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POST-CENSAL POPULATION ESTIMATION TECHNIQUES

prepared by

LEONARD J. FERRO, Associate Planner

under the direction of

MYRON K. NALBANDIAN, Ph. D.

for

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## FOREWARD

The following technical guide was set up originally to estimate post-censal and future populations of the City of Providence for disaster planning purposes. Since population estimates form a key component of urban planning, it was decided to expand this manual to include various population estimate techniques which could be used by different municipal agencies.

The several estimate techniques here presented are by no means exhaustive. As new and more comprehensive data series are developed for Providence, the estimate techniques will be augmented and varied. However, given the state of existing data for Providence, the suggested techniques in this manual can be defended in terms of feasibility at the present time.

The post-censal estimate techniques can be applied annually. Both vital rates and school census data are published at about the same time. The illustrative post-censal estimates should be brought up to date during the spring of each year.

Population projections should probably not be made for time spans of less than five years. The prediction of future populations for small areas contains so many variables that projections of more than ten years in the future are suspect, particularly when such projections are made from an unknown base.

This manual should be revised every few years in the light of new data series and new estimate techniques.

## Chapter 1

### Estimating Techniques

Most projects that are undertaken in the field of city planning require a knowledge of the population within the planning area. Whatever the planning project may be, whether for municipal planning, business, or industry, a knowledge of the population is useful. The United States Census which is conducted every ten years by the Bureau of the Census of the U.S. Department of Commerce satisfies some of this need. But by virtue of the fact that it is taken only once in ten years, this census count leaves something to be desired in the way of accurate and current information in the years between the taking of the decennial censuses.

The purpose of this manual is to provide a variety of methods for estimating the post-censal population of small areas. Obviously, no one method of estimating can provide a completely reliable count, since by the very nature of the small sample size of the data involved and the data series available, the degree of accuracy provided by the different methods also varies. An effort will be made to overcome this difficulty by using several methods which employ different data series, and then comparing the results. There are five different estimates which will be detailed and discussed in this manual. They are, the two vital rates estimates (based on both birth and death statistics); a method based primarily upon that used by the U.S. Census Bureau for their post-censal counts; a refined composite method, developed originally by Donald J. Bogue and associates at Miami University of Ohio and herein used as discussed by Myron K. Nalbandian in an unpublished doctoral thesis entitled Methods of Population Estimation for Small Areas, with Specific Application to Rhode Island; and finally a method using data on public utilities. The results of these estimates are consistent when applied to the City of Providence, R.I. as of July 1, 1963. Although the different estimates vary, they are fairly close and give reasonably accurate estimates of post-censal population.

### Vital Rate Estimates

The first two estimates to be discussed are both based on the Vital Rates Method of Population Estimation. The two methods are based on the assumption that there exists a continuing relationship between the population of a given area and the number of births and deaths in that area. Along with this assumption the assumption must be made that the aforementioned relationship varies according to a similar relationship at the national level. For example, if the birth rate of the entire country changes in a certain direction by a specific amount, the birth rate at the local level will likewise change in the same direction and by a proportional amount. Having made these two assumptions, the calculations involved in arriving at these estimates can be illustrated.

#### Birth Rate Method

Since the theory behind the two vital rates estimates is the same, only the birth method will be presented in detail. The data needed for calculating this estimate is as follows:

1. Total number of births for U. S., and estimate area for the year of the last census, the year proceeding it and following it.
2. The population of the U. S. and estimate area at the last census.
3. The number of births for the U. S. for the estimate year.
4. The estimated population of the U. S. for the estimate year.
5. The number of "resident" births (births to those who reside in the estimate area) for the estimate year.

First of all, the birth rate of the U. S. for the estimate year is calculated. The number of births in the U. S. for not only the census year, but also for the year before and after the census are averaged to get a better "sample" of births for that year. This average is divided by the population of the U. S. for that year to arrive at birth rate for the U. S. for the last censal year. This same procedure is then performed for the area to be estimated in order to get a birth rate for it during the year of the census. In order to illustrate these steps, the estimate that was made for Providence, R. I. for year 1963 follows. The number of births for the U. S. was as follows:

1959	4,239,309		
1960	4,252,668	Average '59-'61	4,268,350
1961	4,263,070		
1963	4,093,090		

Hence, dividing the number of births for 1960 (Average of 59-61) by the total U. S. population in 1960 which was 179,321,000, a crude birth rate of 23.8 births per thousand population is reached. Using the best available figures for 1963 a similar birth rate for the U. S. for 1963 is calculated. Since the assumption is made that births are equally distributed throughout the calendar year, all post-censal estimates of population are made for July 1, of the estimate year. The estimated 1963 U. S. population was 190,684,000. It should be noted that the estimate of 1963 population is effective as of July 1, 1963. Hence in accord with this, the estimate of local population which we secure will likewise be for this date. The 1963 U. S. crude birth rate is 21.5 births per thousand population. Comparing the two rates, we see that the 1963 rate is .903 of the 1960 rate. Therefore we assume that the 1963 Providence birth rate shall be .903 of the 1960 Providence rate.

The next step is to calculate the birth rate for the estimate area (Prov.) for the year 1960. Once again the average of three years for our number of births is taken.

1959	4473		
1960	4410	Average '59-'61	4437 births/year
1961	4336		

From the 1960 U. S. Census Report, it is known that the population of Providence in 1960 was 207,498. Hence the birth rate for Providence was 21.4. It should be remembered that the 1960 and 1963 Providence rates should have the same relationship as the comparable U. S. rates. Hence the 1963 Providence birth rate is  $.903 \times 21.4$  or 19.3 births per thousand population. It is known also from Health Dept. figures that there were 3896 births to residents of Prov. in 1963. Therefore the population of the estimate area (in this case Providence) as of July 1, 1963 was  $\frac{3896 \times 1000}{19.3} = 201,865$

#### Death Rate Method

Along with the above mentioned vital rates method using birth data, an estimate employing the same procedures using death statistics is made. This method is identical to the above and uses the same set of assumptions; the only difference being that deaths and death rates are used in place of births. In the case of the City of Providence, for the same estimate period as in the birth rate method, a population estimate of 203,900 was obtained.

The births and deaths for the City of Providence were obtained from the Annual Reports of the R. I. Department of Health. The population figures for both the U. S. and the estimate areas were obtained from various U. S. Census reports for 1960. The 1963 U. S. Estimate, came from U. S. Census mid-year estimates. The birth and death statistics for the U. S. were obtained from the National Office of Vital Statistics Yearly Reports.

### Census Method

This method consists of estimating different components of the population and combining these estimates to obtain one comprehensive count for the entire population. The basic assumption is that a relationship exists between the migration rate of children of school age and that of the total population, particularly in estimating migration during the post-censal period. A migration rate for school children is obtained and applied to a population base for migration. The natural increase is added to the population estimate after migration to obtain an estimate of the total civilian population. The logic of the method becomes clearer when its calculations are examined. The six steps in the calculation of this estimate are as follows:

1. Estimating the civilian population as of the last census.
2. Estimating the natural increase since the last census.
3. Estimating the current school population and migration rate of school age children.
4. Applying the migration rate of step 3 to the population base to estimate migration of the total population.
5. Estimating net loss to armed forces.
6. Estimating the military population within the area.

### Civilian Population

The civilian population can be obtained from the decennial census. If the civilian labor force is subtracted from the total labor force, the number of military personnel in the area must comprise the difference.

$$\text{Total Labor Force} - \text{Civilian Labor Force} = \text{No. of Military Personnel}$$

The number of military personnel is then subtracted from the total population and the civilian population is the result. There may be a significant difference in the total population and the civilian population since in the taking of the census the military population is added in with the civilian. An example of just how important this can be is found in examining the population of the city of Newport, R. I. There are approximately 15,000 individuals in the military in that city alone. However, in the case of Providence, there are very few military personnel; thus for the purpose of our estimate, the civilian population is taken as the census count figures of 207,498.

### Natural Increase

It is necessary to calculate the natural increase from the time of the last census to the estimate date. The census is effective on April 1, of the years evenly divisible by ten. Providence is used to illustrate the techniques. The last census was taken on April 1, 1960. In order to calculate how many births have occurred since then, it must be assumed the births are evenly distributed over the entire year. Hence, since

by April 1, one fourth of the year has already passed, only three fourths of the births for 1960 are considered since it is assumed that one fourth of the total number of births in 1960 occurred before April 1, and that these have already been counted in the census report. All of the births in 1961, 1962, are added in. Only  $\frac{1}{2}$  of the births for 1963 are counted since the estimate date is July 1, 1963.

1960	4410 x 75%	= 3,308
1961	4336 x 100%	= 4,336
1962	4089 x 100%	= 4,089
1963	3896 x 50%	= 1,948
Total		= 13,681

The number of deaths is obtained in the same manner, the total being 9,071. Hence the natural increase in Providence during the period from April, 1960 to July 1, 1963 was  $13,681 - 9,071 = 4,610$ .

#### SCHOOL POPULATION

This step is to estimate migration trends between the last census and the estimate date. It depends on our knowing the number of children between  $7\frac{1}{2}$  to  $14\frac{1}{2}$  that have migrated since the taking of the last census. Since the estimate date is July 1, 1963, we are interested in knowing how many of the present cohort of  $7\frac{1}{2}$  to  $14\frac{1}{2}$  year olds have left the city since the last census. A subtraction will show that the children who are now  $7\frac{1}{2}$  to  $14\frac{1}{2}$  years old were, at the taking of the last census of April 1, 1960,  $4\frac{1}{4}$  to  $11\frac{1}{4}$  years old. The actual number for this cohort is obtained by taking  $\frac{3}{4}$  of the 4 year olds, all of those through 11 year olds, and  $\frac{1}{4}$  of the 12 year olds. These figures are obtained from the Federal Census Report. In the case of Providence this number was 26,426.

