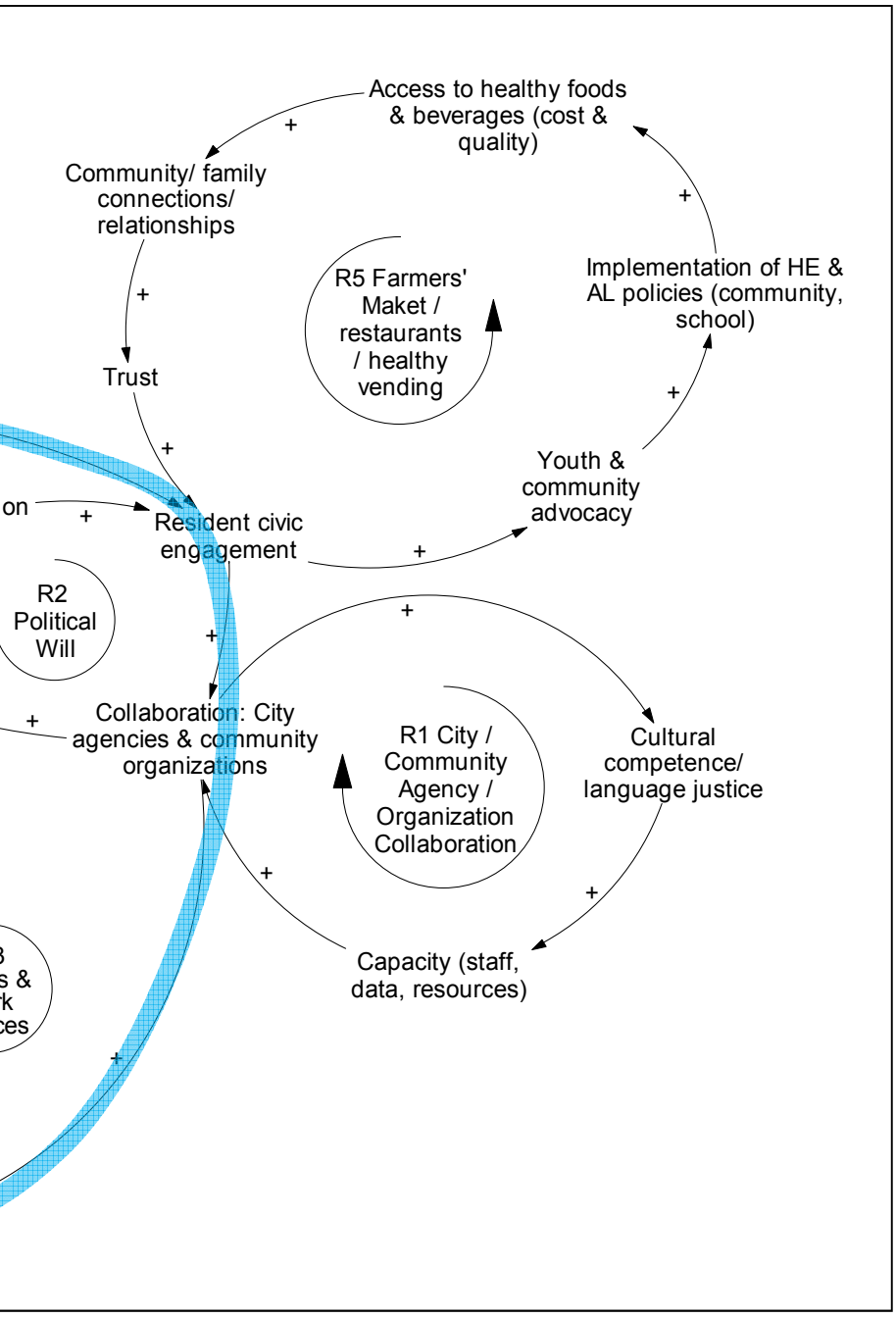
System Insights for *Shape Up Somerville*

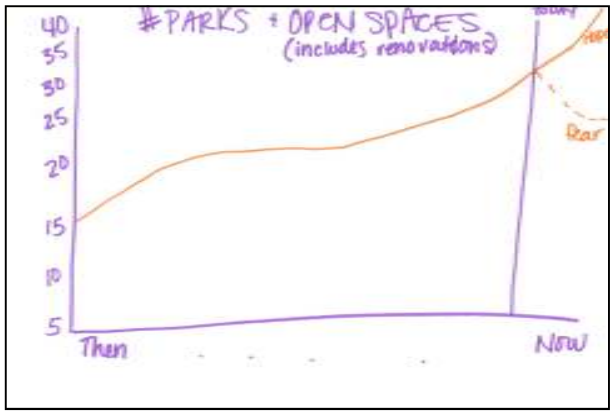
In the behavior over time graphs exercise, participants described an increasing trend for the number of parks and open spaces, including those that have been renovated. Similarly, participants illustrated an increasing trend for the access to higher quality parks and playgrounds from fair to good or great in Somerville since 1995. See the behavior over time graphs on the next page.

"We're not going to be increasing the actual amount of park space in the city, but really the priority needs to be increasing the quality of the space. The park space is there, but is it good quality, is it useful? And that's really the major effort right now." (Participant)

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

- Parks and play spaces that facilitate both opportunities for physical activity and resident interaction and engagement may support sustainability of the quality of these spaces by increasing collaboration of local partners that can generate resources to invest in these spaces.

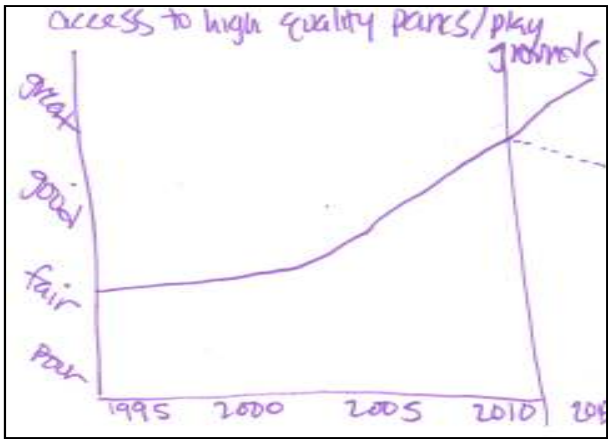




- Somerville has had success in improving the quality and safety of parks and play spaces, yet participants still have concerns about the quality of some of these spaces; therefore, mechanisms for translating the successful strategies to ensure equitable access to quality, safe parks and play spaces throughout Somerville are needed.

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

- What parks and play spaces are used by what groups in the community (e.g., children, adolescents, people in poverty)? Are surrounding residents more or less active? Civically engaged?
- What funds have collaborators successfully secured for parks and play spaces? How can these resources be sustained into the future?
- What are key characteristics of quality parks and play spaces? Safe parks and play spaces? How do these characteristics influence the use of these public recreation facilities?
- Are residents who use parks and recreation facilities more likely to be civically engaged in the community? If so, how does this work? What are the facilitators and barriers?



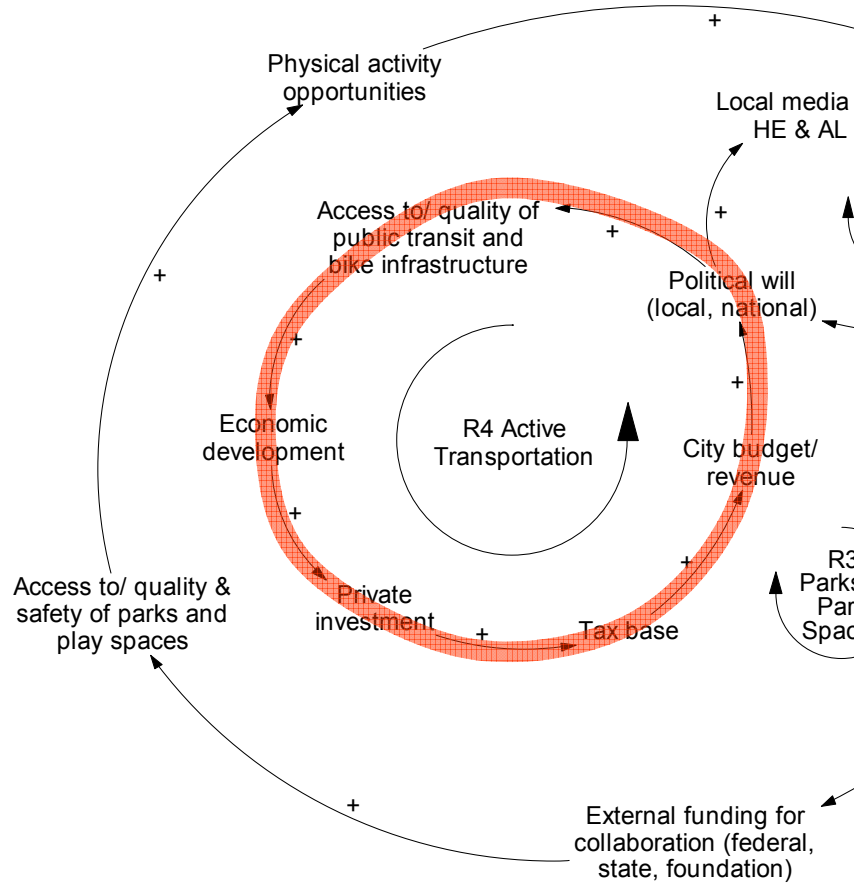
Active Transportation Feedback Loop

The loop highlighted in red in Figure 6 represents another one of the *Shape Up Somerville* strategies, active transportation, to increase active living in Somerville, Massachusetts.

