

Southborough
Public School District

Population and School Enrollment
Projections

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Executive Summary

- The population of the Town of Southborough and the Southborough Public School district is projected to reach 11,131 by the year 2030. This projection represents an increase of nearly 700 or more than 6.5 percent from the 2020 Census population of 10,450. The absolute number of births is projected to increase throughout the projections period from 364 in the 2015 to 2020 period to 497 in the 2020 to 2025 period and again to 620 between 2025 and 2030. This increase results from population growth in the number of women between the ages of 30 and 44 even with continued low fertility rates by age of mother.
- Women of childbearing age, ages 15 to 49, are projected to decline slightly to 1,664 in 2025 and then increase to 1,756 by the year 2030.
- Southborough is projected to experience natural decline (an excess of deaths over births) throughout the 2020 to 2030 period due the aging of the Baby Boom generation.
- The kindergarten to grade 8 enrollment in the Southborough school district is projected to increase from 1,152 in Fall 2021 to 1,237 in Fall 2030. This is an increase of 7.4 percent.
- The class with the largest increase between Fall 2021 and Fall 2030 is projected to be Grade 1, increasing from 116 to 155 followed closely by Kindergarten increasing from 117 to 155. Grades 5, 7 and 8 are projected to decline by 10 students in grade 5, 8 students in grade 7 and 20 students in grade 8.
- Varying the fertility and migration assumptions by implementing a 10 percent increase or decrease in the Total Fertility Rate and Crude Migration rate results in total enrollment range from a low of 1,160 to a high of 1,315 in Fall of 2030. This compares to the base middle assumption which results in total enrollment of 1,237.

Introduction

RLS Demographics, Inc. has been contracted to prepare population and school enrollment projections for the Southborough Public School District. This report presents demographic projections by age and sex based on the 2010 Census and current year Census Bureau estimates and the recently released 2020 Census results. These data are then projected to the year 2040. The enrollment projections are specific to the kindergarten through grade 8 enrollments by grade level. Projection of the population and enrollment is based on the analysis of a number of public data sources including:

- Historical enrollment provided by the Southborough school district,
- Historical and current birth and death counts provided by the Massachusetts Department of Public Health,
- Population counts from the decennial census, current population estimates and American Community Survey data from the U.S. Census Bureau,
- Estimates of total net migration and migration by age and gender prepared by RLS Demographics using Census Bureau estimates and the Life Table Survival Rate methodology.

The school district and the Town of Southborough are geographically coexistent therefore the vital statistics and Census Bureau data for the Town provide the necessary data inputs for the District.

Demographic and Enrollment Projections – Process Overview

The method used for projecting school enrollment for the Southborough School District is a combination of standard methods for demographic projection and school enrollment projection. The demographic Cohort-Component model is used to project population by age and sex because it captures the interaction effects of population age structure, fertility, mortality and migration. The Grade Progression Ratio enrollment projection method utilizes the historical relationship between student movement from one grade to the next to “age” students through their education years. Both models have been used extensively but are not often used in combination.

The demographic model provides detailed age and sex population characteristics which is critical to understanding changes in the female population, births and their future entry into the school-age years. Historical analysis of the relationship between actual births and enrollment in kindergarten and/or first grade is then applied to the projection of future births to generate future students.

Demographic components of change (fertility, mortality and migration) are analyzed to capture total population change and change by age and sex. This is particularly important for projecting births which are dependent on fertility rates and the number of women of childbearing age. Changing household composition and housing unit type are also factors to be considered when analyzing population change. Construction, conversion and demolition activity is an important indicator of change and can also impact school enrollment depending on the type of construction.

The Grade Progression Ratio model is a standard method of projecting school enrollment by grade. The method captures the school enrollment patterns of a cohort of children as they move forward in time and progress from grade to grade. Grade Progression models provide detail of how many students advance into the next grade from the lower grade one year before and are determined by dividing the number of students in a particular grade by the number of students from the previous grade in the previous school year.

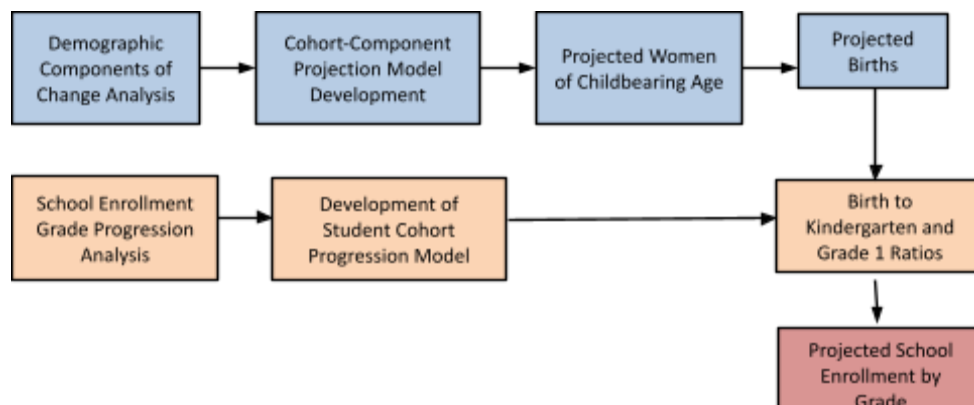
For example, the 2nd grade/1st grade progression ratio is found by dividing the current number of 2nd grade students by last year’s number of 1st grade students. A ratio larger than 1 means there are additional students coming in to the school who were not enrolled in the previous grade. A ratio smaller than 1 means students may be transferring to private school or home school, dropping out, or families with school children are moving away from the community, among other reasons. Because grade-specific progression ratios can fluctuate from one year to

another, it is important to generate and evaluate grade-progression ratios from historical enrollment data. Often a three or five year average will be used to minimize variation.

