Demographic School Analysis: Population Projections for the Avonworth School District

The present analysis will consist of four parts: (1) an initial analysis of demographic and economic processes impacting student enrollments, (2) the ten-year projections of students by grade and level and a summary of each.

To arrive at these projections, we take an in-depth look at shifts in births, levels of in-migration and rate of new housing construction. We examine the changes that have occurred, including whether there have been shifts in the last decade or longer, and for births, in particular, we probe into the processes and structures underlying these shifts, also revealing likely directions in the future. Migration is shown to be quite important. We examine net-migration of *i)* families with preschool children, *ii)* students at each educational level and *iii)* the reproductive age female population by age-cohort. We also look at the rate of new housing construction. And, finally, we briefly look at the enrollment in alternative schooling. A brief overview of the initial analysis is given below.

I. An initial analysis with four overall themes—

(1) Births

(i) We find a general stability in the number of births per 5-year period—at around 120/year--from1990-94 through 2005-09, with one exception—1995-99 when births dropped to just over 100/year. Then from 2010 to 2017 births increased to around 145/year—their current level. A key question is the following: "Should we expect the number of births to remain at the current level or to continue to increase or turnaround and decrease, as in 1995-99?" We expect births to continue at the current level, or higher but consider alternatives—both up and down, tied to (1) the replacement of the baby bust cohorts by the Echo boom cohorts and (2) the on-going expected rate of new housing construction.

(ii) One basis for shifts in the number of expected births is the fundamental large shifts in the primary reproductive age-cohorts in the United States, in Pennsylvania, in Allegheny County and, indeed, in the Avonworth School District—which we will show. We label these shifts or population waves as the Baby Boom, the baby bust and the Echo Boom (Millennials). These population waves are particularly important given the relative constant fertility rates over the last 45 years for white non-Hispanic women in the United States, which we will also show. Not to be confused with this stability, however, is the timing of births over the life cycle—particularly a delay in childbearing, for which we also find evidence. The percent of births in the

district before/after age 30 has shifted from 48%/52% in 1990-94 to 34%/66% in 2010-14.

(2) Net Migration

A 2nd fundamental population process is also in play—net migration into and out of the school district. These processes can be observed at multiple levels: preschool children, students in K to Grade 12 and in the reproductive age female adult residents as follows:
(i) In the last three 5-year periods for which data is available, 1995-99, 2005-09 and 2010-14, there has been a net inflow of preschoolers and their families moving into the district. The average net migration for ages 0-4 has been stable at 11 preschool children in both 2005-09 and 2010-14; in short, this is a net increase of 11 preschool children per year and perhaps, as might be expected, is basically all in Ohio Township—where the preponderance of new home construction is occurring.
(ii) In terms of the net migration of Avonworth School District students, we have developed a method to deduce such flows from time-series enrollment data. Initially assuming no migration, we calculate the difference between the exiting senior class in high school in the spring and the subsequent entering Kindergarten class in the fall—which we call the exit-entry exchange (E3). Then, algebraically, when we subtract the actual student enrollment change, we obtain the net migration (NM). Phrased differently, the 2 processes—E3 and NM, when added together equal the enrollment change per year. For instance, without migration, in the last 5 years the total district enrollment would have increased by 204 students. However, the net in-migration of 48 students increased the actual total enrollment by 252 students, an additional increase of almost 20%.
(iii) We can also deduce the net migration of 5-year age-cohorts in the overall population of school district female residents. This is important in muting or reinforcing the effects of the population waves. Generally, we observe net out-migration in the 15-19 age cohort, as well as both age cohorts in their 20's (20-24 and 25-29); we also generally find net in-migration in the age cohorts in their 30's (30-24 and 35-39) and 40-44. In Avonworth, the most notable exception is the net in-migration by the 25-29 age-cohort, a key cohort for number of births.

(3) Housing

Considerable new housing has been built in the school district in Ohio Township over the last 9 years, 2010- 2018[11], with a total of 830 new homes. Eighty per cent of these were Single Family Dwellings (SFDs). However, in Avonworth, it is not total new homes that is most relevant, but the number that are ***not*** in developments for residents age 55 and over, notably the

[11] We are using new home building permits as our count for new homes and 2018 includes 2018 permits through November.

Traditions of America (TOA) housing, for which we do not expect additional students. There has still been considerable new housing, excluding TOA homes—482 total new homes and 390 SFDs. This is an average of 43 SFDs/year and 54 new homes/year. Over the last 5-10 years, there has been 1 new home built in Emsworth, 1 expected in 2019 in BenAvon and none in BenAvon Heights. In Kilbuck there have been 17 TOA new homes and “a handful” of non-TOA homes. Unless total non-TOA new home construction surpasses the 50 or so baseline per year for new homes built over the past 9 years, we do not expect an additional direct housing impact. The baseline is basically accounted for in the retention ratios and Birth→K ratio since they have growth embedded in them—whether from new homes or students moving into existing homes

(4) Alternate Schooling

Lastly, we will examine students residing in the school district who are enrolled in charter/cyber charter schools or are enrolled in private/parochial schools. There is no data available for students residing in the district who are home schooled. Charter/Cyber Charter student enrollment has decreased from 47 in 2010 to 39 in 2018 (-17%) and has basically oscillated between 30 and 39 students from 2011 to 2018. Private/Parochial student enrollment has been in the 200 to 224 level from 2010 to 2018 with the exceptions of 2013 and 2014 where is was 169 and 240 respectively. A breakdown by educational level, on the other hand, shows a notable decrease in students at the primary level (-19; -35%), somewhat balanced at the high school level by an increase of 27 students (+43%). Overall, enrollment in alternative schooling seems rather stable or slightly declining, while that of the Avonworth School District is increasing.

The assessment of the above set of changes and processes is important in determining the nature of demographic modeling to use, in the selection of parameters for such models and in the interpretation of the underlying processes and the results.

II. Development and analysis of grade specific school district projections for the ten-year period, 2019-2028 (5 Scenarios).

All five of the projection scenarios use the most current four-year retention ratios. Four of the projections use the most current 4-year Birth to Kindergarten ratio; the other projection uses oscillating B→K ratios. Retention ratios in these scenarios have a baseline level of “growth” embedded in them, indirectly taking into account new housing, as well as any other basis for new student inflows into the school district. We will consider maintaining the current level of births, as well as one scenario with increased births and one scenario with decreased births. We will also consider the impact of a small inflow of pre-K children moving into the district.

III. Summary

We will provide a summary of the basic findings, including the most likely student projection scenarios.

I. Initial Analysis

Four (4) major demographic and economic processes are examined with respect to projecting the expected shifts in student population in the Avonworth School District (SD) over the next ten (10) years. The first major factor is the expected number of births per year—currently at about 146/year. We expect that this level or higher will hold for the remainder of the decade. This assumption is based on our analysis of the shifting age structure for key reproductive age females; this will affect entering cohorts at the Kindergarten level, affecting their current trajectory. The second major factor is the additional number of preschoolers moving into the district, in addition to children who have been born there—equivalent to an increase in births of 11 per year. A third factor affecting the student population may be seen if we momentarily assume that migration is zero. In this case, any change in the student enrollment is due to the replacement of students who exit, by the students who enter—which we refer to in this analysis as the Exit-Entry Exchange (EEE or E3). This process, in conjunction with the net-migration of students, accounts for any changes in student enrollment. The fourth factor--potentially affecting the in-migration of families with school age children—is new housing construction. The level of housing development has been considerable over the last nine years, in which there were 830 new housing units built; of these, 80% were SFDs. However, almost 350 of the total new homes were in housing plans for age 55 or older residents, reducing the potential number of new homes built for residents with children to 482 during this most recent 9 years—2010 to 2018. The continuation of such new housing construction, even at the same rate—about 50/year remains important, however in another respect--in attracting families with preschool children. That is, even with lags between residency and enrollment in Kindergarten or Grade 1, the arrival of families with preschool children has yet to conclude in terms of additional students.

The analysis to follow, preceding the student population projections, is important both in terms of determining the nature of the demographic modeling to use and in the selection of parameters for such models. The analysis is also important in the interpretation of the underlying processes involved in the derived projected enrollment. We begin by taking an in-depth look at the demographic side of the process—fertility and migration.

Fertility

A Continuation of the Current Number of Births—the Highest in Almost 3 Decades?