Causal Story for Feedback Loop

Story A: Increasing access to quality public transit and bike infrastructure provides greater economic development opportunities in Somerville (e.g., linking residential and commercial districts). More economic development can attract greater private investment in the city as well. These resources increase the local tax base by bringing employers and their taxes as well as jobs attracting more residents and their taxes. With a larger tax base, the city government has more revenue and a larger budget. These resources help to increase political will to allocate more resources to strategies to improve healthy eating and active living and to reduce childhood obesity. With the political will and the resources, more efforts to improve access to quality public transit and bike infrastructure can be pursued.

Figure 6: Active Transportation Feedback Loop



Story B: The opposite is true in the case where public transit and bike infrastructure is not available. This makes it more difficult to increase economic development and private investment, thus leveling or reducing the tax base for Somerville. With less revenue, there is more competition for the limited resources available in the city's budget, and, therefore, it is more difficult to generate political will to support healthy eating, active living, and childhood obesity initiatives. Without the political will and resources, few improvements can be made to public transit and bike infrastructure in Somerville.

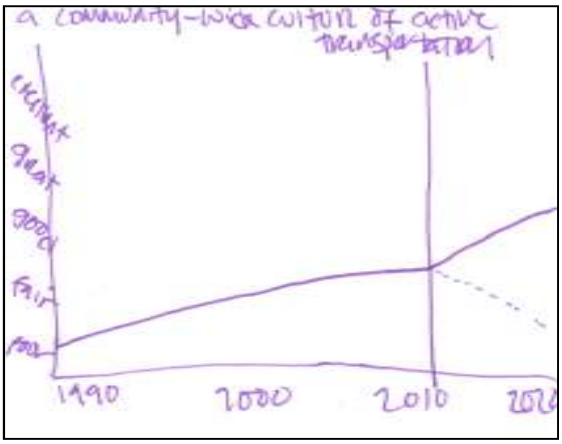
Reinforcing Loop and Notation

Again, this is a reinforcing loop (all "+" signs). It includes causal relationships representing more immediate effects (e.g., a larger tax base provides greater revenue to the city), and, potentially, delayed effects (e.g., the impact of access to public transit and bike infrastructure on economic development).

In Figures 1 and 2, this loop is disconnected (e.g., the connection from city budget/ revenue to political will (local, national) 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. City budget/ revenue has a shadow variable (shown in

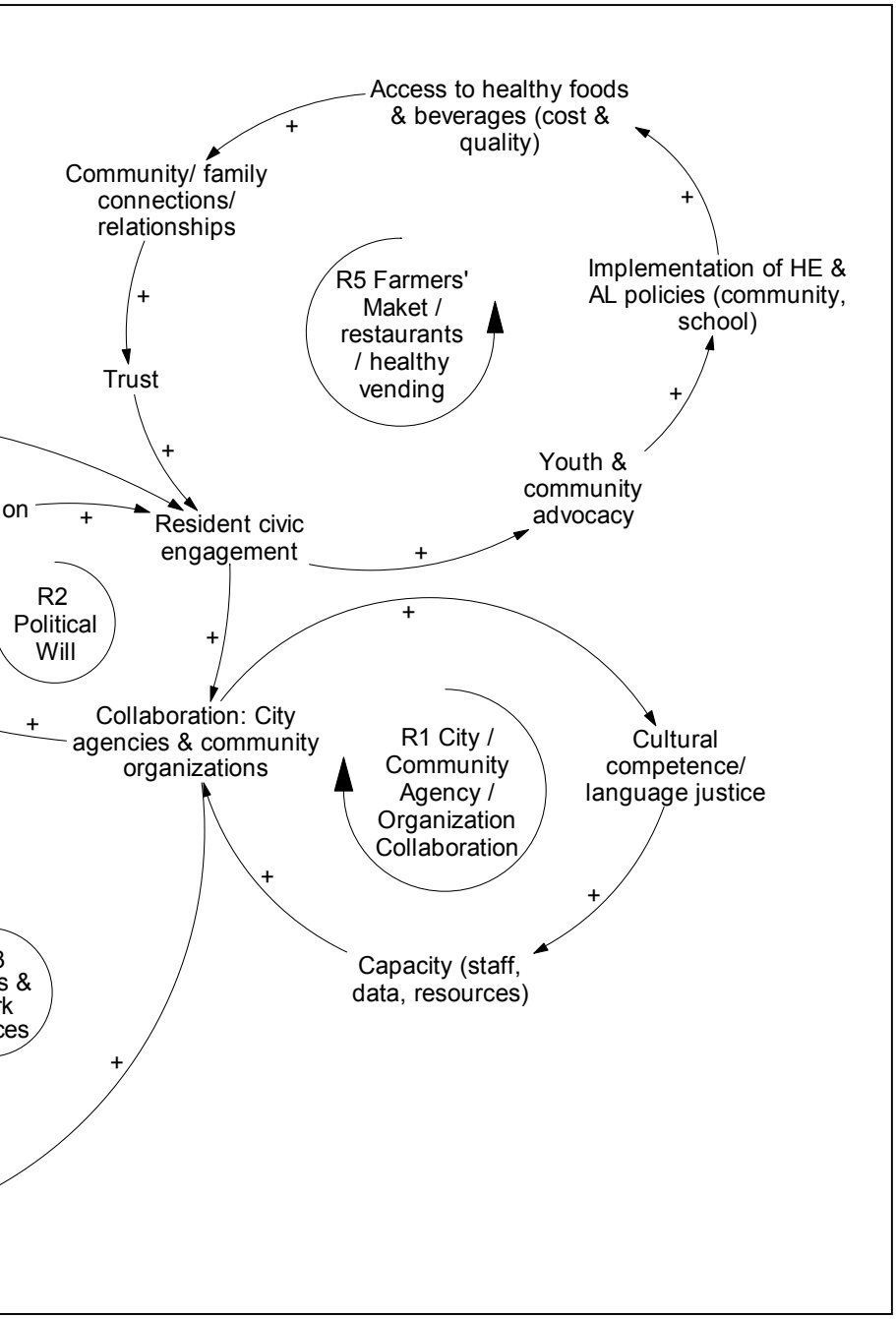
"If we get the six extra transit stations, then people are going to be willing to walk to them. It will be less than a quarter mile from everybody from a transit station, we won't be driving as much getting around. And people can ride their bikes." (Participant)

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.



System Insights for *Shape Up Somerville*

In the behavior over time graphs exercise, participants described a general increase in the community-wide culture of active transportation from poor to fair in Somerville since 1990 (see behavior over time graph).



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

- Improvements to and expansion of public transit and bike infrastructure are likely to have a good return on investment by stimulating economic development and private investment in the local community.
- Efforts to build political will — particularly support from policy-makers — for improvements to transit and bike infrastructure may benefit from economic data forecasting how the short-term expenditures may have substantive long-term financial gains for the city government and the community as a whole.

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

- What types of public transit and bike infrastructure are best suited to stimulating economic development and attracting private investment? How does this impact transportation planning and traffic design/ engineering? How do these infrastructure improvements impact transit use or the number of cyclists?
- What types of economic development or private investment projects may be aligned with transit and bike infrastructure? What strategies can be used to attract relevant developers and businesses?
- What is the potential return on investment from transit and bike infrastructure and the anticipated timeline for the costs and savings? How do policy– and decision-makers respond to these types of returns?

Farmers' Markets/Restaurants/Healthy Vending Feedback Loop

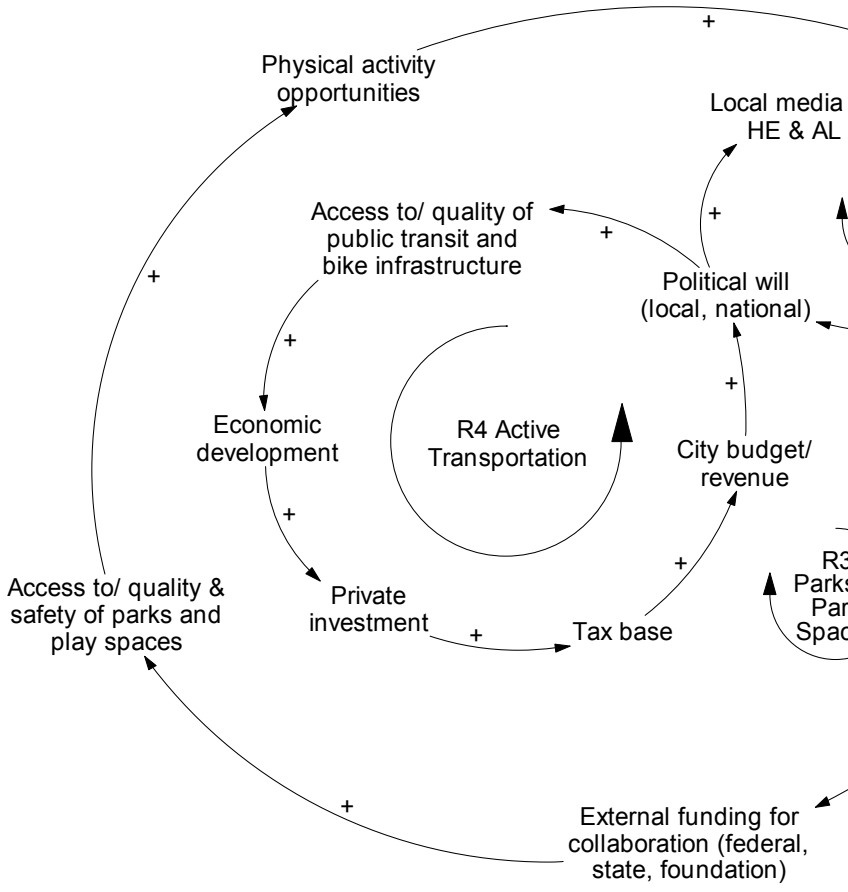
In yellow in Figure 6, the feedback loop represents several of the *Shape Up Somerville* strategies to increase healthy eating, including farmers' markets, restaurants, and healthy vending.