Since some of this cohort can be expected to die during the post-censal estimate years, a survival factor based upon state life tables is applied to the cohort. In the case of Providence, this survival factor was obtained from a report published by the U. S. Department of Commerce, entitled Current Population Reports, series P-25, No. 133, page 19. The survival factor listed for Rhode Island is .99862. This is the average of white male and female survival factors for the  $4\frac{1}{4}$ - $11\frac{1}{4}$  age group. Applying this factor to the cohort obtained from the census figures for April 1, 1960, it is estimated that there will be 26,390 children remaining as of the estimate date if no children had migrated. This figure is compared with the "actual" count obtained from the Providence School Department Census for January 1, 1964. The question occurs at this point as to just how accurate is the school census. By comparing the 1960 school census with the 1960 Federal census, it is ascertained that the school census counts more children than does the Federal Census by a factor of 1.02. Assuming that this is a stable relationship, and that the school census count is higher than the Federal figures by a factor of 1.02, the school census count of 1964 is adjusted.

The actual school census count for the City of Providence as of July 1, 1963 (actually August 1, 1963) was 24,106 for the cohort of  $7\frac{1}{2}$  to  $14\frac{1}{2}$  year olds. If this count is lowered by a factor of 1.02, we get a count of 23,633 which is adjusted to be in accord with Federal census counts.

You will recall that it was estimated that according to U. S. Census figures, there should be in Providence as of July 1, 1963 a total of 26,390 children if no migration took place. The adjusted School Census count shows, however, that there are in fact only 23,633. Thus, there is a difference of 2,757 children between the expected count and the actual count. It is assumed that this difference is attributable to migration. In order to find the percentage of children that have migrated since the 1960 census, the difference between the expected count and the actual count is divided by the 1960 Federal census count. The percent is 10.45%. This percentage represents a migration that is minus with respect to Providence. Care should be taken at this point not to assume that 10.45% is the migration rate of the entire population of the test area. Tests have shown that the migration rate of the entire population is different than the migration rate for  $7\frac{1}{2}$  to  $14\frac{1}{2}$  year olds, which was calculated to be 10.45%. In an effort to determine just how the migration rate of the cohort  $7\frac{1}{2}$  to  $14\frac{1}{2}$  year olds is related to the migration rate of the entire population, the following procedure was followed.

A count was first made of the cohort  $7\frac{1}{2}$  to  $14\frac{1}{2}$  as of April 1, 1960 in order to determine how the migration rate of the  $7\frac{1}{2}$  to  $14\frac{1}{2}$  year olds was related to that of the entire population during the decade of 1950-1960. This date was selected since the census was taken then and an accurate count of children could be obtained at that time. Also from this Federal census it was possible to determine the number of total residents in Providence and thus obtain an accurate picture as to the migration pattern of the city. The cohort of  $7\frac{1}{2}$  to  $14\frac{1}{2}$  year olds as of April, 1960 was traced back using the aforementioned Current Population Reports, series P-25, No. 133, page 19. As it turned out, in order to trace this cohort back to 1950, the 1950 Federal Census must be used and those individuals in Providence under  $5\frac{1}{2}$  years old counted. To this cohort is applied a survival factor of .99450, since some of these children can be expected to die during the ten year period. It should be noted too that this factor is the average of the male and female survival factors for Rhode Island, since the data which is used is not broken down by sex. The number of those under five and one-half years old from the 1950 Federal Census is 27,486; applying the survival factor to this group, results in 27,335 children. This number is only a portion of the cohort that was  $7\frac{1}{2}$  to  $14\frac{1}{2}$  as of April, 1960. In 1950 not all of that cohort had yet been born. So, to the cohort just mentioned, that is those under  $5\frac{1}{2}$  in April 1, 1950, are added the births for three-fourths of 1950, all of 1951 and three-quarters of 1952. These children would eventually fill out the rest of the cohort that was between the ages of  $7\frac{1}{2}$  and  $14\frac{1}{2}$  on April 1, 1960. A survival factor must be applied to the new born children. Since infants are more subject to death immediately after birth, a lower survival factor is applied to this group. Totaling the 1950, 1951, 1952 births (using only the parts of those years indicated) gives a total of 12,398. The survival factor for this group is .96995. This factor is also the average of the male and female survival rates.

Applying this factor to the 12,398 births leaves us with 12,025 children that can be expected to survive to April 1, 1960. Adding the two groups of figures together will give the expected number of  $7\frac{1}{2}$  to  $14\frac{1}{2}$  year olds that will be alive as of April 1, 1960 in Providence. The sum is  $12,025 + 27,335 = 39,360$ .

It now remains to see just how many  $7\frac{1}{2}$  to  $14\frac{1}{2}$  year olds the Federal Census counted in the 1960 Census. The actual count was 24,924. Thus there was a loss of 14,436 children during this period. This figure represents 36.68% of the original cohort. Thus the net migration for the  $7\frac{1}{2}$  to  $14\frac{1}{2}$  year olds from the City of Providence was 36.68% out-migration. However, as has been noted, the migration rate of the entire population is different from the migration rate of the  $7\frac{1}{2}$  to  $14\frac{1}{2}$  year olds. Additional research has also indicated that this relationship is different for different geographical areas. In its manual CURRENT POPULATION REPORTS, the U. S. Census Bureau was for a time using a constant of 1.2 to relate the migration rates of the two groups. The Bureau had thought that the adult population had a migration rate that was higher than the rate of the  $7\frac{1}{2}$  to  $14\frac{1}{2}$  year old cohort by this factor of 1.2. Over the years, it has been found that although the basic concept of an adjustment factor for the migration rate of the two cohorts was a desirable thing, the factor itself varied from time to time and place to place. Nalbandian found that factors in the vicinity of .7 were of value in estimating the population of the City of Providence during the 1950-1960 decade. A comparison of the actual and expected 1950 populations using the migration rate of the  $7\frac{1}{2}$  to  $14\frac{1}{2}$  year olds between 1940-1950, lead him to believe that a relationship near .5 was accurate for that decade.

In an effort to determine just what the factor might be for Providence from 1950-1960, the migration rate of the 7.5 to 14.5 cohort during that decade was applied.. That cohort exhibited a net migration rate of - 36.68% with respect to Providence from 1950-1960. The base population was obtained by adding half the number of births which occurred during the decade to the 1950 population count. This assumes an equal time distribution of post-censal births; therefore, only one-half of this cohort would be subject to migration. Net loss to the armed forces was ignored in this estimate since the total size of the military component was changed very little during the post-censal years and the adjustment would be very small. Adding one-half the births between April 1, 1950 to April 1, 1960 or 24,243, to the census population of 248,674 gives a population base of 272,917. The migration rate of the 7.5 to 14.5 year old cohort is now applied to this population base, resulting in a net out-migration of 100,106 between 1950 and 1960. Hence using this method, with this migration rate, indicates a 1960 population of 172,811. A comparison of these figures with the actual 1960 census figures indicates that this migration rate yields an over-estimation of net out-migration. In actuality, there was an out-migration of 65,419 people during the decade. Hence the net migration of the total population was .65 of the migration rate of the  $7\frac{1}{2}$  to  $14\frac{1}{2}$  year olds.

It should be noted at this point that this adjustment factor of .65 is not in any way purported to represent a causal relationship, but merely to give a "best fit" pattern to our population estimates. It will be remembered too that the work done by Nalbandian indicated a very similar factor for the City of Providence.

In the estimate of population of the City of Providence herein presented, the adjustment factor of .65 is used in order to arrive at a net migration figure for the City of Providence. It has been previously shown that during the post-censal period under consideration extending to July 1, 1963, the net migration rate of the 7.5 to 14.5 cohort was 10.45%. Applying the adjustment factor of .65 to this rate gives an estimated migration rate for the entire population of the City of Providence for the estimate period. This net migration rate is calculated at  $10.45 \times .65 = 6.8\%$ . This rate is used in estimating the post-censal population of Providence.

The population base to which our net migration rate is applied must now be determined. Using the same assumptions regarding the uniform distribution of births throughout the post-censal period, one-half the number of births which occurred during the period to the April 1, 1960 is added to the Bureau of the Census population. One-half of these births is 6,841. Adding this figure to the April 1, 1960 population of 207,498 the total is 214,339. Applying the net migration rate of the entire population to the base population that we have calculated, is shown as follows:

$$214,339 \times 6.8\% = 14,575$$

This figure represents the estimate of net migration from the City of Providence during the post-censal period. It now remains to calculate the population of Providence resulting from natural increase.

It is known that the population of Providence as of April 1, 1960 was 207,498. Further, from R. I. Dept. of Health figures 13,681 births occurred to residents of the City of Providence. The number of deaths to residents of Providence was 9,071 during the post-censal period. In calculating these figures, it was necessary to take only three-fourths of the births and deaths during 1960 since the census was taken after one-fourth of the year had already passed. Hence the natural increase due to births and deaths for the post-censal period was  $13,681 - 9,071 = 4,610$ . Adding this to the 1960 census population gives us a total population of 212,108 not counting the effects of migration.

The migration figure for the City of Providence has already been estimated for the post-censal estimate period. It remains only to subtract the effects of net migration in order to arrive at our estimate.

$$212,108 - 14,575 = 197,533$$

### Net Loss to the Armed Forces

The final factor which we must consider is the effect that armed forces personnel have upon the population of the test area. There are two things to consider when talking of armed forces personnel. One is the number of military people stationed in the estimate area. The second matter for consideration is to determine how many of the normal resident civilian population have been lost to or gained from the armed services. During a time of national emergency such as during the Korean Conflict, there would naturally be a greater number of civilians being lost to the armed services. Immediately after such a crisis ended, exactly the opposite would be true; that many boys would be returning to their former civilian status.

