April 2008

Sterling Town Model

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Major Qualifying Project
As a partial fulfillment of the requirements
For the Degree of Bachelor of Science at
Worcester Polytechnic Institute

Sterling Town Model

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April 24, 2008

Abstract

This project built on a previous System Dynamics model of Sterling, MA. Relationships were examined between the town's budgeting priorities and quality of life, population and demographics. The town population was considered by demographic group based on resources used, tax income and quality of life priorities. Counter intuitive behavior was found whereby increasing the budget priority of schools resulted in long term lower school quality. The resulting recommendation is that town planners consider the interactions between departments when making decisions.

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Figures and Tables

1. Introduction

The goal of this MQP is to build on a previous MQP that modeled the Town of Sterling, Massachusetts, in order to examine the effect of the budget priorities of the planning board on the quality of life, demographics and growth of the town. In 1991, Donald Seville developed a model of the town derived partially from Forrester's model "Urban Dynamics" to look at several problems that were relevant at the time.

His model focused on areas of concern as cited by town officials: quality of schools, population change, electricity rate, and tax rate. This project is building on his model to examine the town budget procedure. Among small towns, a common problem is that of each department head is looking only at his or her silo and the issues directly affecting him or her. This approach overlooks the interactions between the different departments in the town and how the actions of each department can help or hinder the others.

This model also looks at the effects of the budget priorities on the different demographic groups within the town. Each group in the town (families, middle age adults, and retirees) have different desires and priorities in relation to town services. They also each bring different levels of revenue and strain on the town's infrastructure. This model will help reveal the interaction between adjustments in budget priorities and the ensuing strain on town resources to help town managers view the town in a more holistic systems manner.

2. System Dynamics Modeling

2.1 Modeling Terminology

System Dynamics is a modeling method based on a systems thinking approach that focuses on cause and effect relationships between different elements of a system. In order to understand the model of Sterling, MA presented in this paper it is necessary to have a basic understanding of the elements, terminology and tools used in system dynamics (Sterman, 3-5).

The first step in analyzing a system dynamics model is to look at these relationships. They can be visually represented in a causal loop diagram. The causal loop diagram gathers key elements of the model and shows how the causal connections create feedback loops. In this diagram the different elements are connected by arrows that have a plus or minus sign at the end. A plus sign means that an increase (or decrease) of the first variable will cause an increase (or decrease) in the second compared to what it would otherwise have been. While a minus sign shows an inverse relationship (Sterman, 3-39).

The overall feedback loop is said to be positive, reinforcing or negative, stabilizing. A loop is positive if an initial increase (or decrease) in a variable leads to a final increase (or decrease) of that variable through the loop. For example, in a simple population model there is the population and births. If the population is increased then the births will also increase, which in turn increases the population. Thus the feedback loop is a positive one (Sterman, 3-39).

Alternatively when deaths are included in the model it creates a negative or balancing feedback loop with population. An increase in population increases deaths, which decreases the population. These feedback loops can be visually shown in a simple causal loop diagram as below.

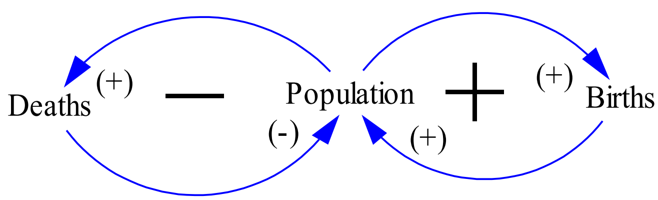


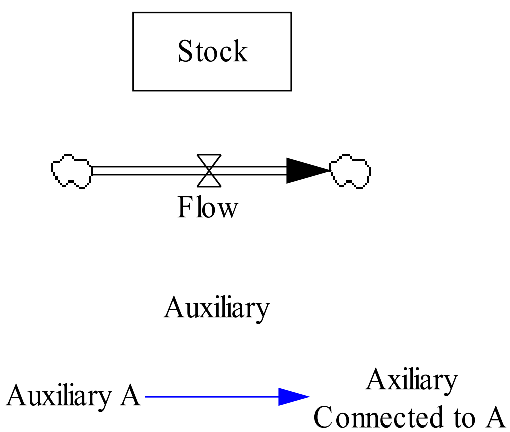
Figure 2.1

This diagram is an aggregated view of the system. The actual model contains the variables of different types as well as constants that might not be part of any feedback loops. These constants are important for calculating other variables but are not part of the feedback structure.

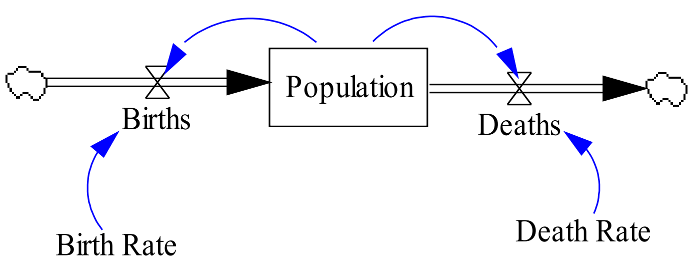
The most basic element of the system dynamics model is the stock, also referred to colloquially as a bathtub. The stock is a variable in which values accumulate over time such as a population, inventory or a bank account. These changes over time are caused by the flows into the stock. In the case of a population the flows are births and deaths (Sterman, 3-39).

In addition to stock and flows there are auxiliary variables. These variables contain constants or other calculations. Relationships between these different types of variables are shown by connectors, which are arrows. The variable at the start of the arrow is contained in the equation of the variable the arrow points at (Sterman, 3-39).

In the Vensim software used for this project a stock is represented by a box, a flow by an hourglass, an auxiliary by its name and a connector as a blue arrow between stocks, flows and auxiliaries.



For the example of a population, there would be a stock of people with two flows, births and deaths. There would also be two auxiliary variables: birth rate and death rate that would connect to births and deaths respectively.



In this model the equations are:

$$\text{Population} = \int (births - deaths)dt$$

Births = Population(t) * Birth Rate

Deaths = Population(t) * Death Rate

The birth and death rates are constants. It can be noted that these two variables are not present in the feedback loops of this system shown earlier. This is because, as can be seen, they are not part of the feedback structure because they are constant.

2.2 Modeling Steps

The modeling process consists of a generally accepted series of steps. The first of these is to identify the problem being modeled so that the bounds of the model can be defined and to create a reference mode. The reference mode shows the behavior that the model is attempting to reproduce and explain (Sterman, 83-105).

In the case of Sterling this reference mode would come from historical data about the town's population and departmental budgets. If the model is accurate about the interactions involved it will be able to reproduce the behavior mode of this data, though not the data itself exactly. The model can be fitted to the data but is only an approximation. The purpose of a model is show trends and behaviors that will result from decision not to make precise predictions.

Once the reference mode has been established a dynamic hypothesis is developed. The dynamic hypothesis is a causal loop diagram containing only the most important variables in the problem. This hypothesis represents the models idea of how things interact and what will produce the observed behavior (Sterman, 83-105).

The dynamic hypothesis is used to construct a stock-flow diagram of the problem. Supporting variables are added until a complete model is built. This model is then tested for robustness and how well it matches the reference mode. If it doesn't then it is likely that at least one important factor is missing from the dynamic hypothesis. In this case the dynamic hypothesis is reviewed and the process is repeated from that point. The testing and repeating process may need to be done many times for a given model. Once the model is satisfactory, it is then tested for sensitivity to various parameters, particularly those which are difficult to estimate. Finally policy ideas can be tested in the model and conclusions can be drawn (Sterman, 83-105).

3. Urban Modeling Background

The first and most famous urban system dynamics model is "Urban Dynamics" created by Jay Forrester. This model focuses on the problem of urban growth and renewal for large cities. In their early life, cities experience a strong growth period in which people flock to the city for urban jobs and housing. After this period the population peaks and then industry and housing begin to deprecate. Eventually, everyone who can will flee the city and leave only the relatively poor behind. Without the lost tax base, the city struggles to provide services and fund any urban renewal projects.

Forrester finds through this model that the policy of building low income housing should be avoided as it results in using scarce land area for those who will contribute little to the growth of the town. Instead the town should work to bring in new businesses that will employ the underemployed and allow them to afford better housing,

While the model has many applicable elements for analyzing towns, towns also have many unique features. The town has a limited land area in which to expand, an attractiveness that is tied to its rural nature and the quality of services and phenomena such as rural trapping, in which rural homeowners can't move even if they want to because no one will buy their house. Towns are also less dependent on local business as many are commuter towns. As such the industry and commercial sectors are less important to the town for growth. Further, towns draw people fleeing from the urban centers looking for a higher quality of life and appreciating the towns rural and agricultural character: the getting out to the country and “fresh air” mentality.

A previous MQP done in 1991 with the town of Sterling by Donald Seville built off of urban dynamics, expanding and modifying, to examine the growth pattern of small towns. This model focused on the key questions of the town at the time: the population growth or decline, the budget, the quality of schools, and the price of electricity.

4. Modeling Sterling

The purpose of this MQP is to build on previous work to create a more disaggregated view of the town. Specifically, the model will look at how the town makes budget decisions and how these impact its future growth and welfare. The model also examines the role of the town zoning board in limiting or encourages what type of housing is built. The dynamic hypothesis is that each service and housing type attracts a different demographic and that these groups come with different demands on the town's services.

It is common sense that that an increase in families with school age children will use more town funds for the education of their children. The relationships between the other demographics and services is worthy of statistical support.

Second, there is feedback in the revenue sector as the different income and age groups will contribute varying amounts in taxes. A young adult having recently entered the work force is far from their peak earning potential and will own a substantially smaller residence than a middle-aged adult who has a much higher income. The young adult is also likely to start a family with children while the middle aged adult's children, if he had them, are past or very nearly past school age. Thus, attracting a young adult brings less tax revenue and expenses for the town for their children's schooling compared to a middle-aged adult who brings substantially more tax revenue and little burden on the town services.

However, the young adult will become a middle-aged person in one or two decades and having established a family in the town may choose to stay there and purchase a larger property or upgrade their existing property. The older person will become an elder and likely downgrade to a smaller house.

The reference mode is the same as that for Seville's model but in this case the town planning board is added to the model. In the first stage, their addition should make no change to the total population of the town, nor to the overall quality of life.

The dynamic hypothesis is that the town will attract different demographics of people depending on how it spends its money and that these different groups have very different demands on the resources of the town. For example, the elderly have no use for school, while families use more resources through the school system than they supply in tax money.

5. Model Sectors

5.1 Fire Department

The Town of Sterling's fire department consists of a majority of volunteers with a few full time fire fighters. The department also runs the towns medical emergency services. Sterling has some of the most sophisticated emergency services technology and because of this, is often called on by other surrounding towns. Whenever Sterling's ambulance is called out to another town they pay for the service. Through these payments, and medical insurance, the ambulance portion of the fire department is entirely self-sufficient.

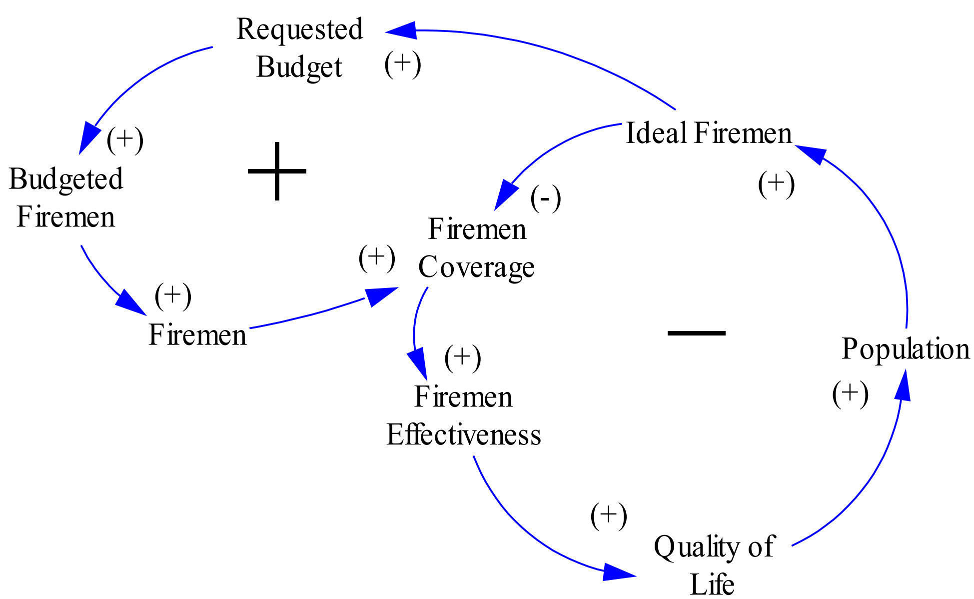


Figure 5.1

This sector is a new addition to the model. The fire department is one of the major groups that the town budget is split between. The town is concerned primarily with how effective the department is and how much it costs. There are two major feedback loops at work within the Fire Department Sector as seen in Figure 5.1. One is between the Population, ideal firemen, firemen coverage, firemen effectiveness and quality of life. This loop is a negative feedback because an increase in population will result in a higher optimal number of firemen and thus a lower firemen effectiveness and quality of life which will result in fewer people moving to the town.

The second feedback loop is between the financial sector and the previous loop. When the ideal firemen increases, the fire department requests more money from the town to cover the additional needs. All else being held constant, the town will budget more money to the fire department (though almost certainly less than requested). This will increase the number of firemen employed and thus increase the effectiveness of the fire department and the population. This loop is positive, promoting increases in population and fire department effectiveness.