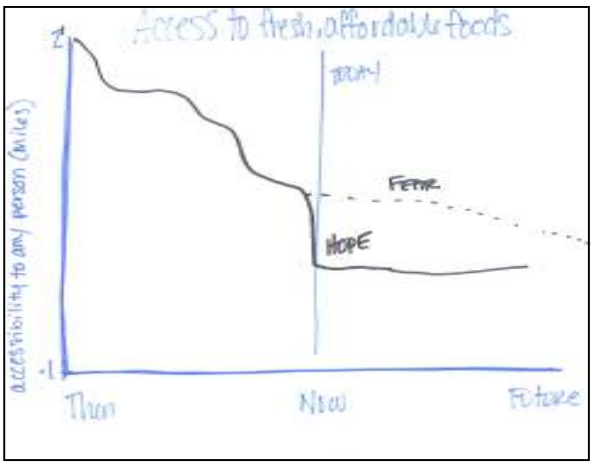
Causal Story for Feedback Loop

Story A: Increased access to quality, affordable, and healthy foods and beverages leads to more or higher quality community and family connections and relationships (e.g., social interactions at a farmers' market, conversations during meals at home). With these relationships, there is greater trust among family and community members, and, in turn, a greater likelihood of resident civic engagement. With more parents and community role models engaged in voting and other forms of civic engagement, youth in the community are more likely to participate in advocacy efforts alongside these adults. More advocacy increases the likelihood of implementation of healthy eating and active living policies, both in schools and in the community. As there is more implementation of healthy eating policies in particular, there is greater access to healthy foods and beverages through farmers' markets, restaurants, and healthy vending, among others.

Story B: In contrast, communities that do not have access to quality, affordable, and healthy foods and beverages are not as well equipped to support community and family connections and relationships that center around food (e.g., events, meals). Without these relationships, there is less trust and less civic engagement, and, ultimately, fewer advocacy initiatives with adults or youth in the community. Less advocacy provides less impetus for the implementation of healthy eating and active living policies. Consequently, there is less access to healthy foods and beverages.

Figure 7: Farmers' Markets/Restaurants/Healthy Vending Feedback L





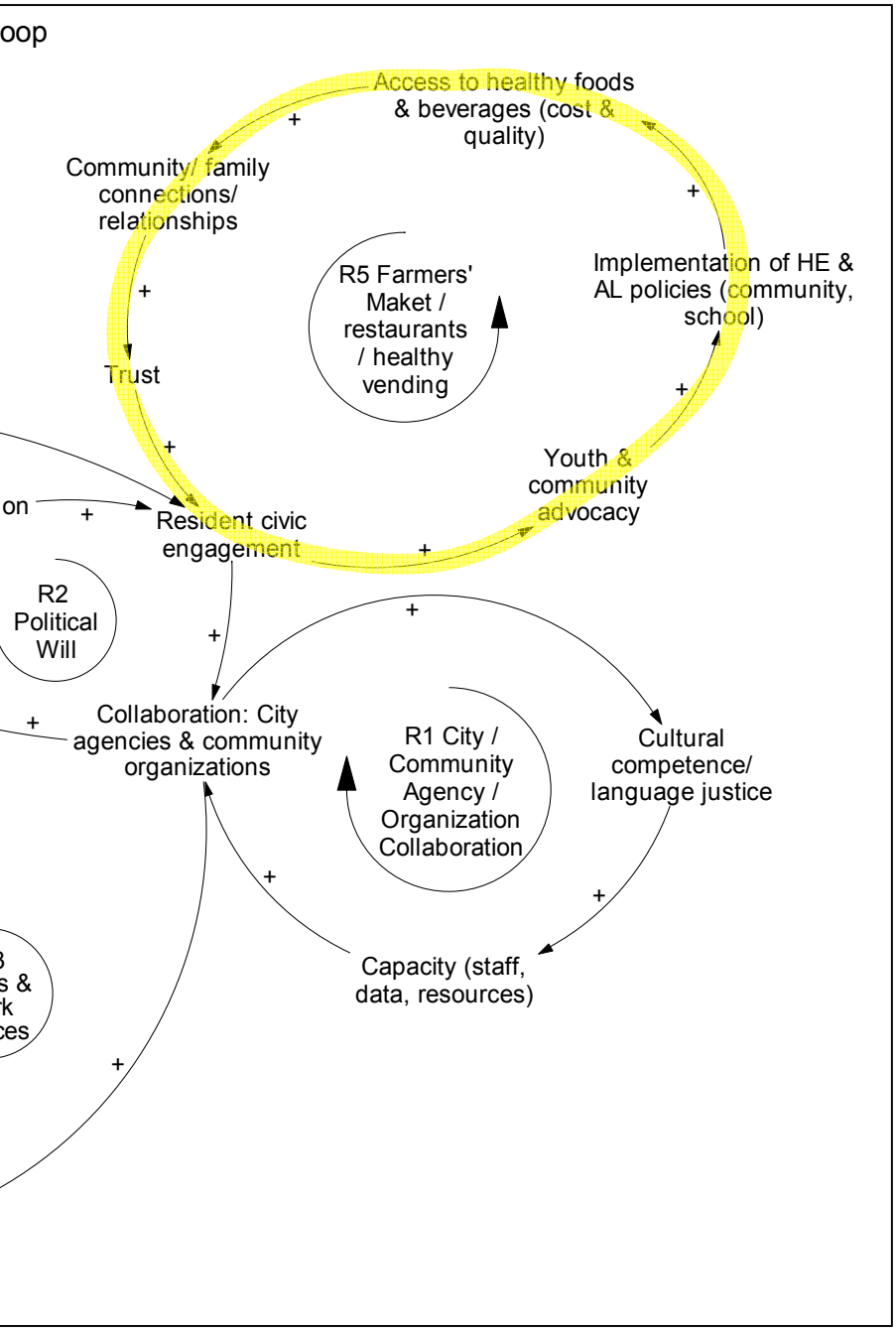
Reinforcing Loop and Notation

This loop also represents a reinforcing loop (all "+" signs). In addition, it includes causal relationships representing more immediate effects (e.g., access to healthy foods and beverages increasing community and family connections and relationships), and, potentially, delayed effects (e.g., youth and

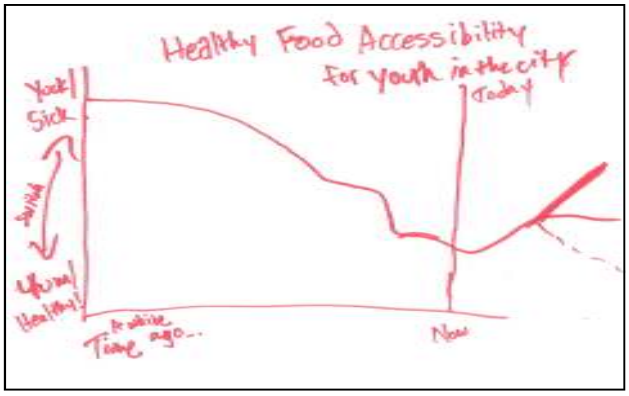
community advocacy resulting in implementation of healthy eating and active living policies).

System Insights for *Shape Up Somerville*

In the behavior over time graphs exercise, participants described a substantial decline in access to fresh, affordable foods (see behavior over time graph on previous page) and a similar decline in healthy food accessibility for youth in



- What are the connections between food and social relationships (e.g., eating meals together)? What facilitates these connections? What gets in the way of these connections?



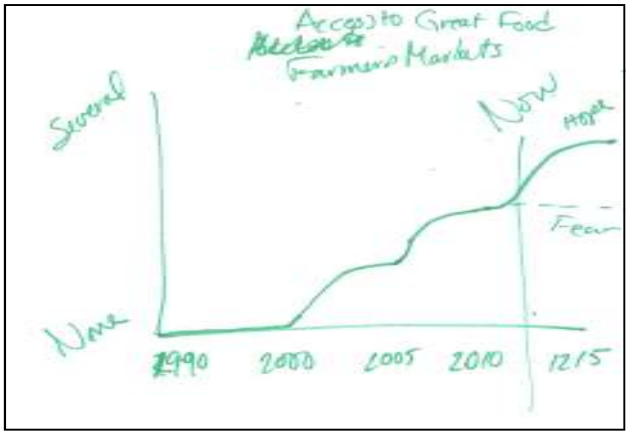
Somerville (top right). However, from 2000 forward, participants identified an increase in access to great food through farmers' markets.