Table 1 provides the number of births by year, per municipality and the total births over the last twenty-eight years. As shown in the lowest quadrant, per 5-year period, the initial level of births was almost 120/year, followed by a decrease of almost 20 births per year, to about 100/year; then for a decade, 2000-2009, the number of births returned to the 120 level per year. Most recently, 2010- 2017, births have changed course and increased by about 25/year—to 145/year.

Focusing on the number of births per 5-year period, shown in the 2nd quadrant from the bottom of Table 1, in 1990-94 there were almost 600 births, followed in 1995-99 by just over 500 births. In contrast, over the next 5 years, 2000-04, births once again returned to the 600 5-year level, and remained at about 600 for an additional 5 years, 2005-09. Then in 2010 and thereafter, births jumped by over 100, to over 700 births per 5-year period, remaining at this level for the last 8 years, 2010 to 2017.

At issue now is what level of births should we expect In the future. "Should we expect the number of births to remain at the current level or to begin to increase or even to decrease?" Births have plateaued before and then dropped. What is different now? Are the forces driving their direction still in play or are we about to see key changes in how these forces operate? In contrast to a black box answer, attempting to extrapolate 2 or more points into a linear slope, here we will take into account the **major shifts in the population age structure or population waves,** as well as **delayed child bearing**—with an increasing proportion of births in the 30's. The normal delay in childbearing is initially into the early 30's and then into the late 30's and early 40's.This 2-phase shift is a rather significant behavioral change. On the other hand, *the population waves that are moving through the age structure are quite pronounced* and are fundamental to a more thorough understanding of why births dropped in 1995-99 and then turned around to the prior level, followed by a substantial increase. One of the main factors in the last 20 years has been the replacement of Baby Boom age-cohorts by smaller "baby bust" age-cohorts in their twenties and subsequently in their thirties—both being key reproductive age-cohorts responsible for most of the births in the United States. Thus, we will look more closely at the shifts in the number of births and the processes underlying these shifts.

<u>Relative Impact of the Different Age-cohorts: Delayed Childbearing</u>

Table 2 provides the births by age-cohort of mother over the last 27 years for the entire school district and reveals part of the nature of the shift in births—delayed childbearing. Note that the "Total Birth" column (Σ) is the same as in Table 1. Table 2 now provides the ***number of births per age-cohort*** for 27 years. Here our initial concern is to address the relative impact of the different age-cohorts. At the top of Table 2, in the early 1990s, one can see the relative dominance, In terms of the number of births, of two age-cohorts, 25-29 and 30-34 (See the % of ∑ row.) The remaining ordering is then as follows: the 35-39 age-cohort, the 20-24 age-cohort, the 15-19 age-cohort and the 40-44 age-cohort. By 1995-99, the shift to births in the early 30s was clear. The drop in relative share (%) for all cohorts less than age 30 was as follows: age 25-29 -6% (33%→27%), age 20-24 -4% (12%→8%) and 15-19 -2% (3%→1%). In contrast, the 30+ age cohorts all increased their relative share or stayed the same: age 30-34 +8% (34%→42%), age 35-39 +4% (16%→20%), and age 40-44 0% (2%→2%). Overall, the before/after age 30 changed from 48%/52% in 1990 to 36%/64%

in 1995-99. This proportional share basically held for the next 15 years—2000-04, 2005-09 and 2010-14, with the 30+ share ranging from 64% to 67%. A possible further shift occurred in 2015-16 of 27%/73%. These shifts clearly depict a process of delayed childbearing. Does a delay in childbearing also mean that there will be a decrease in the number of children per woman? We will address this question below.

<u>Total Fertility Rate</u>[21]

We will briefly take a look at the Total Fertility Rate (TFR) in the United States. We do so for two reasons. First, the shifts in these TFRs have been largely responsible for the oscillations in the population age structure or population waves that we noted above. Second, for white and, more recently for white, non-Hispanic women, the TFRs have been remarkably stable for the past 45 years. Such stability then enables one to focus on the shifts in the number of reproductive women by age to better understand the shifts in the number of births, and to potentially better incorporate such insights into forecasts of future births—at a minimum, in terms of direction, if not magnitude. The Total Fertility Rate for the United States from 1917 to 2016 is given in Table 3. The dark shaded years denote the Baby Boom (1946-1965) and the lighter shaded years denote the baby bust (1971 to 1980). In Table 3, we may observe that the peak of the Baby Boom occurred in 1957 with a TFR of 3.77 and that the trough of the baby bust occurred in

[21] The Total Fertility Rate (TFR) is the average expected total number of children that a woman will have under the current age-specific fertility rates.

1976 with a TFR of 1.74. We may also note from Table 3 that the TFR of 1.74 is the lowest TFR between 1917 and 2016, including the TFRs of the Great Depression. Similarly, the highest TFR between 1917 and 2016 is the TFR of 3.77. Hence, these fertility measures denote the two most distinct fertility points of the past century. Additionally, they are embedded in the most distinct streams of fertility surrounding them, with an entire set of years of relative high fertility and relative low fertility. It is these pivotal streams that are impacting school enrollments nationally, as well as in Pennsylvania, and certainly Allegheny County today, half a century away. As noted above, they will continue to do so, as well, into the future.

In 2010, the population of the Avonworth SD had the following racial distribution: White—94%, Black—3%, Asian—2% and 2+races—1%. The respective TFRs in 2010 were 1.9, 2.0, and 1.7 for white, black and Asian women in the US. If, however, we remove the Hispanic part of the white 1.9 TFR, it is 1.8. Table 4 provides the TFRs for white and white, non-Hispanic females from 1970 to 2016. One of the most striking aspects of these data is the range of the TFRs from 1972 to 2016 for the white, and where it is possible to discern, the white, non-Hispanic females***. For 45 years these TFRs have been in the 1.7 to 1.9 range, meaning that they are, in fact, very stable. In effect, we can treat them as constant.*** *Thus, we can now answer the question posed earlier as to delayed childbearing and the number of children per woman. More specifically, even with* **delayed childbearing***, the total number of children that a white non-Hispanic woman is expected to* *have is the same—only the age has shifted.* The delayed childbearing effect is a one- or two-wave impact and will not recur unless there is a return to more births at lower ages. Thus, once the delayed childbearing effect is complete, the main driver for the number of births, given the stability in the total fertility rates, will be the number of reproductive age women. This can change in two ways—(1) from large scale shifts in the reproductive population, as, for example, the Baby Boom and baby bust and (2) from net migration—in this case largely from new jobs, new housing or the relative attractiveness of the area, including the quality of the school district--in the case of in-migration, and the lack of jobs and/or quality of the schools, in the case of out- migration. It should be noted before continuing, that given the stability in the total fertility rate for whites, we may expect in both the short-term and the more long-term, future echo booms and echo busts, as the oscillation in the relative size of the birth cohorts already born dampens down. Certainly one of the mechanisms for change noted above is occurring in the Avonworth School District—shifts in the number of reproductive age females. Thus, we will now look more directly at the population waves, resulting from the TFRs shown in Table 3.

Relative Size of the Different Age-cohorts/Population Waves: Baby Boom, Baby Bust and the Echo Boom

A second story emerges beyond delayed childbearing if we take a closer look into the nature of the shifts in the number of births by age in Table 2. More specifically, can we identify the structures or processes underlying the shifts in the number of births in Table 2? To begin to do so, we need to take into account the number of reproductive age women in different age-cohorts, since the Baby Boom and baby bust periods have resulted in considerable oscillations in the number of women in the prime childbearing years. To reiterate, at the peak of the Baby Boom (1957) the Total Fertility Rate was 3.8, while at the trough of the baby bust (1976) it was 1.7, less than 1⁄2 that of the Baby Boom peak. Thus, the number of reproductive age females is much larger if they were born in the Baby Boom years and reciprocally, much smaller if they were born in the baby bust years. If fertility rates of these cohorts of women were the same over time, then the number of expected births would vary considerably, with more births to Baby Boom mothers and fewer births to baby bust mothers. This is at least part of explanation for the shifts in births over time, in terms of where in the age distribution to expect increases or decreases in births. It is also pertinent for expectations regarding future levels of births since we are currently beginning to see Echo Boom cohorts, which are larger than the baby bust cohorts, take center stage in the key reproductive ages. We will subsequently explore these points in more depth below.