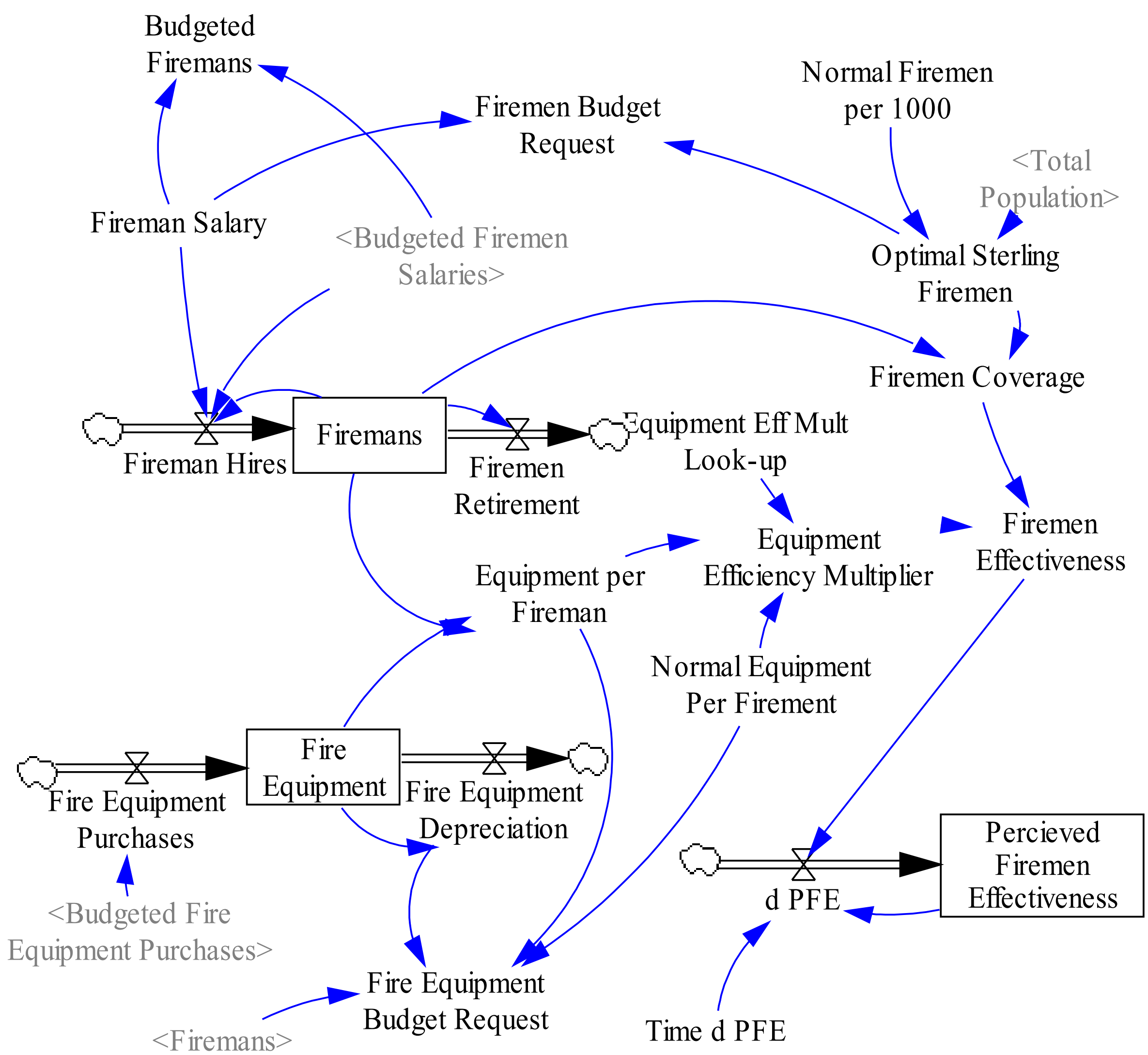


Figure 5.2

The stock flow diagram illustrates in greater detail the relationship between the elements of the sector. The optimal firemen is determined based on the population and the optimal number of firemen per 1000 people this number is estimated based on the current population of Sterling and the fire chiefs indication of how many firemen he would like to have. The department requests from the town enough money to pay for the ideal number of firemen. The ideal equipment per fireman is estimated on how much equipment the town possesses and how many firemen they currently have. The coverage is a ratio of the current number of firefighters to the ideal number.

The equipment efficiency multiplier is slightly more complicated. The equipment to fireman ratio is put through a look-up function that adjusts the efficiency from 0.1 to 1.5 in an s-shaped pattern to reflect how having more or less equipment can make individual firefighters more or less effective at their job. The equipment multiplier and the firemen coverage are multiplied together to the final firemen effectiveness value.

5.2 Police Sector

Sterling is a relatively low crime area due to its low population density. According to the police chief, the town maintains two police per thousand residents compared to the national average of two and a half. The police sector is structurally the same as the fire department sector, as can be seen in Figure 5.3. The changes between them are in the constant values. The police department has entirely full time officers and consequently the average salary is much higher. The normal equipment per officer is slightly lower because police cars are cheaper than pump, tank, and ladder trucks required by the fire department. These changes do not, however, have a drastic effect on the behavior of the sector compared to the fire department sector.

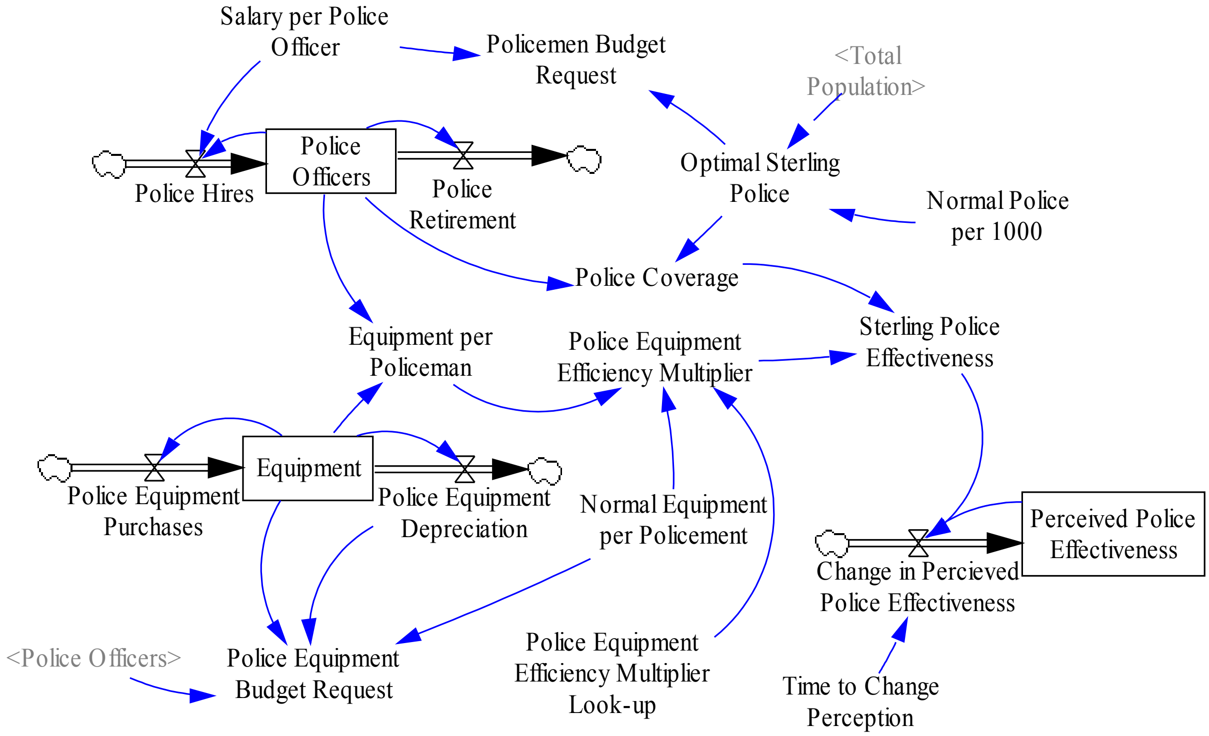


Figure 5.3

5.3 Land Occupied Sector

The land occupied sector calculated how much of the zoned land is being used by the industrial, commercial and housing structures in the town. As this percentage increases it reflects the loss of the agricultural character of the town and open space. A defining characteristic of Sterling is the rural, agricultural characteristic of the town. This is represented by the large average plot size of houses—2 acres. The zoned area is estimated by Seville based on a zoning map of the town and his estimations are used directly in this version of the model.

A low land fraction occupied (LFO) makes the town more attractive to individuals and businesses. So, if it is low then more people and businesses will move to the town than otherwise would. However, as the LFO increases the competition for space makes it less desirable and fewer business and people will move in then otherwise would. Thus, the feedback loops within the land occupied sector are both negative, or balancing, loops. The two loops are entirely independent as businesses and houses compete for different subsets of the land in the town, and the zoning is held constant while the model is run. This sector is one of the most limiting for Sterling’s Growth.

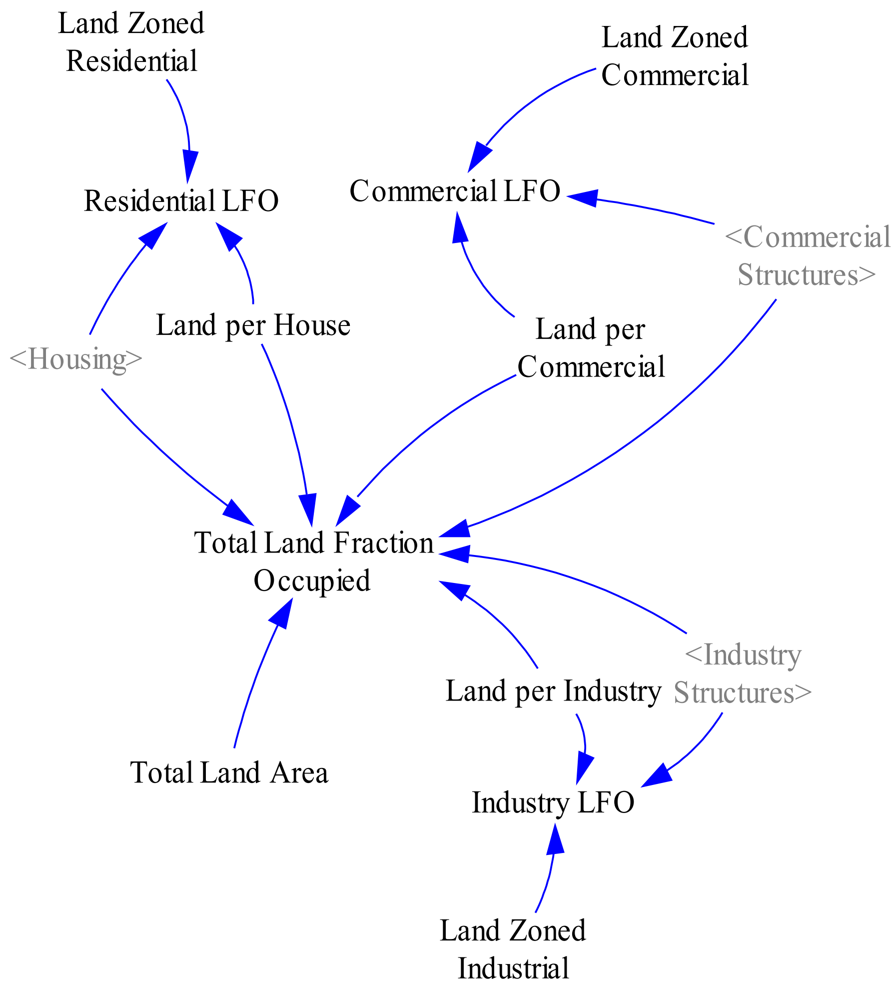


Figure 5.4

5.4 Commercial and Industry Sector

The commercial and industrial sector is taken almost straight from Seville's model. The alterations involve its interaction with the other sectors in the model. The sector is influenced primarily by the land occupied and population sectors. There are eight feedback loops in the sector—all of which are negative.