In 'normal' peacetime conditions, it is natural to assume that unless the size of the U. S. military establishment were in a state of flux, the loss to and gain from the military would be balanced. Since the last census, the size of the U. S. armed forces has changed from about 1,852,000 on April 1, 1960 to about 2,004,000 on January 1, 1964. For a city the size of Providence which comprises only about 200,000 of the approximately 190,000,000 people in the U. S., this change in size of the overall armed services would mean a loss of only about 20 people. It is therefore not worth considering in detail for our present estimate of the population of the City of Providence.

For a closer examination of the procedure involved, the reader is referred to a U. S. Department of Commerce, Bureau of the Census publication entitled CURRENT POPULATION ESTIMATES, Series P-25, No. 133, page 10, item 4(a-1).

The other factor involved that concerns military personnel is the number of military people stationed in the test area. This can be an important component in some cases, but in the case of Providence, it is inconsequential since there are only about 30 military people permanently based in Providence. Since both of these factors are of little consequence, their effects are eliminated. The result is that there are in Providence 197,533 people for the estimate date.

### Component Method

This method of population estimation is one that is probably the most time consuming in this manual. It is a method for estimating the residential population of small areas with specific application in this instance to the City of Providence. The basic method here presented was developed by Donald Bogue and is now being used as one of the methods of estimating population by the Bureau of the Census. However, some modifications have been made in this method by Nalbandian and these modifications will be presented along with the original composite method.

The composite method estimates population by various components of the population. The basic divisions are: population 45 years old and over by sex, females 15-44 years old; males 15-44 years old; children under 5 years old; and children 5-14 years old. Alternate methods will be presented for various age and sex components from birth to 44 years old. The estimate method will become clearer as it is presented.

#### 45 Years Old and Over

The first component to be estimated is the population 45 years old and over. The rationale of this estimate is the same as for the crude vital rates method in that it is assumed that a relationship exists between vital rates and the total population. However, instead of crude death rates for the whole population, age-specific death rates are used here. If data is available, this population component can be separated by sex; in the present instance both sexes are combined.

The computation is similar to that for crude vital rates. Age specific death rates are obtained for the U. S. as a whole in 1960 for the various age groupings shown in Table I. Ten year intervals are the only ones available. Similar age specific death rates were obtained for the U. S. in 1963. It should be noted here that it was necessary to calculate these death rates from U. S. population figures and the numbers of deaths for the various age groups which were obtained from the publications of the National Office of Vital Statistics.

Using a special run of birth and death data for the City of Providence in both 1960 and 1963, which was obtained from the Providence Health Department, the number of births and deaths for the specific age groups was divided by the Providence population in each age group as of April 1, 1960; obtained from the U. S. Census publications. Hence a death rate for Providence for 1960 was obtained by age groups.

Relationships between the 1960 and 1963 Federal birth rates were then calculated for the various age groups in the U. S. Table I shows these relationships. It was then assumed that the same relationships applied to the Providence death rates during the years 1960 to 1963. Hence the Providence rates were adjusted by proportional amounts. A 1963 Providence death rate emerged for each of the different age groups for Providence.

The number of deaths for the City of Providence for the year 1963 had already been obtained from the Providence Health Department E.D.P. runs. Thus, dividing the number of deaths by the appropriate adjusted death rate in the respective age groups gives an estimated population for that age group. The observer may notice at this point that the numbers of deaths obtained from the Providence Health Department runs are different than the number of deaths obtained from the R. I. Dept. of Health for the same time periods. The difference stems from the fact that the Providence Health Dept. records only resident births and deaths which "occur" inside the city whereas the State compiles the births and deaths of all residents of Providence no matter where they occur. Table I indicates the above mentioned method and the pertinent data. The results of estimating this segment of the population are also listed in the Table I. It is also important to note that in the case of the U. S. birth rate for 1960, we have averaged the number of U. S. births in the various age groups for the years 1959, 1960, 1961 in order to get a more balance sample of the deaths for the year 1960 and thus rule out as much as possible any factors which may have been peculiar to 1960 and not necessarily representative of the current trends at that time.

TABLE I. ESTIMATED POPULATION, 45 YEARS OLD AND OVER, PROVIDENCE, R. I.

JULY 1, 1963

Age Group	United States Population		
	Death Rate '59-'61	Death Rate 1963	Ratio 1963:1960
45-54	745	741	.9946
55-64	1710	1710	1.0000
65-74	3765	3872	1.0284
75-84	8642	8372	.9687
85+	19663	20640	1.0496

Age Group	Providence Population		
	Death Rate 1960	1960 Adjusted Death Rate	Number of Deaths '63
45-54	633	630	151
55-64	1565	1565	295
65-74	3166	3256	596
75-84	6686	6477	521
85+	12209	12815	209

City of Providence April 1, 1960 - Estimate Population July 1, 1963		
Age Group	Population April 1, 1960	Estimated Population July 1, 1963
45-54	25914	23968
55-64	22495	18850
65-74	18318	18305
75-84	7598	8043
85+	1417	1631
Total 45+	75742	70797

For any given age group, the actual procedure involves applying the ratio of U. S. death rates between 1960-1963 to the 1960 Providence death rate and thus arriving at the 1963 estimated Providence rate.

Ex. 45-54 .9946 x 633 = 630.

All rates are per 100,000 population.

Females 15 to 44

The next component to be estimated in the component method is that of females 15 to 44 years old. This component is estimated by establishing relationships between U. S. and Providence birth rates. Like the crude vital rates method, this component is calculated assuming that there exists a continuing relationship between the birth rates of the entire nation and the birth rate of Providence. Thus if the birth rate of the entire country tends to increase over a specific period, it is assumed that the birth rate of Providence will increase by a proportional amount. Once more the age-specific birth rates were established for the U. S. by averaging births in the different age categories for the years 1959, 1960, and 1961 in order to obtain a more balanced picture of the actual birth trends. The average in each age group was then divided by the population (female) in that age group to get the birth rate for the age group. Once the birth rate for the years 1960 and 1963 have been calculated for the U. S., a comparison of the two will show the post censal period trend for that age group for the entire nation. It is assumed that the same trend exists between the age-specific birth rates in the City of Providence for the years 1960 and 1963. The number of births that occurred in the City of Providence to Providence residents was obtained through a special E.D.P. run of births and deaths from records of the City of Providence Health Department. After estimating the birth rate of the different age groups for the City of Providence for the year 1963, the number of births that occurred in the city is divided by the adjusted birth rate within each individual age group. Hence, the population of each age group was determined for females.

Once more, to elaborate on the method used to determine the adjusted birth rate in each age group, the simple proportion which was used is shown. All the birth rates shown below are age-specific.

$$\frac{1963 \text{ U. S. Birth Rate}}{1960 \text{ U. S. Birth Rate}} = \frac{1963 \text{ R. I. Birth Rate}}{1960 \text{ R. I. Birth Rate-Unknown Quantity}}$$

The following Table II shows the results of the calculations and also the results of the use of the above mentioned proportion.

TABLE II. ESTIMATE POPULATION 15 TO 44 YEARS OLD, FEMALE, PROVIDENCE  
R. I., JULY 1, 1963

United States Population			
Age Group	1960 Birth Rate Per 100,000	1963 Birth Rate Per 100,000	Ratio 1960-1963
15-19	8951	7474	.835
20-24	25886	22647	.875
25-29	19782	18357	.928
30-34	11329	10690	.944
35-39	5649	5157	.913
40-44	1559	1410	.904

  

Providence R. I. Population				
Age Group	1960 Birth Rate Per 100,000	Adj. Birth Rate Per 100,000-1963	No. Prov. Births 1963	Est. Pop. July 1, 1963
15-19	4091	3416	303	8878
20-24	19420	16993	1312	7730
25-29	18930	17567	929	5294
30-34	10551	9960	553	5173
35-39	5192	4740	292	5662
40-44	1089	984	95	6738
Total				39475

# Males 15 - 44

The next component which is to be estimated is that of the males ages 15-44 years old. This component is estimated by two different methods.

## Sex Ratio Method

The first method is called the simple sex ratio method. It is a method which has as its basic assumption the fact that the relationship between the number of males and females in specific age groups remains the same over time, but for adjustments indicative of national trends. For example, during the 1960 census, we measured a specific ratio of males and females from the actual count. In this method, it is assumed that as of the estimate date July 1, 1963, the ratio of males to females in the specific age group in Providence has changed in the same proportion as in the entire country since April 1, 1960. It is obvious too that the number of males in 1963 is estimated from the number of females in 1963. But the number of females in 1963 was itself estimated from age-specific birth rates. Hence the sex ratio method of determining the male population from 15-44 years old is an 'estimate of an estimate'. Because of the increased possibilities of error that come with such a procedure, another estimate of male population using labor force statistics will be made.

Once more, relationships were established between U. S. and Providence data, in this case sex ratios from the 1960 Federal Census. The 1963 sex ratios in the different age categories for the entire U. S. from U. S. Bureau of the Census estimates found in the P-25 Series were obtained. It was again assumed that proportional relationships existed between 1960 and 1963 sex ratios for the U. S. and Rhode Island. Table III shows the actual figures which were used in the sex ratio method.

