



**Cavanaugh Macdonald**  
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## **Connecticut State Teachers' Retirement System**

**Experience Investigation for the Five-Year  
Period Ending June 30, 2019**



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SR\_GEXPSTD19\_200625



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CONSULTING, LLC

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June 24, 2020

Board of Directors  
Connecticut State Teachers' Retirement System  
765 Asylum Avenue  
Hartford, CT 06105

Members of the Board:

We are pleased to submit the results of a study of the economic and demographic experience for the Connecticut Teachers' Retirement System (System). The purpose of this study is to assess the reasonability of the actuarial assumptions and methods for the System. The actuarial assumptions are used by the actuary to provide a best estimate of the value of all benefits expected to be paid by the System over future years. The valuation uses various methods in determining the required funding necessary to accumulate a sufficient amount of assets to fully fund the expected benefit payments.

This experience study covers the five-year period from July 1, 2014 to June 30, 2019. The timing for this study has been accelerated one-year in order that the changes in assumptions can be implemented in the June 30, 2020 actuarial valuation rather than delayed to the subsequent June 30, 2022 valuation date. As a result of the study, it is recommended that revised assumptions be adopted by the Board for future use. Changing assumptions will not change the actual cost of future benefits but will impact the measurement of the expected value of future benefits and the required contributions to maintain actuarial soundness.

As this report is being prepared, the world is experiencing a pandemic along with corresponding turmoil in the financial markets. We have not reflected these events in our results because it is not yet clear what permanent or on-going impact, if any, that all of this will have that will affect the System. We will continue, as always, to monitor the experience of the System and provide any needed advice regarding revisions to these assumptions.

The experience study includes all active and inactive members including retired members, disabled members and beneficiaries of deceased members. The demographic experience was studied separately for males and females where gender is a basis for material differences in experience.



Board of Directors

June 24, 2020

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This report shows comparisons between the actual and expected cases of separation from active service, actual and expected number of deaths, and actual and expected salary increases. Tables and graphs are used to show the actual rates measured, the rates expected under the current assumptions and, where applicable, the proposed change to rates.

The recommended decrement tables are shown in Appendix A of this report. Use of the new assumptions, when adopted by the Board, will commence with the June 30, 2020 valuation and are suitable for use until further experience indicates that modifications are desirable.

We hereby certify that, to the best of our knowledge and belief, this report is complete and accurate and has been prepared in accordance with generally recognized and accepted actuarial principles and practices which are consistent with the principles prescribed by the Actuarial Standards Board (ASB) and the Code of Professional Conduct and Qualification Standards for Public Statements of Actuarial Opinion of the American Academy of Actuaries.

We further certify that, in our opinion, the assumptions developed in this report satisfy Actuarial Standards of Practice, in particular, No. 27 (Selection of Economic Assumptions for Measuring Pension Obligations) and No. 35 (Selection of Demographic and Other Non-economic Assumptions for Measuring Pension Obligations).

The experience investigation was performed by, and under the supervision of, independent actuaries who are members of the American Academy of Actuaries with experience in performing valuations for public retirement systems. The undersigned meet the Qualification Standards of the American Academy of Actuaries to render the actuarial opinion contained herein.

Respectfully submitted,

A handwritten signature in blue ink that reads 'John J. Garrett'.

John J. Garrett, ASA, FCA, MAAA  
Principal and Consulting Actuary

A handwritten signature in blue ink that reads 'Ben Mobley'.

Ben Mobley, ASA, FCA, MAAA  
Senior Actuary



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## ***Section I - Executive Summary***

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The purpose of an actuarial valuation is to provide a timely best estimate of the ultimate costs of a retirement system. An actuarial valuation for the Connecticut State Teachers' Retirement System (System) is prepared biennially to determine the actuarial contribution rate required to fund the System on an actuarial reserve basis, (i.e. the current assets plus future contributions, along with investment earnings will be sufficient to provide the benefits promised by the System). The valuation requires the use of certain assumptions with respect to the occurrence of future events, such as rates of death, termination of employment, retirement age, and salary changes to estimate the obligations of the System.

The basic purpose of an experience study is to determine whether the actuarial assumptions currently in use have adequately anticipated the actual emerging experience. This information, along with the professional judgment of System personnel and advisors, is used to evaluate the appropriateness of continued use of the current actuarial assumptions. When analyzing experience and assumptions, it is important to recognize that actual experience is reported in the short term while assumptions are intended to be long-term estimates of experience. Therefore, actual experience is expected to vary from study period to study period, without necessarily indicating a change in assumptions is needed.

Cavanaugh Macdonald Consulting, LLC (CMC) has performed a study of the experience of the Connecticut Teachers' Retirement System for the five-year period ending June 30, 2019. This report presents the results, analysis, and resulting recommendations of our study. It is anticipated that the changes, if approved, will first be reflected in the June 30, 2020 actuarial valuation.

These assumptions have been developed in accordance with generally recognized and accepted actuarial principles and practices that are consistent with the applicable Actuarial Standards of Practice adopted by the Actuarial Standards Board (ASB). While the recommended assumptions represent our best estimate of future experience, there are other reasonable assumption sets that could be supported by the results of this experience study. Those other sets of reasonable assumptions could produce liabilities and costs that are either higher or lower.



## ***Section I - Executive Summary***

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### ***Our Philosophy***

Similar to an actuarial valuation, the calculation of actual and expected experience is a fairly mechanical process, and differences between actuaries in this area are generally minor. However, the setting of assumptions differs, as it is more art than science. In this report, we have recommended changes to certain assumptions. To explain our thought process, we offer a brief summary of our philosophy:

- **Do Not Overreact:** When we see significant changes in experience, we generally do not adjust our rates to reflect the entire difference. We will typically recommend rates somewhere between the old rates and the new experience. If the experience during the next study period shows the same result, we will probably recognize the trend at that point in time or at least move further in the direction of the observed experience. On the other hand, if experience returns closer to its prior level, we will not have overreacted, possibly causing volatility in the actuarial contribution rates.
- **Anticipate Trends:** If there is an identified trend that is expected to continue, we believe that this should be recognized. An example is the retiree mortality assumption. It is an established trend that people are living longer. Therefore, we believe the best estimate of liabilities in the valuation should reflect the expected increase in life expectancy.
- **Simplify:** In general, we attempt to identify which factors are significant and eliminate or ignore the ones that do not materially improve the accuracy of the liability projections.



## Section I - Executive Summary

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The following summarizes the findings and recommendations with regard to the assumptions utilized for the System. Detailed explanations for the recommendations are found in the sections that follow.

<b>Summary of Recommended Assumptions</b>	
<b>Economic Assumptions</b>	
<b>Rates of Salary Increase</b>	Composed of Inflation component, Real Rate of Wage Increase component and a Service Based Scale.
Inflation	Recommend no change to the 2.50% rate of inflation.
Real Rate of Wage Increase	Recommend a decrease in the annual rate of real wage increase assumption from 0.75% to 0.50%.
Service Based	Recommend minor changes to the merit portion of the salary scale.
<b>Investment Rate of Return</b>	Composed of Inflation component (2.50% currently) and Real Rate of Return component which is currently 4.40%. We recommend no changes.
<b>Payroll Growth</b>	Recommend change from 3.25% to 3.00% based upon the sum of the rate of inflation and real rate of wage increase assumptions.
<b>Actuarial Methods</b>	
<b>Actuarial Cost Method</b>	Recommend no change to the cost method but we do recommend a change to the techniques used to determine the timing of salary adjustments.
<b>Asset Smoothing</b>	Recommend no change to the current method.
<b>Amortization Method</b>	Recommend no change to the current method.
<b>Demographic Assumptions</b>	
<b>Mortality</b>	Recommend updating to the PubT-2010 published tables with some minor adjustments at ages over 77. Rates are generationally projected with scale MP-2019.
<b>Retirement</b>	Recommend modest adjustments in unreduced and proratable retirement rates for both males and females. Recommend decreasing early retirement rates for both males and females.
<b>Withdrawal</b>	Recommend increases in rates for both males and females.
<b>Disability</b>	Recommend decreases in rates for both males and females.



## ***Section I - Executive Summary***

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### **Financial Impact**

The following table highlights the impact of the recommended changes on the June 30, 2018 actuarial valuation results.