Table 5 provides data for the United States, Pennsylvania and Allegheny County for 5-year cohorts from ages 0 to 44 and depicting the population waves. In the top panel of Table 5, t**he numbers in bold type indicate the Baby Boom** and the shaded numbers indicate the baby bust. We refer to a medium sized cohort born between the Baby Boom and the baby bust as the Transition cohort (1966—1970) and, in effect the leading edge of the baby bust. The Echo Boom cohorts immediately trail the baby bust cohorts and cover at least 2 decades, as did the Baby Boom. The data for Table 5 extend from 1990 to 2010. At all three levels—in the United States, Pennsylvania and Allegheny County, there are decreases in the 20-24, 25-29 and 30-34 female age-cohorts between 1990 and 2000 AND decreases in the 30-34, 35-39 and 40-44 age-cohorts between 2000 and 2010. (See the shaded age-cohorts in the Change by Age-cohort Across Time, the second panel—lower quadrant of Table 5). One has to think in terms of generational change, where the births of daughters in one generation become the mothers of the next generation—here daughters born in the Baby Boom now having children and similarly, daughters born in the baby bust now having children. Thus, the shifts in the 20-24, 25-29 and 30-34 age-cohorts of females in 1990-2000 represent a more tidal shift from the Baby Boom to the baby bust due to changes in fertility levels as noted earlier--from total fertility rates, where on average, their mothers had 3.8 children in 1957 to 1.7 children in 1976. The low fertility rates in the 1970s are referred to as the baby bust. To illustrate, there were 21.3 million children born between 1956 and 1960, at the height of the Baby Boom and 16.3 million births between 1971 and 1975 the onset of the baby bust, a decrease of 5.0 million births and a drop of 23%. Also, these same cohorts-–aged 10 years by 2010—and now 30-34, 35-39 and 40-44 are again experiencing decreases in the number of women. Equally important, in 1990, the four five-year Baby Boom cohorts (born in 1946-1965) occupied three of the key reproductive age-cohorts (25-29, 30-34 and 35-39, as well as the oldest reproductive cohort (40-44). In contrast, by 2000, the Baby Boom daughters occupied only the two older reproductive cohorts and the two five-year baby bust cohorts (born in 1971-1980) were beginning to take center stage, occupying both key twenty-year-old cohorts. (See the shaded age-cohorts in the upper panel of Table 5 to view their aging from the teens to the 20's to the 30's.) A third key reproductive cohort, age 30-34 in 2000, was held by the Transition cohort, which we have described as the leading edge of the baby bust or the 1st baby bust cohort. In 2000, three of the key reproductive age-cohorts (20-24, 25-29 and 30-34) were smaller than their predecessors in 1990, as clearly shown in the upper panel of Table 5. (Look to the left in the same row.) Look also in the lower panel where the size of the change across the decades is given, as well as the percentage change. From 1990 to 2000, the largest decrease was in the 25-29 age-cohort and between 2000 and 2010, the largest decrease was in the 35-39 age-cohort. In both cases, this is the 2nd baby bust cohort. By examining the shaded age-cohorts in the lower panel of Table 5, one can see that they travel in tandem and are decreasing in both decades at all levels—national, state and county. These cohorts are the two baby bust cohorts and the Transition cohort, the latter of which led the declines once the Baby Boom was over. If one looks at the size of the Echo Boom cohorts which follow the baby bust cohorts, they reverse the age-cohort declines and are increasing in both the United States and Pennsylvania in both decades for at least the 1st three Echo Boom cohorts. At the national level the increases range from 14% to 20% in 1990 to 2000 and from 9% to 14% in the 2nd decade, 2000 to 2010. The increases are generally more modest in Pennsylvania—from 4% to 14% in 1990-2000 and 6% to 16% in 2000-2010. In Allegheny County, the story is more mixed with increases in only the 2nd Echo Boom cohort between 1990 and 2000 and for the 1st and 2nd Echo Boom cohorts in 2000 to 2010.[31]

Since the age-cohorts that we have been discussing have a very clear time of birth identification, we can specify their location across time in 5-year sequences—including the future. We do this in Table 6, mapping the shifting of the key Baby Boom, baby bust and Echo Boom cohorts from 1990 to 2020 for 5-year periods from 1990 to 2020. The distinct cohorts include the 4 Baby Boom cohorts, the Transition cohort, the 2 baby bust cohorts and 3 Echo boom cohorts. In 1990, the Baby Boom cohorts occupied all age bands 25 and older, including 3 key reproductive age-cohorts—25-29, 30-34 and 35-39. By 2000, we can see that the baby bust cohorts are in their 20's and occupy the 20-24 and 25-29 age bands. The Transition cohort also occupies the 30-34 age band. So, it follows that the baby bust cohorts will also occupy the 30-34 and 35-39 age bands in 2010, while the 1st two Echo Boom cohorts take over the two twenty age-cohorts. Currently (2015), Echo Boom cohorts occupy 3 key age bands—20-24, 25-29 and 30-34.

The two most important features in Table 6, regarding the future, pertain to the replacement of the baby bust cohorts by the Echo Boom

[3] [1] The smaller the geographical unit being examined, the greater the potential impact of migration.

cohorts in 3 of the 4 key reproductive cohorts by 2015 and the continuation of the Echo boom cohorts in the key reproductive ages beyond 2020 as well. With multiple Echo Boom cohorts moving into all key reproductive ages, the bottom line is that births should increase. This would involve Echo Boomers both moving up (in age) and moving in (the 2000→2010 analog). These Echo Boomers will be replacing the baby bust cohorts as this oscillatory process continues well into the 21st century. And, these shifts in demographic age structure are part of a national, as well as a regional and local, set of shifts tied to at least one familiar term—Baby Boom—and now, by two less familiar terms—baby bust and Echo Boom (Millennials). All municipalities and schools in the United States are embedded in these demographic processes. The distinctions revolve around the extent to which migration modifies these basic population distributions at the particular geographical level.

Table 7 provides the data for the female population in Avonworth SD by 5-year age cohort for ages 15 to 44. The years pertain to 2000, 2010 and 2015. In 1990 the US Census does not have 5-year cohort data for 4 of the 5 municipalities comprising the school district, since their total populations were below 2,500. Only Emsworth Borough had a population greater than 2,500. Nevertheless, the population waves in Avonworth are quite apparent. In 2000, the Baby Boom cohorts, depicted in bold print are much larger than the baby bust cohorts (shaded). Moreover, the baby bust cohorts decrease in size the younger the cohort. This is not the case in 2010, where all 3 baby bust cohorts are about the same size, but it is strikingly so in 2015 when comparing the baby bust cohorts and the 1st Echo Boom cohort. Cohort replacements are seen if we compare the numbers in Table 7 across rows. For instance, the 3rd baby bust cohort in 2010 replaced the Transition Cohort (1st baby bust cohort) in 2000 at age 30-34. It was larger by 21 more women or 6%. ***This is a case where the 3rd baby bust cohort becomes larger than the cohort that it is replacing and therefore the direction flips and should have an increase in births. This outcome was produced by a rather massive net in-migration (+209, +124***%). See the 2 lower quadrants of Table 7 [brackets indicate net migration].

. To develop insight into the shifts in births in Table 2, we will use the lessons learned from Tables 5 and 6 to determine or infer whether births should go up or down for 1990-94 to 1995-99—that is based on the age cohorts and their position in the population waves during the change in 5-year periods. Stated differently, by comparing the new age cohort's expected size relative to that of the prior age cohort that is being replaced at a given age, we can then infer the expected direction—up or down—in expected births—for each cohort, compared to the observed shift in the number of births in Table 2. We will then use the 2000 and 2015 census data thereafter, acknowledging that 2005 is not observable—thus once again relying on the lessons from Tables 5 and 6 to make the inferences.

In sum, we expect that the Baby Boom cohorts entrance to an age cohort to yield increased births; for baby bust cohorts to show decreases in births and for Echo Boom cohorts to once again have increases in births. For instance, from Table 1 we saw births drop sharply from 1990-94 to 1995-99. We can now address why. In Table 2 births dropped in all 3 baby bust cohorts as they entered the 15-19, 20-24 and 25-29 age ranges. Or more succinctly stated, as the Avonwoorth baby bust cohorts entered their 20s, births decreased by 58 (-30%) in the 25-29 leading edge Transition cohort, by -32 (-46%) in the 20-24 2nd baby bust age cohort and by -13 (-68%) in the age 15-19, 3rd baby bust cohort; the total decrease for these three baby bust cohorts is 103 fewer births. Total births dropped by only 81 in 1995-99 due to the increased births by three Baby Boom cohorts (+22). The return of births to the 5-year 600 birth level in 2000 was largely due to the 3rd Baby Boom cohort, ages 35-39 with 51 additional births *and* also the TC and 2nd baby bust cohorts (+19 and +14, respectively), gains *not* in line with the expected relative number of women ages 25-29 and 30-34; we would have expected both to decrease. The implication is that net in-migration and possibly delayed childbearing for both baby bust cohorts changed the outcome.