The advantage of this enrollment projection method is its simplicity in capturing the various factors affecting student enrollment at each grade in a single, computationally simple calculation. Its advantage is also its disadvantage in that it does not capture future population changes due to migration which impacts childbearing women and resulting births. This is especially important in areas of residential change, either growth or decline. The Town of Southborough has grown from 9,767 in the 2010 Census to 10,450 in the 2020 Census. The 2020 Census captured a larger than expected population based on the Census Bureau's 2019 population estimates figure of 10,208. The increase to 2020 was nearly 700 and reflects a 7.0 percent rate of growth. The rate of growth between the 2000 and 2010 Census was much higher at 18.0, indicating that continued growth is likely but at a greatly reduced rate.

This growth also implies changes in the age distribution (aging of the Baby Boom generation and large Millennial generation) and its impact on fertility is a critical element of enrollment projections. Southborough has a somewhat older population with 14.7 percent over the age of 65 and a median age of 43.1 years based on the 2015-19 American Community Survey. An analysis of the district's age distribution and any changes in age patterns of migration will be useful in determining whether or not the district will continue to experience this aging or may begin to attract the younger Millennial generation, many of whom are in their prime childbearing years. **At this time, detailed age distribution data from the 2020 Census is not available.**

The link between the demographic projections of the population by age and sex and the enrollment projections by grade level is in the projected number of births. When analyzing enrollment, it is necessary to look at the number of births occurring five years earlier for kindergarten enrollment and six years earlier for first grade enrollment. The total number of births by year become inputs to the enrollment projections as illustrated in Figure 1.



Demographic Cohort-Component Projections

This report presents the Town of Southborough population projections by age and sex for the period 2010 through 2030. The population is projected in five-year intervals and for five-year age cohorts of the population to 85 and over. The report contains projections for Southborough based on analysis of current fertility, mortality, and migration rates as of 2019 and future assumptions to 2040. While this is a likely scenario, many factors can alter the course of future events. This is not a prediction of future population but rather the population outcome if the assumptions about future fertility, mortality, and migration are fulfilled.

Methodology Overview

The model used for the demographic projections is a standard demographic Cohort-Component method. Population is projected forward by five-year age-sex cohorts utilizing individual transition rates for fertility, mortality, and migration. The age-sex distribution is produced in five-year age intervals through age 84 with an open ended category for population 85 and over.

The model is geography independent which means that its design allows for all input data to be defined specifically for the Town of Southborough. The model utilizes area specific inputs for fertility, migration, and mortality but can also use county, state or national rates if local data isn't available. This is especially useful in the application of survival distributions as it is often impossible to develop town specific life tables and survivorship ratios. That is the case for Southborough. However, the Worcester County population is large enough to provide accurate mortality data and construction of county specific life tables for males and females. These survival distributions are applied to the Southborough population **with the caveat that the mortality rates applied here DO NOT take account of changes in mortality as a result of the COVID-19 pandemic.**

Components of Change Analysis

The measurement of population change over a given period of time is defined by a simple identity known as the demographic balancing equation. In its simplest form, the equation is stated as:

$$P_1 = P_0 + B_{(t,t+n)} - D_{(t,t+n)} + M_{(t,t+n)}$$

Where: P_0 = population at the base period,
 P_1 = population at the end of period n,
B = births between time t and t+n
D = deaths between time t and t+n
M = net migrants between time t and t+n

The Population Estimates Program of the U.S. Census Bureau utilizes a nationwide methodology for estimating total population and age, race, sex characteristics at the county level which follows this basic balancing equation concept. At the town level, the Census Bureau produces estimates of the total resident population only.¹ The estimates for the Town of Southborough for the period 2010 to 2019 are used to define the starting point of the projections process. These estimates have also been supplemented with the recently released 2020 Census population count. However, the data currently available provides only the total population and voting age population age 18 and over. It does not include the detailed 5-year age/sex data. The projections model is calibrated for the 2010 to 2020 period by adjusting the Total Fertility Rate and Crude Migration Rate to yield results controlled to the components of change illustrated in Table 1.

Table 1: Town of Southborough Historical Components of Change, 2000 to 2020

	April 1, 2000	July 1, 2005	April 1, 2010	July 1, 2015	April 1, 2020
Total Population	8,277	9,370	9,767	10,016	10,450
Population Change	X	1,093	397	249	434
Percent Change		13.2%	4.2%	2.5%	4.3%
Cumulative Births		656	473	409	447
Cumulative Deaths		209	219	248	238
Natural Increase		447	254	161	209
Net Migration		646	143	88	33
Crude Net Migration Rate		7.8%	1.5%	0.9%	2.2%

Source: U.S. Census Bureau, Intercensal Estimates of Population, 2000 to 2019. U.S. National Center for Health Statistics, Annual Vital Statistics, 2000 to 2018

The Cohort-Component projection model applies the logic of the balancing equation to the individual age-sex components of the population such that five-year age cohorts by sex are projected forward in intervals, “n”, of five years to the year 2040.

The projections process is really quite simple and has five basic steps:

1. Special populations (college, prison, and other group quarters populations) are removed from the base period population to remove potential distortions of the underlying rates. Special populations typically include college students, prison populations and nursing home populations. These have not been specified for the Southborough projections.
2. Age-specific fertility rates are applied to the mid-period population of women to generate births over the five-year period.