<b>Impact on Actuarial Valuation Results</b> <b>(Dollar amounts in thousands)</b>		
	<b>June 30, 2018 Valuation Results (Revised as of June 18, 2019)</b>	<b>June 30, 2018 Valuation Results with Recommended Assumptions</b>
Normal Cost Rate	13.73%	12.69%
Funded Ratio	51.72%	50.47%
Unfunded Actuarial Accrued Liability (UAAL)	\$16,760,263	\$17,615,434
Increase in UAAL		\$855,171
Employer Contribution Rate	27.77%	28.40%
Increase in Employer Rate		0.63%
Expected FY 2020 Employer Contribution	\$1,208,819	\$1,246,380
Expected Increase in FY 2020 Employer Contribution		\$37,561





## ***Section II – Economic Assumptions***

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There are three economic assumptions used in the actuarial valuations performed for the System. They are:

- Investment Rate of Return
- Rates of Wage Inflation
- Rate of Payroll Growth

Each of these assumptions is separated into its relevant component parts. The investment rate of return assumption is comprised of an inflation component and a real rate of return component. Similarly the rate of wage inflation assumption is comprised of an inflation component, a real rate of wage increase component (also called the productivity component). Finally, the payroll growth assumption uses the components for inflation and real wage increases in determining a reasonable range for annual growth in total payroll. The actuary is tasked with defining a reasonable range and, where appropriate, recommending a best estimate for each of the economic assumptions.

Actuarial Standard of Practice (ASOP) No. 27, “*Selection of Economic Assumptions for Measuring Pension Obligations*”, provides guidance to actuaries in selecting economic assumptions for measuring obligations under defined benefit plans. Economic assumptions primarily consist of investment return, discount rate, post-retirement benefit increases, inflation, and compensation increases. Measurements of defined benefit obligations include calculations such as funding valuations, liability measurements, and cash flow projections. The actuary should consider the purpose of the measurement, the characteristics of the obligation to be measured, and the materiality of the assumption to the measurement when identifying the types of economic assumptions to use for a specific measurement. For each economic assumption the actuary should:

- Identify components of the assumption (if any)
- Evaluate relevant data
- Consider factors specific to the measurement
- Consider other general factors
- Select a reasonable assumption

Each economic assumption should individually satisfy this standard. Furthermore, with respect to any particular valuation, each economic assumption should be consistent with every other economic assumption over the measurement period.



## ***Section II – Economic Assumptions***

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In our opinion, the economic assumptions recommended in this report have been developed in accordance with ASOP No. 27.

The Board reviewed the System’s economic assumptions and adopted significant changes incorporated in the revised June 30, 2018 actuarial valuation which also reflected the enactment of legislative changes to the plan. In this section of our report, we reviewed all the economic assumptions with only one recommended change from those adopted by the Board in 2019. We refer the reader to our prior economic study dated April 24, 2019 for additional discussion of the economic assumptions as we find no compelling reason to make further adjustments.

### **Inflation**

The assumed rate of inflation is the expectation of the long-term annual rate of increase in the Consumer Price Index and is a component of all economic assumptions. This is also called price inflation.

It is important that the inflation assumption be consistently applied throughout the economic assumptions utilized in an actuarial valuation. This is called for in ASOP No. 27 and is also required to meet the parameters for determining pension liabilities and expense under Governmental Accounting Standards Board (GASB) Statements No. 67 and 68.

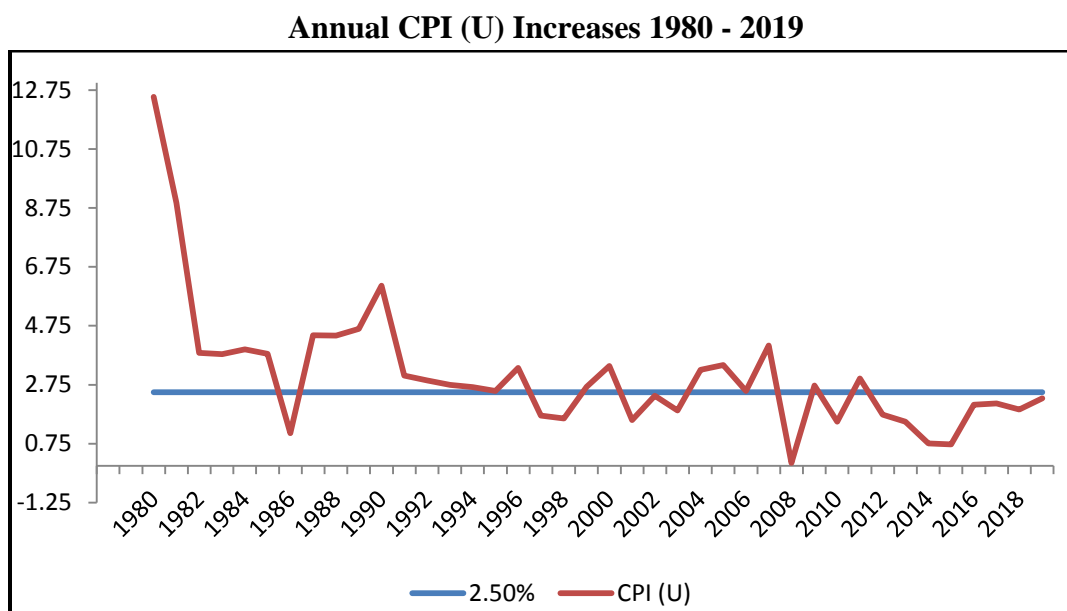
The current price inflation assumption is an assumed annual rate of 2.50%.



## Section II – Economic Assumptions

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**Past Experience:** The Consumer Price Index, US City Average, All Urban Consumers, CPI (U), has been used as the basis for reviewing historical levels of price inflation. The graph below shows the annual increases in the CPI (U) as of December 31st for each of the latest 50 years compared to the current assumed 2.50% rate of inflation.



**Recommendation:** We find the current assumed rate of inflation of 2.50% remains reasonable. We do not feel the economic conditions impacting expected long-term rate of price inflation has changed dramatically from our last review of economic assumptions in 2019.

### Investment Rate of Return

**Background:** The assumed investment return is one of the most significant assumptions in the annual actuarial valuation process as it is used to discount the expected future benefit payments for all active, inactive and retired members. Minor changes in this assumption can have a major impact on valuation results. The investment rate of return assumption should reflect the long-term average annual rate of return which can reasonably be expected based on the target asset allocation and capital market assumptions of the investment professionals.



## ***Section II – Economic Assumptions***

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The current assumption is 6.90%, consisting of a price inflation assumption of 2.50% and a real rate of return (return net of inflation) assumption of 4.40%.

***Analysis:*** We reviewed the most recent asset allocation targets and the capital market assumptions provided by the State Treasurer’s office. The 20-year expected average annual rate of return provided in the information was 7.3% composed of a 2.6% expected rate of inflation and 4.7% expected real rate of return.

***Recommendation:*** Using the assumed rate of 2.50% discussed above, the expected average annual rate of return is approximately 7.2% over a 20-year period. In our opinion, the current 6.9% annual assumed rate of return remains a reasonable assumption and we recommend no change.



## Section II – Economic Assumptions

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### Wage Inflation

**Background:** Wage inflation, thought of as the “across the board” rate of salary increases is comprised of the price inflation assumption combined with an assumption for the real rate of wage increases. The real rate of wage increase is the rate of increase in wages above price inflation. In constructing the rates of salary increases assumptions, the rate of wage inflation assumption is further combined with an assumption for service based salary increases. The service based salary increase assumption is provided in the demographic assumption section of the report. The current assumption implies the assumed real rate of wage increase is 0.75%.

**Analysis:** The Social Security Administration publishes data on wage growth in the United States. As with our analysis of inflation, we provide a table on the following page with the rates of wage inflation data and a comparison with price inflation over various time periods. Since wage data is only available through calendar 2018 we use that year as the end point.

Period Ending 12/31/2018	Average Annual Rate of Wage Inflation	Average Annual Rate of Price Inflation	Average Annual Rate of Real Wage Increase
10 Years	2.4%	1.8%	0.6%
20 Years	3.0%	2.1%	0.9%
30 Years	3.4%	2.4%	1.0%
50 Years	4.6%	4.0%	0.6%

As the table above illustrates, average annual rate of wage increases in the United States has trended downward along with the annual rate of inflation. More specific to TRS, over the study period, the average annual increase in salary for those with 25 or more years of service (beyond the service receiving step increases) exceeded inflation by a rate of 0.49%. This measure was 0.37% in the prior study. We have also reviewed the recent teacher’s salary step rate plans for the 10 largest districts as compared to each district’s salary increase experience over the study period.



## Section II – Economic Assumptions

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**Recommendation:** We recommend decreasing the real rate of wage increase assumption from 0.75% to 0.50% per year.

Real Rate of Wage Increase Assumption	
Current	0.75%
Recommended	0.50%

### Payroll Growth Assumption

**Background:** The assumed future increases in the total payroll of active members is an assumption that only affects the amortization of the unfunded accrued liability and therefore the contribution amounts necessary to fully amortize the unfunded actuarial accrued liability over the specified amortization period. As the amortization method is grading toward the use of a level-dollar method, which doesn't use a payroll growth assumption, this assumption is less material and will be phased out. The reasonable range for this assumption is typically between the rates of price inflation and the rate of wage inflation.