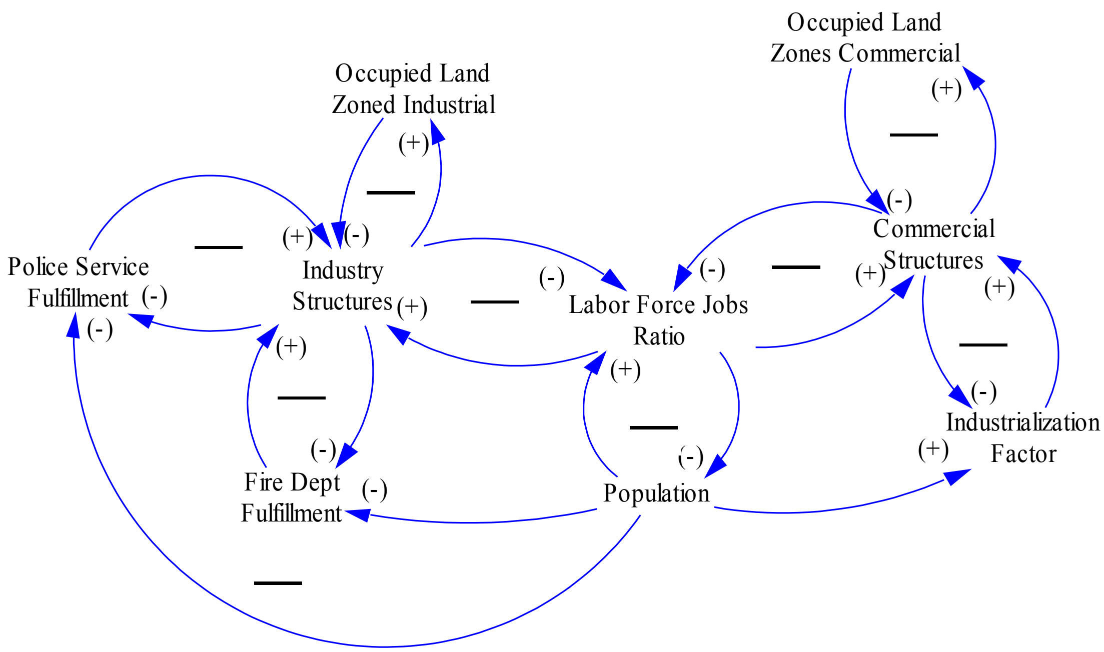


Figure 5.5

The first feedback loops are between industry and commercial structures, and their respective occupied land zoned. A lower occupied land will entice more business, which will fill the zoned land and thus reduce the attractiveness to future businesses. The second set of feedback loops, shared by both commercial and industry, is with the labor force jobs ratio. A higher labor force jobs ratio makes it more attractive for businesses, but more business then lowers the labor force jobs ration.

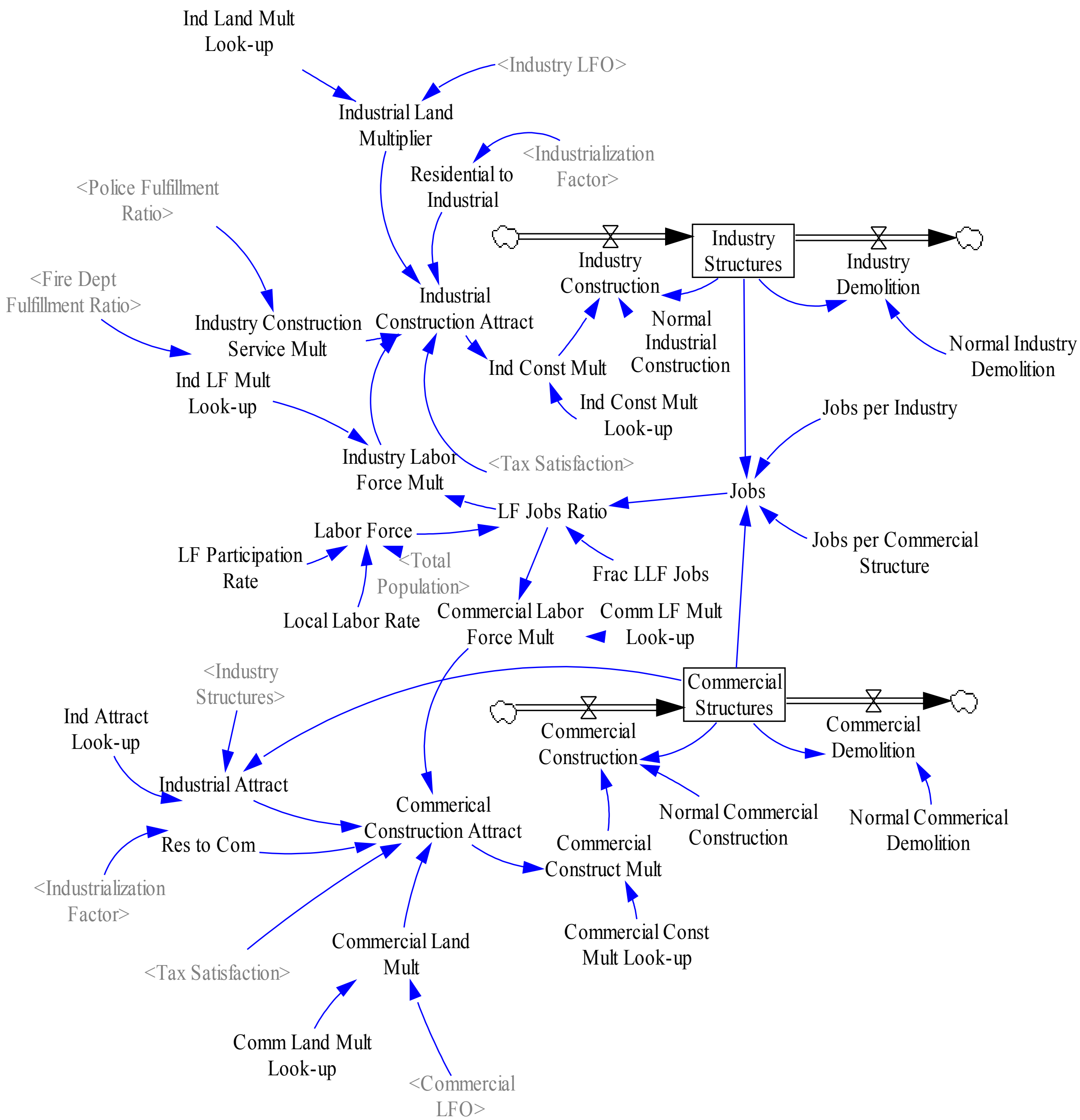


Figure 5.6

The industrial sector has two negative feedback loops because of services. Better service fulfillment for the fire and police department increases the number of industry structures; an increase in industry structures will increase the load on the fire and police department and thus reduce their fulfillment. The commercial sector has a feedback loop between itself and the industrialization factor. A higher industrialization factor mean more commercial structures, which reduces the industrialization factor.

The final feedback loop is between the labor force job ratio and population. A lower labor force job ratio means that is easier to find work and thus more attractive for people to move to Sterling. This population increase, however, will increase the labor force job force ratio. This effect is fairly low for the town of Sterling because it is a primarily commuter community.

5.5 School Sector

The school sector is a somewhat simplified version of the school sector from Seville's model. Sterling is part of a regional school system and thus does not construct schools on their own. It is also unlikely that school construction will be a large factor over any reasonably short run of the model. Private schools were removed because it seemed to be outside of the boundaries of the model and irrelevant to the questions being asked. Removing it made no large difference in the results of the simulations.

Figure 5.7 shows the feedback loops present in this version of the school sector. Good schools are a strong attractor for families to move to Sterling, but the more students who move in the fewer resources are available per a student and thus the lower the quality of the schools. On the other hand, an increase in the number of local students will cause the school to request more money, receive more money and increase the quality of schools. The negative feedback between quality of schools and population is generally the dominant loop in this system because families bring in less in tax revenue than they cost in ideal expenditures per student.

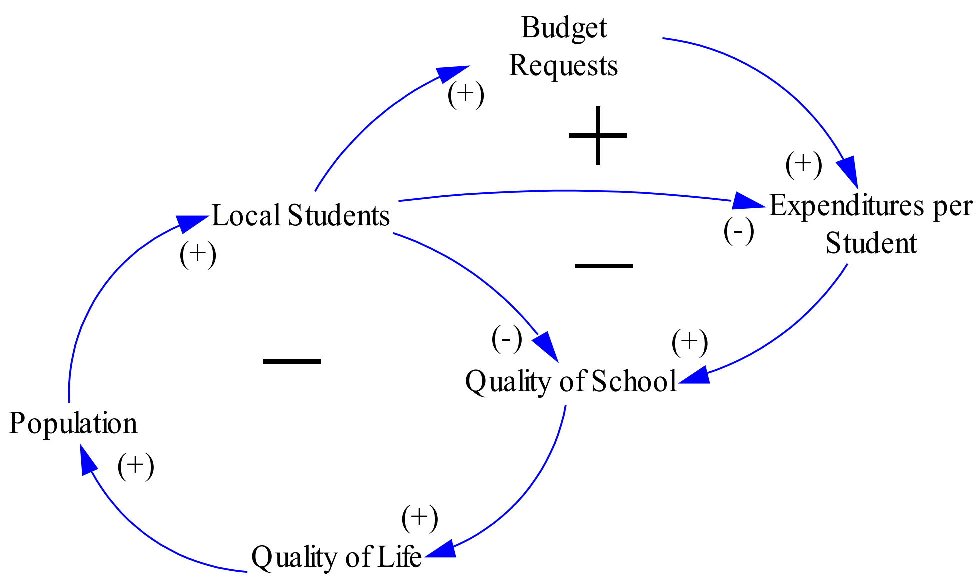


Figure 5.7

The stock flow diagram in Figure 5.8 shows the relationships more exactly. The school requests an expenditures per student budget based on the number of students and the state expenditures per student. The school will always request enough funds to match the state regardless of how much they have been getting in previous years. The budget allocation procedures then sends back what they are allotted to spend that year, and the difference between that and the previous year’s becomes the change in expenditures per students.

The mandatory school spending reflects expenses that the town is obligated to pay every year. This includes the costs to run the school building which cannot be cut, such as building maintenance, heating and electricity costs, as well the state and federally mandated spending for special education students. These expenses are taken out of the allocate-able funds budget in the finance sector and are automatically paid even if that would cause a deficit.