¹ U.S. Census Bureau, “Methodology for the Sub-county Total Resident Population Estimates (Vintage 2019): April 1, 2010 to July 1, 2019”, <https://www2.census.gov/programs-surveys/popest/technical-documentation/methodology/2010-2019/2019-su-meth.pdf>

3. Survivorship ratios by age and gender are applied to the base year population to determine the number of survivors who will be age $a+5$ at the end of the interval.
4. Age-specific migration rates are applied to the base population to calculate the number of net migrants over the interval.
5. Following the balancing equation, the end period population is equal to the survivors of the initial cohort, plus births during the interval, plus net-migrants during the interval.

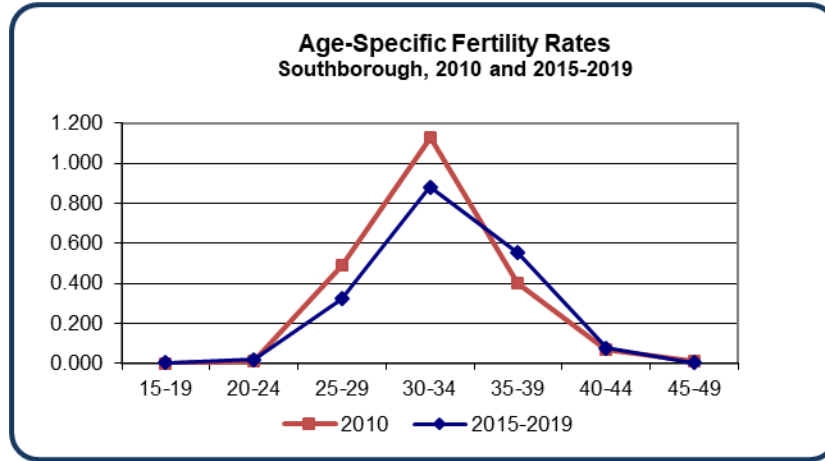
At the end of the five year interval, births become the new age 0 to 4 population and all other age categories become age $a+5$. The last category, 85 and over, is equal to the sum of the population 80 to 84 who have aged to be 85 to 89, plus the 85 and over population which has aged to be 90 and over. This process is repeated for each 5-year time period.

Fertility Analysis

The absolute number of births projected for the Town, in each five-year interval, is calculated by applying age-specific fertility rates to the number of women in the childbearing ages (women age 15 through 49) by 5-year age cohort. The number of male and female births is determined by applying the sex ratio at birth to the total births generated. Specification of the age-specific pattern of fertility has been generated using actual town level vital records data.

The model utilizes age-specific rates as an age pattern of fertility specific to Southborough. The age pattern can be held constant throughout the projection period or altered to reflect changing assumptions about the timing of childbearing. Given the long term stability of fertility rates in the U.S. and already delayed age of childbearing, the age patterns of fertility have been held constant throughout the 30 year projections interval. Figure 1 is the graphic representation of the fertility pattern for the Town of Southborough. The patterns represent the average fertility experience for the 2009 to 2011 births centered on the 2010 Census age distribution and an estimate of the 2018 to 2020 births centered on the 2015 to 2019 ACS age distribution. The 3-year birth periods are used to smooth year-to-year variation in the number of births. Both distributions show a very unique pattern with extremely low fertility rates through the early 20's followed by the peak age-specific fertility rate in the 30 to 34 age group of women. Southborough exhibits a classic pattern of delayed childbearing characteristic of the millennial generation and is seen in the decline of fertility rates in the 25 to 29 and 30 to 34 age groups followed by an increase in rates for the 35 to 39 population from 2010 to the later period. The 2015 to 2019 pattern is assumed to continue throughout the projection period.

Figure SEQ Figure * ARABIC 1



The actual number of births projected, based on the current and projected age pattern of fertility, is determined by the specification of the overall Total Fertility Rate (TFR). The Total Fertility Rate specifies the average number of children a woman will have over her childbearing years. A rate of 2.1 is considered the “replacement” level of fertility. The Southborough fertility rate for 2010 was right at the 2.1 replacement level and had declined by the end of the decade to 1.86 children per woman.

The age pattern of fertility is used to control the distribution of births by age of mother while the TFR is used to control the total number of births generated. This provides the analyst with the flexibility to test assumptions regarding both changes in timing and changes in the level of future fertility. The actual number of births for Southborough by age of mother is available for the 2010 to 2017 period from the Massachusetts Department of Public Health. At the current time, total Southborough births for 2018, 2019 and 2020 are available but lack the age detail. The initial TFR has been calibrated to yield the observed birth data for Southborough and is the starting point for the fertility level shown in Table 2. This series reflects a slight “post-COVID” increase in the TFR throughout the projection period.

Table 2: Town of Southborough Projected Total Fertility Rate

	Actual and Projected Total Fertility Rate					
	2010-15	2015-20	2020-25	2025-30	2030-35	2035-40
Town of Southborough	2.10	1.90	2.10	2.10	2.10	2.10

Migration Analysis

Similar to the modeling of fertility, the model generates net migrants by age and sex for the town based upon an age pattern of migration and a specified total absolute level of migration, the Crude Migration Rate.