System insights for the partnership's farmers' markets/restaurants/healthy eating efforts include:

- In general, the access to healthy foods and beverages has had a substantial decline in Somerville; however, recent efforts to increase access through farmers' markets, restaurants, and healthy vending have the potential to shift this trend if taken to scale in the community.
- Strong social ties — in the family and in the community — can be developed in association with access to healthy foods and beverages. These social ties instill trust and increase engagement in ways that promote greater advocacy to support healthy eating initiatives. Maintaining these connections between food and social relationships may increase sustainability of healthy eating initiatives.

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

- What factors have led to the substantial decline in access to healthy foods and beverages in Somerville? Does access to healthy foods and beverages vary by different populations?



Opportunities for Systems Thinking in Somerville, Massachusetts

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

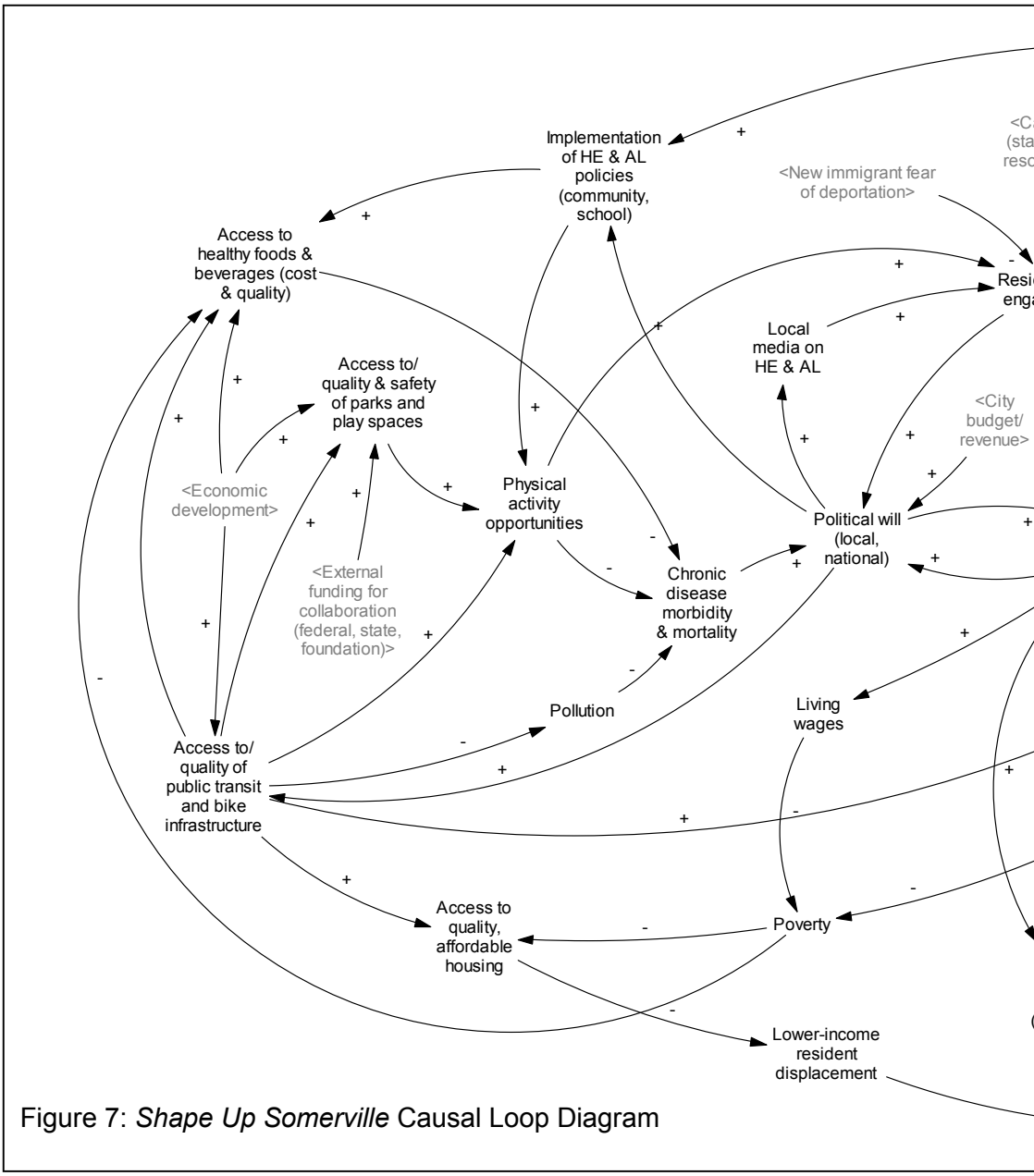


Figure 7: *Shape Up Somerville* Causal Loop Diagram

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 Somerville, Massachusetts to promote healthy eating and active living as well as preventing childhood overweight and obesity.

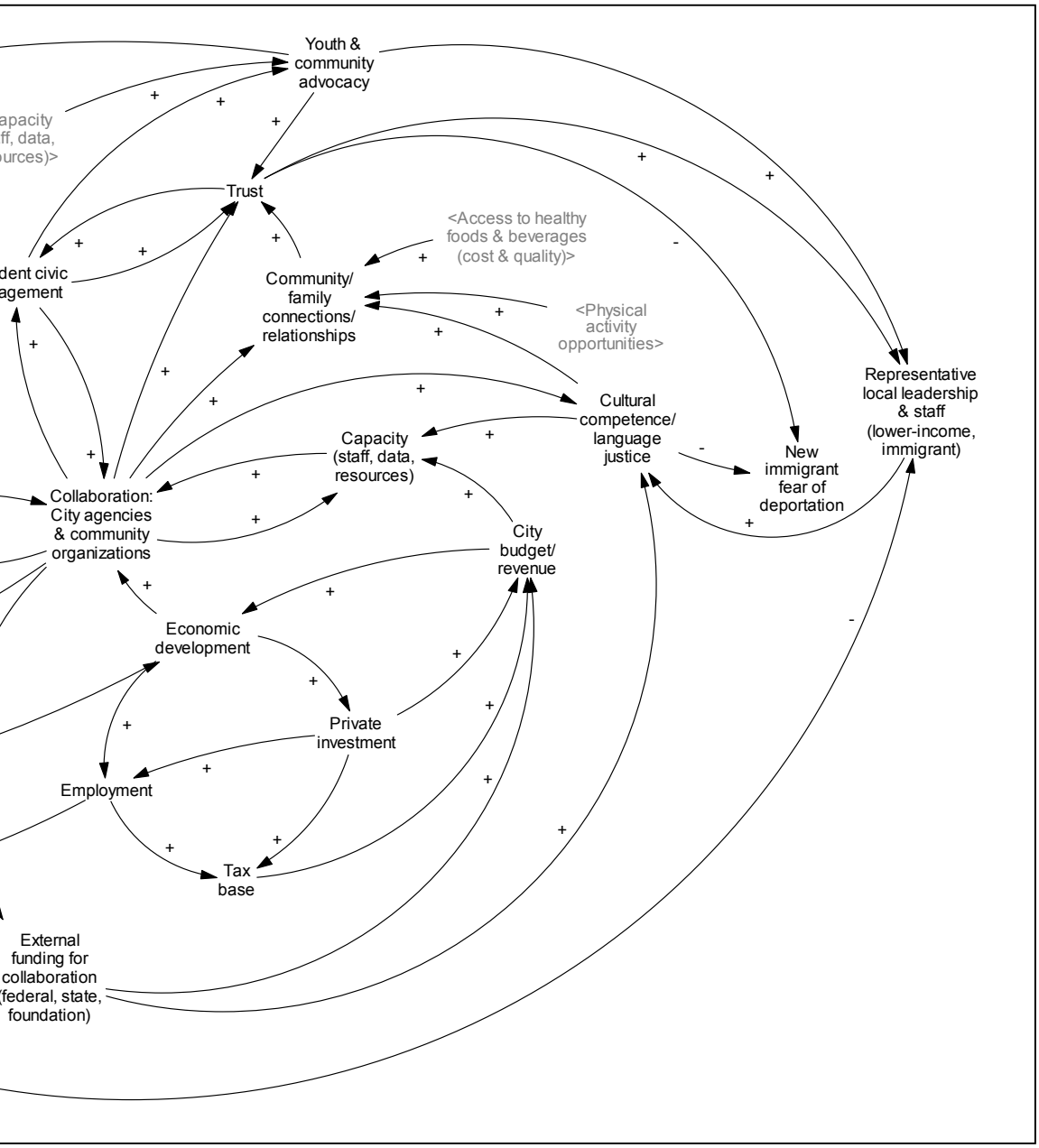
Yet, there are several limitations to this storybook, including:

- the participants represent a sample of the *Shape Up Somerville* 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 corner stores, fast food restaurants, urban agriculture/ local food production, school gardens, exposure to healthy food, demand for healthy food, farmers' markets (with EBT), access to unhealthy food & beverages, balanced age distribution of residents, health care costs, resident quality of life, equity, community sustainability, collective action with surrounding communities; 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 Somerville 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 *Shape Up Somerville* 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/