The current assumption for the payroll growth assumption is 3.25% which is the assumed rate of wage inflation over the period (2.50% price inflation plus 0.75% real rate of wage increases).

**Past Experience:** Over the past 10 years, the total annual payroll of the System as shown in actuarial valuations has grown at an average annual rate of 1.83%. With the enactment of legislative changes to the plan, the plan will grade into a level-dollar amortization method which will eliminate the need for a payroll growth assumption after the grading period.



## Section II – Economic Assumptions

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**Recommendation:** We recommend we lower this assumption from 3.25% to 3.00% to reflect the decrease to the assumed annual rate of price inflation as presented above as well as the decrease in the real wage increase assumption.

Payroll Growth Assumption	
Current	3.25%
Recommended	3.00%

With the phase-in to the level-dollar amortization method, this assumption is graded to 0% over five years from 2020 to 2025. The following table provides the payroll growth rates over the grading period.

Graded Payroll Growth Rates	
Valuation Year	Payroll Growth Rate
2020	3.00%
2021	2.40%
2022	1.80%
2023	1.20%
2024	0.60%
2025	0.00%



### ***Section III – Actuarial Methods***

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#### ***Actuarial Cost Method***

There are various actuarial cost methods, each of which has different characteristics, advantages and disadvantages. However, Governmental Accounting Standard Board (GASB) Statement Numbers 67 and 68 require that the Entry Age Normal cost method be used for financial reporting. Most systems do not want to use a different actuarial cost method for funding and financial reporting. In addition, the Entry Age Normal method has been the most common funding method for public systems for many years. This is the cost method currently used by the System.

The rationale of the Entry Age Normal (EAN) cost method is that the cost of each member's benefit is determined to be a level percentage of his salary from date of hire to the end of his employment with the employer. This level percentage multiplied by the member's annual salary is referred to as the normal cost and is that portion of the total cost of the employee's benefit that is allocated to the current year. The portion of the present value of future benefits allocated to the future is determined by multiplying this percentage times the present value of the member's assumed earnings for all future years including the current year. The Entry Age Normal actuarial accrued liability is then developed by subtracting from the present value of future benefits that portion of costs allocated to the future. To determine the unfunded actuarial accrued liability, the value of plan assets is subtracted from the Entry Age Normal actuarial accrued liability. The current year's cost to amortize the unfunded actuarial accrued liability is developed by applying an amortization factor.

It is to be expected that future events will not occur exactly as anticipated by the actuarial assumptions in each year. Actuarial gains/losses from experience under this actuarial cost method can be directly calculated and are reflected as a decrease/increase in the unfunded actuarial accrued liability. Consequently, the gain/loss results in a decrease/increase in the amortization payment, and therefore the contribution rate.

***Recommendation:*** Considering that the Entry Age Normal cost method is the most commonly used cost method by public plans, that it develops a normal cost rate that tends to be stable and less volatile, and is the required cost method under calculations required by GASB Numbers 67 and 68, we recommend the Entry Age Normal actuarial cost method be retained for the System.





## ***Section III – Actuarial Methods***

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### ***Actuarial Value of Assets***

In preparing an actuarial valuation, the actuary must assign a value to the assets of the fund. An adjusted market value is often used to smooth out the volatility that is reflected in the market value of assets. This is because most employers would rather have annual costs remain relatively smooth, as a percentage of payroll or in actual dollars, as opposed to a cost pattern that is extremely volatile.

The actuary does not have complete freedom in assigning this value. The Actuarial Standards Board also has basic principles regarding the calculation of a smoothed asset value, Actuarial Standard of Practice No. 44 (ASOP 44), *Selection and Use of Asset Valuation Methods for Pension Valuations*.

ASOP 44 provides that the asset valuation method should bear a reasonable relationship to the market value. Furthermore, the asset valuation method should be likely to satisfy both of the following:

- Produce values within a reasonable range around market value, AND
- Recognize differences from market value in a reasonable amount of time.

In lieu of both of the above, the standard will be met if either of the following requirements is satisfied:

- There is a sufficiently narrow range around the market value, OR
- The method recognizes differences from market value in a sufficiently short period.

These rules or principles prevent the asset valuation methodology from being used to manipulate annual funding patterns. No matter what asset valuation method is used, it is important to note that, like a cost method or actuarial assumptions, the asset valuation method does not affect the true cost of the plan; it only impacts the incidence of cost.

***Recommendation:*** Currently, the actuarial value of assets recognizes a portion of the difference between the market value of assets and the expected market value of assets, based on the assumed valuation rate of return. The amount recognized each year is 25% of the difference between market value and expected market value or a 4-year smoothed period. This method is in widespread use and complies with ASOP 44 guidance. We recommend no change to the asset smoothing method.



### ***Section III – Actuarial Methods***

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#### ***Amortization of the Unfunded Actuarial Accrued Liability***

The actuarial accrued liability is the portion of the actuarial present value of future benefits that are not included in future normal costs. Thus, it represents the liability that, in theory, should have been funded through normal costs for past service. Unfunded actuarial accrued liability (UAAL) exists when the actuarial accrued liability exceeds the actuarial value of plan assets. These deficiencies can result from:

- (i) plan improvements that have not been completely paid for,
- (ii) experience that is less favorable than expected,
- (iii) assumption changes that increase liabilities, or
- (iv) contributions that are less than the expected amount.

**Amortization Method:** With the enactment of Public Act 19-117 (PA 19-117), the amortization method is provided under State statutes. Effective with the June 30, 2020 actuarial valuation, the method establishes a 30-year amortization period for the UAAL which exists as of June 30, 2018 with subsequent changes to the UAAL amortized separately over closed 25-year periods. This is commonly referred to as a layered amortization method and is expected to reduce the future contribution volatility as compared to the prior method. Also, PA 19-117 provides the payment amounts will be determined under a 5-year phase-in from the current level percent of payroll amortization payments to a level dollar amount amortization.

Under the level percent method, the initial amortization payments are lower than they would be under a level dollar amortization payment method, but the payments increase at the expected payroll growth rate each year so that ultimately the annual payment far exceeds the level dollar payment. In contrast, the level dollar amortization payment method is similar to the method in which a homeowner pays off a mortgage. The liability, once calculated, is financed by a constant fixed dollar amount, based on the amortization period until the liability is fully amortized. This results in the liability steadily decreasing as each payment, like a mortgage, pays all the interest on the UAAL and a portion of the principal amount of the UAAL. We will enact the changes to the amortization method provided in PA 19-117 as part of the June 30, 2020 valuation of the System and expect this change to the amortization methodology will enhance the actuarial condition of TRS in future years.



## ***Section IV – Demographic Assumptions***

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There are several demographic assumptions used in the actuarial valuations performed for the System. They are:

- Rates of Mortality
- Rates of Retirement
- Rates of Withdrawal
- Rates of Disability
- Rates of Salary Increase

Actuarial Standard of Practice (ASOP) No. 35, “*Selection of Demographic and Other Noneconomic Assumptions for Measuring Pension Obligations*” provides guidance to actuaries in selecting demographic assumptions for measuring obligations under defined benefit plans. In our opinion, the demographic assumptions recommended in this report have been developed in accordance with ASOP No. 35.

The purpose of a study of demographic experience is to compare what actually happened to the membership during the study period (July 1, 2014 through June 30, 2019) with what was expected to happen based on the assumptions used in the most recent Actuarial Valuations.

Detailed tabulations by age, service and/or gender are performed over the entire study period. These tabulations look at all active and retired members during the period as well as separately annotating those who experience a demographic event, also referred to as a decrement. In addition the tabulation of all members together with the current assumptions permits the calculation of the number of expected decrements during the study period.

It is common in demographic studies to weight the exposures and decrements by an approximation of the associated liability. In this experience investigation, we performed our analysis on both a count and amount-weighted basis focusing mainly on the results on an amount-weighted basis.

If the actual experience differs significantly from the overall expected results, or if the pattern of actual decrements, or rates of decrement, by age, gender, or service does not follow the expected pattern, new assumptions are recommended. Recommended changes usually do not follow the exact actual experience during the observation period. Judgment is required to extrapolate future experience from past trends and current member behavior. In addition, non-recurring events, such as early retirement windows, need to be taken into account in determining the weight to give to recent experience.



## ***Section IV – Demographic Assumptions***

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The remainder of this section presents the results of the demographic study. We have prepared tables that show a comparison of the actual and expected decrements and the overall ratio of actual to expected results (A/E Ratios) under the current assumptions. If a change is being proposed, the revised A/E Ratios are shown as well. Salary adjustments, other than the economic assumption for wage inflation discussed in the previous section, are treated as demographic assumptions.



## *Section IV – Demographic Assumptions*

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### **RATES OF MORTALITY**

**Background:** One of the most important demographic assumptions in the valuation is mortality because it projects how long benefit payments will be made. The longer members live, the greater the true cost of future benefit obligations will be.