The age pattern specifies the age distribution of net migrants and is gender specific. This can be thought of as the propensity to migrate, one age category relative to another, in any given area or time period. The absolute level of net migration is controlled by the specification of the



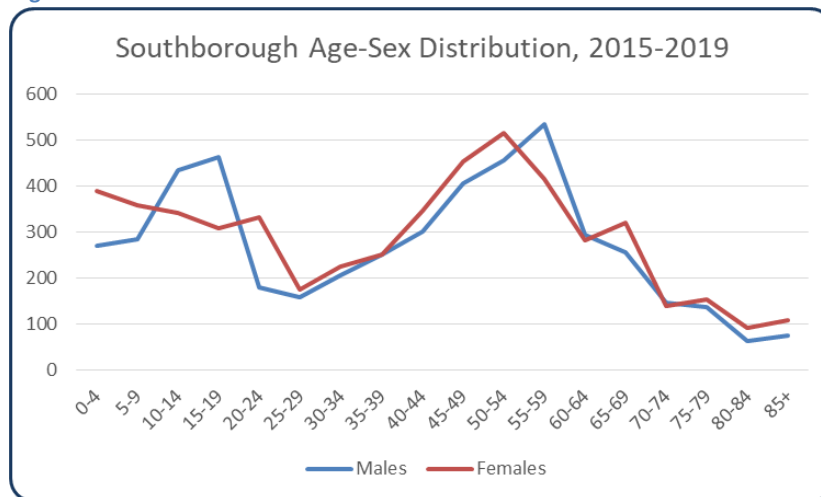
Crude Migration Rate. As with the fertility module, the model has the flexibility to alter assumptions regarding changes in the age pattern of migration and the Crude Migration Rate in each time period.

In the development of the age-specific migration patterns, rates were calculated for the 2010 to 2015 and 2015 to 2020 periods. There have been significant economic changes over the decade with the earlier half experiencing somewhat lower rates of migration as the nation recovered from the Great Recession. In addition to this uncertainty and the lack of detail age distribution data from the 2020 Census, it was necessary to make adjustments to the age pattern that was output from the Components of Change module.

Three primary issues needed resolution:

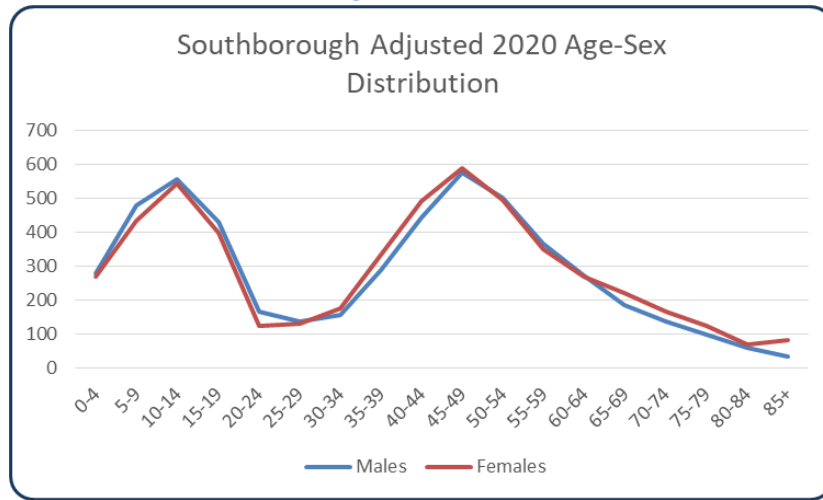
- 1) The ACS 2015-2019 age/sex distribution showed significant distortion in age pattern and age-specific sex ratios. This was especially true for the age groups under 25 and Figure 2 illustrates this. These are important age groups as they will age into the childbearing years and affect future births. There is little reason for such disparity between males and females and differences across the age groups.

Figure 2



- 2) In addition to the age-sex issue, the total population reported from the 2020 Census is about 330 higher than the ACS estimate. When these differences are carried through the projections process to calibrate the 2010 to 2020 experience, the resulting 2020 age distribution carries the same distortions as the ACS data. It was necessary to develop an adjusted 2020 age distribution that reflected the natural cohort aging from 2010 and the new 2020 Census total population. This was accomplished by using the expected 2020 population age distribution and controlling it to the 2020 Census total. Figure 3 shows the result of this adjustment.

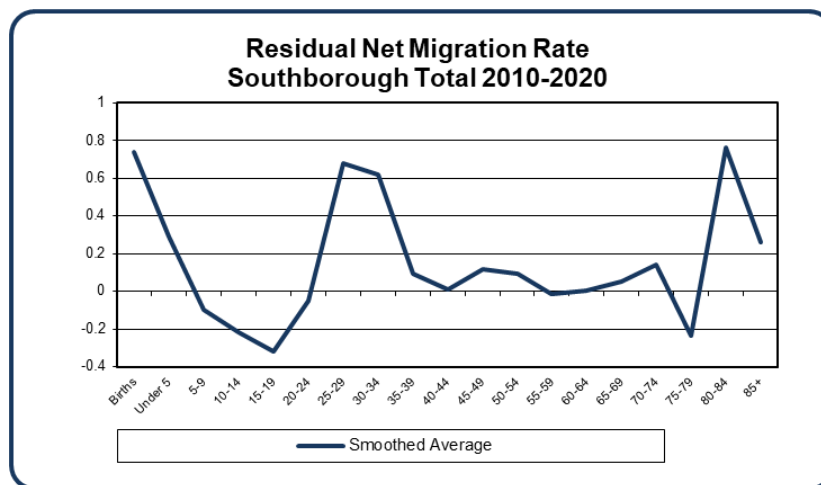
Figure 3



- 3) Even with the previous adjustments, the age-sex specific patterns of migration show very different patterns for males and females and the migration rates are greatly affected by the small population base in a number of age categories. It's important to remember that the 2010 to 2020 period is the base for calibration of future transition rates so the distribution illustrated in Figure 3 was used as the target distribution of adjusting the age-specific rates. Rather than specifying migration rates by sex, the smoothed total migration pattern for both males and females.

- 4) Finally, Figure 4 shows the extreme peak rates of migration that would be applied to youngest populations, the 25 to 30 year olds and the saw tooth rates of the senior population. These rates were constrained to more closely approximate the adjusted 2020 age distribution as the starting point for the projections.