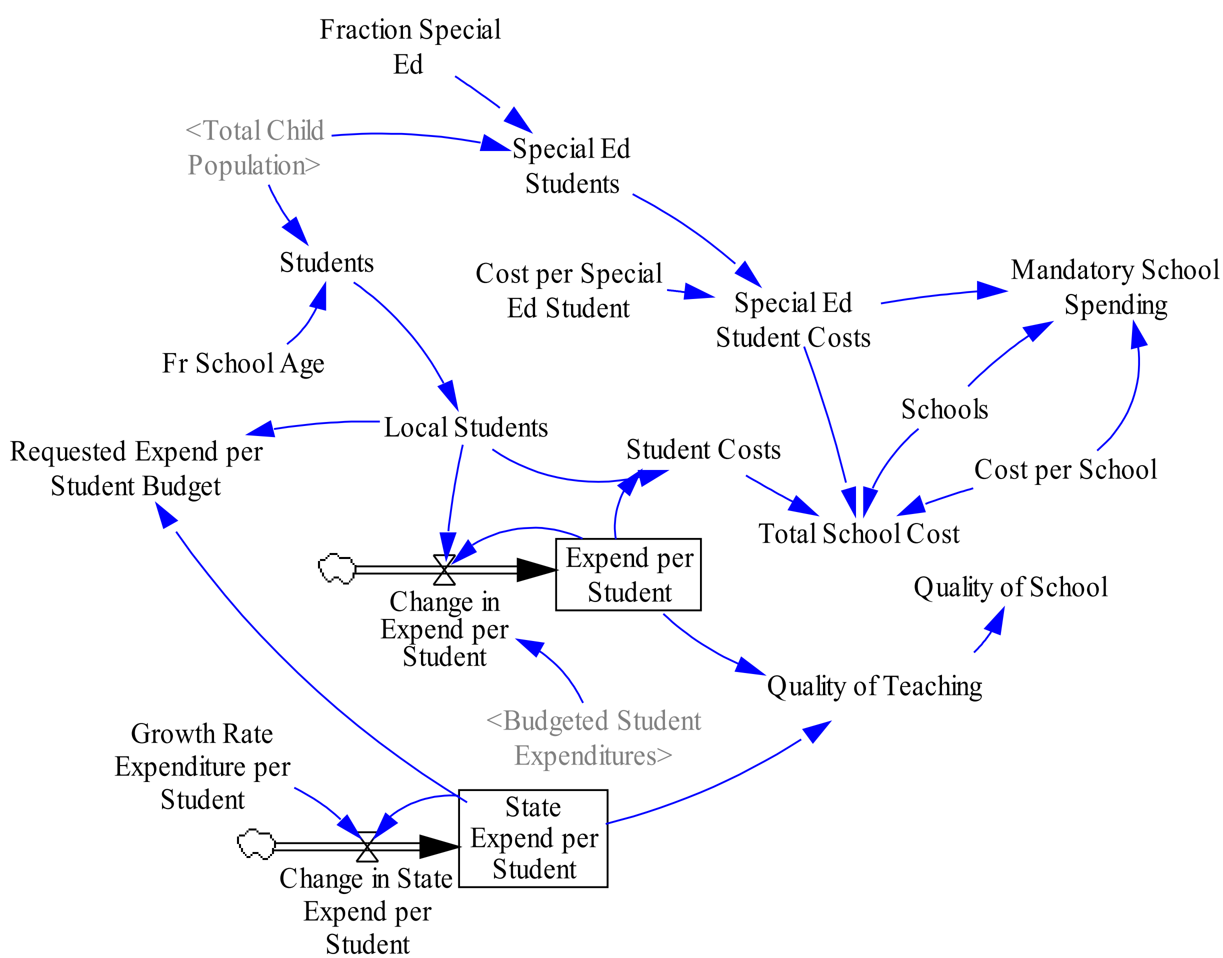


Figure 5.8

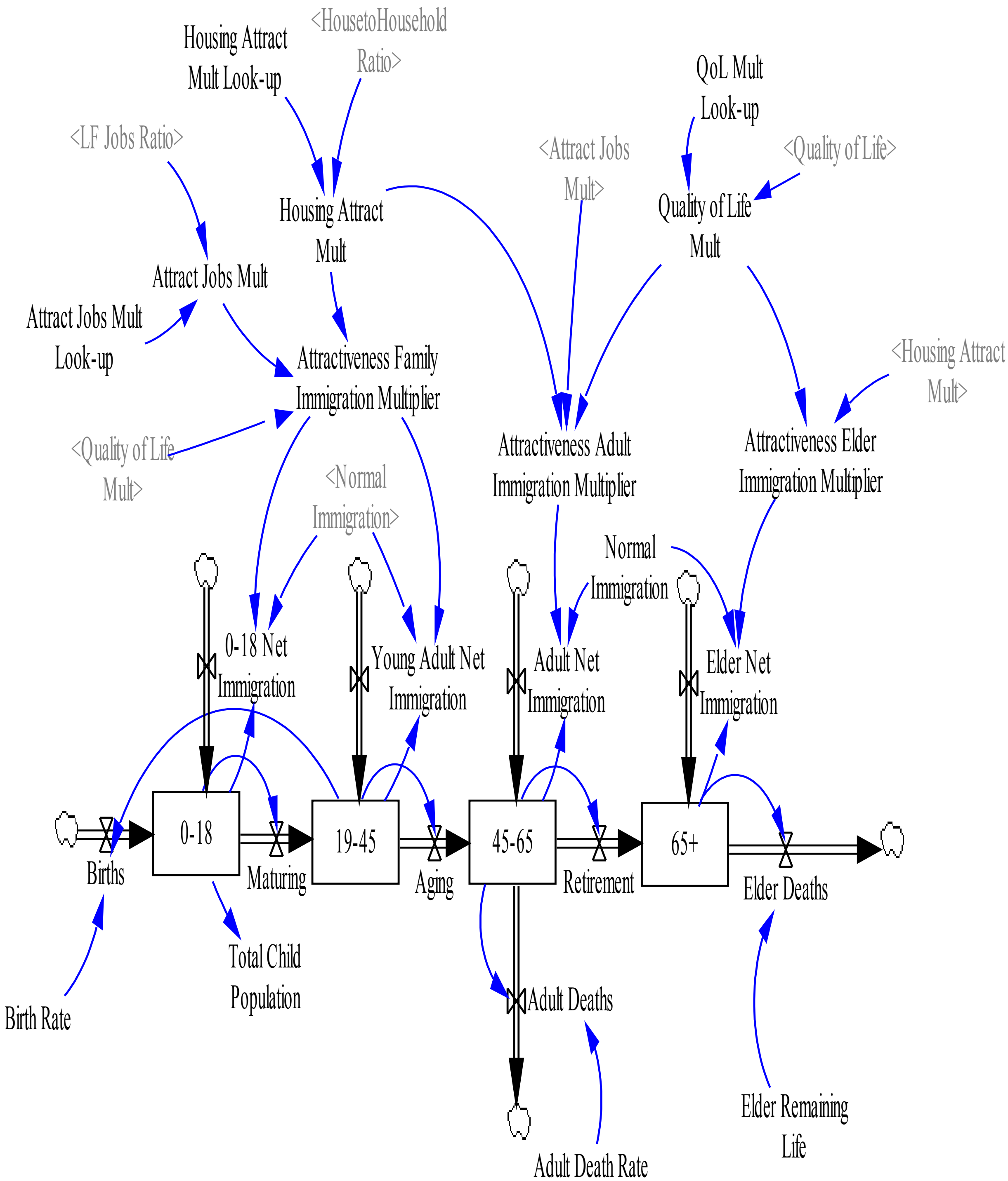
The quality of schools is based on the expenditures per student compared to the state average expenditures per student. These expenditures combine the money spent on teachers and teaching supplies. A higher ratio means closer to or exceeding the desired level of funding per student. Crowding was removed because the town does not control the construction of schools in the region. The model assumes that either the area would not need additional schools in a short run time, or that the regional district would arrange for them to be built.

5.6 Housing and Demographic

The housing and demographic sector has some of the largest changes from Seville’s model. While the basics are the same, the population in this model is divided into a four stock aging chain. The population is divided based on their contributions and drains on the town’s resources. The first group is children that form the school age population. The second group is adults from 19 to 45 who are in their prime child rearing years. These two groups immigrate to the town together based on the family attractiveness factor. The third group is adults from 45 to 65, who’s children are mostly grown, and are in the prime of their income generation. The final group is the adults above 65 who are at retiring age.

As seen in Figure 5.9, there are different attraction values for each age group based on what they value most (described in the quality of life sector). These are the many causes of interesting fluctuations in the population of Sterling over time, as the relative birth and death rates are constant over the time period in which the model is run. The birth and death rate numbers are taken from Seville’s model.

The other two factors that affect immigration are job availability and housing availability. The labor force jobs ratio, as discussed in the commercial and industry sector, brings more families and middle aged adults to the town when it is low and less when it is high.



Housing Attract Mult Look-up
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QoL Mult Look-up
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Elder Net Immigration
0-18
19-45
45-65
65+
Births
Maturing
Aging
Retirement
Elder Deaths
Total Child Population
Adult Deaths
Birth Rate
Elder Remaining Life
Adult Death Rate

Figure 5.9

The housing factor shows that people can't move into town when there are very few houses available, and that people are more likely to move somewhere when there is an abundance of housing to choose from up to a certain point. In response, houses are more likely to be built when there is a high household to house ratio, as seen in Figure 5.10. The housing construction is also limited by the residential land fraction occupied.

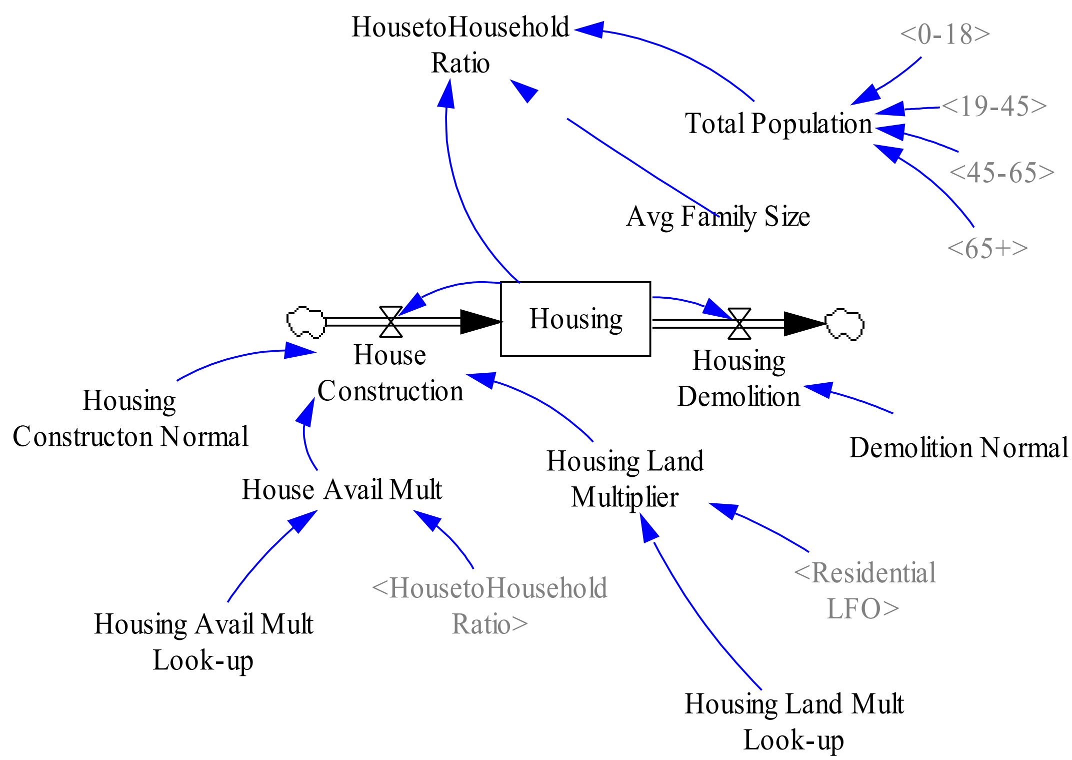


Figure 5.10

The two major feedback loops internal to this sector are between the total population, house to household ratio, and the total population, for the first loop, and between the house to households ratio and houses, for the second loop. Both of these loops are negative loops. Included in Figure 5.11 is one of the smaller feedback loops. This loop is between population and births. There are many instances of this sort of feedback loop in the model that were not discussed previously. These minor feedback loops exist wherever there is a growth rate multiplied by the current value of a stock: the births, housing construction and business construction. These minor feedback loops push the model for positive growth unless externally limited, but are not an interesting part of the dynamic growth patterns.

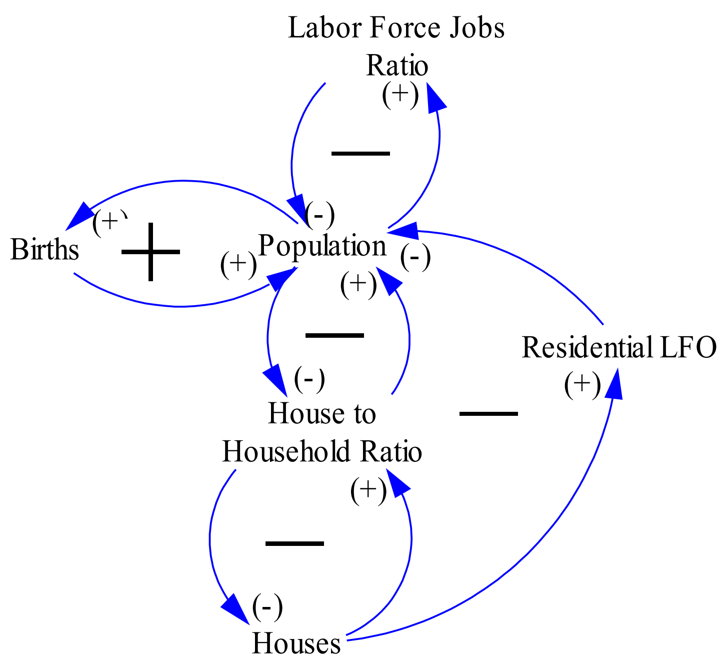


Figure 5.11

5.7 Quality of Life

Quality of life is a variable that tries to summarize, in a numerical way, all the things that make life in one town more or less pleasant than life in another town. These include how crowded the town is, the quality of schools, and level of town services. In this version of the model the services are broken up into the fire and police department—as described in their respective sectors—and miscellaneous town services. The misc. services stock combines town services such as plowing and road maintenance.