Over the last few generations, rates of mortality have been declining, meaning people are generally living longer. Furthermore, the actual experience of large, public retirement systems that include school employees indicate that school groups, and teachers in particular, continue to exhibit better mortality than the average working population.

Because of the substantial amount of data required to construct a mortality table, actuaries usually rely on standard tables published by the Society of Actuaries. Actuaries then use various adjustments such as age adjustments or scaling to these standard, published mortality tables in order to better match the observed mortality rates of a specific group.

The first of these adjustments is an age adjustment that can be either a “set back” or a “set forward”. A one-year age set back treats all members as if they were one year younger than they truly are when applying the rates in the mortality table. So, a one year set back would treat a 61 year old retiree as if he will exhibit the mortality of a 60 year old in the standard mortality table.

The second adjustment that can be used to adjust the mortality rates in a standard table to better fit actual experience is to “scale” a mortality table by multiplying the probabilities of death by factors less than one (to reflect better mortality) or factors greater than one (to reflect poorer mortality). Scaling factors can be applied to an entire table or a portion of the table. Of course, if needed, actuaries may use both of these methods to develop an appropriate table to model the mortality of the specific plan population.

In 2019, the Society of Actuaries released a family of mortality tables named the Pub-2010 tables. While prior pension mortality tables have been based solely on private corporate and union retirement plans, these new tables are based entirely on public sector plan data. These tables are split by three membership types: Safety, Teachers, and General to reflect the observed differences in mortality patterns related to the three groups. Tables are further split for healthy retirees, disabled retirees, contingent beneficiaries, and employees.



## ***Section IV – Demographic Assumptions***

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The issue of future mortality improvement is one that the actuarial profession has become increasingly focused on studying and monitoring. This has resulted in changes to the relevant Actuarial Standard of Practice, ASOP 35, *Selection of Demographic and Other Noneconomic Assumptions for Measuring Pension Obligations*. This ASOP requires the pension actuary to make and disclose a specific recommendation with respect to future improvements in mortality after the valuation date, although it does not require that an actuary assume there will be future improvements. There have been significant improvements in longevity in the past, although there are different opinions about future expectations, and thus there is a subjective component in the estimation of future mortality improvement. We believe it is prudent to anticipate that the trend will continue to some degree in the future and that it is appropriate to reflect some future mortality improvement as part of the mortality assumption.

There are two widely-used ways to reflect future improvements in mortality:

- (1) Static table with “margin”
- (2) Generational mortality

The first approach to reflecting mortality improvements is through the use of a static mortality table with “margin.” Under this approach, the Actual to Expected Ratio is intentionally targeted to be over 100% so that mortality can improve without creating actuarial losses. This has been the approach used historically by many systems because of its computational simplicity.

Another approach, referred to as generational mortality, directly anticipates future improvements in mortality by using a different set of mortality rates based on each year of birth, with the rates for later years of birth assuming lower mortality than the rates for earlier years of birth. The varying mortality rates by year of birth create a series of tables that contain “built-in” mortality improvements, e.g., a member who turns age 65 in 2035 has a longer life expectancy than a member who turns age 65 in 2020. When using generational mortality, the Actual to Expected Ratios for the observed experience are set near 100% as future mortality improvements will be taken into account directly in the actuarial valuation process. Over the last 10-15 years, this method has become quite common as computing power has increased.



## Section IV – Demographic Assumptions

### Mortality – Healthy Retirees

#### *Past Experience:*

The current basis for rates of mortality for healthy retirees is the RPH-2014 White Collar table with employee and annuitant rates blended from ages 50 to 80 projected to the year 2020 using the BB improvement scale and further adjusted to grade in increases (5% for females and 8% for males) to rates over age 80. This is a static mortality table selected with the previous experience study to anticipate some margin for improved mortality. The tables below present the actual to expected headcount-weighted analysis of mortality experience.

Healthy Retiree Mortality Experience					
Males					
Age	Exposures	Actual Deaths	Expected Deaths under Current Assumptions	Count Based A/E Ratio	Weighted A/E Ratio
Less than 60	473	3	1.7	1.765	1.790
60-69	17,285	127	142.5	0.891	0.779
70-79	23,425	407	440.3	0.924	0.881
80-89	10,334	707	653.6	1.082	1.061
90-99	1,872	375	319.2	1.175	1.156
100 and over	21	8	7.6	1.053	1.246
Total	53,410	1,627	1,564.9	1.040	1.005

Healthy Retiree Mortality Experience					
Females					
Age	Exposures	Actual Deaths	Expected Deaths under Current Assumptions	Count Based A/E Ratio	Weighted A/E Ratio
Less than 60	1,557	7	3.7	1.892	1.662
60-69	47,644	231	258.8	0.893	0.855
70-79	43,775	477	619.7	0.770	0.793
80-89	18,008	897	903.6	0.993	0.984
90-99	4,647	763	666.7	1.144	1.153
100 and over	248	80	78.5	1.019	0.997
Total	115,879	2,455	2,531.0	0.970	0.960



## ***Section IV – Demographic Assumptions***

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Overall, the current assumed mortality rates performed well over the study period as A/E ratios are fairly close to 1. The margins in mortality rates included with the development of the current assumption have degraded over the study period as mortality experience has improved, especially for females. We recommend a change to the Pub-2010 set of tables for Teachers. In analyzing this table, we observed, in general, that mortality rates at ages above 80 tended to consistently produce A/E ratios above 1.0, meaning that fewer deaths were expected compared to actual experience over the study period. We believe it is appropriate to slightly scale rates at these ages to better match the experience of the system. We further recommend a change from the current static approach to a generationally projected approach which will better anticipate future mortality improvements. In our analysis leading to our recommendations, we relied on the amount-weighted data over the study period to reflect that the System’s liability measures are amount-weighted.

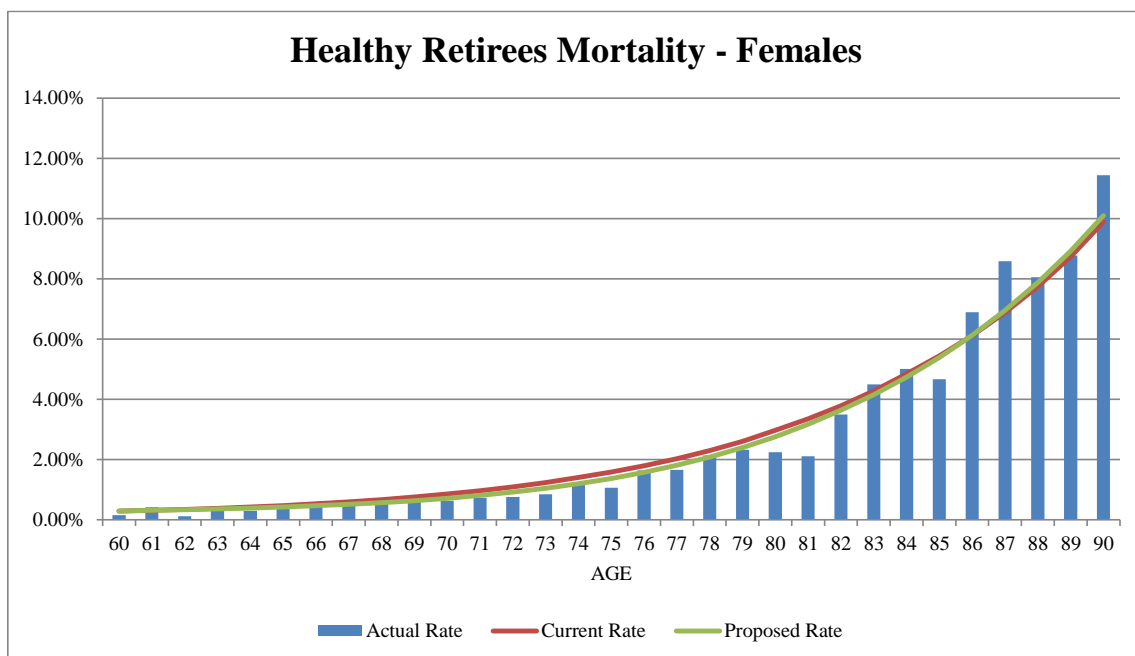
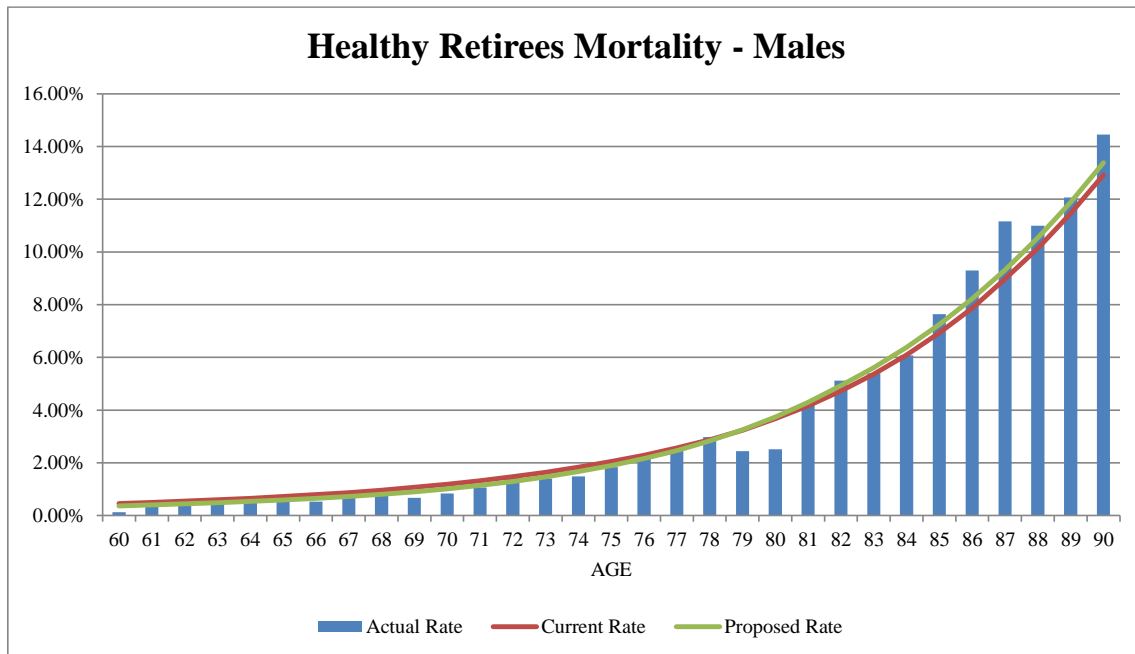
***Recommendation:*** We recommend that the rates of healthy post-retirement mortality be revised to the PubT-2010 Healthy Retiree Table. We further recommend that rates be adjusted by 105% for males and 103% for females at ages 82 and above with a geometric phase-in of these adjustments beginning at age 78. We also recommend the use of the MP-2019 mortality improvement scale generationally to anticipate future mortality improvements.