TABLE III. ESTIMATED POPULATION, 15 TO 44, MALES, PROVIDENCE, R. I.  
JULY 1, 1963

United States Population				
Age Group	Sex Ratio 1960	Sex Ratio 1963	Ratio 1963:1960	
15-19	1.0072	1.0276	1.0202	
20-24	.9536	1.0054	1.0543	
25-29	.9633	.9861	1.0236	
30-34	.9578	.9770	1.0200	
35-39	.9497	.9635	1.0145	
40-44	.9581	.9540	.9957	

  

Providence Population				
Age Group	Sex Ratio 1960	Adj. Sex Ratio 1963	Female Pop. 1963	Est. Male Pop. 1963
15-19	.9780	.9978	8873	8853
20-24	1.0160	1.0712	7730	8280
25-29	1.0003	1.0239	5294	5421
30-34	.9400	.9588	5173	4960
35-39	.9120	.9252	5662	5238
40-44	.8450	.8414	6738	5669
Total				38421

### Labor Force Method

The second method which is employed in estimating the male population of the City of Providence is that which uses statistics concerning the labor force. However, because of the great numbers of men between 15 and 19 who are still in school and not in the labor force, this age group has been omitted from this estimate.

One assumption that is vital to this method is that the age composition of the labor force has not changed significantly during the post-censal years. The total number of males in the labor force for the City of Providence is available for the years 1960 and 1963. Since the labor force statistics are not available for specific age groups, we had to refer to the U. S. Census in order to determine the percent of the labor force which was in each age group of males in 1960. As mentioned, it is now assumed that the same composition and percentages apply to the 1963 labor force figures.

The total labor force of the state was approximately 217,700 in 1960. Table IV shows the number in the labor force of the state for five year intervals for the groups under discussion. The number in each age group is divided by the total in order to obtain the percent of the total labor force that was in each age group. The percentages were then listed under the heading "PERCENT OF TOTAL FORCE". The figures were obtained from the Federal Census Bureau 1960 Census. This results in the percent of the total labor force for the state that is in each age group. It is assumed that these percentages also hold true for Providence.

The next data series is the Department of Employment Security data under the heading of "ALL INDUSTRIES". This series gives only the total number of persons employed in the City of Providence as of 1960 under the All Industries classification. However, the percentages of the total work force that are in the various age groups have been determined for males. Thus, applying these percentages to the total for all industries, we estimate how many men in the different age groups work in the all industries classification. This is listed under "NUMBER OF ALL INDUSTRIES" for April 1, 1960. From the Federal Census are noted the actual number of males in the age-specific groups. A ratio of Civilian Population to the Number of Males in All Industries is now calculated. That ratio is listed under the column "RATIO, ALL INDUSTRIES TO CIVILIAN POPULATION". There are fewer in the civilian population category owing to the fact that more males in each age groups work in Providence than live there.

The next task is to relate these figures to the 1963 population. Once again a total of ALL INDUSTRIES from D.E.S. is available for the City of Providence; only this next series is for 1963. Now applying the same percentages for the total labor force, in individual age groups, we arrive at a labor force figure for 1963. This is noted in the lower half of the table under the date July 1, 1963 and under the heading NUMBER OF ALL INDUSTRIES. A ratio of individuals in the all industries classification to the civilian population has been determined, and now the civilian male population of the City of Providence can be estimated. As noted in Table IV, the total male population from 20 to 44 is estimated at 29,241 by this method.

TABLE IV. ESTIMATED CIVILIAN POPULATION 20 TO 44 YEARS OLD, MALE,  
PROVIDENCE, R. I. July 1, 1963

April 1, 1960					
Age Group	Civilian Pop.	No. in Labor Force	% of Total Labor Force	No. of All Industries	Ratio, All Industries to Civilian Pop.
20-24	7006	18837	8.65	8918	127.3
25-29	5797	20348	9.35	9639	166.3
30-34	6122	25048	11.50	11856	193.7
35-39	6393	28651	13.16	13567	212.2
Total					
Labor Force -		217713			

July 1, 1963			
Age Group	Number of all Industries	Ratio	Estimated Pop.
20-24	8334	127.3	6547
25-29	9008	166.3	5417
30-34	11080	193.7	5722
35-39	12679	212.2	5975
40-44	11205	200.8	5580
Total			29241

In order to check the consistency of the two methods, we compare the methods which we have just discussed. It is interesting to note that by the labor force method it was estimated that the male population of the City of Providence between the ages of 20 and 44 years was 29,241. Using the sex ratio method, the total in Table III for males 15 to 44 was 39,475. However, the group between 15 and 19 years old comprised 8878 of this group. Thus, by the sex ratio method, it was estimated that the group between 20 and 44 was 29,568. The fact that the two estimates by the two different methods are so close argues not only for the accuracy of the methods; but since in the sex ratio method male population was derived from an estimate of the female population, the estimate of the female population which was used in obtaining the estimate of male population is probably a good one also.

Some mention should be made here concerning the troublesome component of both males and females from 15 to 24 years old. Even the Census Bureau has problems with the census counts of these ages, and the estimate is equally difficult. An alternative method to the ones used here is the use of marriage rates by age groups in place of birth rates and sex ratios. The calculations are the same as for birth and death rates, establishing a relationship between U. S. and local rates for 1960 and the estimate year.

However, because of the difficulty in obtaining data for use in this estimate on a regular basis, I am eliminating it from this manual.

### 5 to 14 Year Olds

The five to fourteen year olds are estimated from school census counts. There are no particular problems here aside from adjustments based on relationship of the 1960 school census to the Federal census of 1960. As mentioned previously, it was found from a comparison of the cohort of 7½ to 14½ year olds, that the school census counts more children in this group than does the Federal Census by a factor of 1.02. In order for the school census figures to be in the same frame of reference as the rest of our estimates in this particular manual, the school census counts must be adjusted, and thus reduced to the Federal census level. The school census counts will be divided by a factor of 1.02. Or to put in another way, we shall multiply the school census counts by the reciprocal of 1.02. The reciprocal of 1.02 is .98039. The Table V which follows illustrates this method.

Table V. ESTIMATED POPULATION 5-14 YEARS OLD, MALE AND FEMALE,  
PROVIDENCE, R. I. JULY 1, 1963

Age Group	Number Counted by School Census	Adjustment Factor	Adjusted Population
5	3349	.98039	3283
6	3366	"	3300
7	3204	"	3141
8	3132	"	3070
9	3151	"	3089
10	3024	"	2965
11	3009	"	2950
12	2923	"	2866
13	2776	"	2722
14	2973	"	2915
<u>Total</u>			<u>30301</u>

The remaining cohort to be estimated is composed of children under five years of age. This cohort is estimated by birth counts and survival factors. A migration estimate was also made for this component based upon data compiled in the school census estimate with adjustments made for the subject cohort. Various studies of the migration rate of this cohort have indicated that approximately 1.7 times as many children under five migrate than do these in the cohort from 7.5 to 14.5. Or to put it another way, the migration rate of the cohort under 5 years old is greater than the migration rate of the cohort 7.5 to 14.5 years old by a factor of 1.7.

Specifically the U. S. Bureau of the Census found that this factor was about 1.7. A later study done by Nalbandian corroborated these findings. Using a different data series for the City of Providence, Nalbandian determined by independent means that the ratio should be 1.74. For the purposes of our present study, the approximate figure of 1.7 shall be used. Since we have already arrived at a migration rate for the cohort from 7.5 to 14.5 of 10.45% we can easily calculate the expected migration rate of the group under 5 years old. This calculation yields a result of 17.76 as the adjusted migration rate of the subject cohort.

The estimate date is July 1, 1963. It is therefore necessary to calculate which children are to be enumerated in this study. It is known that all the children who have been born since the taking of the 1960 Federal Census are under 5 years old as of the estimate date since 5 years has not elapsed between the estimate date and the last census. Only those children who were under 5 as of July 1, 1963 are counted. Assuming an even distribution of births over each entire year, we take 3/4 of the 1960 births, all of the births during 1961 and 1962 and one half of the births which occurred during 1963. All of these children have been subjected to the somewhat higher death rate of infants during the post-censal period. The survival factor for this group is .970. There were, however, a small group of children alive at the estimate date who were counted in the census. Since the census was taken 3.25 years ago, these children were at the time of the census less than 1.75 years old. Thus we count all those children who were under one at the time of the census. To this group are added only three-fourths of those who were one year old at the census taking. Here also we are assuming an equal distribution of births throughout the year. This group which was enumerated in the census has a survival factor somewhat higher than the other group since those who were counted in the census were born before the post-censal estimate period and were not subject to the infant death rate during the post-censal period. Table VI which follows shows the actual counts and calculations for the estimate of this final cohort.

TABLE VI. ESTIMATED POPULATION UNDER 5 YEARS OLD, PROVIDENCE, R. I.  
JULY 1, 1963

Census Pop. & Births by Yr.	Number	Survival Rate	Pop. No. Migration	Migration Rate	Estimated Pop.
Pop. under 1					
April 1, 1960	4165	.996	4148	.1896	3362
3/4 1 Yr. Olds					
April 1, 1960	3047	.996	3035	"	2460
3/4 Births 1960	3308	.970	3209	"	2601
All Births 1961	4336	.970	4206	"	3409
All Births 1962	4089	.970	3966	"	3214
1/2 Births 1963	1948	.970	1890	"	1532
Total			20454		16578

This is the last component of this method. The various components will be summed up as follows in order to give us a complete estimate for this COMPONENT METHOD.

under 5 - - - -	16,578
5-14 - - - -	30,301
15-44 - - - -	77,896
45+ - - - -	70,797
<u>TOTAL - - - -</u>	<u>195,572</u>

### Utilities Method

The final method which is to be discussed is the utilities method. Basically this method involves examining the change in the use of utilities in a given area and estimating any change in population in that area as being proportional to the change in the utilities. For example, if in the test there is a certain percent decrease in the number of customers of a utility, then we could expect a proportional decrease in the population. Applying this argument to the City of Providence, we observed that the population of the city in 1963 could be expected to be lower than in 1960.