Figure SEQ Figure 1* ARABIC 4



As with the fertility assumption, the Crude Migration Rates, shown in Table 3, for the 2010 to 2015 and 2015 to 2020 periods are calibrated to reflect the net migration implied by the Census Bureau current population estimates and new 2020 Census total population for Southborough.

Table 3: Projected Crude Migration Rate by Sex

Town of Southborough	Projected Crude Migration Rate					
	2010-15	2015-20	2020-25	2025-30	2030-35	2035-40
Males	3.50	3.22	3.40	3.40	3.40	3.40
Females	3.50	3.22	3.40	3.40	3.40	3.40

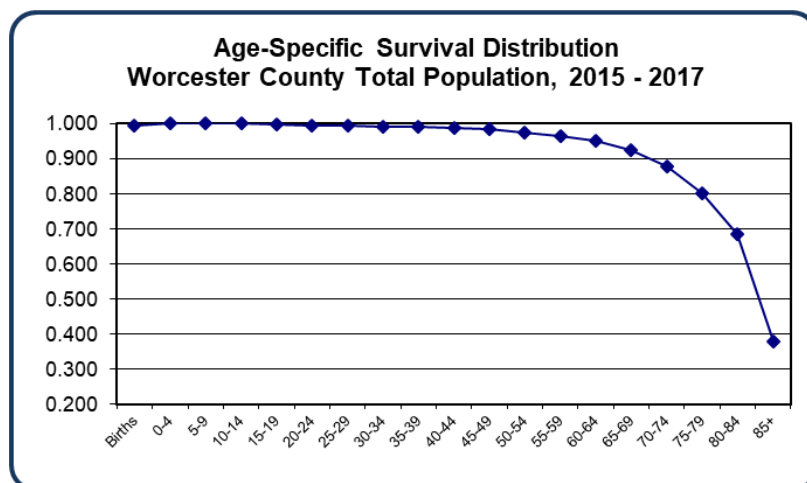
Mortality Analysis

Mortality is the least volatile of the three components of change – fertility, migration and mortality. As noted earlier, the population is aged by applying age and gender specific survivorship ratios for a five-year period to the base population by five-year age group. The model allows for area specific assumptions regarding the change in survivorship however, in the younger age groups most critical for school enrollment projections, there is little variation in survivorship at the county or state level. Computation of the life table and survivorship ratios for Southborough is not possible due to the population size of Southborough. The survivorship ratios for Worcester County are used in the model and assumed to remain constant throughout the projection interval. While continued increase in life expectancy is likely, the Social Security Administration latest life table projections show the greatest increases in the population age 65 and over – which will not impact projections of the younger population. ² Here again, it is important to note that these rates DO NOT incorporate any impacts brought on by the COVID-19 pandemic.

Worcester County data on deaths by age for the three-year period 2015 to 2017 were used to construct the county specific life table. Figure 5 illustrates the age-specific survival rate distribution and clearly shows the high level of survivorship in the younger ages – those most critical for the projection of women of childbearing age.

² U.S. Social Security Administration, Office of the Actuary, Actuarial Study No. 12. https://www.ssa.gov/oact/NOTES/as120/LifeTables_Body.html#wp1169453

Figure SEQ Figure * ARABIC 5



Sources of Data

- Massachusetts Department of Public Health, Division of Health Statistics
- U.S. Census Bureau
 - 2000 Census of Population, Summary File 1, Population by Sex and Age
 - 2010 Census of Population, Summary File 1, Population by Sex and Age
 - 2020 Census of Population, Public Law 94-171 Redistricting data file
 - Intercensal Estimates of the Resident Population by Five-Year Age Groups, Sex, Race, and Hispanic Origin: April 1, 2010 to July 1, 2019
- U.S. Department of Health and Human Services, Centers for Disease Control, National Center for Health Statistics
- U.S. Social Security Administration, “Life Tables for the United States Social Security Area, 1900-2100”, Actuarial Study No. 120.

Demographic Projections Summary

- The population of the Town of Southborough and the Southborough Public School district is projected to reach be 11,131 by the year 2030. This projection represents an increase of nearly 681 or more than 6.5 percent from the 2020 Census population of 10,450.
- The absolute number of births is projected to increase throughout the projections period from 364 in the 2015 to 2020 period to 497 in the 2020 to 2025 period and again to 620 between 2025 and 2030. This increase results from population growth in the

number of women between the ages of 30 and 44 even with the relatively stable total female population age 15 to 49 and continued low fertility rates by age of mother.

- The number of deaths will increase from 423 in the 2015 to 2020 period to 629 in the 2025 to 2030 period due to the aging of the Baby Boom generation.
- Southborough is projected to experience natural decline (an excess of deaths over births) throughout the 2020 to 2030 period due the aging of the Baby Boom generation.
- During the 2010 to 2020 period, based on the projections model and the 2020 Census results, Southborough is estimated to have a net in-migration of 340 between 2010 and 2015 and declining to 317 by 2020. For the remainder of the projection period net in-migration is projected to increase slightly to 361 for the 2020 to 2025 period and remain stable at 361 for the 2025 to 2030 period.
- Women of childbearing age, ages 15 to 49, are projected to decline slightly to 1,664 in 2025 and then increase to 1,756 by the year 2030. However, it is the distribution of older women within that larger age category that accounts for the most births.