## Section IV – Demographic Assumptions

The following graphs show a comparison of the current, actual and proposed rates of healthy retiree mortality.





## Section IV – Demographic Assumptions

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The resulting A/E ratios are shown in the following tables.

Healthy Retiree Mortality Experience					
Males					
Age	Actual Deaths	Expected Deaths under Proposed Assumptions	Weighted A/E Ratio under Current Assumptions	Weighted A/E Ratio under Proposed Assumptions	
Less than 60	3	1.7	1.790	2.243	
60-69	127	129.1	0.779	0.940	
70-79	407	436.8	0.881	0.953	
80-89	707	711.5	1.061	1.020	
90-99	375	338.7	1.156	1.130	
100 and over	8	7.7	1.246	1.257	
Total	1,627	1,625.5	1.005	1.020	

Healthy Retiree Mortality Experience					
Females					
Age	Actual Deaths	Expected Deaths under Proposed Assumptions	Weighted A/E Ratio under Current Assumptions	Weighted A/E Ratio under Proposed Assumptions	
Less than 60	7	4.5	1.662	1.626	
60-69	231	235.0	0.855	0.972	
70-79	477	556.0	0.793	0.915	
80-89	897	912.0	0.984	0.998	
90-99	763	703.8	1.153	1.134	
100 and over	80	82.5	0.997	0.986	
Total	2,455	2,493.8	0.960	1.010	



## Section IV – Demographic Assumptions

### Mortality – In-Pay Beneficiaries

#### *Past Experience:*

The mortality of in-pay beneficiaries applies to the survivors of members who retired with a joint and survivor payment form. The current basis for rates of mortality for in pay beneficiaries is the RPH-2014 White Collar table with employee and annuitant rates blended from ages 50 to 80 projected to the year 2020 using the BB improvement scale and further adjusted to grade in increases (5% for females and 8% for males) to rates over age 80.

In Pay Beneficiary Mortality Experience						
Males						
Age	Exposures	Actual Deaths	Expected Deaths under Current Assumptions	Count Based A/E Ratio	Weighted A/E Ratio	
Less than 60	220	14	0.3	46.667	12.249	
60-69	670	9	5.4	1.667	2.101	
70-79	830	22	15.7	1.401	1.746	
80-89	428	37	28.1	1.317	1.341	
90-99	84	20	15.6	1.282	1.294	
100 and over	25	2	12.0	0.167	0.117	
Total	2,257	104	77.1	1.349	1.516	

In Pay Beneficiary Mortality Experience						
Females						
Age	Exposures	Actual Deaths	Expected Deaths under Current Assumptions	Count Based A/E Ratio	Weighted A/E Ratio	
Less than 60	423	17	0.7	24.286	19.037	
60-69	1,405	13	7.7	1.688	1.484	
70-79	2,431	60	39.7	1.511	1.503	
80-89	2,161	131	110.8	1.182	1.250	
90-99	562	86	75.5	1.139	1.160	
100 and over	48	9	20.7	0.435	0.678	
Total	7,030	316	255.1	1.239	1.286	



## Section IV – Demographic Assumptions

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In general, the current mortality assumptions anticipated fewer deaths than actually occurred at almost all ages. Because of these observations and that the Pub-2010 family of tables offers a specific table for contingent survivors, we believe a change to the mortality tables is appropriate. After analyzing this table relative to the System’s experience we believe a set forward age adjustment is appropriate to bring the A/E ratios closer to 1.

**Recommendation:** We recommend that the rates of in-pay beneficiary mortality be revised to the PubT-2010 Contingent Survivor Table. We further recommend that rates be set forward 1 year for both males and females. We also recommend the use of the MP-2019 mortality improvement scale generationally to anticipate future mortality improvements.

The resulting A/E ratios are shown in the following tables.

In Pay Beneficiary Mortality Experience					
Males					
Age	Actual Deaths	Expected Deaths under Proposed Assumptions	Weighted A/E Ratio under Current Assumptions	Weighted A/E Ratio under Proposed Assumptions	
Less than 60	14	1.3	12.249	4.425	
60-69	9	12.0	2.101	1.052	
70-79	22	28.7	1.746	1.024	
80-89	37	39.3	1.341	1.006	
90-99	20	17.5	1.294	1.164	
100 and over	2	11.5	0.117	0.121	
Total	104	110.3	1.516	1.052	



## Section IV – Demographic Assumptions

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In Pay Beneficiary Mortality Experience					
Females					
Age	Actual Deaths	Expected Deaths under Proposed Assumptions	Weighted A/E Ratio under Current Assumptions	Weighted A/E Ratio under Proposed Assumptions	
Less than 60	17	2.1	19.037	7.554	
60-69	13	16.9	1.484	0.809	
70-79	60	62.9	1.503	1.074	
80-89	131	150.9	1.250	0.981	
90-99	86	92.3	1.160	0.994	
100 and over	9	20.9	0.678	0.665	
Total	316	346.0	1.286	1.009	

### Other Mortality Tables

There was limited data available to analyze mortality for other groups within the System. We assume the trend of future mortality experience should follow the expectation of the retirees and we recommend the same family of mortality tables as follows:

For disabled retirees, we recommend adopting the PubT-2010 Disabled Retiree Table projected generationally with MP-2019.

For active members, we recommend adopting the PubT-2010 Employee Table projected generationally with MP-2019.

For deferred vested members, we recommend adopting the active member mortality table for the period before commencement of benefits and the healthy retiree mortality table for the period after commencement of benefits.



## Section IV – Demographic Assumptions

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### **RATES OF RETIREMENT**

**Background:** The rates of retirement are used to determine the expected number of separations from active service due to retirement. The plan provides for three types of retirement based on different eligibility requirements. There are four sets of retirement rates to handle the different types of retirement.