### Gas Company Customers

In the year 1960 at the taking of the census, there were in Providence about 58,170 individual subscribers to gas fuel. In that year as mentioned, the Federal government took the Decennial Census. Therefore the population of Providence at that time is known. With the assistance of the Providence Gas Company, we can determine that as of July 1, 1963 there were approximately 54,890 customers being served by the Gas Company. It should be noted that because the Gas Company compiles its data as of December of each year, it was necessary to interpolate between December, 1963 and December of 1964 in order to arrive at an approximate figure for the month of July. The same type of interpolation was done in order to arrive at a customer figure for April, 1960.

It is assumed that the change in the number of gas customers reflects a change in population of the city. If the necessary proportion is now set up, we can then estimate the population of the city on the basis of changing customer figures for the estimate date:

$$\frac{58,176}{207,498} = \frac{54,889}{X}$$

Hence the estimate for the Gas Company statistics is 195,765

### Electric Company

Figures obtained from the Narragansett Electric Company provide the numbers of customers which were served by the Electric Company for the last several years. The figures given by the Electric Company were averages of the number of customers for each month in the year. In these estimates the averages for the years of 1960 and 1963 are used. Once more we compared the figures for population supplied by the Federal Census of 1960 and estimated the population in 1963 on the basis of changes in the number of customers of the Electric Company. The calculations are as follows.

$$\frac{73,100}{207,498} = \frac{69,900}{X}$$

In this case the estimate is 198,415.

If the two utility estimates are averaged, the final estimate of this method is 197,090.

: Other Utilities

: Since the information of the Telephone Company is for the present kept  
: by exchanges only, and these exchanges overlap city boundaries, in-  
formation which was useful for the purposes of this study was not  
available. Information supplied by the Water Supply Board likewise  
proved to be not helpful in this particular study.

### Average of Estimates

Before proceeding to the discussion of the daytime population the results of averaging the various estimates will be shown. The individual estimates which were made were based on characteristics of individual segments of the population such as the birth and death rates, and also the labor force. Each of the individual factors is subject to different causal relationships. No effort was herein made to describe or to explain any of the causes which effect population change, but merely to devise systems for consistently measuring those changes. However, since these may be subjective changes; stemming in part from individual characteristics of the various cohorts, we are averaging the various estimates. Table VII which follows shows the different estimates and the average of all the different estimates.

TABLE VII. INDIVIDUAL ESTIMATES: RESULTS OF AVERAGING OF INDIVIDUAL ESTIMATES, PROVIDENCE, R. I. JULY 1, 1963

Description of Estimate	July 1, 1963
	Estimate
Vital Rates (Birth)	201,865
Vital Rates (Death)	203,900
Census Bureau Method	197,533
Component Method	195,572
Utilities Method	197,090
AVERAGE OF ESTIMATE	199,192

The last figure of 199,192 which is the average of all the estimates is probably the best estimate which can be made at this time.

### Resident Population by Census Tracts

In an effort to estimate current population by Census Tracts certain assumptions are necessary. Because no reliable figures are available for birth rates and death rates for the individual census tracts, it shall be assumed that the city-wide average prevails in these smaller areas. The dominant force which is evident in the population change of the City of Providence during the post-censal period is migration. It has already been shown that the population of Providence in 1963 is near 200,000 people. If it is assumed that the migration in the census tracts is indicative of the total population change, than we can use our knowledge of migration in the census tracts in order to estimate the population change in each tract. The result of the following discussion can be noted in the table entitled "Resident Population", on pages 30 and 31.

Chapter 2

POPULATION ALLOCATION BY CENSUS TRACT

This section discusses the method of allocation of population change in Providence among the various census tracts of the city. Two basic series were used in this allocation: a series derived from migration data on school children and families among the various tracts, and a vital rates series calculated for each tract.

Absolute numbers of migrants consisting of children and families were obtained from the annual Providence School Censuses for the entire post-censal period of estimate from April 1, 1960 to January 1, 1964. These counts were adjusted to represent approximately 85 percent of the total migrating population.

Two additional studies bear out the rationale for this adjustment. Mayer and Goldstein in their study of Providence population in 1961 found an adjustment factor of approximately 80 percent for this population, and Bogue in his migration studies for the Bureau of the Census found a figure of about 80 percent for the State of Rhode Island.

Using 85 percent adjustment, the inter-census tract migration pattern based upon the school census data for Providence is as follows for the post-censal period:

TABLE I. INTER-CENSUS TRACT MIGRATION; APRIL 1, 1960 to JANUARY 1, 1964,  
TOTAL POPULATION, PROVIDENCE, R. I.

Census Tract	Net Migration	Census Tract	Net Migration
1	+ 8	20	- 59
2	+ 2	21	- 5
3	- 8	22	- 213
4	+ 89	23	+ 111
5	- 458	24	+ 110
6	- 243	25	- 185
7	- 797	26	- 576
8	- 141	27	- 291
9	- 284	28	+ 15
10	- 173	29	- 108
11	- 332	30	- 114
12	- 492	31	- 908
13	+ 83	32	- 2
14	- 68	33	+ 50
15	- 743	34	+ 215
16	- 176	35	- 150
17	- 150	36	- 84
18	- 648	37	- 353
19	- 414		

Using a combined vital rates estimate of population by census tracts, Mayer and Goldstein in the previously cited study found that using school census counts 34 census tracts showed out migration and that 33 tracts showed an out migration using vital statistics estimates. In the present study of the post-censal period, using school census data 26 census tracts show an out

migration; vital statistics estimates show that 21 census tracts have an out migration. Since the school census counts appear to be more reliable than vital statistics data for small areas and short time periods, school census counts were used as the basis for apportionment of the total population loss among the various tracts. It will be noted that the adjusted migration of the school census count of children and families and the total population loss estimated from the four estimate methods used independently are very close in their respective estimates.

#### Peak Daytime Population

The daytime population estimates discussed in this manual are structured by component estimates of at-home population, at-work population, in school population, on-street population, and shopping and services population. Each of these components was estimated separately and summed to estimate daytime population. It must be borne in mind that the present estimates are estimates of peak daytime population. Thus, when a certain number of shoppers is estimated as the downtown peak, this does not refer to the total number of shoppers but simply to the maximum number of shoppers found downtown at any single time during the entire day. The same applies to the other population components. Since these are 8 A.M. to 6 P.M. population estimates, it is obvious that the in-school population, for example, will sometimes form part of the peak daytime population and at other times will become a part of the at-home or residential population. The estimate of each of the population components of daytime population will be discussed separately.

#### At-Home Daytime Population

The at-home population estimate is essentially a residual population estimate of daytime population after the other components have been estimated and applied to the total residential population. The in-school, at-work, on-street, and shopping and services populations are determined and the numbers of these populations leaving given areas are estimated. The remaining residential population then becomes the at-home population.

The in-school population was assumed to be equally distributed in relation to the residential population; that is, that school children leave home to go to school in the same proportion as the total number of people who live in the area. Although it is true that some families send several children to school while others have no school children in the family, these differences should cancel out. Therefore, using the school population through Grade 12, this population can be subtracted from the residential population.

The at-work population like the school population was estimated to be generated in the same manner as the residential population is distributed. Consideration must be given to people coming from out of Providence to work in Providence and to those workers living in Providence and working outside the City limits. Once these adjustments have been made, the number of workers can be subtracted from the residential population.

The on-street population, like the two previous components, is also assumed to be proportionally generated by the residential population.

Shopping and services population in food stores and neighborhood commercial establishments is assumed to be a part of the residential population of the given area. Shopping and services population in the downtown area and the major satellite shopping areas is assumed to come from outside the district in which the shopping and service center is located, and is also assumed to be equally generated by the residential population.

In a previous estimate of the at-home population made by Nalbandian for the firm which carried out the Providence Shelter Survey, it was found that the at-home population was about 38 percent of the residential population. In the present survey or population estimate, it was found that the at-home population was about 41 percent of the residential population. The Stanford Research Institute regression equation for estimating at-home population gives a factor of 40 percent when the equation is applied to Providence. Since the three independent estimates are so close, the figure of 40 percent was used for Providence in the present estimate.

It must be remembered that unlike the residential population estimates, there is no parameter for the daytime population estimate. Therefore, when possible, more than one estimate should be made of each daytime population component with the possible exception of the in-school population which can be obtained with a high degree of accuracy from school enrollment figures supplied by the School Department.

#### At Work Daytime Population

The at-work population was estimated by two independent methods; the adjustment of a seven-year-old count supplied to the Bureau of the Census by the Rhode Island Department of Employment Security, and a peak population method involving traffic studies and an origin and destination study. Each will be discussed in turn. It should be stated here that several different parameters are available for this -population component, including the 1960 count by the Bureau of the Census. The main problem is the distribution of this population within the City itself rather than the estimate of the total number of workers. It should be stated also that the Department of Employment Security is even now running a series showing the number and type of workers by Census Tracts in Providence, but this series will not be available in time to be used in this manual. However, once the series is completed it can be used in place of the present estimate procedure.