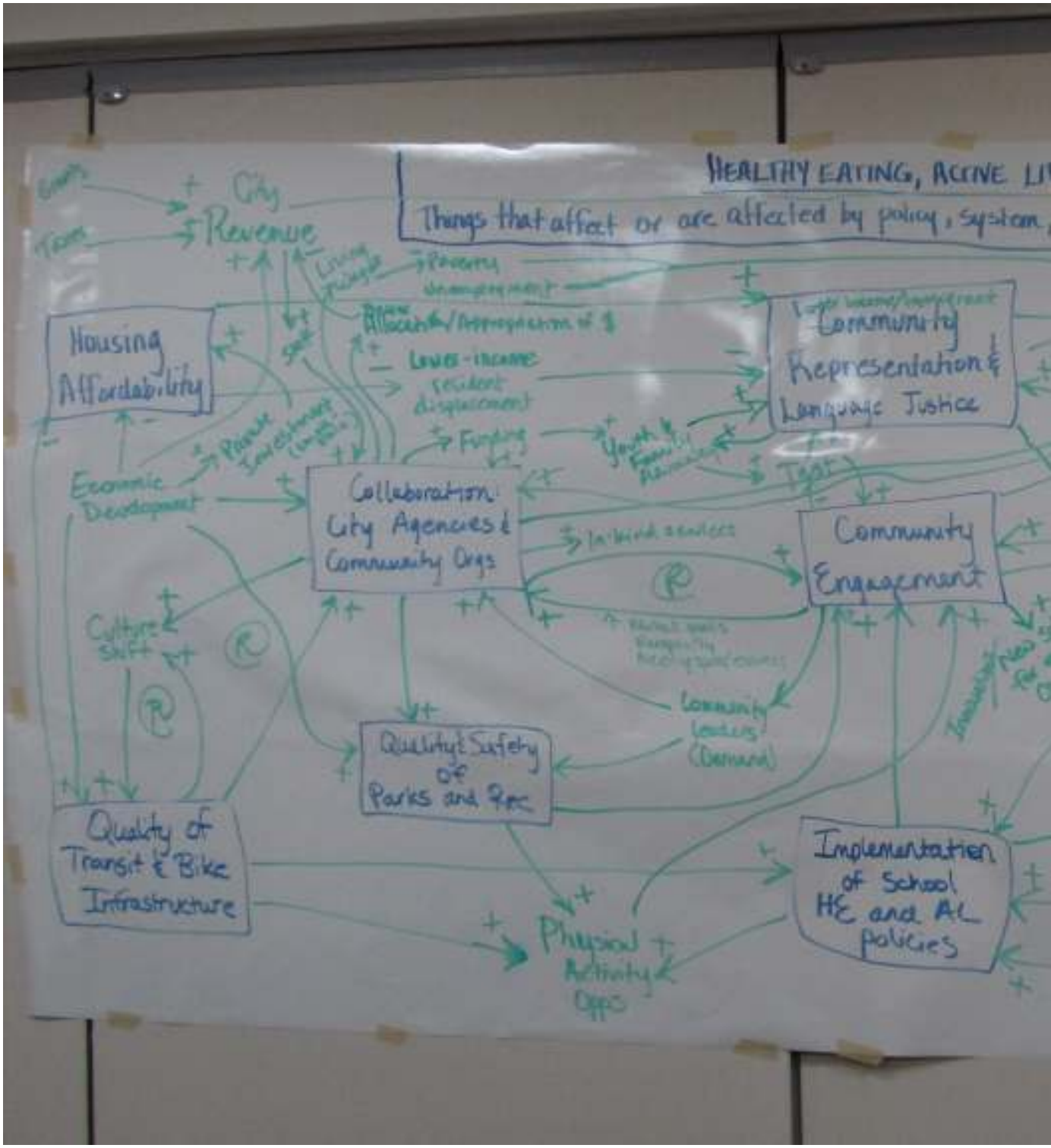
Vennix, J. (1996). Group model building. New York, John Wiley & Sons.

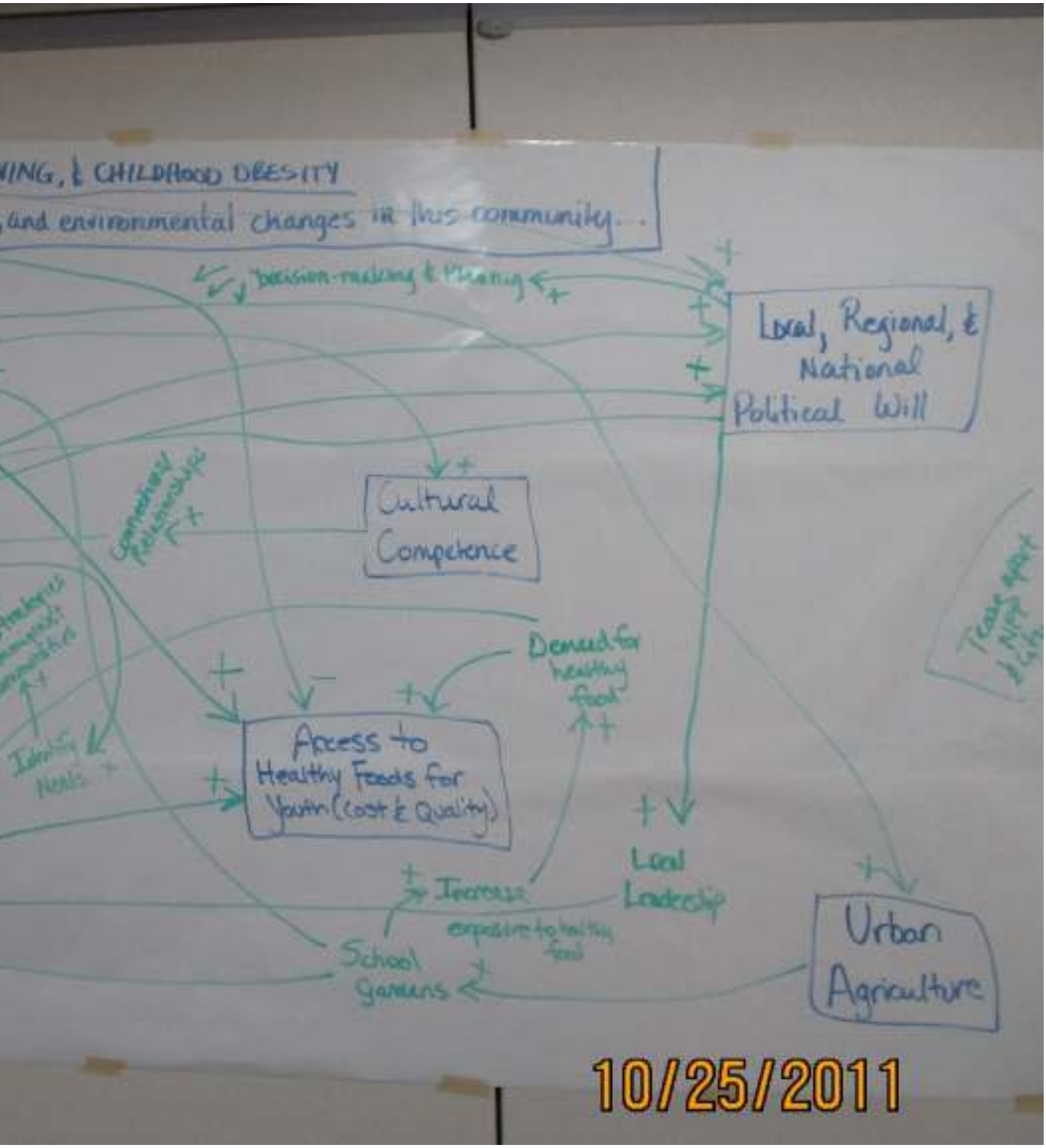
Zagonel, A. and J. Rohrbaugh (2008). Using group model building to inform public policy making and implementation. Complex Decision Making. H. Qudart-Ullah, J. M. Spector and P. I. Davidsen, Springer-Verlag: 113-138.