#### **Rates of Unreduced Retirement (with less than 35 years of service)**

**Past Experience:**

Males eligible for unreduced retirement with less than 35 years of service				
Age	Actual	Expected	A/E Ratio	
			Count	Weighted
60	89	110.0	0.809	0.812
61	60	104.0	0.577	0.566
62	62	88.3	0.702	0.707
63	48	80.6	0.596	0.582
64	52	66.6	0.781	0.801
65	60	79.5	0.755	0.742
66	50	46.5	1.075	1.074
67	32	33.3	0.961	0.932
68	35	27.5	1.271	1.207
69	11	17.4	0.634	0.549
70 and over	39	138.0	0.283	0.288
Total	538	791.5	0.680	0.670



## Section IV – Demographic Assumptions

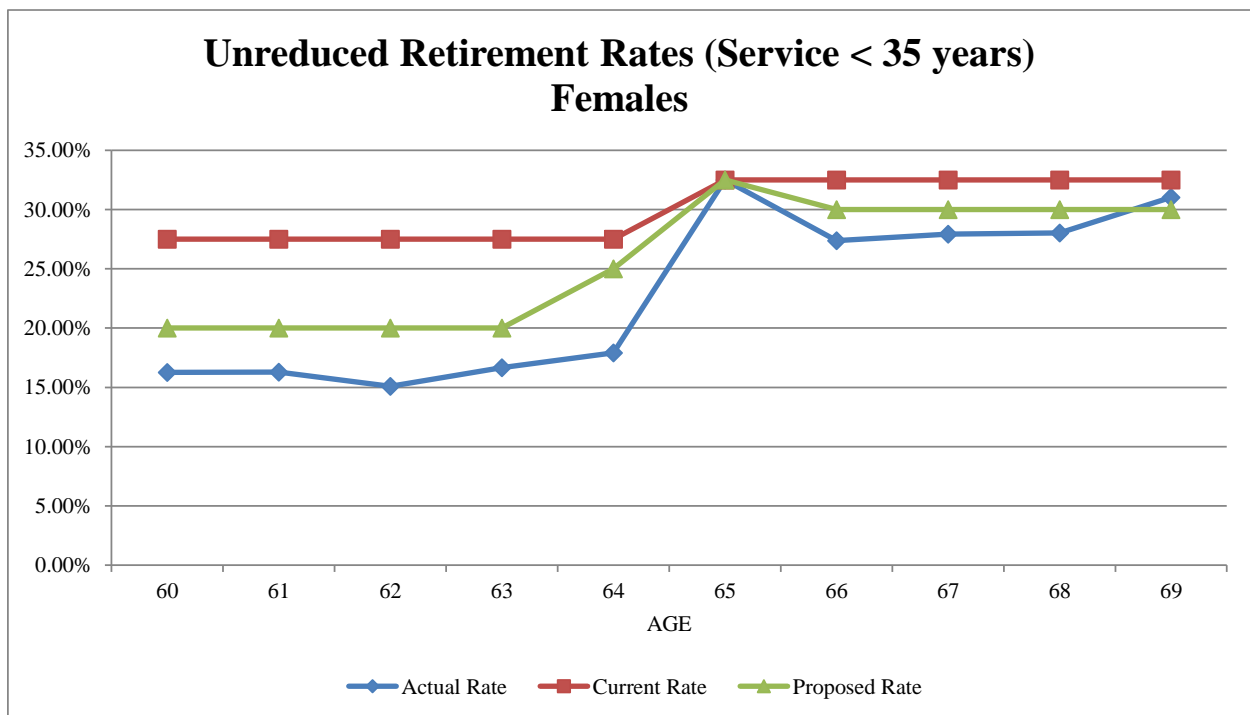
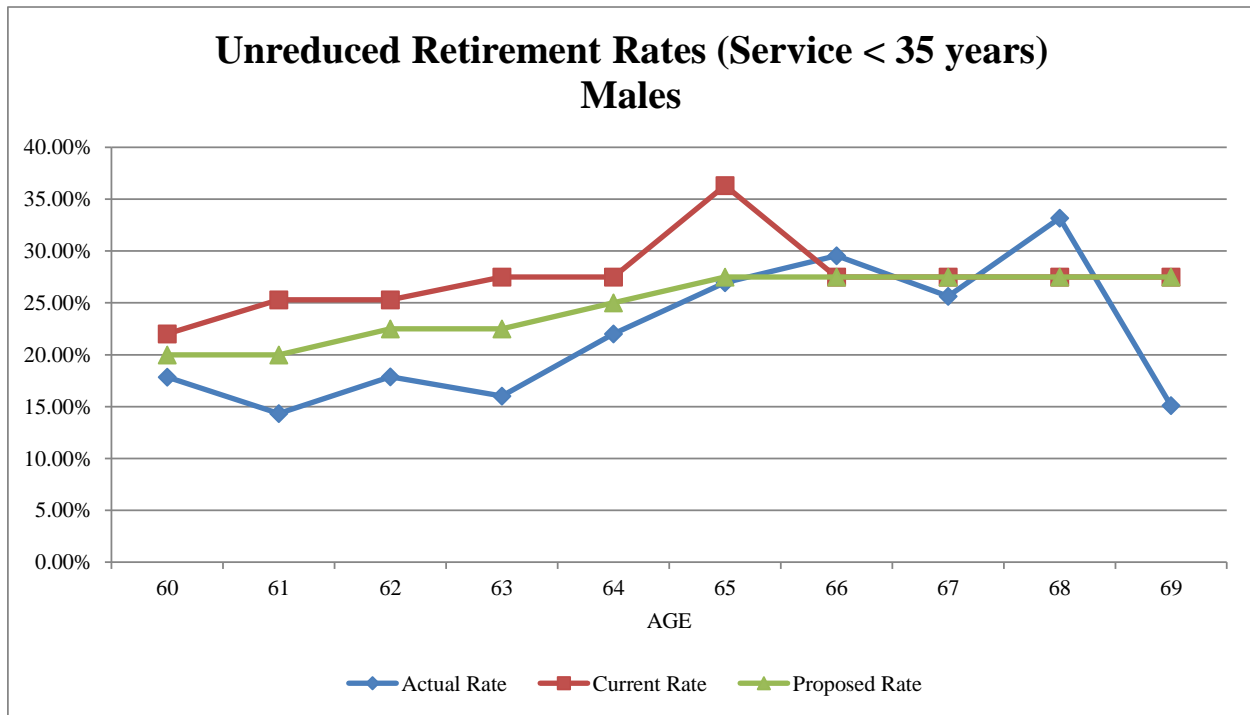
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Females eligible for unreduced retirement with less than 35 years of service				
Age	Actual	Expected	A/E Ratio	
			Count	Weighted
60	304	509.6	0.597	0.592
61	281	469.1	0.599	0.592
62	238	424.0	0.561	0.548
63	245	402.9	0.608	0.606
64	241	363.3	0.663	0.651
65	371	366.9	1.011	1.000
66	224	266.9	0.839	0.842
67	183	206.4	0.887	0.859
68	131	152.8	0.857	0.863
69	102	107.6	0.948	0.954
70 and over	186	216.8	0.858	0.840
Total	2,506	3,486.2	0.719	0.711

In general, there were slightly fewer retirements than expected particularly at younger ages for both males and females and to a lesser degree at older ages for females. We believe modest adjustment to the current rates would be appropriate. The following graphs show the actual rates of retirement by age compared with the current assumed retirement rates as well as the recommended rates.



## Section IV – Demographic Assumptions







## Section IV – Demographic Assumptions

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**Recommendation:** We recommend general increases to the female assumed retirement rates and increases to the male assumed retirement rates at younger ages.

The resulting A/E ratios are shown in the following tables.

Males eligible for unreduced retirement with less than 35 years of service		
Age	Weighted A/E Ratio	
	Current	Proposed
60	0.812	0.893
61	0.566	0.716
62	0.707	0.794
63	0.582	0.712
64	0.801	0.881
65	0.742	0.980
66	1.074	1.074
67	0.932	0.932
68	1.207	1.207
69	0.549	0.549
70 and over	0.288	0.780
Total	0.670	0.856

Females eligible for unreduced retirement with less than 35 years of service		
Age	Weighted A/E Ratio	
	Current	Proposed
60	0.592	0.813
61	0.592	0.815
62	0.548	0.754
63	0.606	0.833
64	0.651	0.716
65	1.000	1.000
66	0.842	0.912
67	0.859	0.931
68	0.863	0.935
69	0.954	1.034
70 and over	0.840	0.737
Total	0.711	0.845



## Section IV – Demographic Assumptions

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### Rates of Unreduced Retirement (with 35 or more years of service)

#### Past Experience:

Males eligible for unreduced retirement with 35 or more years of service				
Age	Actual	Expected	A/E Ratio	
			Count	Weighted
55	0	0.0	0.000	0.000
56	1	1.2	0.862	0.891
57	17	22.0	0.774	0.818
58	40	49.3	0.812	0.819
59	43	69.3	0.621	0.620
60	54	48.6	1.111	1.071
61	67	56.9	1.177	1.127
62	62	55.9	1.109	1.170
63	62	56.9	1.089	1.069
64	47	47.0	0.999	1.026
65	51	53.7	0.949	0.951
66	49	33.0	1.484	1.490
67	23	26.7	0.862	0.808
68	18	23.1	0.779	0.746
69	21	20.9	1.004	0.995
70 and over	38	132.0	0.288	0.289
Total	593	696.5	0.851	0.845