The 1950 D.E.S. at work count of covered employment was adjusted to include government employees at that time. The subtraction of the estimated covered employment from the final total employment gives the number of government workers by census tract location. Since these locations for government employment have changed very little over the seven year period, it was necessary only to distribute proportionately the new total for government workers in 1964. By the same token, the total employment in Providence for 1964 is available from D.E.S. summary

reports, particularly in the print-out series supplied to the State Transportation Study by D.E.S. Experts in the City of Providence Plan Commission were consulted for major changes in places of employment in Providence during the seven-year interval in question. On the basis of this information, the total employment in Providence was distributed among the various census tracts. Once again, it should be emphasized that the employment totals for Providence in the various years are available from several sources, including a recent study done by Brown University Department of Economics as a sub-contractor for the Community Renewal Plan. Also, employment in the downtown area has been counted by different agencies including the Bureau of the Census. Once the downtown employment is subtracted from the total Providence employment, distribution can be made of the remaining at-work population during the daytime.

An independent estimate of downtown employment was made by using a peaking technique based upon bus transportation quarter-hourly figures which included an origin and destination study of these passengers. Moreover, traffic counts of the total number of persons entering and leaving the downtown area are made monthly and annually. The State Transportation Study has completed the major portion of an origin and destination study which included the Providence Downtown Area as a separate component. The at-work estimate proceeded as follows:

1. Beginning at 6:00 A.M. and including the 8:30 downtown destination, all bus passengers who remained downtown were assumed to be there for working purposes. Ninety percent of the passengers remaining downtown and arriving between 8:30 and 9:00 A.M. were assumed to be working. These transportation counts included entering and leaving the downtown destination so remaining populations can be estimated. This at-work bus population is about 11,000 people.

2. The total number of bus passengers from 6:00 A.M. to 6:00 P.M. is known. The at-work population comprises 17 percent of this total population.

3. The total number of auto drivers and passengers entering and leaving the downtown area during the day is known. Assuming the same proportion of at-work passengers as by bus transportation, 17 percent is about 19,000 people who can be assumed to be at work in the downtown area.

4. Using the same percentage of pedestrian counts, about 5,000 people can be assumed to walk to work in the downtown area. Adding these at-work counts gives a total of about 35,000 people at work in the downtown area, which corresponds very closely with several other independent estimates of this component. The usefulness of the above procedure will become apparent in the estimate of the shopping and services peak population.

Although the total employment for Providence as a whole shows a slight decrease for the post-censal period, it should be kept in mind that the downtown employment increase is a function of the changing pattern of downtown services and can be reconciled with the total employment estimates for Providence. As in the residential population estimates, the combination of several different estimates is probably better than any

single estimate and is used in the present daytime evaluation of the population, particularly for the downtown area.

#### In-School Daytime Population

The in-school daytime population is the easiest of the daytime components to estimate. Data for attendance at Providence public schools through Grade 12 was obtained from the Providence School Department. Data for parochial schools by individual location and private schools by total attendance was also obtained.

These schools were then coded by census tracts to conform to estimates made for other daytime components, even though a separate plan was drawn up for school children. The census tract coding permits an estimate to be made of peak population during the day by census tracts. The principal function of coding school population by tracts is in areas where no separate school plan has been prepared.

#### On-Street Daytime Population

The on-street daytime population component is a relatively small part of the total daytime population. The present estimates of this component have been derived from traffic counts supplied by the Department of Traffic Engineering of Providence, and have been adjusted to average passenger-per-car figures. Distribution by Census tracts was made from capacities and flows of the main highways within each tract. Once again, an earlier Bureau of the Census estimate was useful in the present context. This component has been combined with the shopping and services component.

#### Shopping and Services Population

The peak shopping and services population by Census Tracts was estimated separately for the downtown area and for other areas in Providence. Aside from the downtown and satellite shopping and service centers, a constant was used for the remaining Census Tracts. The method for estimating peak shopping and services population for the downtown area was basically the same as for one of the at-work population estimates for the same area, and proceeded as follows:

1. The number of bus passengers by 15 minute intervals entering and leaving the downtown area was known.
2. The peak population of the total number of bus passengers in the downtown area during the day was known. This occurred about 1:30 P.M.
3. The percentage of the total number of working population to the shopping population of bus passengers was known.
4. The peak population of shoppers in relation to the total number of bus passengers during the day could then be derived. This was about 6,000 persons.
5. The total number of automobile drivers and passengers during the day with the downtown area as their destination was known.

6. The same percentage of workers and shoppers for the private automobile as for the bus -passengers was assumed.
7. A peak population of shoppers arriving in the downtown area by private transportation could then be deduced. This was about 11,000 people.
8. Pedestrian counts of those entering and leaving the downtown area during the day were known.
9. Assuming the same proportions of workers and shoppers as for the bus passengers, the peak number of shoppers reaching the downtown area on foot could be estimated. This was about 2,500 people.
10. Adding the totals for bus, private automobile, and walking arrivals, the peak shopping population for the downtown area could be estimated. Allowing for some estimate error, a peak population of about 20,000 people in this component seems to be indicated.

It should be emphasized here that the population in question is not a total population of those people coming downtown for shopping and services, but a peak population. It may well be that more than 20,000 people come downtown during the course of a normal business day to shop and receive various kinds of services, but not all of these people are found downtown at the same time. The analysis of the bus passengers shows that the maximum number of such passengers are within the downtown limits sometime between 1:00 P.M. and 2:00 P.M., and this time period has been adopted here as the peak population hour.

#### Total Daytime Population

Finally, the various components of the daytime population can be summed to obtain an estimate of the peak daytime population by Census Tracts. However, since separate CSPs have been drawn up for the various daytime population components estimated here, only the downtown area needs to be summed in terms of a total census tract population. It appears to be a defensible procedure to estimate the peak downtown population of Providence at the present time as consisting of not more than 60,000 people. This estimate is necessary also to determine the surplus shelter capacity remaining for the population found outside downtown but which must be sheltered downtown. The various component estimates are shown in the following Table.

POPULATION ESTIMATES JANUARY 1, 1964, PROVIDENCE, R. I.

Census Tract	Nighttime Population			Daytime Population				
	Resident Population	Nighttime Work, Shop- ping & Services	Peak Nighttime Population	At Home Daytime	In School Daytime	At Work Daytime	On Street Shopping & Services, Days	Peak Daytime Population
1	7542		7542	3017	645	3420	700	7782
2	8710		8710	3484	975	2563	600	7622
3	6933		6933	2773	1985	1627	700	7085
4	6420		6420	2568	835	598	100	4101
5	6388		6388	2555	1905	684	300	5444
6	3390		3390	1356	1265	1454	400	4475
7	6867	2100	8967	2747	2715	9403	1600	16465
8	774	28000	28774	310	770	35000	20000	56080
9	4500	800	5300	1800		2736	800	5336
10	4527		4527	1811	1919	425	200	4355
11	4876		4876	1950	815	1109	400	4274
12	4329		4329	1732	585	1440	400	4157
13	5467		5467	2187	650	338	200	3375
14	6582		6582	2633	290	1541	300	4764
15	3096		3096	1238	175	4500	250	6163
16	6802		6802	2721	775	511	300	4307
17	3953		3953	1581	330	259	300	2470
18	6145		6145	2458	1755	173	200	4586
19	6440	2100	8540	2576	1695	4190	1800	10261
20	3739		3739	1496	510	338	200	2544
21	9122		9122	3649	3872	259	200	7980
22	5287		5287	2115	1125	5983	800	10023
23	6029		6029	2411	915	770	600	4696
24	7076		7076	2830	3135	943	500	7408
25	3221		3221	1288	398	3000	1700	6386
26	5650		5650	2260	1605	1109	350	5324
27	5177		5177	2071	490	943	100	3604
28	5676		5676	2270	1105	1109	100	4584
29	6662		6662	2665	1510	425	250	4850
30	378		378	151		2500	1000	3651
31	3812	1000	4812	1525	1033	1706	1000	5264
32	4376	100	4476	1750		173	100	2023
33	5577	2340	7917	2231	935	1109	2000	6275

Census Tract	Nighttime Population		
	Resident Population	Nighttime Work, Shop- ping & Services	Peak Nighttime Population
34	5684		5684
35	5909		5909
36	7395	1400	8795
37	5495		5495
Total	200006	37840	<u>237864</u>

Daytime Population				
At Home Daytime	In School Daytime	At Work Daytime	On Street Shopping & Services, Days	Peak Daytime Population
2274	1565	684	300	4823
2364	640	1282	1000	5286
2958	2889	2736	1400	9983
2198	945	943	500	4586
80003	42756	97983	41650	<u>262392</u>

Chapter 3

POPULATION ANALYSIS AND PROJECTION

Several different estimates of the future population of Providence follow. All of these estimates have as their rationale the prediction of population from past experience. The hazards of predicting future populations for small areas like Providence are too well known to be labored here. The various techniques applied to the present estimates will be discussed as they are presented.

However, it can be assumed that Providence has a continuing relationship to the larger functional areas with which it is integrated. In the present instance, these areas might be assumed to be Providence County, the three counties which border on Providence, the Standard Metropolitan Statistical Area as defined by the Bureau of the Census, and the State of Rhode Island.

Therefore, it was decided to make estimates of the future population of Providence in relation to the four larger population entities cited above. The details of the various estimate methods are contained in Appendix I which is submitted with this manual. Here, only summaries of both the method and the estimate figures are given.

Before any particular time-series method can be selected, the problem of determining which of the many past observations shall be used as a basis for future projections presents itself. For example, in the United States as a whole, if data for the entire population history of the country are used as the basis for projections, a best-fit curve applied to the data results in a curve which approaches Pearl's logistic curve. On the other hand, if data for the present century alone are considered, a best-fit curve results in a section of a parabola. Similarly, the selection of a population base for projecting Rhode Island population is the key element in the projection of its population.