Appendix A: Behavior Over Time Graphs Generated during Site Visit

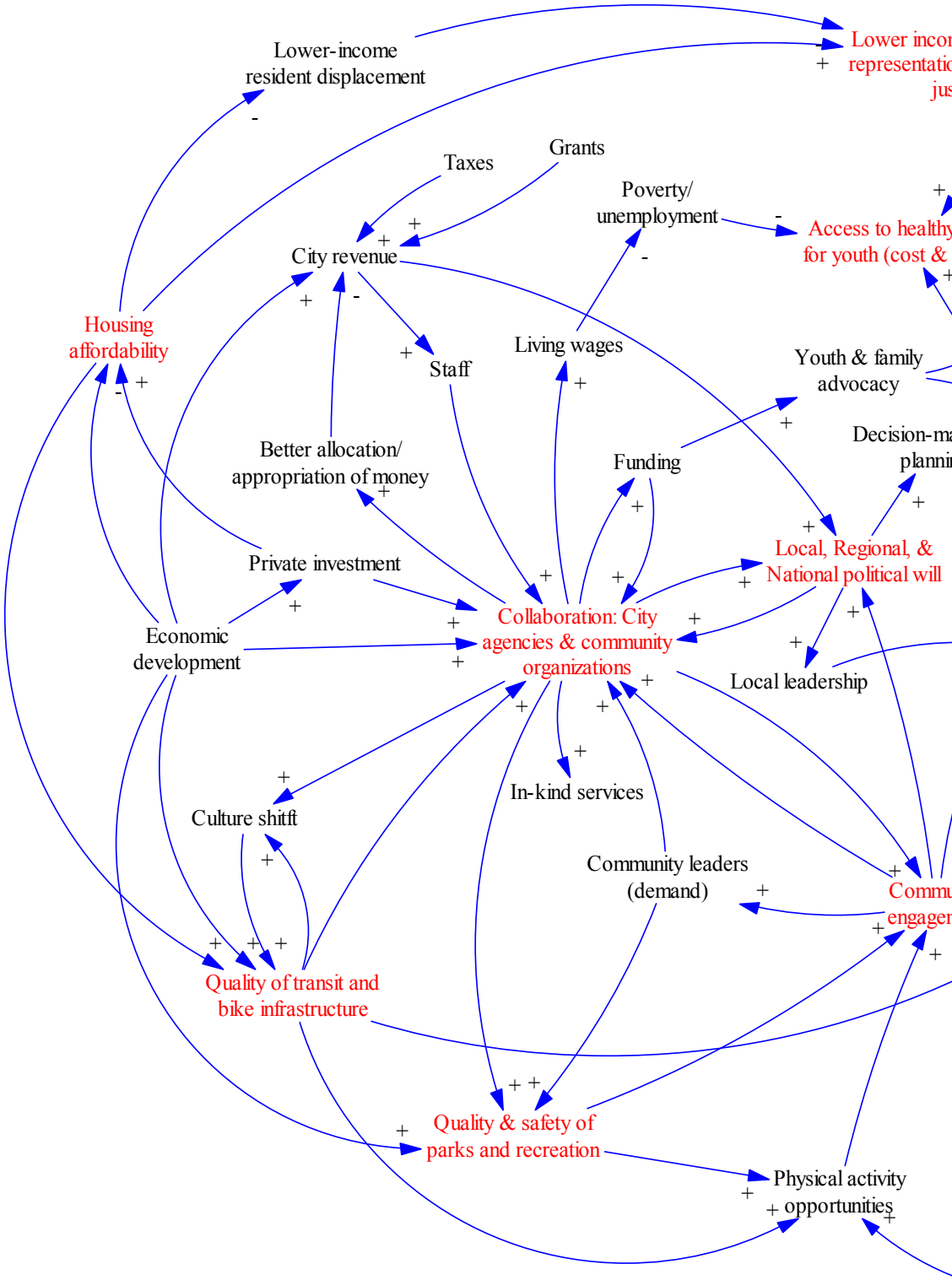
Somerville, Massachusetts: *Shape Up Somerville*	
Categories	**Number of Graphs**
Active Living Behavior	1
Active Living Environments	11
Funding	0
Healthy Eating Behavior	1
Healthy Eating Environments	8
Marketing and Media Coverage	1
Obesity and Long Term Outcomes	1
Partnership & Community Capacity	14
Policies	3
Programs & Promotions (Education and Awareness)	1
Social Determinants of Health	9
Total Graphs	**50**

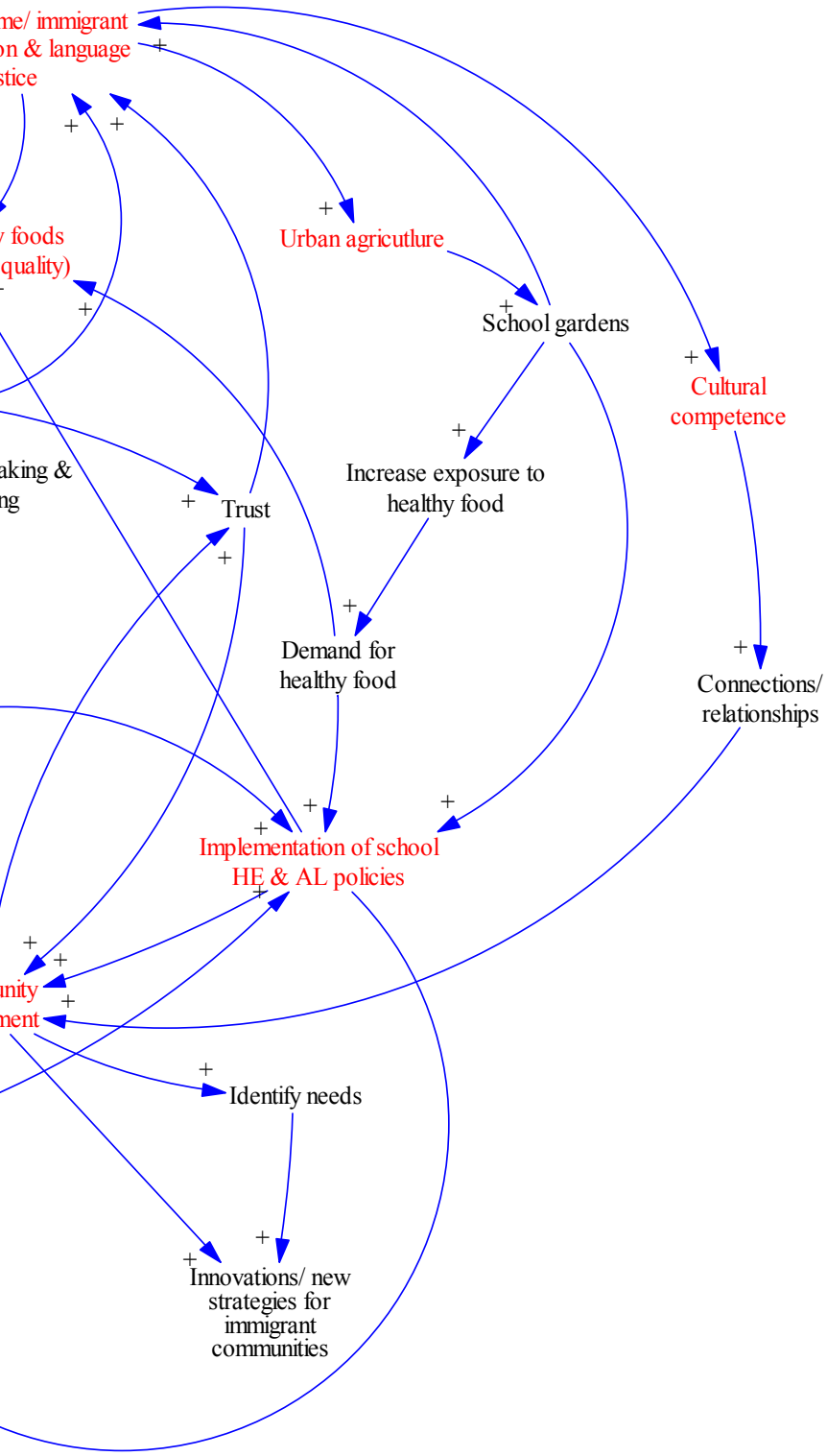
Appendix B: Photograph of the Original Version of the *Shape Up Somerville* Causal Loop Diagram




NING, & CHILDHOOD OBESITY
and environmental changes in this community...
decision-making & Planning
Local, Regional, & National Political Will
Cultural Competence
Demand for healthy food
Access to Healthy Foods for Youth (cost & Quality)
Local Leadership
Increase exposure to healthy food
School Gardens
Urban Agriculture
10/25/2011