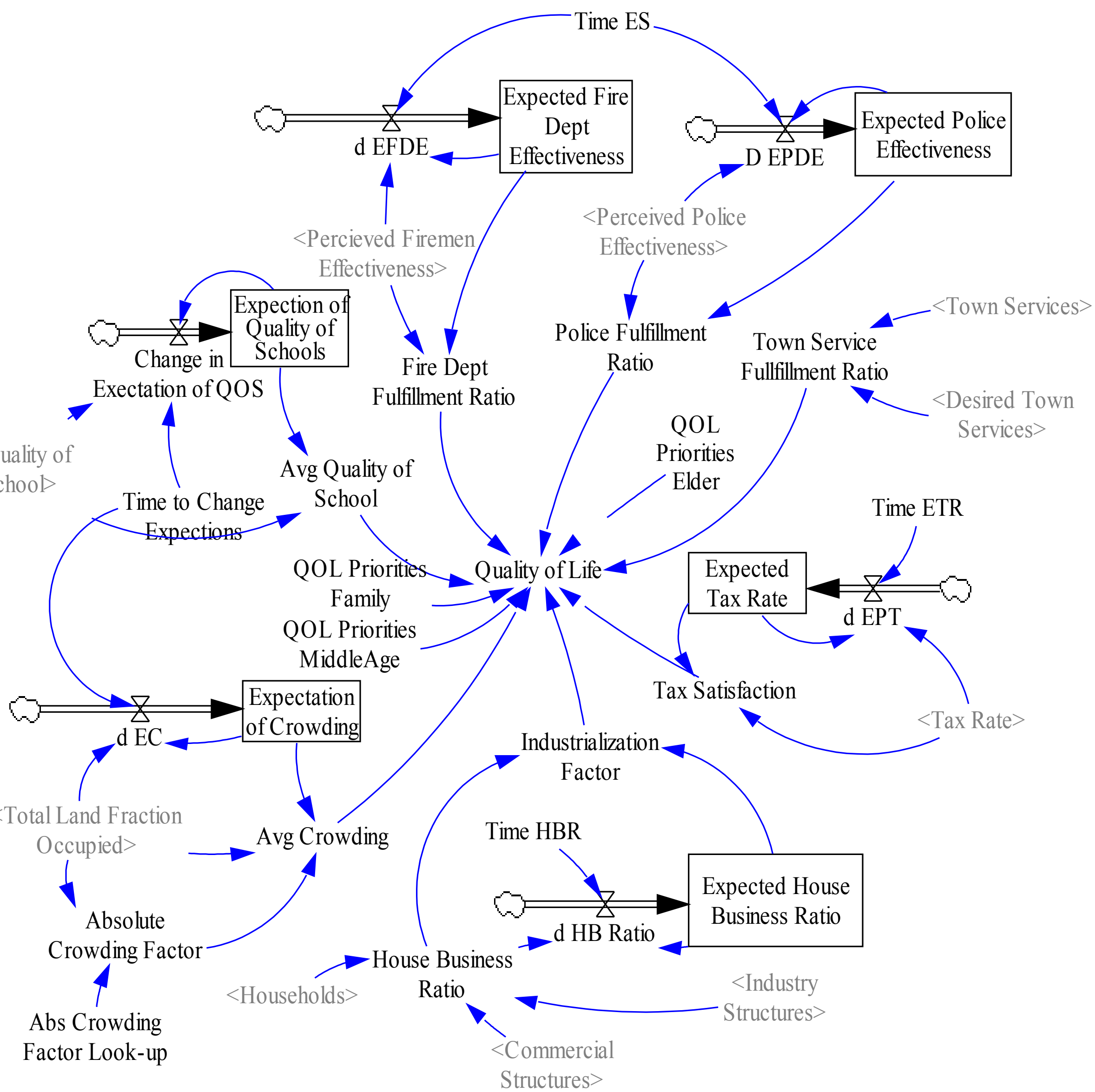


Figure 5.12

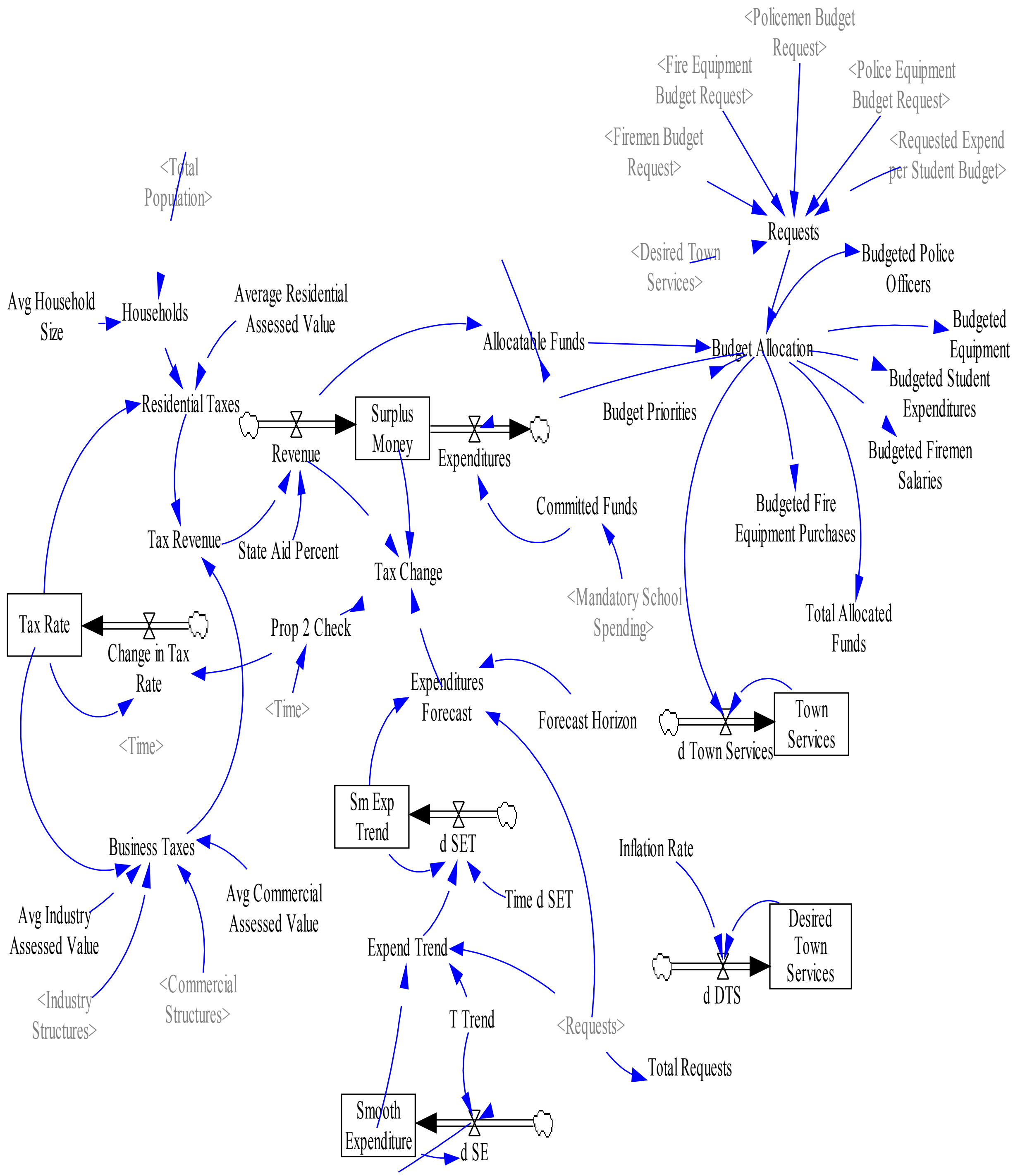
As can be seen in Figure 5.12, each demographic sector has its own priorities for its quality of life. Things that different groups value more are weighted in the quality of life calculation. Quality of life is calculated by first finding the fulfillment ratio for each aspect. This is done by putting its actual value over a normal or expected value. Then each of these is multiplied by the corresponding priority value and are added together. This is then divided by the sum of the demographic groups priorities. This makes the equation the total actual quality over the total normal or expected quality.

The feedbacks between the quality of life, and all sectors it is derived from, are negative because increases in quality draw more people to move to the town. A higher population puts more strain on all the areas and thus drives the quality of life down. The second set of loops is between increase quality of town services, increase in population and increase in taxes. These loops are positive as they lead to growth in the town. These loops are dominant as long as the growing population provides a larger fund base than the population costs in services.

5.8 Financial Sector

The financial sector represents the town’s budgeting procedure. The budget portions are new, while the tax rate change sections are from Seville’s model. The town receives budget requests from each of the departments. It has a priority by allocation function that determines how much each sector gets based on their assigned priorities. The base priorities were chosen based on a previous interview with the heads of the Sterling town boards.

The town changes the tax rate based on the trend of the requested expenditures and the previous year's revenues. If the trend is for more requests the following year than revenue was received this year,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<Total Population>
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Households
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Budget Allocation
Budgeted Equipment
Budgeted Student Expenditures
Residential Taxes
Surplus Money
Revenue
Expenditures
Budget Priorities
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Committed Funds
Budgeted Fire Equipment Purchases
Tax Revenue
State Aid Percent
Tax Change
Tax Rate
Change in Tax Rate
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Expenditures Forecast
Forecast Horizon
Town Services
d Town Services
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Sm Exp Trend
d SET
Business Taxes
Inflation Rate
Time d SET
Avg Industry Assessed Value
Avg Commercial Assessed Value
Desired Town Services
Expend Trend
d DTS
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T Trend
<Requests>
Total Requests
Smooth Expenditure
d SE

Figure 5.13

then the town will raise taxes. As in Seville's model there is a Proposition 2 ½ check. Proposition 2 ½ is a state law in Massachusetts that limits increases in town property taxes after 1982 to 2 ½ percent. Thus after 1982, if the town would like to raise taxes more than 2 ½ percent, they are limited to a 2 ½ percent increase.

The revenue comes from property taxes on residential and business properties in the town. In this version, there are two groups of property owners. One consists of people between 45 and 65, and the other group consists of all other residents of the town. Those 45 to 65 years old statistically have higher values homes (US Census Bureau). Their homes are valued at seven percent above Seville's average value, while the other group's homes are valued at seven percent below Seville's value to get the fourteen percent spread seen in Census results.

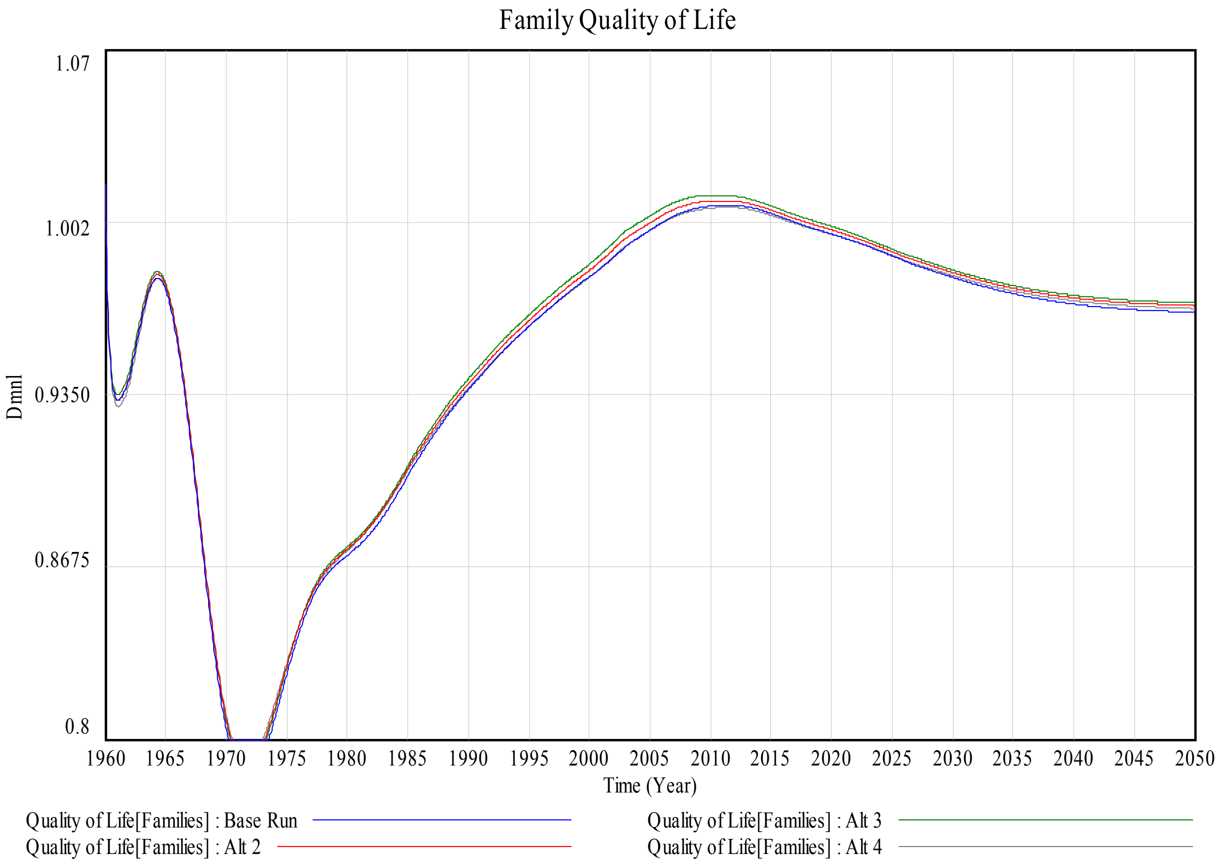
6. Model Results

The base run of the model shows the same basic result pattern as Seville's model. The model is not calibrated to a particular data set as it is not meant to be used for exact predictions. The different runs of the model were made using a variety of priority sets for the budget allocation function. These sets are seen in Table 6.1.

Department	Base	Alt 1	Alt 2	Alt 3	Alt 4
School	2	1	1.5	1.9	1.8
Police	1.9	1.9	1.5	1.8	2
Fire	1.8	1.8	1.5	1.75	2
Misc.	1.75	1.75	1.5	2	1.7

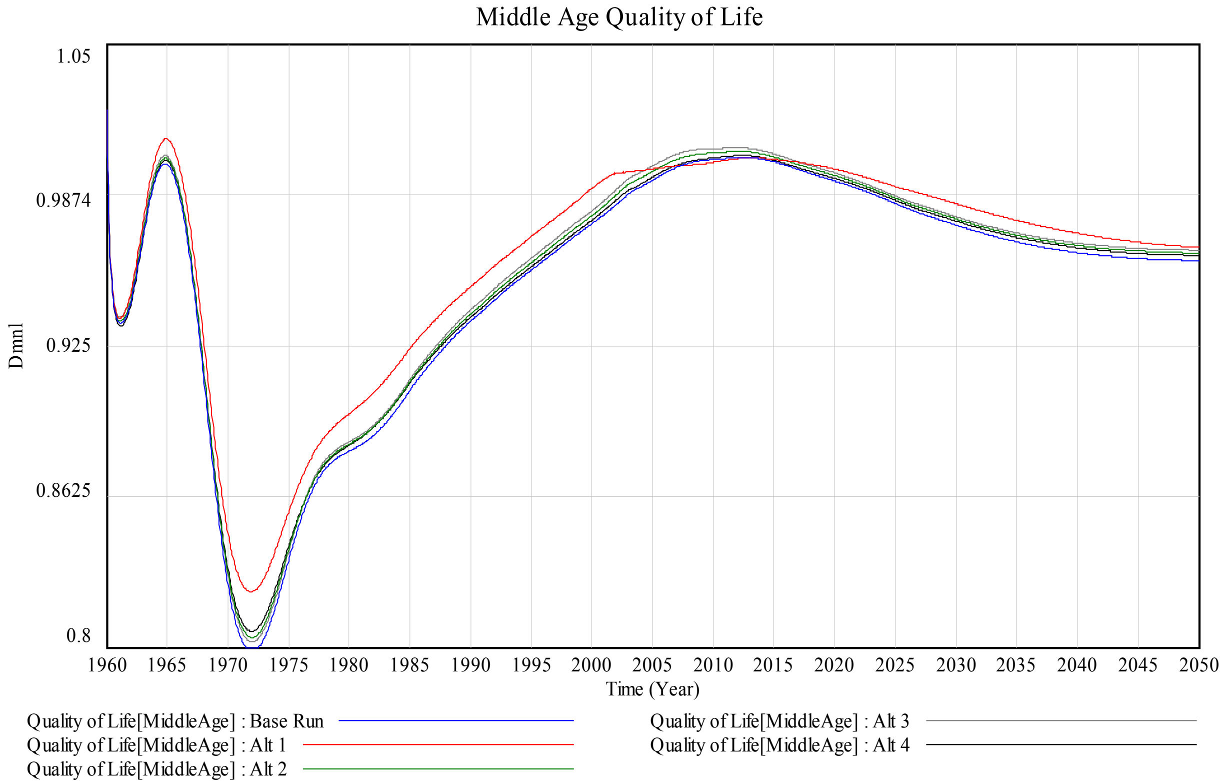
Table 6.1

The model runs are compared based on the effect of these values on the quality of life at the end of the simulation, and the total population of the town. These values are shown in the following graphs.