In 2005-09, as the baby bust cohorts entered their 30s, births again decreased (-14 for the 30-34 age cohort and -19 for the 35-39 age cohort), as expected. Echo 1, the 1st Echo Boom cohort (20-24), in contrast, had an expected increase (+13). The outlier for this 5-year period is the 3rd baby bust cohort, age 25-29, with an increase of 20 births—once again suggesting net in-migration, increasing the number of women ages 25-29 living in the school district. Similarly, in 2010-14, as expected, we have decreased births (-7) for the leading edge of the baby bust cohorts (TC), but _not_ expected, a very large increase in births in the 3rd baby bust cohort (+85), ages 30-34. Increases of 17 additional births also occurred for the 25-29 1st Echo boom cohort, as expected, but there was a comparable 17 additional births in the 35-39 2nd baby bust cohort, _not_ expected. Overall, for the four key age cohorts (20-24, 25-28, 39-34 and 35-39) and the four 5-year periods in which the number of births could change (up or down), there are 16 cases. Eleven of the 16 cases (69%) "fit" the expectations based on population waves***. For births in 2010-14, Table 2 indicated an increase of 85 births from the 30-34 baby bust age cohort. The example above (p 16), given for Table 7 indicated that net in-migration was rather massive and that this 30-34 age-cohort was larger than the cohort that it replaced, thereby flipping the expected direction for births, from decreases to increases.*** This outcome increases the number of cases where the population wave or its modification via net in-migration, at least had the correct direction for shifts in births—now 12 of 16 cases or 75%.

As to the future, we have data in 2 tables to inform our expectations. Table 6 indicates that by 2015, 3 of the 4 key cohorts (29-24, 25-29 and 30-34) are occupied by Echo Boom cohorts. Daughters born in the baby bust occupied only 1 key cohort (35-39). Table 7 (bottom quadrant, right side) shows the relative size of the cohort replacements for 2015 in the Avonworth School District---ie observable data for the Table 6 age cohorts in 2015. The

1st Echo cohort (30-34) had a 24% increase in the number of women; the 2nd Echo cohort had a slight decrease (-4%), but is essentially stable and the 3rd Echo cohort (20-24) had a 19% increase in the number of women. In contrast to the 3rd baby bust cohort increase in 2000 to 2010, between 2010 and 2015 this cohort shows a decrease of 12%, somewhat dampening the expectations of birth increases, but not eliminating them. To date, births have remained at 146/yr. and no increase in births has been seen, despite the potential indicated in Table 7. We now turn to net migration to shed further insight.

Migration

Net Migration of Preschoolers

The 1st distinct view into net-migration provides additional insight into what to expect in Kindergarten enrollment in the next five years and possibly longer. By comparing the census count for children less than five years of age in year x to the births to school district residents in the prior five years (x-5 to x), we can ascertain the net-migration of families with preschoolers. Three sets of such data are shown in panels A, B and C of Table 8. In panel A of Table 8, we contrast the census count of children under age 5 in **2000** (column A) to the number of births for years 1995-99 (column B). The difference indicates the net-migration (column C) and column D gives the average number of new children per year of age (0-4). In 1995-99, there was a net in-migration of 37 preschoolers for an average of 7 new preschool children per year. In panel B, comparing births for 2005-09, and children under 5 in the census in **2010,** there is an uptick in net in-migration to 57 preschool children moving in, an average of 11 additional preschool children per year. Then in the most recent period of 2010-14 births and the **2015** census count, the number of preschool children *moving in* remained about the same--53 children, an average again of 11 new preschoolers per year. Just how important are such migration impacts?

The average number of births per year has increased over the last 25 years from an average around 120/yr. in 1990-94 to 146/yr. currently. If we now take 90% of the new in-migrating preschoolers as “expected” additional Kindergarten entries for 2019 and all years thereafter, then the net in-migration of 11 such preschoolers adds 10 to the potential K entrant class. From a longer time frame, incorporating the 1995-99 inflows averaging 7 preschoolers per year, the current inflow has increased by 4 additional students relative to the 25 additional births.

Net-Migration(NM) of Students

The Exit-Entry Exchange (E3) and Net-Migration (NM)

For a 2rd look at net-migration and more specifically the net migration of students from Kindergarten through Grade 12, we bring such migration into play alongside what we refer to as the Exit-Entry Exchange. The two processes jointly determine the student enrollment changes. We use an accounting system based on a hypothetical or counterfactual case. What we refer to here as “net migration” pertains to all entries and exits. Thus, we are using the term “migration” in a very restricted sense—migration into or out of the Avonworth School District student population. Actual migrants into the school from outside the school district—whether from other parts of Allegheny County or other parts of Pennsylvania, or other states, or even from overseas, are in the count, but not distinguished from one another. From the numerical enrollment data alone, we have no information on source of origin of the mover. The same holds for actual migration out of the school district—we do not know the destination. Additionally, we do not know the type of move if it is a local one. For example, a dropout at the high school level is certainly an exit and a second grader who did not attend the first grade in the Avonworth School District is an entrant. Both are counted as "migrating" out of or into the school. In short, "net migration," as used here refers to the difference of all exits and all entrants to the Avonworth School District. This "net migration" can be obtained using only enrollment data. Below, we will briefly describe the method.

Initially, we momentarily assume the counterfactual case of "What if no one migrated?" Then, the change in the student population (C) would be totally determined by the difference in the sizes of the Grade 12 graduates exiting at the end of year t-1 and the size of the entering Kindergarten class in year t. That is, C= [K_t - $G12_{t-1}$]. Second, we compute the actual change in overall enrollment, denoted by E, where E=(Total Enrollment in t) - (Total Enrollment in t-1). Now, denote "net migration" as F. Then, E=C+F or F=E-C. Table 9 provides these data and outcomes for the most recent decade in the Avonworth School District from 2009-2018. We will illustrate the process by describing a single year and then we will discuss the overall results. For 2017-18, 101 seniors from the 2017-18 school year exited (eg, graduated in the spring), while 166 new students entered Kindergarten the following fall (column A), a difference of 65 additional students. (Table 9, columns A and B and row t=2018-19; see footnote to the table.) Thus, with no migration, the student population would increase by 65 students. (Δ_1 , column C). The actual enrollment change was an increase of 111 students (Column E: the Δ_2 column is shown as the difference in the population at t minus the population at t-1). Therefore, "net-migration" here is positive (more entrants than exits), and is +46 (the Net Migration Column F, which is (E-C) or [111 – 65] =46. That is, 46 more students entered the school district, further increasing student enrollment from +65 without migration, to the actual increase of 111.

A summary of the net migration is given at the bottom of Table 9, with the 5-year changes in parentheses in the 10-year coverage. In the last 5 years, without migration, enrollment would have increased by just over 200 students (last row, column C, +204), but the actual increase was 252 (last row, column E) due to the net in-migration of 46 students (last row, column F). Migration was much less important in the prior five-year period, 2009-2013 (See the next to last row, columns C, E and F and the numbers in parentheses.). In this 5-year period, enrollment would have increased by 156 without the net out-migration of 14 students. Hence, enrollment actually increased by 142 students. Over the last 10 years (2009-2018), without migration, enrollment would have increased by 360 students (+26%); but with the net in-migration of 34 students (+2%), the actual enrollment increased by 394 students (+28%), from a total student enrollment of 1,403 in 2008 to one of 1,797 in 2018; 91% of this increase was E3 and only 9% NM. However, in the last 5 years the proportions were 81% (E3) and 19% (NM). This result is somewhat misleading due to the NM in 2017 showing up in 2018 enrollments. At issue is whether or not this higher level of net in-migration is a new normal or a one-year aberration. Either way, it is duly noted as potentially important. We will now look at these processes at each educational level.

Table 9A presents the results for the primary level, where one might expect much of the migration to occur. As shown in the last column, net in-migration for the most recent 5-year period was 19 students and in the prior 5 years, it was negative (-2), totaling only 17 new students over the decade. The growth of almost 100 primary students is largely due to E3 (82%), not NM (18%). years. For the primary enrollment being examined here, these results might be described as a case of low in-migration.