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

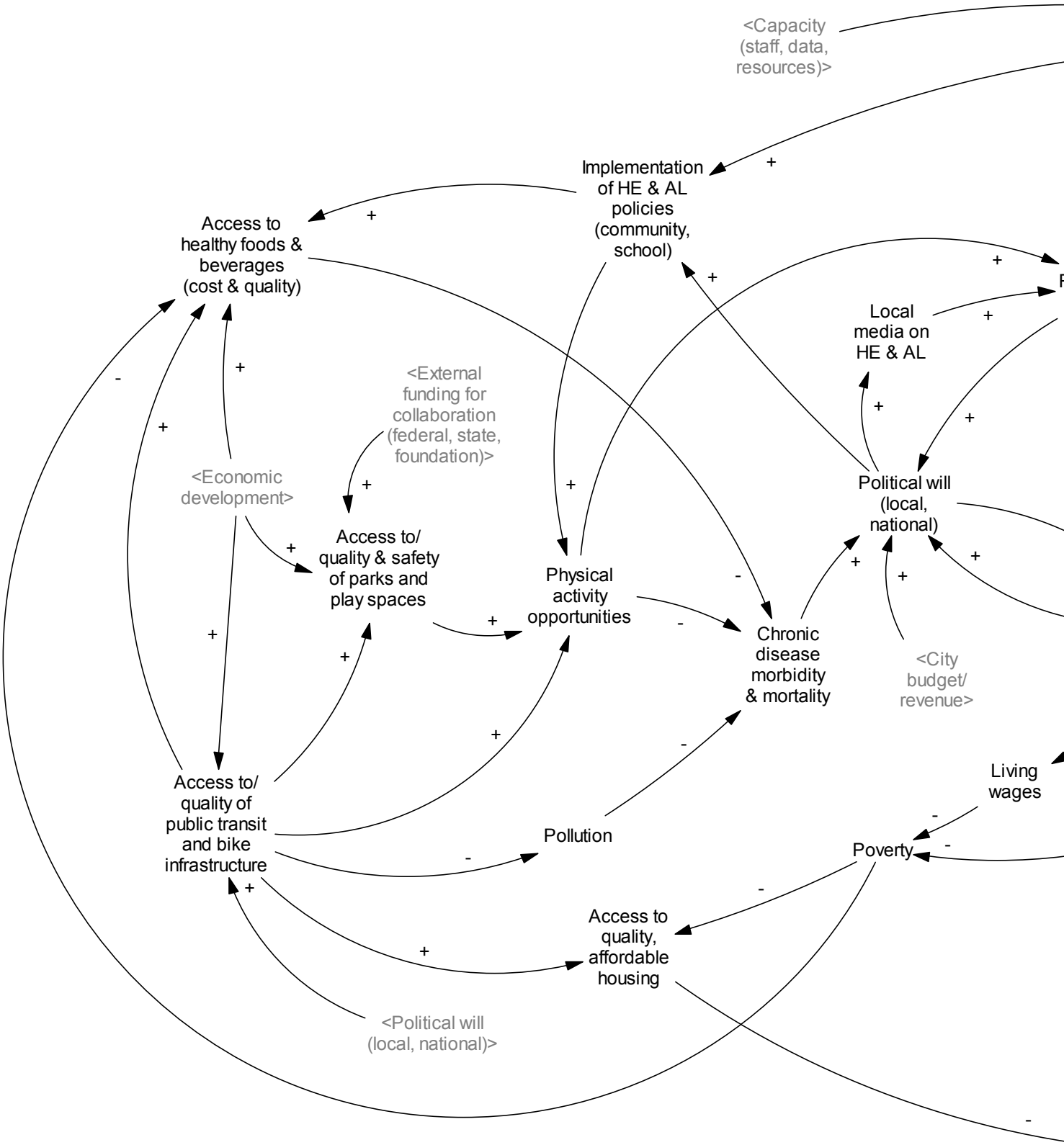


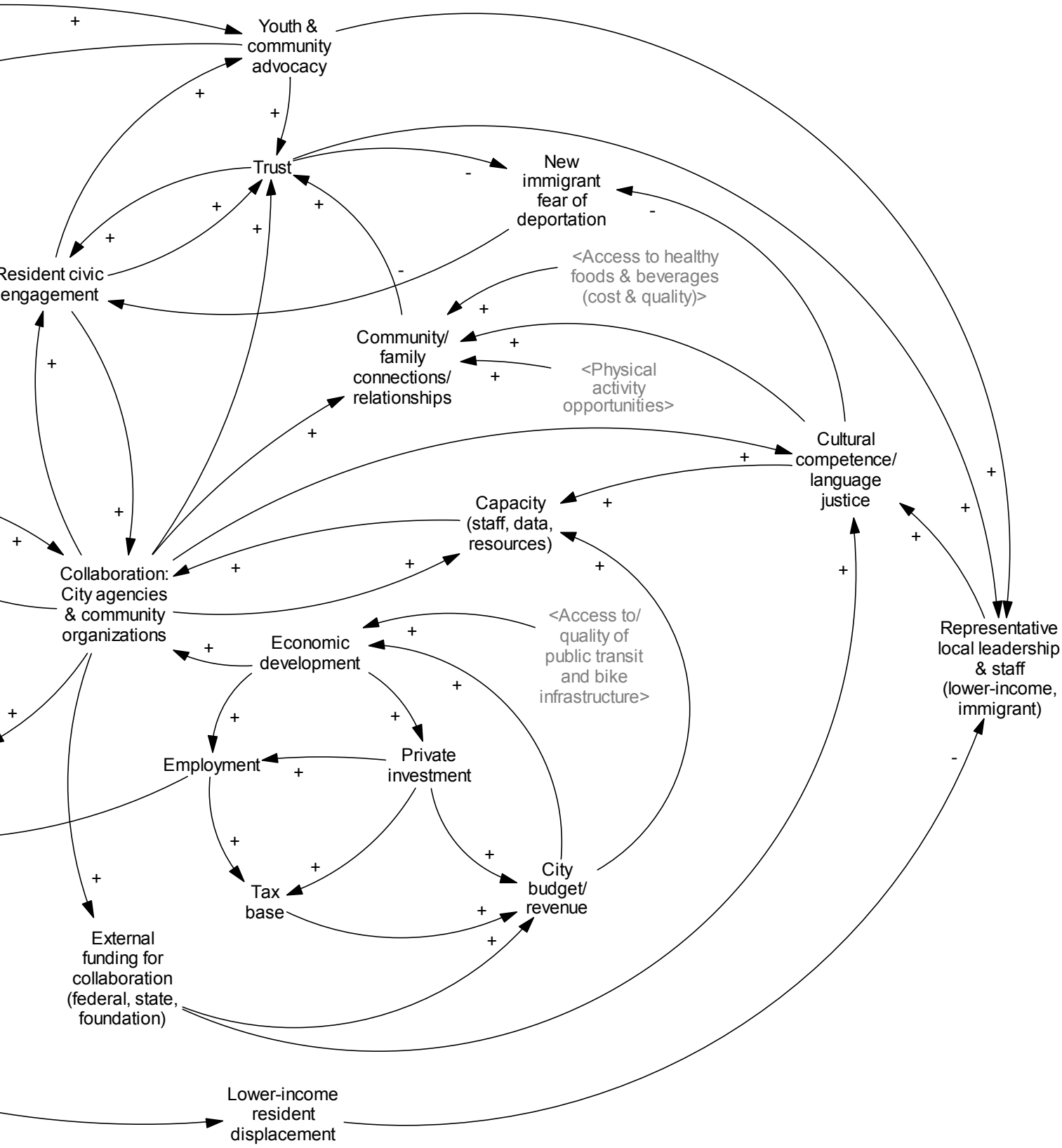


Tease apart NFP and city?

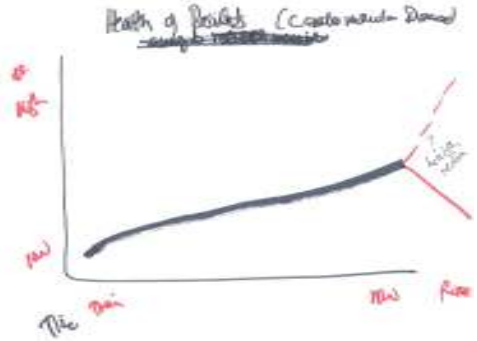
Increase mutual goals
receptivity meeting
space/resources

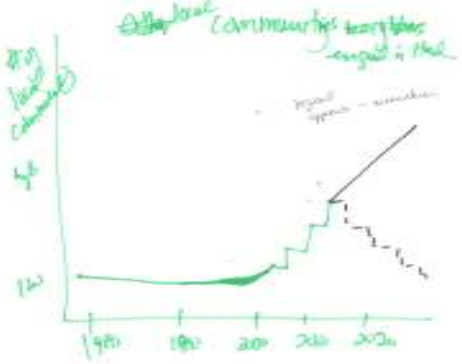
Appendix D: Transcript Translation of the Causal Loop Diagram into Vensim PLE

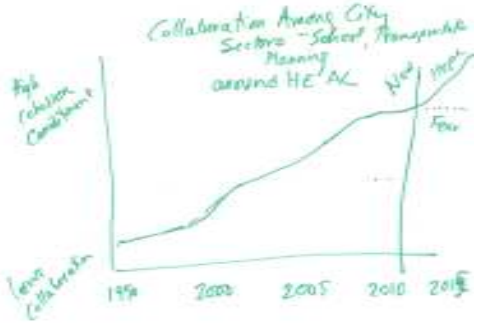


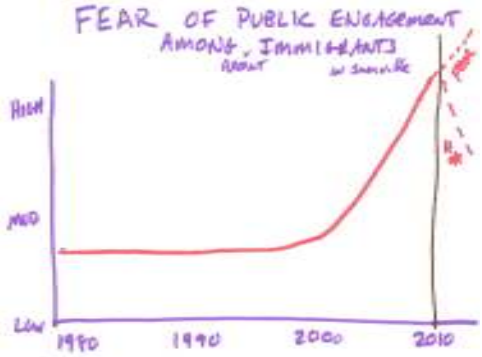

Youth & community advocacy
Trust
New immigrant fear of deportation
Resident civic engagement
<Access to healthy foods & beverages (cost & quality)>
Community/ family connections/ relationships
<Physical activity opportunities>
Cultural competence/ language justice
Capacity (staff, data, resources)
Collaboration: City agencies & community organizations
<Access to/ quality of public transit and bike infrastructure>
Economic development
Representative local leadership & staff (lower-income, immigrant)
Employment
Private investment
City budget/ revenue
Tax base
External funding for collaboration (federal, state, foundation)
Lower-income resident displacement

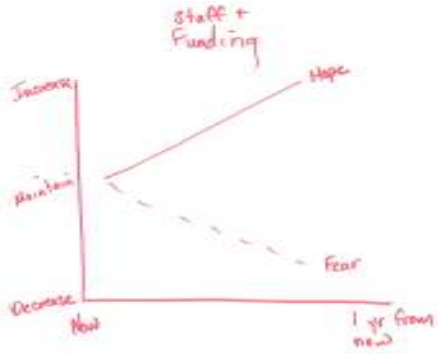
Appendix E: Behavior Over Time Graphs not Represented in the Storybook