Table 4: Population Projection Summary

	2010	2015	2020	2025	2030
Total Population	9,767	10,192	10,450	10,779	11,131
Population Change	X	425	258	329	352
Total 5-year Births	X	409	364	497	620
Total 5-year Deaths	X	324	423	529	629
Natural Increase	X	85	-59	-32	-9
Net Migration	X	340	317	361	361
Female Population	4,931	5,119	5,230	5,369	5,519
Females Age 15 to 49	2,100	1,948	1,744	1,664	1,756

School Enrollment Grade Progression Ratio Projections

Historical enrollment

Analysis of the historical trends in enrollment are important to understanding the overall district trends but standard projection methods typically rely on the most current three or five year trend to determine grade progression. This is most important for projecting the short-term projections but must be viewed within the historical perspective. Table 5 presents historical and current enrollment for the Southborough Public School district.

Table 5: Historical Enrollment by Grade

	F-2014	F-2015	F-2016	F-2017	F-2018	F-2019	F-2020	F-2021
Total (K-8)	1,291	1,268	1,257	1,235	1,191	1,200	1,135	1,152
Total (1-8)	1,172	1,140	1,138	1,105	1,080	1,060	1,031	1,035
Kindergarten	119	128	119	130	111	140	104	117
Grade 1	107	121	136	120	133	117	143	116
Grade 2	126	110	127	138	124	138	120	146
Grade 3	152	131	118	128	134	120	134	127
Grade 4	128	159	137	121	129	135	123	137
Grade 5	166	138	161	137	129	133	129	123
Grade 6	152	161	143	159	136	129	132	128
Grade 7	160	156	157	146	152	135	123	129
Grade 8	181	164	159	156	143	153	127	129
K minus G8	-62	-36	-40	-26	-32	-13	-23	-12

Total enrollment K-8 has shown a continuous slight decline each year between Fall 2014 and Fall 2018. There was a slight increase in 2019 followed by a large decline in Fall 2020. However, this past year decrease should be viewed with caution because of the impacts of the nationwide COVID-19 pandemic. Southborough’s experience is not unlike many schools where students are attending from home, parents are taking on home schooling of their children or may have moved children into private school settings. Enrollment has seen a slight increase in Fall 2021 which is likely a modest return to in-school attendance.

The overall enrollment increase between Fall 2018 and 2019 is primarily a result of increased kindergarten enrollment where the count of students increased from 111 to 140. All of that increase was lost in Fall 2020, dropping back to 104 due to the pandemic. Overall, the decline in enrollment can be attributed to a greater number of graduating 8th graders in comparison to a smaller number of entering kindergartners. That difference was greater in the early years shown and has lessened as smaller cohorts of students (due to declining births) have reached the older grades and exited. If a stable number of births were to continue into the future, enrollment would stabilize except for the impact of external factors like migration and shifts between public versus private or home schooling.

Grade Progression Ratio Methodology

The highlighted progression of enrollment of the Fall 2014 grade 1 students in Table 5 through their grade 8 enrollment illustrates the basic calculation of grade progression. The Grade Progression Ratio method is used to project enrollment by most schools nationwide. The current student distribution by grade is a good indicator of what the following year enrollment will be in each successive grade as students transition from one grade to another. It is a simple calculation which divides the number of students in a grade by the number of students from the previous grade in the previous school year. A ratio greater than one means there are more students entering school that year than those enrolled in the previous grade. A ratio that is less than one means there are fewer students enrolled than in the previous grade.

This simple calculation actually reflects change resulting from a variety of processes. If the ratio is greater than one, students may have entered through:

- in-migration of their parents,
- movement from other schools,
- movement from private to public schools,
- housing growth attracting new families.

The opposite would be examples of how the ratio could be less than one:

- out-migration of parents,
- students being home schooled
- movement from public to private schools
- demolition or conversion of residential housing to commercial uses.

Because grade-specific transition ratios may vary considerably from one year to the next, projections typically use a three or five year average experience to project future school enrollment. Table 6 presents the grade progression ratios for Southborough by grade and the three-year average using enrollment for Fall 2019, 2020 and 2021. It is important to note that the kindergarten to grade 1 ratio is over 1.000 and ranges from 1.080 in Fall 2017 to 1.115 in Fall 2021. This is an indicator that more students are enrolled in grade 1 than would be expected based on their enrollment in kindergarten. The higher ratio in Fall 2021 is likely the return to in-class schooling as the pandemic eased. The birth to kindergarten ratio is considerably higher, indicating in-migration of student's families.

Table 6: Grade Progression Ratios by Grade

	F-2015	F-2016	F-2017	F-2018	F-2019	F-2020	F-2021	3-Year Average
Births to Kindergarten	1.347	1.566	1.912	1.220	1.772	1.106	1.136	1.338
Kindergarten to Grade 1	1.017	1.063	1.008	1.023	1.054	1.021	1.115	1.064

Grade 1 to Grade 2	1.028	1.050	1.015	1.033	1.038	1.026	1.021	1.028
Grade 2 to Grade 3	1.040	1.073	1.008	0.971	0.968	0.971	1.058	0.999
Grade 3 to Grade 4	1.046	1.046	1.025	1.008	1.007	1.025	1.022	1.018
Grade 4 to Grade 5	1.078	1.013	1.000	1.066	1.031	0.956	1.000	0.996
Grade 5 to Grade 6	0.970	1.036	0.988	0.993	1.000	0.992	0.992	0.995
Grade 6 to Grade 7	1.026	0.975	1.021	0.956	0.993	0.953	0.977	0.974
Grade 7 to Grade 8	1.025	1.019	0.994	0.979	1.007	0.941	1.049	0.999

Historical and Projected Births

Future students entering the school in kindergarten are based on the number of births occurring five years earlier. Historical birth data for Southborough comes from the Massachusetts Department of Public Health. The most current data from the Department of Public Health is through calendar year 2020. Projected annual births are generated by the Cohort-Component projection method as discussed earlier.