The population pattern of the State shows a relatively consistent pattern of population change between 1870 and 1910. The rate of population increase during each of the decades of this period was about 25 percent. Also, the rate of urban growth in size and number of cities of the State was about 30 percent between 1890 and 1900, and between 1900 and 1910.

Beginning with the year 1920, a new cycle of population development in Rhode Island seems to have begun. The consistent increase in urbanization previously pointed out began to decline, and the suburban areas of the State entered upon their present growth cycle. The economy of the State which had previously been based upon the textile industry entered upon a period of transition; some textiles moved to the Southern part of the country and were partially replaced by a growth in jewelry and other small industries, as well as an increase in service trades.

Furthermore, aside from the relatively intuitive arguments presented above, there is some empirical evidence that the present population cycle began in 1920. It must be remembered that the principal assumption inherent in population projections used in a particular data series is that the series is internally consistent, and that any portion of the series which is projected will give results which are consistent with the data from other portions of the series. The base points of 1900, 1910, 1920 and 1930 were

tested for this assumption, and only the 1920 point returned consistent results. Furthermore, an independent study by Mayer and Goldstein of Brown University adduced additional evidence that the present Rhode Island population cycle began in 1920. For these reasons, the population projections in this manual have been carried out using a population pattern which began in 1920 and which is assumed to continue to 1970. The basic data are, of course, the decennial population counts of the Bureau of the Census from 1920 to 1960.

Projections of Providence Population and Providence Functional Area Populations

An initial series of projections was made for Providence and for the four functional areas previously defined: Providence County, Providence, Bristol, and Kent Counties--these three were included since they form the basis for the Rand Corporation series of projections which will be discussed later--, the Standard Metropolitan Statistical Area as defined by the Bureau of the Census, and the State of Rhode Island. The projection estimates follow:

Providence	<u>163,000</u>
Providence County	<u>544,000</u>
Providence, Bristol, and Kent Counties	<u>738,000</u>
SMSA	<u>761,000</u>
Rhode Island	<u>926,000</u>

As will appear later, the straight extrapolation estimate for the City of Providence is almost certainly too low. The cycle seems to hold for the larger areas of Three Counties, the SMSA, and the State as a whole, but the best-fit curve for Providence is too much influenced by the sharp population loss in the 1950-1960 decade. A straight line fit would minimize this influence, but it seems that this would be an artificial adjustment. It is better to discard the above type of estimate for Providence.

A second series of projections was made using the various decennial relationships of Providence to its functional areas and applying this relationship extended to 1970. The relevant Tables are cited in the Appendix to this report. Once again, the influence of the sharp change in the 1950-1960 relationship of Providence to the subject larger areas influences the population estimate to the point that the resulting estimate for Providence is almost certainly too low an estimate. The various estimates are as follows:

Providence:	Providence County	<u>166,500</u>
Providence:	Providence, Bristol, and Kent Counties	<u>162,400</u>
Providence:	SMSA	<u>159,800</u>
Providence:	State of Rhode Island	<u>152,800</u>
Average of Estimates		<u>160,300</u>

Estimates of Providence Population Related to Projected Labor Force;  
Providence and Various Functional Areas

The economics department of Brown University and Hammer Associates of Washington, D. C. made a series of labor force projections for 1970 for the other areas of Rhode Island. Using these labor force estimates in relation to known and estimated populations, it is possible to derive some estimates of Providence population for 1970. Once again, details of this procedure are given in the Appendix. Taking as a base point the 1950 and 1960 counts of population and labor force for Providence and Rhode Island, and extending these relationships to 1970 gives the following estimates for Providence population in 1970:

Providence	<u>195,600</u>	(Using Extrapolated Rand Estimate for state 1970)
"	<u>205,800</u>	(Using Mayer-Goldstein Estimate for state 1970)

Cohort-Survival: Natural Increase Population Estimates for Providence

At least five different cohort-survival estimates of Providence and Rhode Island population have been made since the 1960 Bureau of the Census count became available for these populations. Three of these will be discussed here: Mayer and Goldstein's study done by Brown University for the Rhode Island Development Council and hereafter cited as M-G Study; the Rand Corporation study for the three counties of Providence, Bristol, and Kent combined and hereafter cited as the Rand study, and the State Transportation Population Study done in conjunction with the Bureau of Public Works Study of State Transportation and hereafter cited as the Transportation study. The Rand study projects the 1970 population only for the three counties; the M-G study projects the 1970 population for the State, Counties, and individual cities and towns of Rhode Island; and the Transportation Study projects the 1970 population with Census Tracts as the smallest unit.

Both the Rand and the Transportation Study use a five-year cohort-survival time period, while the M-G study uses a ten-year period. Both the M-G study and the Transportation Study hold the birth rate constant during the projection period; the Rand study uses an age-specific adjusted birth rate. All the three studies assume a constant death rate, although the Rand study does contain some minor adjustments in cohort death rates. The Rand and Transportation studies use 1960 rates; the M-G study uses the average of annual 1950-1960 vital rates.

Before turning to a discussion of the various migration assumptions in the cited studies, the natural increase or closed population projections should be examined. All three of these studies, due to the methods by which they are carried out, give essentially the same estimate of natural increase for Providence for the 1960-1970 decade. This estimate is about 17,000 people. However, actual natural increase data for Providence for the period of April 1, 1960 to January 1, 1964 show an increase of about 5,000 people; the actual figure is 5,146. Using 5,150, an

extrapolation of this pattern of natural increase to 1970 would give a natural increase for Providence of less than 14,000 for the decade as against the 17,000 estimate using past birth and death rates. Since the death rate can be assumed to hold relatively constant during the 1960-1970 time period, it must be assumed that the birth rate in Providence is declining, and the existing birth-rate assumptions must be modified.

However, it should again be emphasized that the population projections for the larger areas and for the State as a whole are probably more accurate than those made for an area as small as Providence; nevertheless, for purposes of this Phase report, an estimate of the future population for Providence alone must be made. Much more serious than the vital rates assumption are the assumptions of migration for an area such as Providence. While the Rand study makes projections only for the three-county area, both the M-G and the Transportation studies consider either individual cities and towns or census tracts. Both these latter studies make estimates for the State as a whole for 1970, and force the smaller areas to agree with the projected State totals. The Rand study makes projections for a closed population--that is a population with no migration--and for five-year periods using one-half the migration rate for the previous decade, adjusting the population each five years to include this migration before further cohort-survival estimates are carried out. The Transportation study uses one-half the previous decade migration rate for the first five-year projection period, and one-fourth of the 1950-1960 migration rate for the second five-year period of 1965-1970. The M-G study divides the State into distance zones using the urban complex of Providence-Pawtucket-Central Falls as one central city and Woonsocket for the other. The second zone consists of the immediate suburbs of these two central city complexes. The third zone is called the peripheral suburbs, and the rest of the States comprises the fourth zone. The M-G study projects three populations for each city and town of the State, all using the same natural increase assumptions. For the 1970 projections, the first series assumes three-fourths of the 1950-1960 migration rate for Zones 1 and 2, and the total 1950-1960 migration rate for Zones 3 and 4. The migration for the State as a whole is derived from the summation of individual city town migrations using these assumptions. The second series uses the same assumptions as series I except that the net migration for the State is assumed to be zero, and individual city and town migration estimates are forced to conform to the zero assumption for the State. The third series uses the same basic assumptions except that individual city and town migrations are forced to conform to an assumption that the State migration is at the same rate for 1960-1970 as it was from 1950-1960, and individual city and town migration must add up to the State total.

The importance of the various migration assumptions becomes clearer when the three population estimates of the M-G study are examined for Providence in 1970. It will be remembered that the migration assumptions for Providence are the same for all three series estimates except for the fact that the first series is not forced to conform to any State total, the second series is forced to conform to a State net migration of zero, and the third series is forced to conform to a State migration total

which assumes the same migration for Providence in the three series ranges from an out-migration of 38,000 people to an out-migration of almost 50,000 people. This difference would be even larger if differential migration estimates for Providence itself were adopted. For example, if it were assumed that the same rate of migration would prevail in the 1960-1970 decade as existed in the 1950-1960 decade, the total out-migration of Providence would be more than 50,000 people. On the other hand, if no net migration were assumed for Providence in the estimate decade, the population estimate would change by the same 50,000 plus figure. The differential migration estimates between these extremes likewise influence the final population prediction.

As for the natural increase, it is useful to examine the actual post-censal pattern of migration from the last 1960 census count to January 1, 1964. Using the school census figure as a basis for estimate and making the proper adjustments to the total population in accord with the Federal census counts, the migration rate for Providence during this post-censal period can be estimated to be about one-fourth of the rate which was obtained during the 1950-1960 time period. The closest approximation to this rate is the assumption adopted by the Transportation study which assumes one-half the 1950-1960 rate for the 1960-1965 period and one-fourth the 1950-1960 rate for the 1965-1970 period. Both the M-G study and the Rand study seem to have adopted migration assumptions which are too high, and which give an estimate of 1970 Providence population which are as a result of the migration assumptions, too low. However, these high out-migration assumptions are somewhat balanced by the high estimates of natural increase. The population estimates for Providence for 1970 of the three cited studies follow:

Mayer and Goldstein:	Series I	<u>186,100</u>
Mayer and Goldstein:	Series I	<u>181,400</u>
Mayer and Goldstein:	Series III	<u>174,800</u>

Rand:	Series I	<u>174,000</u>
Rand:	Series II	<u>164,000</u>

State Transportation: 185,700

#### Providence CSP Estimates, Residential Population-1970

On the basis of the previous analysis, it was decided to adopt a different frame of reference for estimating Providence population for 1970. It should be borne in mind that the post-censal population estimates given in Phase IV of this CSP included both the natural increase and the migration components. Therefore, it is assumed that the pattern of natural increase and migration of the post-censal period from 1960 to 1964 will continue during the 1960-1970 decade. It becomes necessary, then, simply to extrapolate the post-censal trend through the decade in question. This gives a parameter of population change for Providence as a whole which can then serve as the basis for allocation of this population change among the various census tracts of the City. The extrapolation of the post-censal trend through the decade gives an estimate of Providence population for 1970 of about 185,000. Details of this extrapolation are contained in the Appendix to this Phase report.