Table 9B provides the data for the elementary level (G3-G6), where NM is relatively large and roughly equal to E3. In the 1st 5 years, E3 yielded 41 additional students, while for NM it was 45 additional students, a 48%52% share, respectively. In the prior 5 years, E3 had 46 additional students to NM’s 36, a 56%/44% share. Overall, for the decade E3 yielded 87 more students and NM 81 new students, a 52%/48% share and a total of 168 additional students.

Table 9C gives the comparable data for the middle school. where NM is virtually nonexistent and E3 totals 48 students over the decade. E3 provides 82% of the growth in the 1st 5 years, increasing to 100% over the decade. We will abbreviate the discussion at the high school and provide the bottom line from Table 9D as follows:

	E3	NM	Enrollment Δ
2009-13	+98	-22	+76
2014-18	-+47	-42	+5
2009-18	+145	-64	+81

Like the primary and middle school levels, it is E3 that drives growth at the high school level, but unlike both the primary and middle school, NM at the high school substantially mutes the expected growth from E3, reducing it by over 40%.

A summary by educational level and time period by E3 and NM, as well as their combined effects is provided in Table 10. With the exception of the Elementary School, where E3 and NM are roughly equal, NM is basically quite low or negative and it is E3 that primarily accounted for the growth in student enrollment over the last decade—a 91%/9% relative share. District enrollment growth was substantial over the decade—almost 150 in the prior 5 years and just over 250 in the last 5 years for almost 400 additional students (394).

Retention Ratios and the Birth-to-Kindergarten Ratio

A 3rd look at net migration, as well as the process of grade progression, involves retention ratios. In this analysis, we will use retention ratios as a baseline for projecting the changes in student population. The annual "retention ratios" shown in Table 11 are averaged over four years to increase the reliability of the estimates. "Retention ratios" have an element of growth embedded in them since they may be above one (1.0). Thus, for instance in Table 11, nine of the twelve retention ratios are greater than or equal to 1.0. At Grades K→1,1→2, 2→3, 4→5 and 5→6, the retention ratios are 1.024,1.018,1.018, 1.019 and 1.021, respectively. Even for the 3 grades where the retention ratios are less than 1.0, they are essentially .99 or greater (.985, .986 and .994) and hence virtually 1.0. The largest two retention ratios are for K→Grade 1: 1.023, a 2% increase and G5→G6: 1.021, also a 2% increase. Retention ratios over 1.0 also capture part of the growth stemming from housing construction, as well as net in-migration into the district, but they do so indirectly. That is, these ratios are not true "retention/survival rates" of the students in the origin grade or they would necessarily be less than or equal to 1.0. Rather these ratios capture retention of current students, replacements for any students who leave (if ≥1.0) and in-migration of students whose families move into the district, whether into new or existing housing. While they do not directly relate the specific underlying processes affecting the students, they reflect such processes indirectly. Hence, we refer to those retention ratios as entailing "embedded growth."

Perhaps the most striking ratio is the Birth-to-Kindergarten (B→K) ratio, shown in the last row of Table 11. In 2002-05, the ratio is .938, in 2006-09 it is .957 and in 2010 the ratio is 1.099. The most current B→K ratio is 1.043. A ratio of 1.043 means that per 100 births, 5-6 years later K enrollment is expected to be 104. This is the B→K ratio that will be used in most of the student projections in Section II***. The 1.043 B→K ratio is a 4-year average***. When evaluating the stability of this ratio, we found considerable variation, ranging from .93 to 1.17, a span of .24. One of the student projections that we will consider includes an oscillatory B→K ratio, including a high ratio, then a low ratio, etc. Obviously, any ratio greater than 1.0 indicates the occurrence of net in-migration and specifies its magnitude. For instance, the K→G1 and G5→G6 ratios of 1.024 and 1.021 indicate that net in-migration adds 2% to the G1 and G6 enrollment. Also, net in-migration of preschoolers adds to the K enrollment—underscoring that it is not only births that is an important factor in future student enrollments, but it is net-migration of preschoolers and students elsewhere as well. Overall, in terms of both the accounting framework (E3 & NM) and the parametric framework of retention and Birth→K ratios, it seems reasonable to conclude that net in-migration of preschoolers and students are both important and relatively modest. What is not so readily grasped is that the B→K ratio and the subsequent retention ratios act, in effect, like compound interest, ratcheting up the effect at each grade or as each milestone is reached. How does one grasp the comparison of 2 ***sets*** of B→K and the subsequent retention ratios? For instance, how does one compare the relatively large B→K ratio of 1.099 in 2010-13 (column 4 of Table 1), along with the subsequent retention ratios, to that of 2014-18 (1.043) followed by its successive retention ratios? One might expect that the 1.043 B→K ratio and its subsequent retention ratios would be a decrease from the 1.099 B→K ratio and its subsequent retention ratios in 2010-13. Table 12 provides the ***cumulative*** B→K and subsequent retention ratios for all grades. We will refer to each set of ratios in Table 12 as Set #1 to Set #4, corresponding to columns 2-5 in Table 12. Even though Set #3 has a far higher B→K ratio at the onset, by Grade 1 Set #4 is already higher, a result of 1.043 x 1.024 = 1.068 versus 1.099 x .958 = 1.053. The most current ratios in Set #4 have the largest growth, peaking at 1.17 in Grade 7, followed by Set #3, peaking at 1.14, then Set #1 at 1.12 and Set #2 at 1.03. A ***cumulative*** set of ratios captures the continued rate of growth, even for small increments above 1.0. Interpreting Set #4, per 100 births, we would have 104 K students, then 107 students at G1, 109 by G2, 111 by G3, 112 by G4, 114 by G5 116 by G6 and 117 by G7, etc. These findings correspond to the growth experienced in the Avonworth School District over the last decade and indicate that such growth is not over. In fact, should births remain at the current level of 146/year and the ratios in Set #4 also hold, then one equilibrium result is that by 2028, student enrollment will be 2,111 an increase of 324 students.

Net Migration of Adults by Age-cohort in Conjunction with Cohort Replacement

The key idea in the deduction of the cohort replacement and net-migration streams, from a comparison of two population distributions over time, is the following: *I)* to make row comparisons for the cohort replacement outcomes (simply comparing the two distributions for each age-cohort at the two points in time) and *ii)* to view the rows diagonally holding constant the birth year for net migration. In the ***ages 0 to 50***, the changes in *ii)* are due almost entirely to net-migration, versus death. That is, for the initial (eg 2000) cohort ages x to x+5, ten years later it will be ages x+10 to x+15. If no one migrated or died, then the population would have the same number of people as in x to x+5—aging in place; if the numbers differ, then this is due to net-migration, with either additional gains or losses.[41]

In a prior section examining births, we looked in some depth at the cohort replacement process and particularly focused on the replacement of Baby Boom cohorts by baby bust cohorts and also the replacement of baby bust cohorts by Echo Boom cohorts—the latter already occurring for the 20's and about to take place for the 30's. The 1st set of replacements (baby bust for Baby Boom cohorts) has resulted in major declines in births, particularly

[41] This example is for comparing decennial census data 10 yrs. apart. For the comparison to follow using the decennial census and the ACS data 5 years apart (2010 and 2015), then a 5-year cohort age x to x+5 in 2010, will be x+5 to x+10 in 2015, etc.

in 1990-94→1995-99 when births dropped by just over 80 (See Table 1.), from about 590 to 510. Yet net in-migration reversed the direction expected for the 3rd baby bust cohort in 2010-14, playing a substantial role when births jumped from 600 to 700. Currently, the 2nd set of replacements (Echo Boom for baby bust cohorts) are expected to mainly add births or maintain the current level, but net out-migration could reverse such outcomes. Here we briefly want to concentrate on this complementary process to cohort replacement—net migration (NM). To expedite the review, we return to Table 7.