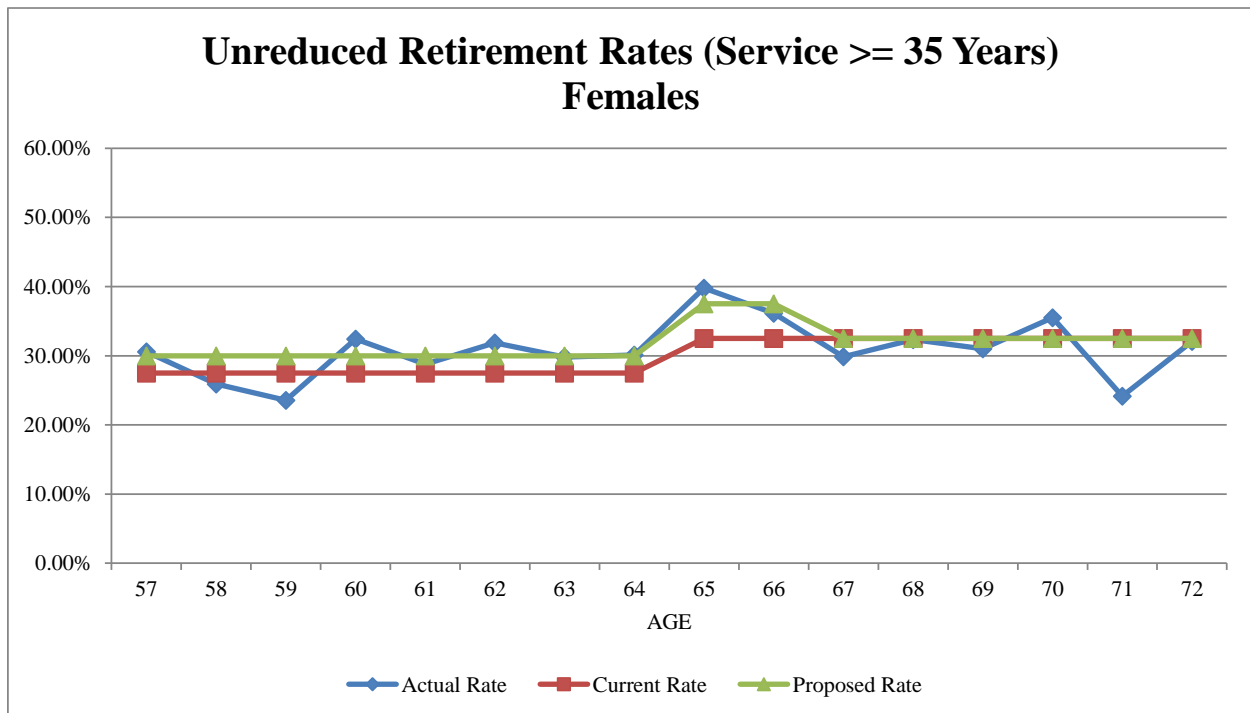
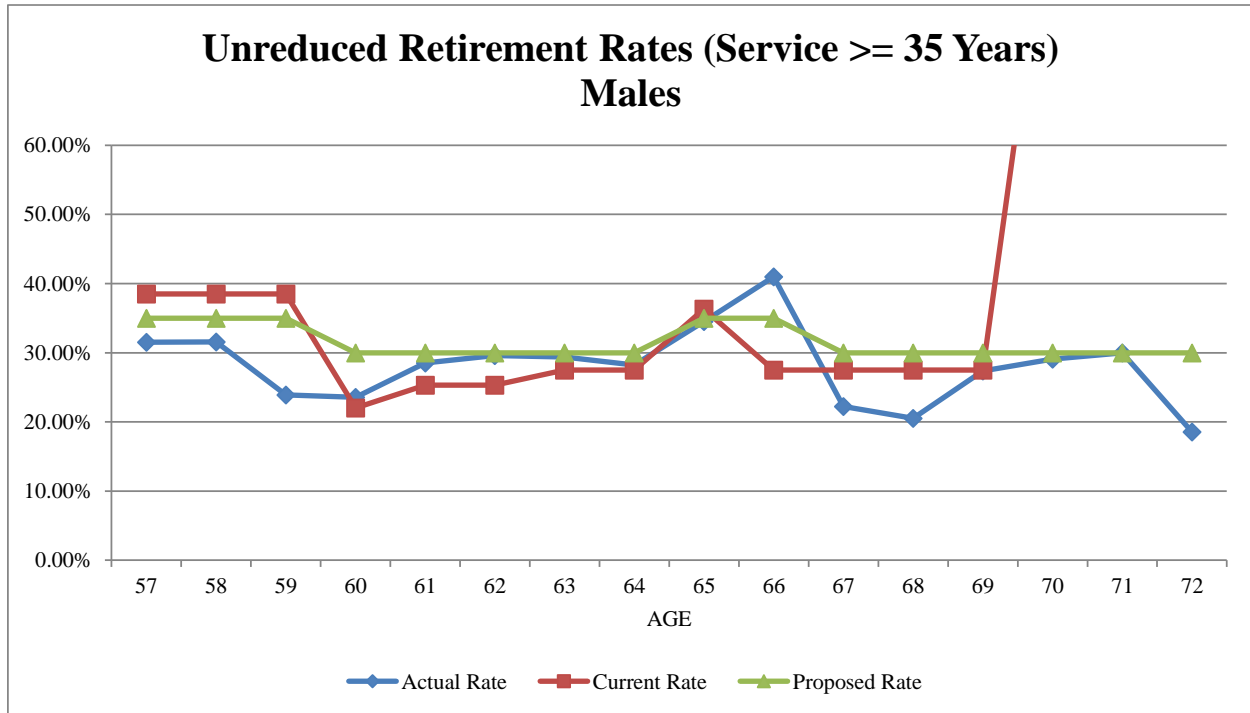
## Section IV – Demographic Assumptions

Females eligible for unreduced retirement with 35 or more years of service				
Age	Actual	Expected	A/E Ratio	
			Count	Weighted
55	1	0.3	3.704	3.636
56	4	3.9	1.034	1.060
57	60	53.6	1.119	1.112
58	99	104.0	0.952	0.943
59	129	150.4	0.858	0.857
60	206	177.9	1.158	1.179
61	181	170.8	1.060	1.046
62	198	170.8	1.160	1.159
63	167	152.4	1.096	1.085
64	137	125.4	1.092	1.094
65	155	123.8	1.252	1.224
66	110	96.9	1.136	1.112
67	67	71.8	0.933	0.919
68	54	54.6	0.989	0.995
69	39	42.3	0.923	0.954
70 and over	118	131.8	0.895	0.913
Total	1,725	1,630.6	1.058	1.055

Over the study period, there were fewer retirements for males than expected. In particular, it was noted that significantly fewer males retired between the ages of 70 and 75 than expected. The current assumption is that males with 35 or more years of service begin retiring at 100% at age 70. We believe changing this to 100% beginning at age 75 as well as a few other modest adjustments is appropriate. For females, there were more retirements than expected but, generally, the current rates performed quite well. We believe only modest adjustments to the current rates are appropriate. The following graphs show the actual rates of retirement by age compared with the current assumed retirement rates as well as the recommended rates.



## Section IV – Demographic Assumptions





## Section IV – Demographic Assumptions

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**Recommendation:** We recommend pushing out 100% retirement rates to age 75 and modest adjustments at other ages for male assumed retirement rates and only slight changes in female assumed retirement rates.

The resulting A/E ratios are shown in the following tables.

Males eligible for unreduced retirement with 35 or more years of service		
Age	Weighted A/E Ratio	
	Curent	Proposed
55	0.000	0.000
56	0.891	0.980
57	0.818	0.900
58	0.819	0.901
59	0.620	0.682
60	1.071	0.785
61	1.127	0.950
62	1.170	0.986
63	1.069	0.980
64	1.026	0.941
65	0.951	0.986
66	1.490	1.171
67	0.808	0.741
68	0.746	0.684
69	0.995	0.912
70 and over	0.289	0.806
Total	0.845	0.894

Females eligible for unreduced retirement with 35 or more years of service		
Age	Weighted A/E Ratio	
	Curent	Proposed
55	3.636	3.333
56	1.060	0.971
57	1.112	1.019
58	0.943	0.864
59	0.857	0.786
60	1.179	1.080
61	1.046	0.959
62	1.159	1.063
63	1.085	0.994
64	1.094	1.003
65	1.224	1.061
66	1.112	0.964
67	0.919	0.919
68	0.995	0.995
69	0.954	0.954
70 and over	0.913	0.680
Total	1.055	0.950



## Section IV – Demographic Assumptions

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### Rates of Proratable Retirement