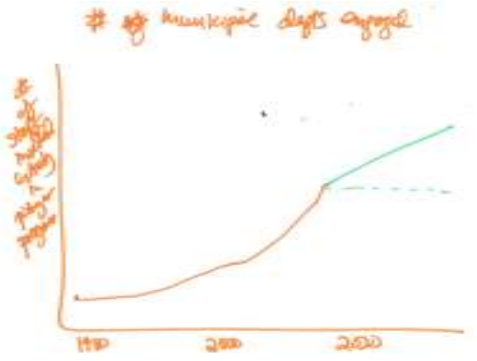


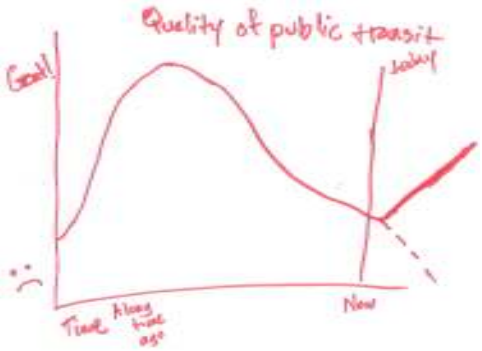


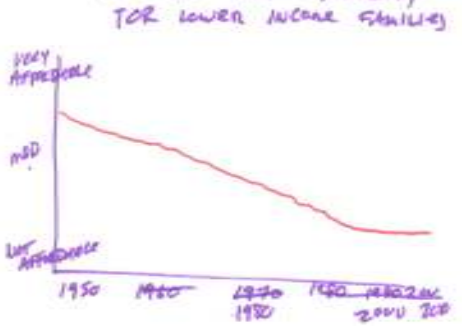


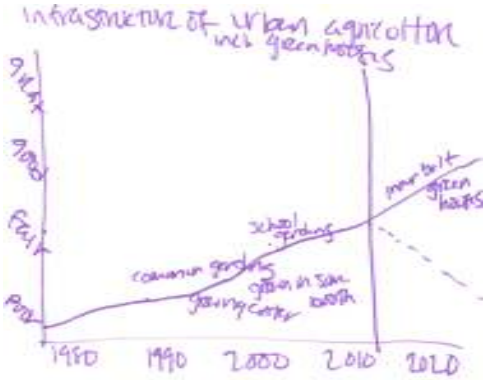


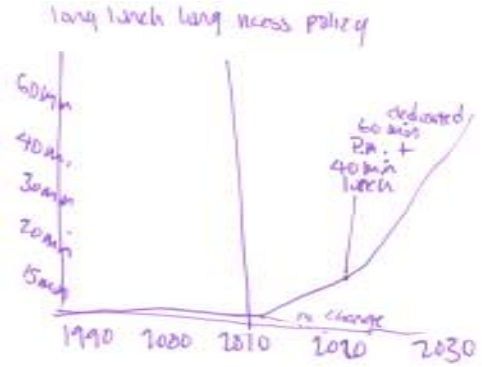


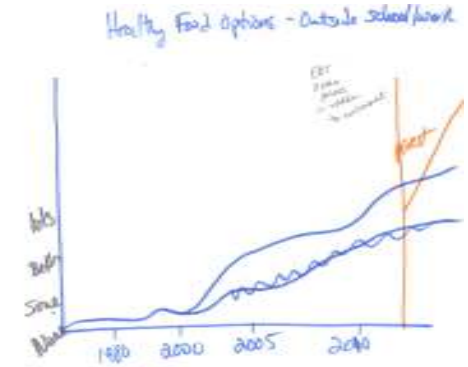


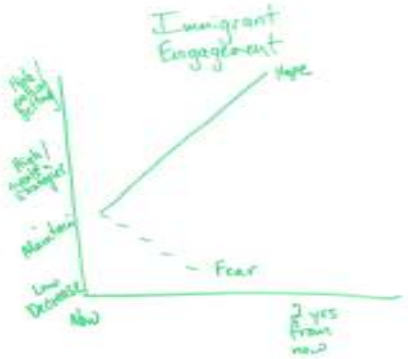


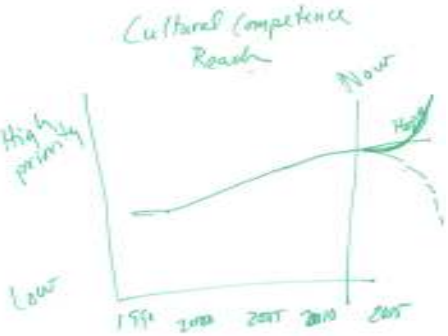


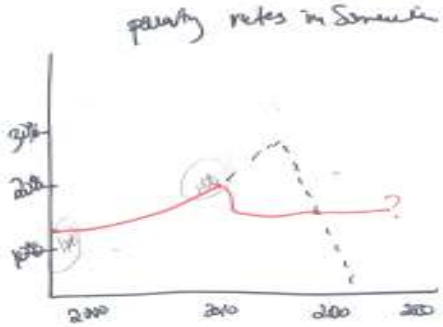


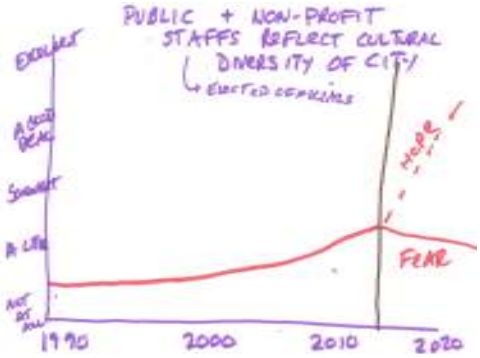


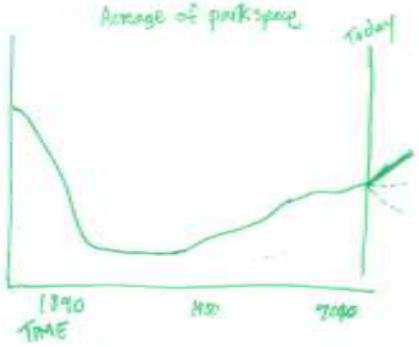


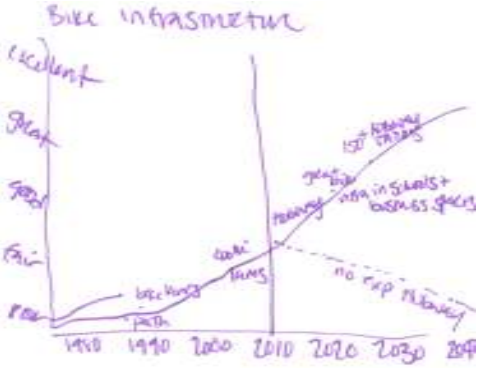

Immigrant Engagement
Hope
Fear
Now
2 yrs from now

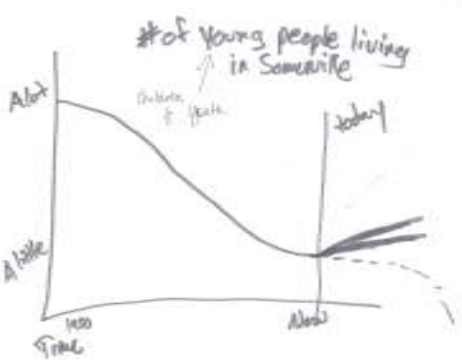

Cultural Competence Reach
Now
High priority
Low
1990
2000
2005
2010
2015

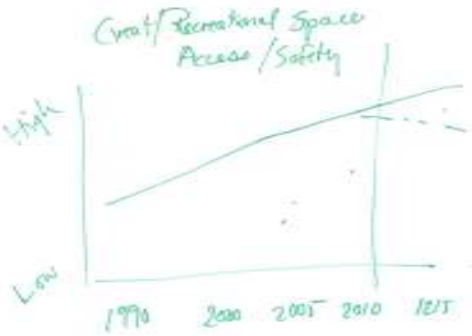

poverty rates in Somerville
2000
2010
2020

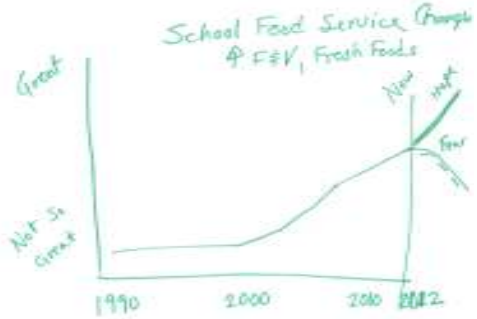

PUBLIC + NON-PROFIT STAFFS REFLECT CULTURAL DIVERSITY OF CITY
ELECTED OFFICIALS
HOPE
FEAR
1990
2000
2010
2020

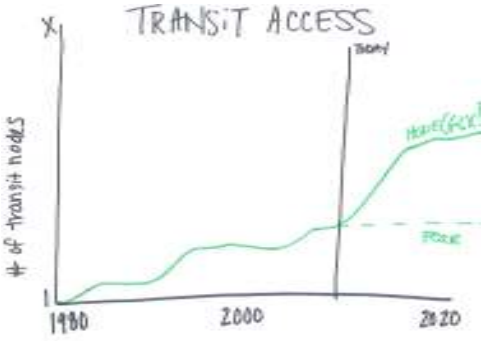

Acreage of parkspace
Today
1890
TIME
2050


Bike infrastructure
Excellent
Great
Fair
Poor
1990
2000
2010
2020
2030

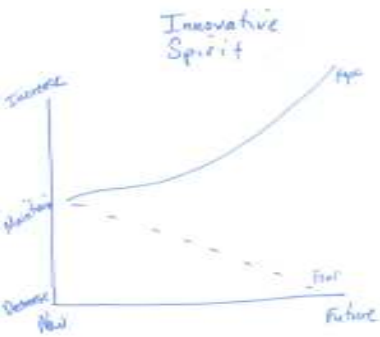

# of young people living in Somerville
Today
1950
Time


Great/Recreational Space Access/Safety
High
Low
1990
2000
2005
2010


School Food Service Changes
Great
Not so great
1990
2000
2010


TRANSIT ACCESS
# of transit nodes
1980
2000
2020


School PE improvements
High priority
Low priority
1990
2000
2005
2010
2015


Innovative Spirit
Future

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