For the Avonworth School District residents, we have restricted the data to age-cohorts between 15-19 and 40-44, the childbearing years. Let's take the 2010 30-34 age-cohort as an example (top quadrant, 2nd column, 3rd row). This cohort numbered 378 residents in 2010 and 470 in 2015 (cohort replacement: +92); also, in 2010 the 25-29 cohort numbered 351 female residents, indicating that 119 of these residents moved in [470 - 351 = +119]. So the cohort increased, but this outcome would have reversed, with a decline to 351 residents aging in place without the quite large net in-migration of 119 women. That is, if NM = 0, then the 25-29 cohort of 351 women would have aged to be 30-34 by 2010 and then cohort replacement would have involved a decrease from 378 to 351 female residents, a decrease of 27. What actually occurred was an increase to 470 residents or 470 - 351 = +119 due to the NM of 119 age 30-34 residents moving into the district. In short, the NM outcome is already embedded in the cohort replacement outcome. What is important here is the relative size of this NM component, with particular attention to the cohorts in the 20-39 age band. We find the following for 2010 to 2015:

Age-cohort	Cohort Replacement	Net Migration (NM)
15-19	**-98 (-38%)**	**-141 (-47%)**
20-24	+46 (+19%)	+28 (+11%)
25-29	-14 (-4%)	**+96 (+40%)**
30-34	**+92 (+24%)**	**+119 (+34%)**
35-39	-46 (-12%)	-35 (-9%)
40-44	+33 (+9%)	+25 (+6%)

There is no 2005 census data on age structure, meaning that we will utilize 10-year data, looking at cohort replacement and NM across the decade from 2000 to 2010. These data are shown below:

Age-cohort	Cohort Replacement	Net Migration (NM)
15-19	+20 (+8%)	-9 (-3%)
20-24	**+72 (+43%)**	-71 (-23%)
25-29	**+107 (+44%)**	**+112 (+47%)**
30-34	+21 (+6%)	**+209 (+124%)**
35-39	-27 (-6%)	**+145 (+59%)**
40-44	-66 (-15%)	+24 (+7%)

The sheer size of some of these numbers and the accompanying large percentage changes is striking, especially those shown in bold print. Another feature regarding NM, that is unusual, is the large net in-migration of the 25-29 age-cohort in both time spans. It is more common for both cohorts in their 20s to have net out-migration and for both cohorts in their 30s to have net in-migration. Life is not so simple for the 20-24 and 35-39 cohorts in the Avonworth School District. A 3rd observation regarding the NM for Avonworth is the rather massive NM inflows in 2000→2010 for the 30-34 age cohort—the case already noted in terms of its contribution to the increase in births in 2010-14.

Enrollment in the Avonworth School District and in Alternative Schooling

We now turn to enrollment in alternative schooling by children of residents in the Avonworth SD. But 1st we take a brief look at the student enrollment in the Avonworth SD over the last 29 years, with the primary focus on the last decade. This data is given in Table 13. The largest growth per 5-year period over the last 29 years occurred between 1990 and 1995—with 375 additional students. The 2nd such growth was between 2010 and 2015, an increase of 169 students. Were we to also incorporate the last 3 years as a distinct period (2015-2018), then it would be the 2nd fastest growh period over the last 29 years—185 additional students--and 2010-2015 would be the 3rd such highest growth period. The only 5-year period with a decline in enrollment was 2000-2005 with a decrease of 98 students. If we look at the 5-year changes by educational level, we can see somewhat of a cascading decline starting with the Primary School's decrease of 22 students in 1995 to 2000, followed by decreases in the Elementary (-87) and Middle Schools (-45) in 2000 to 2005; an additional decline at the Middle School occurred in 2005 to 2010 (-19). The High School technically did not decline in any of the 5-year spans in Table 13; it was +2 students between 2005 and 2010, but this was due to a 1-year jump of 27 students in 2010. In all other years between 2005 and 2010, the High School had fewer students than in 2005.

Focusing more on the near term, If we simply take the last 5 years and the prior 5 years, enrollment increased by 252 students in the last 5 years and 142 students in the prior 5 years. Across the last decade then, enrollment has increased by 394 students. This coincides with the wrapping up of several ongoing housing developments starting much earlier, as well as the most recent housing developments of Cobblestone and Overlook. The latter 5 years also coincides with the most recent jump in births from the 600 to the 700 level, which began in 2010 and has continued to 2017. Below is a summary of the enrollment changes over the last decade by educational level, shown previously as part of Table 10:

	Enrollment Δ		
Educational Level	**Last 5 Yrs**	**Prior 5 Yrs**	**10 Years**
Primary	+51	+46	**+97**
Elementary	**+86**	**+82**	**+168**
Middle School	+39	+9	+48
High School	**+76**	+5	+82
Total	**+252**	**+142**	**+394**

Generally, the Primary School has experienced rather steady growth of about 50 additional students each 5-year period. It grew by almost 100 students over the last 10 years. The Elementary School, by far, has had the most growth—above 80—in each 5-year period and totaling almost 170 additional students. The Middle School's enrollment grew by approximately 40 students in the last 5 years, but had only 9 additional students in the prior 5 years (2008-2013). The High School also experienced its main enrollment growth in the last 5 years, adding 76 students, whereas it had added only 5 students in the prior 5 years. Overall, enrollment growth was nearing 150 in the prior 5 years, accelerating to 252 additional students in the last 5 years.

We now examine students residing in the school district who are enrolled in alternative schooling. Data for home-schooled students is not available, but the data for charter/cyber charter and private/parochial students is given in Table 14. While in 2010, chart/cyber charter enrollment was 47 students, from 2011 to 2018 such enrollment has generally been in the 35-39 range—neither increasing nor decreasing. Private/parochial enrollment has fluctuated, particularly in 2013 and 2014; before that it was mostly in the 220 range and after 2015 it was just above 200. Combined, the enrollment in both types of alternative schools has decreased by about 20 students, from 261 to 239 students. This contrasts markedly from enrollment changes occurring in the Avonworth public school.

Table 15 provides a breakdown of the students enrolled in alternative schooling by educational level. Perhaps the clearest finding here is for private/parochial students, with substantial declines at all but the high school level. At the Primary and Middle School levels, the decline is over 30%, while at the high school the increase is 43%, basically cancelling most of the losses at the lower levels. The overall decrease is 7%, masking the significant proportional redistribution that is taking place.

<u>Housing Development</u>

Lastly, we will now take a look at housing development over the last 9 years (2010-2018). The importance of this segment of the analysis is that, should we find sufficient housing development, then we can go beyond the indirect effects of retention ratios and also take into account the direct effects of housing. The data are shown in Table 16.

Considerable new housing has been built in the school district in Ohio Township over the last 9 years, 2010- 2018[51], with a total of 830 new homes. Eighty per cent of these were Single Family Dwellings (SFDs). However, in Avonworth, it is not total new homes that is most relevant, but the number that are ***not*** in developments for residents age 55 and over, notably the Traditions of America (TOA) housing, for which we do not expect additional students. There has still been considerable new housing, excluding TOA homes—482 total new homes and 390 SFDs. This is an average of 43 SFDs/year and 54 new homes/year. Over the last 5-10 years, there has been 1 new home built in Emsworth, 1 is expected in 2019 in BenAvon and none in BenAvon Heights. In Kilbuck there have been 17 TOA new homes built and “a handful” of non-TOA homes.[62]

What would it take to obtain a direct housing impact beyond that embedded in the retention ratios and B→K ratio? Unless total non-TOA new home construction surpasses the 50 or so baseline per year for new homes, as built in 2015, 2016 and 2017, we do not expect an additional direct

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[51] We are using new home building permits as our count for new homes and 2018 includes 2018 permits through November.

[62] Kilbuck Township Community Snapshot 2015 Comprehensive Plan Update, page 60 : “The Township’s housing stock consists almost entirely of owner-occupied single-family detached homes at a variety of affordability levels. Only a handful of building permits have been issued during the last 10 years…” Both TOA developments in Ohio Township, Sewickley Ridge (starting in 2013) and Summer Seat (starting in 2016) are now basically complete. The Kilbuck TOA homes are part of Sewickley Ridge.

housing impact. That is, the baseline is basically accounted for in the retention ratios and Birth→K ratio since they have growth embedded in them—whether from new homes or students moving into existing homes. Presently, there are no major ongoing or newly approved housing developments in Ohio Township. Several housing developments starting much earlier, including Deer Valley Estates, Heritage Estates, Avonworth Heights and Thompson Terrace, have been wrapping up the last lots in the last 9 years. The two newer plans, Cobblestone (starting in 2007) and Overlook Estates (starting in 2016) are basically complete. Cobblestone, with 499 homes, essentially took a decade to complete and Overlook, with 76 homes took 3 years. No major housing plans, on the order of Cobblestone, in terms of total new homes, is underway, nor are 6 Overlooks, which it would take to match Cobblestone's total new houses. In sum, at present, there is no data to support an expectation of new home construction to be built at a rate surpassing 50/year.