The Cohort-Component projection model is based on five-year periods of time and five-year age cohorts, therefore the resulting number of births represents the total for each five year period. Annual births are required for the enrollment projections and this necessitates the use of a method of interpolation to split the five-year births into annual births. There are a variety of methods for accomplishing this from simple linear interpolation (the assumption that births occur uniformly throughout the five-year period) to the use of multipliers which take account of the previous and subsequent five-year periods. The simple linear method would divide the five year data by 5 to obtain annual births. The method used here is known as the Karup-King interpolation formula.³ For example, in order to determine the annual births between 2025 and 2030, the interpolation uses five-year births for the period 2020 to 2025, 2025 to 2030 and 2030 to 2035. Figure 4 illustrates the relationship between the projected five-year total births between 2020 and 2035 and the resulting estimated annual births for the period 2025 through 2029.

³ Shyrock, H., Siegel, J. and Associates, U.S. Bureau of the Census, "Methods and Materials of Demography", U.S. Government Printing Office, Washington, DC, 1971, p. 688.

Figure 4: Estimated Annual Birth Example

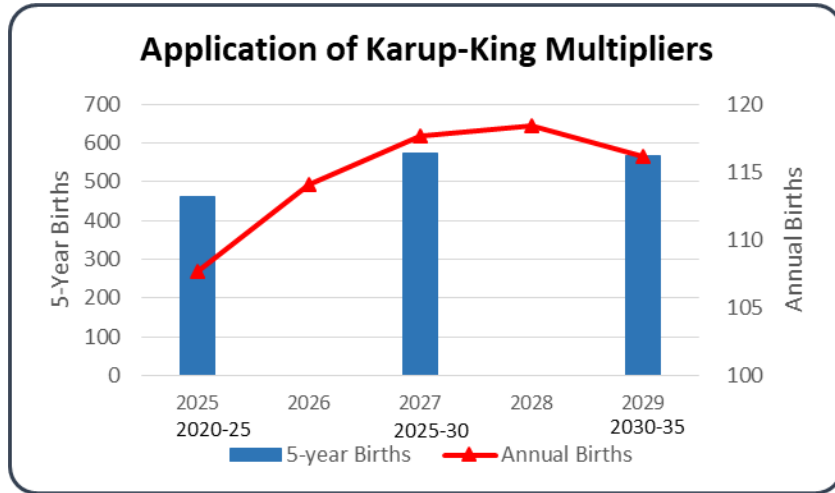


Table 7 presents the current (2010 through 2020) and projected (2021 through 2025) annual birth trend. In order to determine the projected kindergarten enrollment in Fall of 2031, it is necessary to carry the Karup-King method through the 2030 to 2035 period in order to estimate the annual 2025 births. Births in 2025 become kindergarten students five years later.

Table 7: Current and Projected Annual Births

Birth Year	2010	2011	2012	2013	2014	2015	2016	2017
School Year	F-2016	F-2017	F-2018	F-2019	F-2020	F-2021	F-2022	F-2023
Total Births	95	76	68	91	79	94	103	76
Birth Year	2018	2019	2020	2021	2022	2023	2024	2025
School Year	F-2024	F-2025	F-2026	F-2027	F-2028	F-2029	F-2030	F-2031
Total Births	84	98	76	94	100	105	109	116

Southborough K-8 Enrollment Projections

Table 8 presents the kindergarten to grade 8 enrollment history and projections for the Southborough Public School District. The projections are the result of applying the 3-year average grade progression ratios to the current enrollment and applying the birth to kindergarten ratio to the projected births.

Table 8: Current and Projected Enrollment - Southborough School District

	F-2015	F-2016	F-2017	F-2018	F-2019	F-2020	F-2021	F-2022	F-2023	F-2024	F-2025	F-2026	F-2027	F-2028	F-2029	F-2030
Total K to 8	1,268	1,257	1,235	1,191	1,200	1,135	1,152	1,133	1,124	1,138	1,130	1,131	1,149	1,156	1,196	1,237
Total K to G1	1,140	1,138	1,105	1,080	1,060	1,031	1,035	1,031	1,012	1,007	1,028	1,005	1,015	1,016	1,050	1,082
Kindergarten	128	119	130	111	140	104	117	102	112	131	102	126	134	141	146	155
Grade 1	121	136	120	133	117	143	116	124	108	120	139	108	134	142	149	155
Grade 2	110	127	138	124	138	120	146	119	128	111	123	143	111	138	146	154
Grade 3	131	118	128	134	120	134	127	146	119	128	111	123	143	111	137	146
Grade 4	159	137	121	129	135	123	137	129	149	121	130	113	125	146	113	140
Grade 5	138	161	137	129	133	129	123	136	129	148	121	130	113	124	145	113
Grade 6	161	143	159	136	129	132	128	122	136	128	147	120	129	112	124	144
Grade 7	156	157	146	152	135	123	129	125	119	132	125	143	117	126	109	121
Grade 8	164	159	156	143	153	127	129	129	125	119	132	125	143	117	125	109

Impact of Fertility and Migration Changes on Population and Enrollment

Projections are nothing more than the mathematical result of a set of assumptions about the future course of population change. As described earlier, the projection of the number future births is based on the timing of fertility illustrated by the age-specific pattern and the Total Fertility Rate (TFR) which defines that level of fertility. The age pattern and Total Fertility Rate used in the current projections is based on historical analysis of reported birth data and assumptions about the future change in the TFR.

Those assumptions may, or may not, be born out in the future and the impact of the COVID-19 pandemic is still an unknown factor. Because of this, the District is interested in understanding the potential impact of an increase or decrease in the fertility levels and hence, the number of births and long-term impact on enrollment.