It can be seen that this estimate is relatively high when compared to most of the other estimates, although it approaches the Transportation estimate and Series I of the Mayer-Goldstein estimate. It will be recalled that the Transportation migration assumption closely approximates the actual post-censal migration rate, and Series I of the Mayer-Goldstein study has a relatively high natural increase to offset the higher migration rate assumption. Also, the Series II M-G estimate is not forced to agree with any state total.

#### Allocation of Population Change, Providence-1970

Once the total population estimate for Providence for 1970 has been secured, the problem of allocating this population change among the different census tracts presents itself. Three different allocative processes were used in this procedure. The first allocation series was based upon the known population changes during the post-censal period as explained in Appendix V of Phase IV of the CSP. In the first series, it was assumed that population changes in specific census tracts would continue in the same pattern as in the post-censal period; these changes were then extrapolated through the 1960-1970 decade. This procedure resulted in an estimated population of about 187,500 as against the extrapolated total of about 185,000. This is presented as Series I in the Appendix.

A second allocation series was made which forced the total of population change to agree with the Providence total of 185,000. This is presented as Series II in the Appendix.

Finally, a third series was calculated using the population parameter of 185,000 and allocating the population change in the decade on the basis of known variables which will be introduced in the 1960-1970 decade. The specifics of this Series III are contained in the Appendix. For example, known housing construction anticipated before 1970 in specific census tracts gives estimates of increased population expectations. Not only planning experts in the City Plan Commission were consulted, but private developers were asked their opinions about future development in specific areas of Providence. Using the first series as a guide, Series III was evolved as the best opinion of a given population change in Providence. This Series III is the basis for recommended shelter development in Providence.

RESIDENTIAL POPULATION ESTIMATE, 1970, PROVIDENCE, R.I.

<u>CENSUS</u> <u>TRACT</u>	<u>SERIES I</u>	<u>SERIES II</u>	<u>SERIES III</u>
1	7555	6711	7500
2	8713	7767	8700
3	6920	6183	6900
4	6568	5640	6500
5	5625	6098	5300 (1)
6	2985	3236	2000 (2)
7	5539	6827	4000 (3)
8	539	815	2400 (4)
9	4027	4262	4000 (5)
10	4239	4187	4200
11	4323	4639	4200
12	3509	4295	3500
13	5605	4796	5500
14	6469	5924	6400
15	1858	3420	2300 (6)
16	6509	6216	6500
17	3703	3655	3800
18	5065	6051	5200
19	5750	6106	5600
20	3641	3383	3800 (7)
21	9114	8130	9100
22	4932	4899	4700 (8)
23	6214	5272	6200
24	7259	6205	7200
25	2913	3034	2600 (9)
26	4690	5546	4500
27	4692	4871	5500
28	5701	5043	4700
29	6482	6031	6400
30	188	438	300
31	2299	4205	4000 (10)
32	4373	3900	4300
33	5660	4923	5800
34	6042	4872	5800
35	5659	5397	6000
36	7255	6662	7200
37	4907	5209	4700 (11)
TOTAL	187522	184838	187300

( 1 ) - CRP recommended for clearance for industrial use.

( 2 ) - "

( 3 ) - CRP recommended for clearance.

( 4 ) - Weybosset Hill Development.

( 5 ) - CRP recommended clearance for residential and commercial rehabilitation.

( 6 ) - Possibility of arrested area development.

( 7 ) - CRP recommends development of the arrested area.

( 8 ) - CRP recommended for clearance for industrial use.

( 9 ) - "

(10) - Lippitt Hill Development.

(11) - Highway clearance program.

## APPENDIX I

This Appendix is concerned with methods of predicting population for Providence for 1970. Estimates in this series are based on straight population cycle extrapolation, extrapolation of relationships of Providence to larger functional areas, cohort survival and migration assumption methods, and extrapolation of post-censal trends through the decade in question.

### Extrapolation of Population Cycle

The present population cycle of Rhode Island can be assumed to have begun in 1920 as explained in the body of this report. Straight extrapolation of this cycle for the several areas of Rhode Island using the decennial Bureau of the Census counts as a base and fitting a least squares curve to the given observations produced the following results:

$$\text{Providence: } y = 200,000 + 44,200x - 8,400x^2 \quad x=6 \text{ (1970)} \quad y = 163,000$$

$$\text{Providence County: } y = 411,400 + 76,700x - 9,100x^2 \quad x=6 \text{ (1970)} \quad y = 544,000$$

Providence, Bristol, and Kent Counties:

$$x=6 \text{ (1970)} \quad y = 738,000 \quad y = 481,600 + 66,100x - 3,900x^2$$

$$\text{Providence SMSA: } y = 482,000 + 65,100x - 3,100x^2 \quad x=6 \text{ (1970)} \quad y = 761,000$$

$$\text{Rhode Island: } y = 557,000 + 52,500x - 3,100x^2 \quad x=6 \text{ (1970)} \quad y = 926,000$$

### Extrapolation of Relationships of Providence to Functional Areas

Using the same 1920-1970 population cycle, the total populations of Providence and the four functional areas previously cited were extrapolated in terms of the relationship of Providence to each of these areas during the decennial count periods. The resulting equations give an estimate of the relationship of Providence to each of these areas for 1970. Since estimates of the population of the larger areas are usually more accurate than population estimates for smaller areas, an attempt was made to predict Providence population estimates relationships. The population estimates of the larger areas which were used in applying the projected relationships were the population estimates resulting from the previous least-squares equations projected to 1970. The results of this procedure follow:

$$\text{Providence: } y = .491 + .0088x - .0066x^2 \quad x=6 \text{ (1970)} \quad y = .306$$

$$\text{Providence: } y = .430 + .013x - .008x^2 \quad x=6 \text{ (1970)} \quad y = .220$$

$$\text{Providence: } y = .433 + .0115x - .0081x^2 \quad x=6 \text{ (1970)} \quad y = .210$$

$$\text{Providence: } y = .380 + .017x - .0088x^2 \quad x=6 \text{ (1970)} \quad y = .165$$

Population Estimate Providence: Providence County 1970:	166,500
Population Estimate Providence: Three Counties 1970:	162,400
Population Estimate Providence: Providence SMSA	160,000
Population Estimate Providence: Rhode Island	153,000

## APPENDIX I (Cont.)

### Extrapolation of Relationship of Population to Labor Forces

In this procedure it is assumed that the population of Providence and the population of Rhode Island are known from the census counts of 1960. It is also assumed that the size of the labor force of both Providence and Rhode Island are known for 1970 from projections made by the Brown University Department of Economics for the Providence Community Renewal Plan. The population of Rhode Island is also assumed to be known for 1970. Therefore, using the existing relationships of population to labor force, it is possible to derive an estimate of the population of Providence for 1970.

Two series were attempted: one uses the manufacturing employment of the two areas of Providence and Rhode Island, the other uses total labor force figures, holding unemployment constant.

In the manufacturing employment series, the relationship of total population of Rhode Island related to manufacturing employment is .1457. In 1960. In 1970, using the Rand estimate of population, the Rhode Island relationship changed to .1443; using the M-G estimate, the relationship changed to .137. Applying these relationships to Providence, the Rand estimate gives a population estimate for Providence in 1970 of about 213,000 people; the Mayer-Goldstein estimate gives a Providence estimate for 1970 of about 224,000. It is obvious that manufacturing employment cannot be used to estimate total population due to the changing economic composition and function of the central city of Providence.

Using total employment rather than manufacturing employment does not improve the 1970 estimates for Providence very much. Employing the same technique, total employment with the Rand estimate gives a Providence estimate for 1970 of about 196,000 people; the Mayer-Goldstein estimates gives a Providence estimate for 1970 of about 206,000. This total procedure is given here to show that not all data series can be fruitfully applied to population estimates, especially when the total population of an area must be obtained.

### Cohort-Survival-Natural Increase Population Estimates

The various techniques and assumptions of cohort-survival and migration population estimates have been discussed in the body of this report. The method of extrapolating the post-censal pattern of population in Providence up to January 1, 1964 through the decade of 1960-1970 has also been explained. The original estimate parameter adopted for Providence in 1970 using this method is about 185,000 people.

## APPENDIX I (Cont.)

### Allocation of Population Change, 1960-1970

The method of allocating post-censal population change was explained in the body of this population manual. In allocating the estimates population change in 1970, three different series are presented here in the last table of this report. The first series extrapolates the trend of 1960-1964 population through the decade. The second series extrapolates the post-censal trends but forces the total population to agree to 185,000 people in 1970. The third series represents the best estimates of census tract populations using actually begun or proposed urban renewal projects in Providence up to 1970, and incorporates expert City Plan Commission advice and objectives as well as demographic techniques as such. Notes concerning the various assumptions are included in the cited Table.

# IN CITY COUNCIL

MAR 3-1968

FIRST READING  
REFERRED TO COMMITTEE ON URBAN REDEVELOPMENT  
RENEWAL & PLANNING

.....  
*Vincent Vespia*, CLERK