The bottom line here is that there will be no additional *direct* impact from new housing construction beyond that estimated in the retention ratios and the B→K ratio—which have indirect impacts from net migration to both existing housing stock and new homes. In fact, the results from the net migration analysis indicate continued housing impacts via new residents more than just replacing those who move out, including families with preschool children.

Summary

In summary, we have examined several major demographic and economic effects to take into consideration when making our projections. We now re-iterate ten of the main findings. ***Finding# 1: Births are currently at their highest level in over 3 decades***. The first finding is that, in contrast to many school districts in Pennsylvania, where births have dropped for the last 20 years, in Avonworth the drop was confined to one 5-year period, 1995-99, and for the 8 most current years, births are at their highest level in 3 decades. In 1990-94 births were about 600 or 120/yr. Then in 1995-99 births dropped to just above 500/yr. (100/yr.), but bounced back to around 600 or 120/yr for the next decade, 2000-2009. From 2010 through 2017 births increased to another level—around 700 or 145/yr. ***Finding #2***: ***Delayed Childbearing is continuing, with ever more births to mothers age 30 or higher.*** Births have continued to shift to women over age 30. In 1990-94 the below/above % for women age 30 or above was 48%/52%. by 1995-99 the share was 36%/64% and this share basically held for the next decade and ½.The 2 most recent years it has increased once again to 28%/72%. Since the Total Fertility Rates for white, non-Hispanic women have remained quite constant (1.7-1.9) for the last 45 years, delayed childbearing does not mean fewer children per woman. Rather the number of children is the same; only the timing has changed. ***Finding #3***: ***The distinct Total Fertility Rates in the United States for essentially the 2^nd^ half of the 20^th^ century,***

1945-2000, produced Population Waves in the age structure, including in Avonworth, and these Population Waves are largely responsible for the changes in births. The decrease in births in 1995-99 was largely due to the replacement of Baby Boom cohorts of women by baby bust cohorts. This is when the baby bust women occupied both age cohorts in their 20s. The jump in births, from 500 to 600, was mainly produced by 2 Baby Boom cohorts in their late 30s and early 40s; it was also complemented by 2 baby bust cohorts, likely bolstered by net in-migration, but there is no data to verify the latter. But, in the jump in births from 600 to 700, in 2010-14, it was the 1st Echo boom cohort and the 3rd baby bust cohort that were key (More on this case in Finding #4). ***Finding #4***: ***Net In-Migration for smaller cohorts such as the baby bust cohorts, can change the direction of births—up versus down if it is sufficient to change the direction of the cohort replacement.*** In the case above there was data to confirm net in-migration for this 3rd baby bust cohort, sufficient to make it larger than the cohort that it replaced and hence modifying the population wave. This net in-migration played a major role in the latest birth increase. ***Finding #5***: ***Net in-migration of Preschoolers has increased.*** For the most part, net-migration of preschoolers is negative for all but Ohio Township. However, Ohio Township's net in-migration has been substantial and increasing over time. It was 35 in 1995-99, 76 in 2005-09 and 88 in 2010-14 or 7, 15 and 18 per year. For the entire district the comparable numbers are 7, 11 and 11. In effect, net in-migration has increased as births increased and held steady as births plateaued in 2010-2014. The 11 new preschoolers complement the births. ***Finding #6: Using E3 and NM as generators of enrollment change at the student level, we find NM's role modest at the Primary level, with both E3 and NM equal and significant at the Elementary level, and neutral or negative at the Middle and High School levels.*** Over the last decade, we find the following: Primary School--80 out of a growth near 100 is due to E3 making NM near 20—so not a driving force, but certainly not trivial; Elementary School—a growth of 168 students, roughly equal at 87 and 81 due to E3 and NM, respectively; Middle School—basically all E3; and High School—E3 quite large, but muted greatly by net out-migration, 145 and -64, respectively. Overall. E3 is extremely powerful in yielding 360 additional students and NM 34 additional students. The positive influence of NM at the Primary and Elementary Schools should not be ignored, as will be shown below. ***Finding #7: The retention and B→K ratios have substantial growth embedded in them, with 9 0f the 12 retention ratios equal or greater than 1.0 and the remaining 3 near 1.0; the B→K ratio is over 1.04.*** The small increases over 1.0 act like compound interest when multiplied sequentially and reach 1.17 by Grade 7. The retention ratios from K to G6 also strongly reinforce Finding #6, but also parameterizes the process where any ratio greater than 1.0 indicates the occurrence of net in-migration and specifies its magnitude. For instance, the K→G1 and G5→G6 ratios of 1.024 and 1.021 indicate that net in-migration adds 2% to the G1 and G6 enrollment. Also, net in-migration of preschoolers adds to the

K enrollment—underscoring that it is not only births that is an important factor in future student enrollments, but it is net-migration of preschoolers and students elsewhere as well. ***Finding #8***: ***Net in-migration of women in both the 25-29 and 30-34 age cohorts is quite high, adding to both increased births and student net in-migration.*** This occurrence is unusual for the 25-29 age-cohort, since the more typical case is net out-migration in both 20+ cohorts and net in-migration in both 30+cohorts. ***Finding #9***: ***Enrollment in the Avonworth School District has increased considerably in the last decade, accelerating in the last 5 years while enrollment in alternative schooling is declining a bit (-7%).*** The fastest enrollment growth over the last 29 years was in 1990-94, an increase of 375 students; the 2nd fastest was in 2015-2018 (+185); and the 3rd fastest was in the prior 5 years, 2010-2015 (+169), with the 2nd and 3rd cases from 2010-2018 together adding 394 students. In contrast, alternative schooling overall is declining, with the most significant changes occurring in private/parochial students—over a 30% decline at the Primary and Middle School levels and aver a 40% increase at the high school level. ***Finding #10***: ***Major housing development has occurred over the last decade with a continued rather high rate of construction, but it appears to be dampening down.*** The construction of new homes in Ohio Township has totaled 830 over the past 9 years (92/yr., primarily SFDs—664 (74/yr.). Since homes in the Traditions of America developments are not pertinent for student projections, a more apt construction count excludes the TOA homes.

The construction is still considerable, with 482 new homes and 390 SFDs, averaging 54/yr. and

43/yr., respectively. However, the main developments, some starting some time ago and some starting more near term are completed or near completion. This includes Cobblestone (499 homes) that started in 2007 and took about a decade to complete, as well as Overlook Estates (74 homes) , beginning in 2016 and completed in 2018. Presently, there are no new Cobblestones on the near term horizon nor a set of 6-7 Overlooks. More specifically, there is no data to support an expectation of new home construction to be built at a rate surpassing 50/year. The bottom line here is that there will be no additional *direct* impact from new housing construction beyond that estimated in the retention ratios and the B→K ratio—which have indirect impacts from net migration to both new housing and to extant older housing. We will now move to the student projections, utilizing key parts of this analysis.

II. Development and Analysis of Grade-Specific School District Projections for the Ten-Year Period 2019-2028

Scenario I: Projections with Fertility at Current Levels, Aging and Embedded Growth

The Scenario I projections use the following:

1. 2018 observed student populations per grade;

2. 2014-2017 four year retention ratios (Table 11) based on school enrollment for 2014-2018; for the $B_{t-5} \rightarrow K_t$ ratio, the K refers to K in 2015-2018 and births in 2010-2013;

3. For 2019-2022 projections, the observed births (2013-2017) in the Avonworth SD were used; and

4. For 2023-2028 projections, the expected number of births is based on the most current 4-year average for 2014-2017, 146. (See Table for individual years.)

This scenario assumes that births will remain at the current level—146 per year for 2018 to 2023. As discussed in the analysis, births have continued at the present level for nine years and here we assume that births will continue at this level. This scenario takes into account the following: 1) the most recent birth data, 2) the most recent retention ratios, which have embedded growth or net-migration, and 3) the most recent 4-yr. Birth-to-Kindergarten enrollment ratio (1.043).

The results for this scenario are given in Table 17. In the first 5 years, all 4 educational levels experience growth, with the largest increases at the Elementary School and High School—+99 and +70 students respectively. Growth at the Primary and Middle Schools is much less--+8 and +32, respectively

In the 2nd five years, only the High School has significant growth--+88 students. There is modest growth at the Middle School—24 additional students, while the Primary School adds only 6 students and the Elementary School is expected to lose 13 students. **Overall, by 2028, the projections indicate an increase of 314 students (+17%).** This includes an additional 158 students at the High School (+32%), about 100 additional students at the Elementary and Middle Schools (+15% and 21%, respectively), and only 14 additional students at the Primary School (+3%).