Table 9 presents the results of a 10 percent increase in both the Total Fertility Rate and Crude Migration Rate. This results in a population that is 184 higher in 2030 than the original projection. The cumulative number of births through the entire projection period would increase from 1,890 to 2,003 or 6.0 percent.

Table 9

	2010	2015	2020	2025	2030
Total Population	9,767	10,192	10,458	10,862	11,315
Population Change	x	425	266	404	453
Total 5-year Births	x	409	364	547	683
Total 5-year Deaths	x	324	423	529	629
Natural Increase	x	85	-59	18	54
Net Migration	x	340	326	390	397
Female Population	4,931	5,119	5,230	5,410	5,611
Females Age 15 to 49	2,100	1,948	1,744	1,664	1,757

Table 10 presents the same summary showing the effect of a 10 percent decrease in the TFR and CMR throughout the period. In this case, the cumulative number of births would decline from 1,800 to 1,778 or 5.9 percent.

Table 10

	2010	2015	2020	2025	2030
Total Population	9,767	10,192	10,458	10,696	10,946
Population Change	x	425	266	238	250
Total 5-year Births	x	409	364	447	558
Total 5-year Deaths	x	324	423	529	627
Natural Increase	x	85	-59	-82	-69
Net Migration	x	340	326	317	321
Female Population	4,931	5,119	5,230	5,327	5,429
Females Age 15 to 49	2,100	1,948	1,744	1,662	1,756

The enrollment projections are based on the actual reported births in Southborough through preliminary 2020 data. Births are expected to enter Kindergarten at age five so the changes in fertility assumptions don't impact K-8 enrollment until the Fall of 2026 and Fall of 2027 for Grade 1-8.

Assuming a 10 percent decline in the TFR and CMR throughout the projections period results in a total enrollment decrease of 77 students by the Fall 2030 school year to 1,165. At the higher end of the range, an increase of 10 percent results in a total increase of 79 students. Because births won't affect enrollment until the later years of the projection period, Table 11 shows that most grade level enrollments are not projected to change and the greatest impact occurs in the younger grades.

Table 11

	10 Percent Decrease in TFR and CMR					Original Fertility/Migration Assumption					10 Percent Increase in TFR and CMR				
	F-2026	F-2027	F-2028	F-2029	F-2030	F-2026	F-2027	F-2028	F-2029	F-2030	F-2026	F-2027	F-2028	F-2029	F-2030
Total K to G8	1,119	1,122	1,112	1,136	1,160	1,131	1,149	1,156	1,196	1,237	1,144	1,176	1,200	1,256	1,315
Total G1 to G8	1,005	1,003	988	1,004	1,020	1,005	1,015	1,016	1,050	1,082	1,005	1,029	1,045	1,095	1,144
Kindergarten	114	119	125	131	141	126	134	141	146	155	138	148	155	161	171
Grade 1	108	121	127	133	140	108	134	142	149	155	108	147	157	165	172
Grade 2	143	111	125	130	136	143	111	138	146	154	143	111	151	161	170
Grade 3	123	143	111	125	130	123	143	111	137	146	123	143	111	151	161
Grade 4	113	125	146	113	127	113	125	146	113	140	113	125	146	113	154
Grade 5	130	113	124	145	113	130	113	124	145	113	130	113	124	145	113
Grade 6	120	129	112	124	144	120	129	112	124	144	120	129	112	124	144
Grade 7	143	117	126	109	121	143	117	126	109	121	143	117	126	109	121
Grade 8	125	143	117	125	109	125	143	117	125	109	125	143	117	125	109

Glossary

Age-Specific Fertility Rate – The Age-Specific Fertility Rate is calculated as the number of births by age of mother divided by the number of women of the same age. For example, births to women age 25 to 29 divided by the number of women age 25 to 29. It is a more accurate representation of fertility than crude measures based on the total population or the population of all women. The Age-Specific Fertility Rate can be thought of as the “probability” of women of a certain age giving birth.

Age-specific Migration Rate – The Age-Specific Migration Rate is calculated as the number of net migrants during the migration period for a specific age category divided by the number of persons in that age category at the beginning of the migration period. For example, between 2010 and 2015, the number of net migrants age 30 to 34 is divided by the number of 30 to 34 persons in 2010.

Crude Migration Rate – The Crude Migration Rate is the total number of net migrations (the balance between in-migrants and out-migrants) divided by the total population at the beginning of the migration period. For example, when measuring migration between 2010 and 2015, the Crude Migration Rate is the number of net migrants during the period divided by the total population in 2010.

Grade Progression Ratio – The ratio of students in a current grade and school year to the students in the previous grade one year earlier. For example, 500 students enrolled in grade 3 in the Fall of 2019 divided by 450 students enrolled in grade 2 in the Fall of 2018 equals a grade progression ratio of 1.111.

Sex Ratio – The sex ratio is typically calculated as the ratio of males to females. Typically the sex ratio at birth is greater than 1.0 slightly favoring more male births than female births. By age 65, the sex ratio greatly favors women due to their greater longevity.

Total Fertility Rate – The Total Fertility Rate is the sum of age-specific fertility rates and represents the average completed fertility of women across all ages. A Total Fertility Rate of 2.1 represents the “replacement” level of fertility – that level which accounts for a woman replacing herself, her partner and accounting for childless women.

Survivorship Ratio – The survivorship ratio at any given age represents the probability that an individual age “x” will survive to age “x + n” where “n” is the number of years in the interval. For example, the probability that an individual at age 30 on the exact day of their birthday will survive five years to be age 35 on the exact day of their birthday.