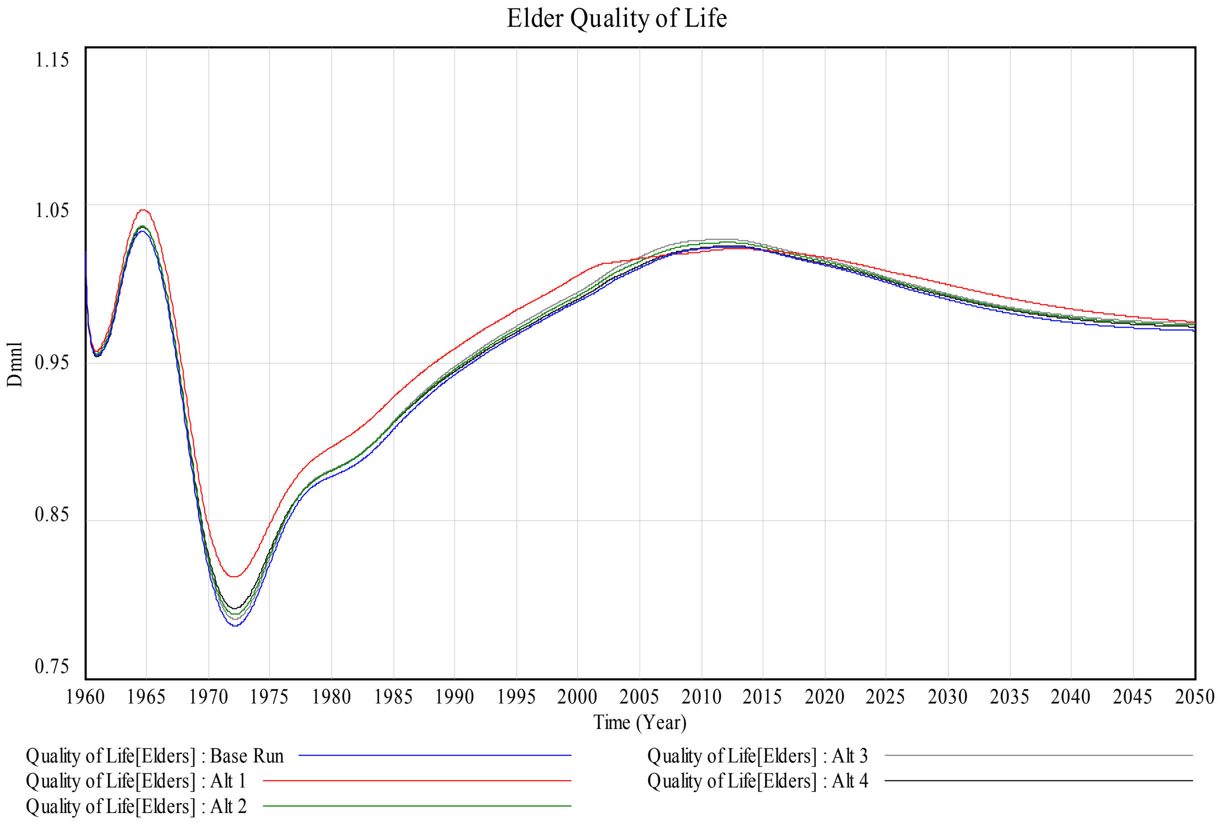
Family Quality of Life
1.07
1.002
0.9350
0.8675
0.8
Dmnl
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
Time (Year)
Quality of Life[Families] : Base Run
Quality of Life[Families] : Alt 2
Quality of Life[Families] : Alt 3
Quality of Life[Families] : Alt 4

Figure 6.1



Middle Age Quality of Life
1.05
0.9874
0.925
0.8625
0.8
Dmnl
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
Time (Year)
Quality of Life[MiddleAge] : Base Run
Quality of Life[MiddleAge] : Alt 1
Quality of Life[MiddleAge] : Alt 2
Quality of Life[MiddleAge] : Alt 3
Quality of Life[MiddleAge] : Alt 4

Figure 6.2



Elder Quality of Life
1.15
1.05
0.95
0.85
0.75
Dmnl
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
Time (Year)
Quality of Life[Elders] : Base Run
Quality of Life[Elders] : Alt 1
Quality of Life[Elders] : Alt 2
Quality of Life[Elders] : Alt 3
Quality of Life[Elders] : Alt 4

Figure 6.3

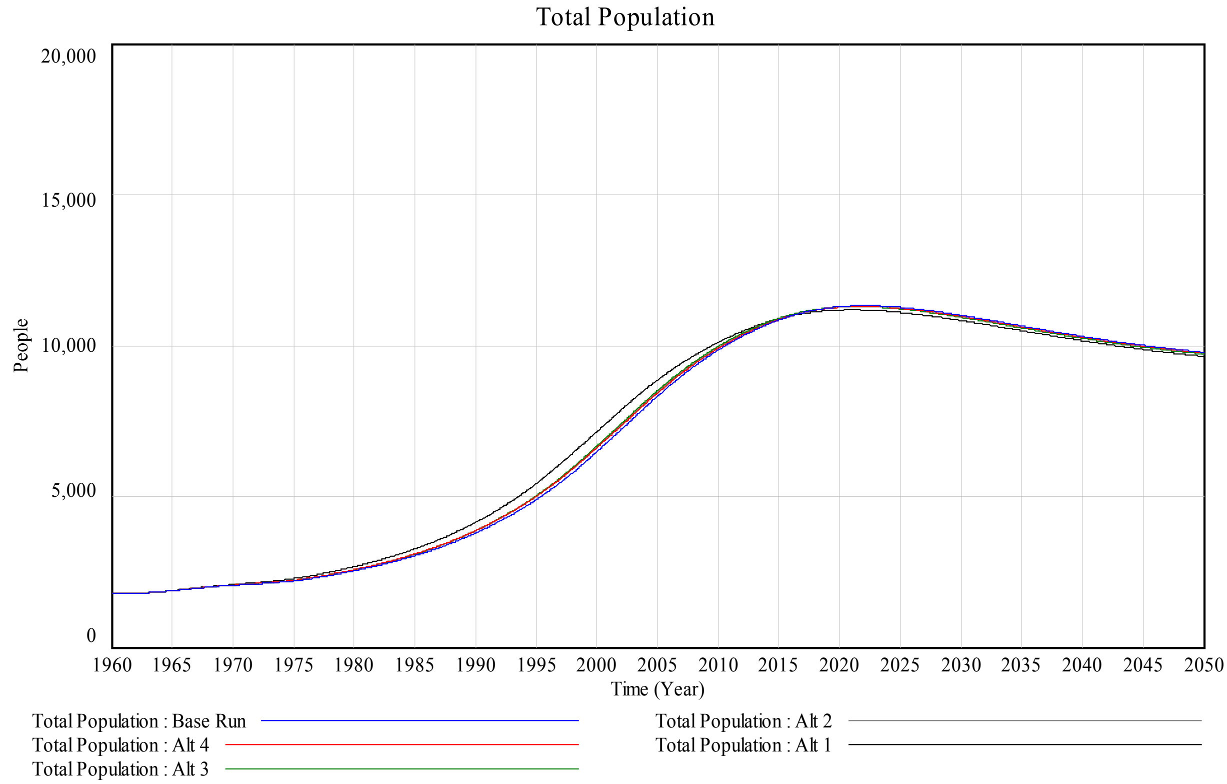


Figure 6.4

The graphs show that the base priority settings result in a lower quality of life than any other setting testing across all demographic groups, even when families are valuing schools twice as much as any other factor. It is common for towns to place a high priority on school funding, but these results show that may not be wise. The schools are by far the largest section of the budget and taking five or ten percent away from schools can increase smaller sectors substantially more than five or ten percent.

By increases in school quality, the town attracts families with school age children. These families cost the town more to educate than they provide in taxes. This leads to lower quality schools that cost more, and less money is available for other services that the middle age or eldery populations value. By weighting other services that the middle age population values, the town can bring in more revenue that will improve the quality of schools over time.

In this way the system behaves counter intuitively because giving schools a higher budget priority can result in more money being spent on lower quality schools. A similar feedback might occur if other populations used other resources disproportionately to the income they bring, but no such connections are present in this model. It is important for the different departments in the town to talk about which groups a particular policy is likely to attract and what challenges, financial or otherwise, those groups will bring with them.

7. Conclusions and Recommendations

The model showed very counterintuitive results. The different sectors all interact, and it is important for the planning boards of Sterling to talk to each other and consider how the decisions of one board affect the others. Traditionally, the heads of town boards are very much concerned only with their own silos. This approach can lead to short sighted bickering, while each group tries to get a larger slice of the pie without understanding that giving up something now could lead to a larger pie later.

The Sterling town boards are working now towards communicating amongst themselves. An “All Boards” meeting was held on Saturday of the second weekend of April this year. The town is working towards the goal of having all the town boards work together in their planning effort. This model will help the town examine the impact of different budgeting decisions on the future of the town.

The model does not give a definitive answer to what effect different budget priorities will have on the town. Instead, the goal is to help the town to think about the impact that their decisions will have on the sorts of people attracted to the town. By understanding the interactions between the silos, the town can more accurately plan to create the future they desire.

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Appendix

```
"0-18 Net Immigration" = Normal Immigration * Attractiveness Family Immigration Multiplier\
		* "0-18" - "0-18" * 0.07
	~	People / Year
	~		|

"0-18" = INTEG( "0-18 Net Immigration" + Births - Maturing , 486)
	~	People
	~		|

"19-45" = INTEG( Maturing + Young Adult Net Immigration - Aging , 540)
	~	People
	~		|

"45-65" = INTEG( Adult Net Immigration + Aging - Adult Deaths - Retirement , 540)
	~	People
	~		|

"65+" = INTEG( Elder Net Immigration + Retirement - Elder Deaths , 234)
	~	People
	~		|

"Abs Crowding Factor Look-up" ( [(0,0)-(10,10)],(0,1.14),(0.0833,1.27),(0.167,1.32),(0.25,1.3)\
		,(0.333,1.23),(0.417,1.16),(0.5,1.02),(0.583,0.907),(0.667,0.822),(0.75,0.736),
(0.833,0.632)\
		,(0.971,0.45),(1,0.148) )
	~	Dmnl
	~		|

Absolute Crowding Factor = "Abs Crowding Factor Look-up" ( Total Land Fraction Occupied\
		)
	~	Dmnl
	~		|

Adult Death Rate = 0.01
	~	People / Year
	~		|

Adult Deaths = "45-65" * Adult Death Rate
	~	People/Month
	~		|

Adult Net Immigration = Attractiveness Adult Immigration Multiplier * Normal Immigration\
```

* "45-65" - "45-65" * 0.07
~ People/Year
~ |

Aging = "19-45" / 26
~ People / Year
~ |

Allocatable Funds = Revenue - Committed Funds
~ Dollars/Year
~ |

Attract Jobs Mult = "Attract Jobs Mult Look-up" (LF Jobs Ratio)
~ Dmnl
~ |

"Attract Jobs Mult Look-up" ([(0,0)-(10,2)],(0,1.1),(1,1.09),(2,1.07),(3,1.05),(4,1.03)\
,(5,1),(6,0.97),(7,0.95),(8,0.93),(9,0.91),(10,0.9))
~ Dmnl
~ |

Attractiveness Adult Immigration Multiplier = Attract Jobs Mult * Housing Attract Mult\
* Quality of Life Mult[MiddleAge]
~ Dmnl
~ |

Attractiveness Elder Immigration Multiplier = Housing Attract Mult * Quality of Life Mult[\
Elders]
~ Dmnl
~ |

Attractiveness Family Immigration Multiplier = Attract Jobs Mult * Housing Attract Mult\
* Quality of Life Mult[Families]
~ Dmnl
~ |

Average Residential Assessed Value = 170000
~ Dollars / house
~ |

Avg Children Per Family = 2.03
~ People
~ average children per family based on national statistics
|

Avg Commercial Assessed Value = 205000
~ Dollars / Commercial Structures
~ |

Avg Crowding = (Absolute Crowding Factor + Expectation of Crowding / Total Land Fraction Occupied\
) / 2
~ Dmnl
~ |

Avg Family Size = 3.5
~ Dmnl
~ |

Avg Household Size = 3.13
~ People / households
~ |

Avg Industry Assessed Value = 475000
~ Dollars / Industry Structures
~ |

Avg Quality of School = (Expection of Quality of Schools + Quality of School / Expection of Quality of Schools\
) / 2
~
~ |