The number of students at the beginning of the projection in 2018 and the expected number in 2028 in this scenario are as follows:

Educational Level	2018	2023	2028
Primary School	453	461	467
Elementary School	575	674	661
Middle School	271	303	327
High School	498	568	656
Total	1,797	2,006	2,111

This Scenario is viewed as the 2nd most likely scenario for the Avonworth School District.

Scenario II: Projections with Oscillating Fertility

In Section I, we noted that the 4-yr. average B→K ratio had considerable volatility across years. For instance, the most current B→K ratio (1.043) had the following individual yearly B→K ratios:

2015: 1.138
2016: ,934
2017: .939
2018: 1.169

We used the lowest and highest individual yearly B→K ratios iteratively starting in 2019 (.934), then 2020 (1.169), followed by 2021 again at .934, etc The results are given in Table 18. We can readily see the oscillations in K, then Grade1 and so on. The 10-year outcomes do not vary much from Scenario I, as expected, but the unfolding of the oscillating process produces different yearly outcomes. The greatest differences are at the

Primary School and the High School—with about 20 additional students at the Primary School and about 20 fewer students at the High School.

Scenario III: Projections with Increased Preschool Net In-Migration

This scenario takes the results on net in-migration of preschoolers from Section I and adds 5 preschoolers per year to the K entrants. Otherwise, the same parameters as in Scenario I are used in this scenario. The results are provided in Table 19. In the 1st 5 years growth in the Primary and Middle Schools is relatively small and about the same, with an increase of 23 and 32 students, respectively. As in Scenario I, it is the Elementary School and High School that have the larger growth--+110 and +70, respectively. In the 2nd 5 years, it is the Middle School and High School with the higher growth--+36 and +94 respectively. The Primary and Elementary Schools have very little change (+6 and -3). Overall in this scenario the district is expected to grow by 368 students, after 10 years. Almost half of this growth is expected at the High School (+168, +33%), with an increase of over 100 additional students at the Elementary School (+19%). The Middle School is expected to increase by 68 students (+13%) and the Primary School by 29 students (+6%).

Scenario IV: Projections with Higher Fertility

This scenario uses the same parameters as in Scenario I. What differs here pertains to the future projection years, 2023-2028, for which we must make assumptions about the number of births. We now ***increase*** them modestly from the most recent (2014-2017) 4-year average baseline of 146 births per year. The basis for the consideration of such an increase is the unfolding of a new replacement regime—the replacement of the baby bust female cohorts by the Echo Boom cohorts, increasing the number of reproductive women in the key fertility age groups (as discussed in Section I). In this scenario we have assumed that the births from 2018 to 2023 will be 156, an increase over the current level by 10/year. The *full* impact from the Echo Boom cohorts will not occur until 2020, as shown by their occupancy of all 3 key reproductive age-cohorts—25-39, 30-34 and 35-39--in Table 6. Given the net in-migration of preschoolers in the district, which adds to the births for subsequent K entries, and increase in births in the last 8 years, the assumption of yet additional births here seems quite reasonable.

The results for Scenario IV are shown in Table 20. The changes are indicated in the shaded cells and, as can be readily seen, there are no changes at the middle and high school levels since the changes in births after 2020 do not reach beyond the 5th grade in the 10-year projection period. The Primary School is expected to increase by 19 students in the 1st 5 years and by 28 students in the 2nd 5 years for a total of 47 students (+10%), The Elementary School has a growth of almost 100 in the 1st 5 years and 20 additional students in the 2nd 5 years. a growth of 120. The Middle School is more similar to the Primary School, with an expected increase of 32 students in the 1st 5 years and 24 students in the 2nd 5 years, totaling 56 students by 2028. The High School's expected increase is 70 additional students in the 1st 5 years and 88 in the 2nd 5 years, a total growth of 158 students. As noted above, there is no difference between Scenario I at the Middle and High Schools. Overall, growth in this scenario is expected to be 220 students in the 1st 5 years and 160 in the 2nd 5 years for a total of 380 students.

The number of students at the beginning of the projection in 2018 and the expected number in 2028 in this scenario are as follows:

Educational Level	2018	2023	2028
Primary School	453	472	500
Elementary School	575	674	694
Middle School	271	303	327
High School	498	568	656
Total	1,797	2,017	2,177

This Scenario is viewed as the most likely scenario for the Avonworth School District.

Scenario V: Projections with Lower Fertility

In this scenario we assume births from 2018 to 2023 are modestly lower than the current level of 146/year. We now assume births from 2018 onward will be 136 births /year--10 less than the current level,. The remaining parameters are as in Scenarios I, III and IV. This scenario is basically a lower bound. Births have not declined since 1995-99, so this case is, in effect, either a hiccup or outlier, with an expectation that births will drop 10 births/yr. below the 2010-17 or current level of 146 births and become a new normal.

The results are shown in Table 21. Since the new births will not impact the enrollment beyond Grade 5, as was the case with Scenario IV, the results for the Middle and High Schools are the same as in Scenarios I and IV. Thus, we will only discuss the Primary, Elementary and Total enrollments. The changes are indicated in the shaded cells as in Scenario IV. In this scenario, the Primary School is expected to decrease by 16 students in both 5 year periods, while the Elementary School is expected to increase by 99 students in the 1st 5 years, then reverse course and decline by 46 students in the 2nd 5 years. Total enrollment is still expected to increase by almost 200 in the 1st 5 years (+199), then add another 50 students in the 2nd 5 years for a total growth of about 250 students (+249).

This Scenario (V) is NOT viewed as a likely outcome, but is provided should such a shift to lower births occur.

Summary

This demographic study has considered a range of possibilities for projecting the expected student enrollment changes in the future—with explicit linkages to the rather in-depth analysis in Section I. These alternative futures or Scenarios (S's) include the following:

S V; modest decrease in births (B): B= 136/yr.
S I: current level of births: B= 146/yr.
S IV: modest increase in births: B= 156/yr.
S III: 5 additional preschoolers enter K per yr,
SII: oscillatory B→K ratios.

Scenarios II, III and V seem most unlikely. The scenarios that are more likely are as follows:

Scenario IV Most likely

Scenario I 2nd most likely

To see longer-term implications of these scenarios, we extended the time frame and operation of the sequential retention ratios 1 grade at a time until all grades, including Grade 12 were filled. We viewed these results as equilibria. They are meant to convey the outcomes that will ensue should the process continue another 7 years[71]; that is, until changes chartered in each scenario have run their course and the new Kindergarten entrants have reached Grade 12 so that the new level of entry has pervaded the entire grade structure. For Scenarios I and IV, the most likely cases, the equilibria results are summarized below, in terms of changes in student enrollment. In order of likelihood:

		10 Yr. Outcome	Equilibria Outcome
Most likely: Scenario IV	Pr S	500 (+47)	500 (+47)
	El S	694 (+119)	705 (+130)
	MS	327 (+56)	359 (+86)
	HS	656 (+158)	697 (+199)
	Total	2,177 (+380)	2,261 (+464)
2nd most likely: Scenario I	Pr S	467 (+14)	467 (+14)
	El S	661 (+86)	664 (+89)
	MS	327 (+56)	342 (+71)
	HS	656 (+158)	665 (+167)
	Total	2,111 (+314)	2,138 (+341)

[71] Since here the new K students entered in 2023 and have already reached Grade 5 by 2028.

In equilibria, the most likely case, Scenario IV, has a sizable increase overall by about 80 students and that of Scenario by only about 25 students. It is by no means a given that births will increase, as assumed in Scenario IV. As yet, there is no concrete evidence to support such a change. There are fundamental elements that lean in that direction, however. That is, *(i*) the Echo Boom cohorts will remain at center stage through 2020, in terms of occupying 3 of the 4 key age cohorts; *(ii*) the new housing in Cobblestone and Overlook have very low student/housing ratios, in the order of .40 to .50, in contrast to .7 or higher for many SFD developments. This may be due to young families with preschool children moving in and, as yet to enter K or perhaps they have yet to have children, consistent with delayed childbearing, as discussed in Section I; or *(iii*) perhaps new housing developments will start. Still, the fact that no current birth increase is observable suggests caution in our conclusion as to the relative likelihood of Scenarios I and IV and moves our assessment of Scenario I higher, making it almost as likely as Scenario IV.