Birth Rate = 0.014
~ 1 / Year
~ http://allcountries.org/uscensus/83_projected_fertility_rates_by_race_origi\
n.html
|

Births = "19-45" * Birth Rate
~ People/Month
~ |

Budget Allocation[Budget Subscripts] = ALLOCATE BY PRIORITY (Requests[Budget Subscripts\
] , Budget Priorities[Budget Subscripts] , ELMCOUNT(Budget Subscripts), 10, Allocatable Funds\
)

~ Dollars / Year
~ |

Budget Priorities[Budget Subscripts] = 2, 2, 2, 2, 1.8, 1.7
~ Dmnl
~ |

Budget Subscripts : FireDept,FireEquipment,PoliceDept,PoliceEquipment,ExpendonStudent\
,TownServices
~ Dollars
~ |

Budgeted Equipment = Budget Allocation[PoliceEquipment]
~ Dollars
~ |

Budgeted Fire Equipment Purchases = Budget Allocation[FireEquipment]
~ Dollars / Year
~ |

Budgeted Firemans = Budgeted Firemen Salaries / Fireman Salary
~ People
~ |

Budgeted Firemen Salaries = Budget Allocation[FireDept]
~ Dollars / Year
~ |

Budgeted Police Officers = Budget Allocation[PoliceDept]
~ People / Year
~ |

Budgeted Student Expenditures = Budget Allocation[ExpendonStudent]
~ Dollars / Year
~ |

Business Taxes = (Industry Structures * Avg Industry Assessed Value + Avg Commercial Assessed Value\
* Commercial Structures) * Tax Rate
~ Dollars / years
~ |

Change in Exectation of QOS = (Quality of School - Expection of Quality of Schools) \
/ Time to Change Expections

~ 1 / Year
~ |

Change in Expend per Student = (Budgeted Student Expenditures / Local Students) - Expend per Student\

~ Dollars / Student / Year / Year
~ |

Change in Percieved Police Effectiveness = (Sterling Police Effectiveness - Perceived Police Effectiveness\
) / Time to Change Perception
~ 1 / years
~ |

Change in State Expend per Student = Growth Rate Expenditure per Student * State Expend per Student\

~ Dollars / Student / Year / Year
~ |

Change in Tax Rate = Tax Rate * Prop 2 Check
~ Dollars / Assessed Dollars / Year /Year
~ |

"Comm Land Mult Look-up" ([(0,0)-(10,10)],(0,1),(0.1,1.15),(0.2,1.3),(0.3,1.4),(0.4,1.45)\
,(0.5,1.4),(0.6,1.22),(0.7,1),(0.8,0.72),(0.9,0.34),(1,0.01))
~ Dmnl
~ |

"Comm LF Mult Look-up" ([(0,0)-(10,10)],(0,0.2),(0.2,0.25),(0.4,0.35),(0.6,0.5),(0.8,0.7)\
,(1,1),(1.2,1.35),(1.4,1.6),(1.6,1.8),(1.8,1.95),(2.2,2.2))
~ Dmnl
~ |

"Commercial Const Mult Look-up" ([(-1,0)-(3,2)],(-1,0),(0,0),(0.480122,0.254386),(0.87156,0.596491)\
,(1,1),(1.15291,1.31579),(1.39755,1.54386),(1.66667,1.72807),(2,1.8),(2.44954,1.8))
~ Dmnl
~ |

Commercial Construct Mult = "Commercial Const Mult Look-up" (Commerical Construction Attract\

)
~
~ |

Commercial Construction = Commercial Structures * Normal Commercial Construction * Commercial Construct Mult\

~ Commercial Structures / Year
~ |

Commercial Demolition = Commercial Structures * Normal Commerical Demolition
~ Commercial Structures / Year
~ |

Commercial Labor Force Mult = "Comm LF Mult Look-up" (LF Jobs Ratio)
~ Dmnl
~ |

Commercial Land Mult = "Comm Land Mult Look-up" (Commercial LFO)
~ Dmnl
~ |

Commercial LFO = (Land per Commercial * Commercial Structures) / Land Zoned Commercial\

~ Dmnl
~ |

Commercial Structures = INTEG(Commercial Construction - Commercial Demolition , 45)
~ Commercial Structures
~ |

Commerical Construction Attract = Commercial Land Mult * (Commercial Labor Force Mult\
^ 0.5) * Industrial Attract * Res to Com * Tax Satisfaction
~ Dmnl
~ |

Committed Funds = Mandatory School Spending
~ Dollars / Year
~ |

Cost per School = 100000
~ Dollars / School / Year
~ |

Cost per Special Ed Student = 4000
~ Dollars / SE Student
~ |

d DTS = Desired Town Services * Inflation Rate
~ Dollars / Year / Year
~ |

d EC = (Total Land Fraction Occupied - Expectation of Crowding) / Time to Change Expec-tions\

~ 1 / Year
~ |

d EFDE = (Percieved Firemen Effectiveness - Expected Fire Dept Effectiveness) / Time ES\

~ 1 / years
~ |

D EPDE = (Perceived Police Effectiveness - Expected Police Effectiveness) / Time ES\

~ 1 / years
~ |

d EPT = (Tax Rate - Expected Tax Rate) / Time ETR
~ Dollars / Assessed Dollars / Year / Year
~ |

d HB Ratio = (House Business Ratio - Expected House Business Ratio) / Time HBR
~ 1 / Year
~ |

d PFE = (Firemen Effectiveness - Percieved Firemen Effectiveness) / Time d PFE
~ 1 / years
~ |

d SE = (SUM (Requests[Budget Subscripts!]) - Smooth Expenditure) / T Trend
~ Dollars / Year / years
~ |

d SET = (Expend Trend - Sm Exp Trend) / Time d SET
~ Dollars / years / years
~ |

```
d Town Services = Budget Allocation[TownServices] - Town Services
	~	Dollars / Year/ Year
	~		|

Demo groups : Families,MiddleAge,Elders
	~	People
	~		|

Demolition Normal = 0.015
	~	1 / Year
	~		|

Desired Town Services = INTEG( d DTS , 55000)
	~	Dollars / Year
	~		|

Elder Deaths = "65+" / Elder Remaining Life
	~	People / Month
	~		|

Elder Net Immigration = Normal Immigration * Attractiveness Elder Immigration Multiplier\
		 * "65+" - "65+" * 0.07
	~	People/Year
	~		|

Elder Remaining Life = 13
	~	years
	~	Averge lifespan (78) minus current age
	|

Equipment = INTEG( Police Equipment Purchases - Police Equipment Depreciation , 60000\
		)
	~	Dollars
	~		|

"Equipment Eff Mult Look-up" ( [(0,0)-(2,2)],(0,0.1),(0.330275,0.105263),(0.556575,0.22807)\
		,(0.911315,0.482456),(1.0948,0.912281),(1.27217,1.15789),(1.44954,1.29825),
(1.62691,1.47368)\
		,(1.80428,1.5),(2,1.5) )
	~	Dmnl
	~		|

Equipment Efficiency Multiplier = "Equipment Eff Mult Look-up" ( Equipment per Fireman\
```

/ Normal Equipment Per Firement)
~ Dmnl
~ |

Equipment per Fireman = Fire Equipment / Firemans
~ Dollars / Firemen
~ |

Equipment per Policeman = Equipment / Police Officers
~ Dollars / policeman
~ |

Expectation of Crowding = INTEG(d EC , Total Land Fraction Occupied)
~ Dmnl
~ |

Expected Fire Dept Effectiveness = INTEG(d EFDE , Percieved Firemen Effectiveness)
~ Dmnl
~ |

Expected House Business Ratio = INTEG(d HB Ratio , House Business Ratio)
~ Houses / Businesses
~ |

Expected Police Effectiveness = INTEG(D EPDE , Perceived Police Effectiveness)
~ Dmnl
~ |

Expected Tax Rate = INTEG(d EPT , 5 / 1000)
~ Dollars / Assessed Dollars / years
~ |

Expection of Quality of Schools = INTEG(Change in Exectation of QOS , 1)
~ Dmnl
~ |

Expend per Student = INTEG(Change in Expend per Student , 643)
~ Dollars / Student / Year
~ |

Expend Trend = (SUM (Requests[Budget Subscripts!]) - Smooth Expenditure) / (SUM (\
Requests[Budget Subscripts!]) * T Trend)
~ Dmnl
~ |

```
Expenditures = Committed Funds + SUM ( Budget Allocation[Budget Subscripts!] )
	~	Dollars / Year
	~		|

Expenditures Forecast = SUM ( Requests[Budget Subscripts!] ) * ( 1 + Sm Exp Trend * Forecast Horizon\
		 )
	~	Dollars / Year
	~		|

Fire Dept Fulfillment Ratio = Percieved Firemen Effectiveness / Expected Fire Dept Effective-ness\

	~	Dmnl
	~		|

Fire Equipment = INTEG( Fire Equipment Purchases - Fire Equipment Depreciation , 650000\
		)
	~	Dollars
	~		|

Fire Equipment Budget Request = ( Normal Equipment Per Firement - Equipment per Fireman\
		 ) * Firemans + Fire Equipment Depreciation
	~	Dollars
	~		|

Fire Equipment Depreciation = Fire Equipment / 30
	~	Dollars / Year
	~		|

Fire Equipment Purchases = Budgeted Fire Equipment Purchases
	~	Dollars / Year
	~		|

Fireman Hires = ( Budgeted Firemen Salaries / Fireman Salary ) - Firemans
	~	People / Year
	~		|

Fireman Salary = 5000
	~	Dollars / Firemen
	~		|

Firemans = INTEG( Fireman Hires - Firemen Retirement , 20)
```

~ People
~ |

Firemen = INTEG(Fireman Hires - Firemen Retirement , 11)
~ Firemen [8.40779e-045,?]
~ |

Firemen Budget Request = Fireman Salary * Optimal Sterling Firemen
~ Dollars
~ |

Firemen Coverage = Firemans / Optimal Sterling Firemen
~ Dmnl
~ |

Firemen Effectiveness = Firemen Coverage * Equipment Efficiency Multiplier
~ Dmnl
~ |

Firemen Retirement = Firemans / 30
~ People / Year
~ |

Forecast Horizon = 1
~ Year
~ |

Fr School Age = 0.78
~ Students / Person
~ |

Frac LLF Jobs = 0.6
~ Dmnl
~ |

Fraction Special Ed = 0.017
~ SE Students / Person
~ |

Growth Rate Expenditure per Student = 0.03
~ Dollars / Dollar / Service / Year
~ |

House Avail Mult = "Housing Avail Mult Look-up" (HousetoHousehold Ratio)

~ Dmnl
~ |

House Business Ratio = Households / (Commercial Structures + Industry Structures)
~ Houses / Businesses
~ |

House Construction = Housing Constructon Normal * House Avail Mult * Housing Land Multi-plier\
* Housing
~ Houses / Year
~ |

Households = Total Population / Avg Household Size
~ housholds
~ |

HousetoHousehold Ratio = Housing / (Total Population / Avg Family Size)
~ Houses / People
~ |

Housing = INTEG(House Construction - Housing Demolition , 476)
~ Houses
~ |

Housing Attract Mult = "Housing Attract Mult Look-up" (HousetoHousehold Ratio)
~ Dmnl
~ |

"Housing Attract Mult Look-up" ([(0,0)-(3,2)],(0,0),(0.183486,0),(0.642202,0.377193)\
,(1,1),(1.3211,1.36842),(1.6055,1.54386),(1.94495,1.54386))
~ Dmnl
~ |

"Housing Avail Mult Look-up" ([(0,0)-(10,10)],(0.6,0.1),(0.68,0.15),(0.76,0.3),(0.84,0.45)\
,(0.92,0.6),(1,1),(1.08,1.35),(1.16,1.6),(1.24,1.8),(1.32,1.95),(1.4,2))
~ Dmnl
~ |

Housing Constructon Normal = 0.0525
~ 1 / Year
~ |

Housing Demolition = Demolition Normal * Housing

~ Houses / Year
~ |

"Housing Land Mult Look-up" ([(0,0)-(1.5,2)],(0,1.17),(0.2,0.98),(0.252294,0.807018)\
,(0.325688,0.640351),(0.477064,0.473684),(0.665138,0.27193),
(0.87156,0.0877193),(1,0)\
)
~ Dmnl
~ |

Housing Land Multiplier = "Housing Land Mult Look-up" (Residential LFO)
~ Dmnl
~ |

"Ind Attract Look-up" ([(0,0)-(10,10)],(0,1.96),(0.667,1.54),(1.33,1.34),(2,1.22),(2.67,1.14)\
,(3.33,1.06),(4,1),(4.67,0.936),(5.33,0.85),(6,0.746),(6.67,0.613),(7.33,0.375),
(8,0.1)\
)
~ Dmnl
~ |

Ind Const Mult = "Ind Const Mult Look-up" (Industrial Construction Attract)
~
~ |

"Ind Const Mult Look-up" ([(1,0)-(3,2)],(-1,0),(0,0),(0.480122,0.254386),(0.87156,0.596491)\
,(1,1),(1.15291,1.31579),(1.39755,1.54386),(1.66667,1.72807),(2,1.8),
(2.44954,1.8))
~ Dmnl
~ |

"Ind Land Mult Look-up" ([(0,0)-(10,10)],(0,1),(0.1,1.15),(0.2,1.3),(0.3,1.4),(0.4,1.45)\
,(0.5,1.4),(0.6,1.22),(0.7,1),(0.8,0.72),(0.9,0.34),(1,0.01))
~ Dmnl
~ |

"Ind LF Mult Look-up" ([(0,0)-(10,10)],(0,0.2),(0.2,0.25),(0.4,0.36),(0.6,0.5),(0.8,0.7)\
,(1,1),(1.2,1.35),(1.4,1.6),(1.6,1.8),(1.8,1.95),(2,2))
~ Dmnl
~ |

Industrial Attract = "Ind Attract Look-up" (Commercial Structures / Industry Structures\
)
~ Dmnl

~ |

Industrial Construction Attract = Industrial Land Multiplier * (Industry Labor Force Mult\
^ 0.5) * Industry Construction Service Mult * Residential to Industrial * Tax Sat-
isfaction\

~ Dmnl
~ |

Industrial Land Multiplier = "Ind Land Mult Look-up" (Industry LFO)
~ Dmnl
~ |

Industrialization Factor = House Business Ratio / Expected House Business Ratio
~ Dmnl
~ |

Industry Construction = Industry Structures * Normal Industrial Construction * Ind Const Mult\

~ Industry Structures / Year
~ |

Industry Construction Service Mult = (Fire Dept Fulfillment Ratio + Police Fulfillment Ratio\
) / 2
~ Dmnl
~ Sums effects of fire and police departments service fulfillments, with \
equal weighting
|

Industry Demolition = Industry Structures * Normal Industry Demolition
~ Industry Structures / Year
~ |

Industry Labor Force Mult = "Ind LF Mult Look-up" (LF Jobs Ratio)
~ Dmnl
~ |

Industry LFO = Industry Structures * Land per Industry / Land Zoned Industrial
~ Dmnl
~ |

Industry Structures = INTEG(Industry Construction - Industry Demolition , 3)
~ Industry Structures
~ |

Inflation Rate = 0.03
~ 1 / years
~ |

Jobs = (Industry Structures * Jobs per Industry) + (Commercial Structures * Jobs per Commercial Structure\
)
~ Jobs
~ |

Jobs per Commercial Structure = 3.5
~ Jobs / Commercial Structures
~ |

Jobs per Industry = 9
~ Jobs / Industry Structures
~ |

Labor Force = LF Participation Rate * Total Population * Local Labor Rate
~ People
~ |

Land per Commercial = 2
~ acres / commercial
~ |

Land per House = 2
~ acres / house
~ |

Land per Industry = 8
~ acres / industry
~ |

Land Zoned Commercial = 500
~ acres
~ |

Land Zoned Industrial = 1000
~ acres
~ |

Land Zoned Residential = 8750

~ acres
~ |

LF Jobs Ratio = Labor Force / (Frac LLF Jobs * Jobs)
~ People / Job
~ |

LF Participation Rate = 0.46
~ Dmnl
~ |

Local Labor Rate = 0.2
~ Dmnl
~ |

Local Students = Students
~ Students
~ |

Mandatory School Spending = Schools * Cost per School + Special Ed Student Costs
~ Dollars / Year
~ |

Maturing = "0-18" / 18
~ People / Year
~ |

Normal Commercial Construction = 0.07
~ 1 / Year
~ |

Normal Commerical Demolition = 0.025
~ 1 / Year
~ |

Normal Equipment Per Firement = 59000
~ Dollars / Firemen
~ |

Normal Equipment per Policement = 20000
~ Dollars / Police
~ |

Normal Firemen per 1000 = 11

~ {Firemen / 1000 People}
~ |

Normal Immigration = 0.0893
~ People / Year
~ |

Normal Industrial Construction = 0.07
~ 1 / Year
~ |

Normal Industry Demolition = 0.025
~ 1 / Year
~ |

Normal Police per 1000 = 2
~ Police / People
~ |

Optimal Sterling Firemen = Normal Firemen per 1000 * (Total Population / 1000)
~ Firemen
~ |

Optimal Sterling Police = Total Population / 1000 * Normal Police per 1000
~ Police
~ |

Perceived Police Effectiveness = INTEG(Change in Percieved Police Effectiveness , Sterling Police Effectiveness\
)
~ Dmnl
~ |

Percieved Firemen Effectiveness = INTEG(d PFE , Firemen Effectiveness)
~ Dmnl
~ |

Police Coverage = Police Officers / Optimal Sterling Police
~ Dmnl
~ |

Police Equipment Budget Request = Police Equipment Depreciation + (Normal Equipment per Policement\
* Police Officers) - Equipment

~ Dollars
~ |

Police Equipment Depreciation = Equipment / 5
~ Dollars / Year
~ |

Police Equipment Efficiency Multiplier = "Police Equipment Efficiency Multiplier Look-up"\
(Equipment per Policeman / Normal Equipment per Policement)
~ Dmnl
~ |

"Police Equipment Efficiency Multiplier Look-up" ([(0,0)-(2,2)],(0,0.1),(0.330275,0.105263)\
,(0.556575,0.22807),(0.911315,0.482456),(1.0948,0.912281),(1.27217,1.15789),
(1.44954,1.29825)\
,(1.62691,1.47368),(1.80428,1.5),(2,1.5))
~ Dmnl
~ ~ :SUPPLEMENTARY
|

Police Equipment Purchases = Budgeted Equipment - Equipment
~ Dollars / Year
~ |

Police Fulfillment Ratio = Perceived Police Effectiveness / Expected Police Effectiveness\

~ Dmnl
~ |

Police Hires = (Budgeted Police Officers / Salary per Police Officer) - Police Officers\

~ People / Year
~ |

Police Officers = INTEG(Police Hires - Police Retirement , 3)
~ People
~ |

Police Retirement = Police Officers / 30
~ People / Year
~ |

Policemen = INTEG(Police Hires - Police Retirement , 11)
~ Police [8.40779e-045,?]

~ |

Policemen Budget Request = Optimal Sterling Police * Salary per Police Officer
~ Dollars
~ |

Prop 2 Check = IF THEN ELSE (Time > 1982, IF THEN ELSE (Tax Change > 0.025, 0.025, \
Tax Change) , Tax Change)
~ Dollars / Dollars / years
~ |

QOL Effectors : QOS,Fire,Police,Industrialization,Crowding,TaxSatisfaction,MiscServices
~ Dmnl
~ |

"QoL Mult Look-up" ([(0,0)-(3,2)],(0,0),(0.183486,0),(0.642202,0.377193),(1,1),
(1.3211,1.36842)\
,(1.6055,1.54386),(1.94495,1.54386))
~
~ |

QOL Priorities Elder[QOL Effectors] = 0, 1.5, 1.5, 1.25, 1, 0.75, 1
~ Dmnl
~ |

QOL Priorities Family[QOL Effectors] = 1.5, 1.25, 1.5, 1, 1, 1, 1
~ Dmnl
~ families value schools, and police (safety) most and fire/emergency \
services over the other elements
|

QOL Priorities MiddleAge[QOL Effectors] = 0, 1, 1.5, 1.5, 1.25, 1.5, 1
~ Dmnl
~ |

Quality of Life[Families] = (QOL Priorities Family[QOS] * Avg Quality of School + QOL Priorities Family[\
Fire] * Fire Dept Fulfillment Ratio + QOL Priorities Family[Police] * Police Fulfillment Ratio\
+ QOL Priorities Family[Industrialization] * Industrialization Factor + QOL Priorities Family[\
Crowding] * Avg Crowding + QOL Priorities Family[TaxSatisfaction] * Tax Satisfaction\

+ QOL Priorities Family[MiscServices] * Town Service Fullfillment Ratio) / SUM (\
QOL Priorities Family[QOL Effectors!]) ~~|
Quality of Life[MiddleAge] = (QOL Priorities MiddleAge[QOS] * Avg Quality of School \
+ QOL Priorities MiddleAge[Fire] * Fire Dept Fulfillment Ratio + QOL Priorities MiddleAge[\
Police] * Police Fulfillment Ratio + QOL Priorities MiddleAge[Industrialization] * \
Industrialization Factor + QOL Priorities MiddleAge[Crowding] * Avg Crowding + QOL Priorities MiddleAge[\
TaxSatisfaction] * Tax Satisfaction + QOL Priorities MiddleAge[MiscServices] * Town Service Fullfillment Ratio\
) / SUM (QOL Priorities MiddleAge[QOL Effectors!]) ~~|
Quality of Life[Elders] = (QOL Priorities Elder[QOS] * Avg Quality of School + QOL Priorities Elder[\
Fire] * Fire Dept Fulfillment Ratio + QOL Priorities Elder[Police] * Police Fulfillment Ratio\
+ QOL Priorities Elder[Industrialization] * Industrialization Factor + QOL Priorities Elder[\
Crowding] * Avg Crowding + QOL Priorities Elder[TaxSatisfaction] * Tax Satisfaction\
+ QOL Priorities Elder[MiscServices] * Town Service Fullfillment Ratio) / SUM (QOL Priorities Elder[\
QOL Effectors!])
~ Dmnl
~ actual quality of life (by priority) over normal quality of life (by \
priority)
|

Quality of Life Mult[Demo groups] = "QoL Mult Look-up" (Quality of Life[Demo groups] \
)
~ Dmnl
~ |

Quality of School = Quality of Teaching
~ Dmnl
~ |

Quality of Teaching = Expend per Student / State Expend per Student
~ Dmnl
~ |

Requested Expend per Student Budget = State Expend per Student * Local Students
~ Dollars / Year

~ |

Requests[FireDept] = Firemen Budget Request ~~|
Requests[FireEquipment] = Fire Equipment Budget Request ~~|
Requests[PoliceDept] = Policemen Budget Request ~~|
Requests[PoliceEquipment] = Police Equipment Budget Request ~~|
Requests[ExpendonStudent] = Requested Expend per Student Budget ~~|
Requests[TownServices] = Desired Town Services
~ Dollars
~ |

Res to Com = IF THEN ELSE (Industrialization Factor < 1, Industrialization Factor * \
0.9, 1)
~ Dmnl
~ This parameter simulates the local resistance to commercial growth. Where \
the industrialization factor is low, meaning the town feels over \
developed, commercial growth is discouraged.Nothing happens when the \
industrialization factor is high because the town perfers industry growth.
|

Residential LFO = (Housing * Land per House) / Land Zoned Residential
~ Dmnl
~ |

Residential Taxes = (Households * Average Residential Assessed Value) * Tax Rate
~ Dollars / years
~ |

Residential to Industrial = Industrialization Factor
~ Dmnl
~ |

Retirement = "45-65" / 20
~ People / Year
~ |

Revenue = Tax Revenue + Tax Revenue * State Aid Percent
~ Dollars / Year
~ |

Salary per Police Officer = 32000
~ Dollars / Year
~ |

```
Schools = 2
	~	Schools
	~		|

Sm Exp Trend = INTEG( d SET , Expend Trend )
	~	Dollars / years
	~		|

Smooth Expenditure = INTEG( d SE , Expenditures )
	~	Dollars / Year
	~		|

Special Ed Student Costs = Cost per Special Ed Student * Special Ed Students
	~	Dollars
	~		|

Special Ed Students = Fraction Special Ed * Total Child Population
	~	SE Students
	~		|

State Aid Percent = 0.15
	~	Dmnl
	~		|

State Expend per Student = INTEG( Change in State Expend per Student , 643)
	~	Dollars / Student / Year
	~		|

Sterling Police Effectiveness = Police Coverage * Police Equipment Efficiency Multiplier\

	~	Dmnl
	~		|

Student Costs = Local Students * Expend per Student
	~	Dollars
	~		|

Students = Total Child Population * Fr School Age
	~	Students
	~		|

Surplus Money = INTEG( Revenue - Expenditures , 0)
	~	Dollars
	~		|
```

T Trend = 2
~ years
~ |

Tax Change = (Expenditures Forecast - (Revenue + Surplus Money)) / Revenue
~ Dmnl
~ percent revenue increase desired
|

Tax Rate = INTEG(Change in Tax Rate , 5 / 1000)
~ Dollars / Assessed Dollars / Year
~ |

Tax Revenue = Residential Taxes + Business Taxes
~ Dollars / years
~ |

Tax Satisfaction = Expected Tax Rate / Tax Rate
~ Dmnl
~ |

Time d PFE = 2
~ years
~ |

Time d SET = 2
~ years
~ |

Time ES = 12
~ years
~ |

Time ETR = 4
~ years
~ |

Time HBR = 7
~ years
~ |

Time to Change Expections = 3
~ years

~ |

Time to Change Perception = 2
~ years
~ |

Total Allocated Funds = SUM (Budget Allocation[Budget Subscripts!])
~ Dollars / Year
~ |

Total Child Population = "0-18"
~ People
~ |

Total Land Area = 10250
~ acres
~ |

Total Land Fraction Occupied = (Housing * Land per House + Commercial Structures * Land per Commercial\
+ Industry Structures * Land per Industry) / Total Land Area
~ Dmnl
~ |

Total Population = "0-18" + "19-45" + "45-65" + "65+"
~ People
~ |

Total Requests = SUM (Requests[Budget Subscripts!])
~ Dollars
~ |

Total School Cost = Cost per School * Schools + Special Ed Student Costs + Student Costs\

~ Dollars / Year
~ |

Town Service Fullfillment Ratio = Town Services / Desired Town Services
~ Dmnl
~ |

Town Services = INTEG(d Town Services , 55000)
~ Dollars / Year
~ |

Young Adult Net Immigration = Normal Immigration * Attractiveness Family Immigration Mul-
tiplier\
 * "19-45" - "19-45" * 0.07
~ People / Year