#### *Past Experience:*

Males eligible for proratable retirement				
Age	Actual	Expected	A/E Ratio	
			Count	Weighted
60	14	18.8	0.743	0.754
61	17	17.1	0.994	0.938
62	9	23.7	0.380	0.379
63	18	28.6	0.629	0.646
64	27	23.8	1.134	1.192
65	32	26.9	1.189	1.096
66	27	31.2	0.865	0.854
67	19	24.2	0.785	0.733
68	11	18.6	0.591	0.577
69	19	22.2	0.856	0.918
70 and over	25	37.5	0.667	0.713
Total	218	272.6	0.800	0.798



## Section IV – Demographic Assumptions

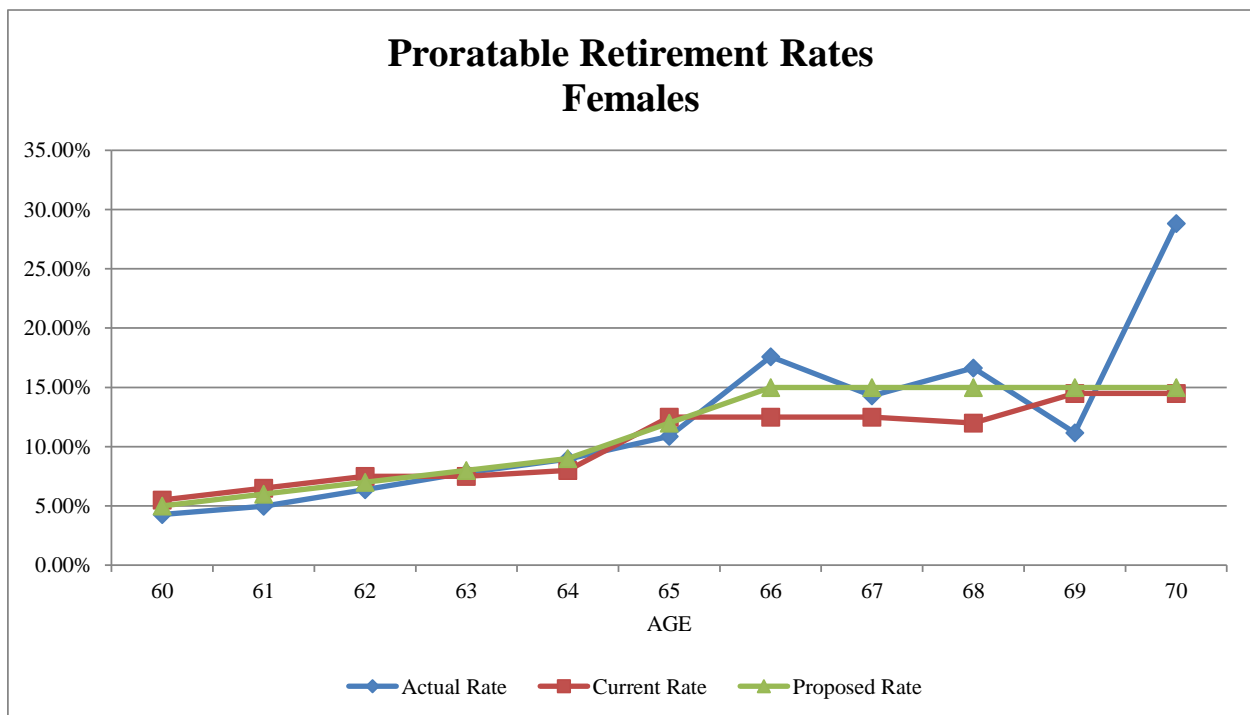
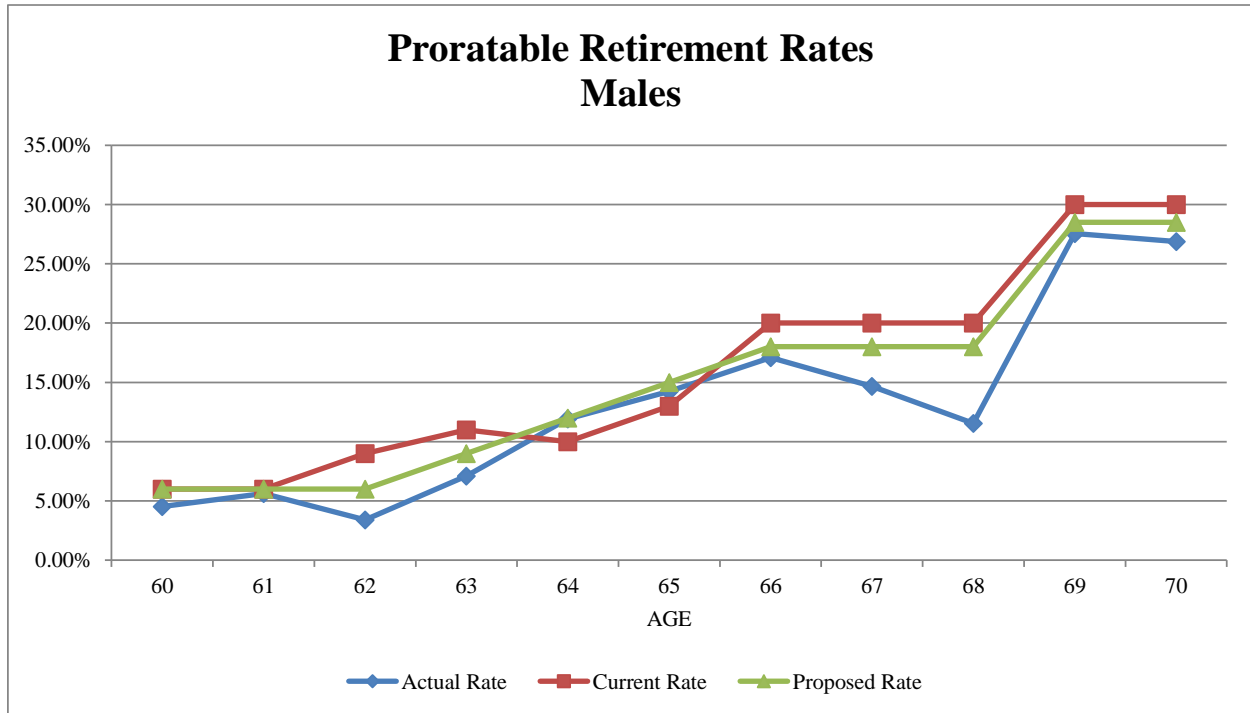
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Females eligible for proratable retirement				
Age	Actual	Expected	A/E Ratio	
			Count	Weighted
60	61	76.7	0.796	0.778
61	63	80.3	0.785	0.767
62	72	83.5	0.862	0.851
63	77	72.5	1.061	1.038
64	71	61.6	1.153	1.117
65	67	74.5	0.899	0.869
66	81	56.4	1.437	1.407
67	44	37.8	1.165	1.144
68	32	23.5	1.361	1.387
69	13	17.7	0.736	0.771
70 and over	49	30.1	1.630	1.588
Total	630	614.5	1.025	1.008

Over the study period, there were generally fewer retirements for males than expected and about the expected number of retirements for females though somewhat more at higher ages. We believe only modest adjustments to the current rates are appropriate. The following graphs show the actual rates of retirement by age compared with the current assumed retirement rates as well as the recommended rates.



## Section IV – Demographic Assumptions







## Section IV – Demographic Assumptions

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**Recommendation:** We recommend modest adjustments in both male and female assumed retirement rates.

The resulting A/E ratios are shown in the following tables.

Males eligible for proratable retirement		
Age	Weighted A/E Ratio	
	Curent	Proposed
60	0.754	0.754
61	0.938	0.938
62	0.379	0.568
63	0.646	0.790
64	1.192	0.993
65	1.096	0.949
66	0.854	0.949
67	0.733	0.814
68	0.577	0.641
69	0.918	0.967
70 and over	0.713	0.747
Total	0.798	0.843

Females eligible for proratable retirement		
Age	Weighted A/E Ratio	
	Curent	Proposed
60	0.778	0.856
61	0.767	0.830
62	0.851	0.912
63	1.038	0.973
64	1.117	0.993
65	0.869	0.905
66	1.407	1.173
67	1.144	0.953
68	1.387	1.110
69	0.771	0.745
70 and over	1.588	1.598
Total	1.008	0.980



## Section IV – Demographic Assumptions

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### Rates of Early Retirement

#### *Past Experience:*

Males eligible for early retirement				
Age	Actual	Expected	A/E Ratio	
			Count	Weighted
Under 50	0	2.0	0.000	0.000
50	1	1.5	0.654	0.881
51	1	2.2	0.461	0.397
52	4	2.6	1.515	1.573
53	2	6.0	0.332	0.358
54	5	10.9	0.458	0.368
55	13	25.0	0.520	0.503
56	26	38.9	0.669	0.648
57	27	44.9	0.602	0.609
58	24	46.4	0.517	0.505
59	39	59.5	0.655	0.705
Total	142	239.9	0.592	0.596



## Section IV – Demographic Assumptions

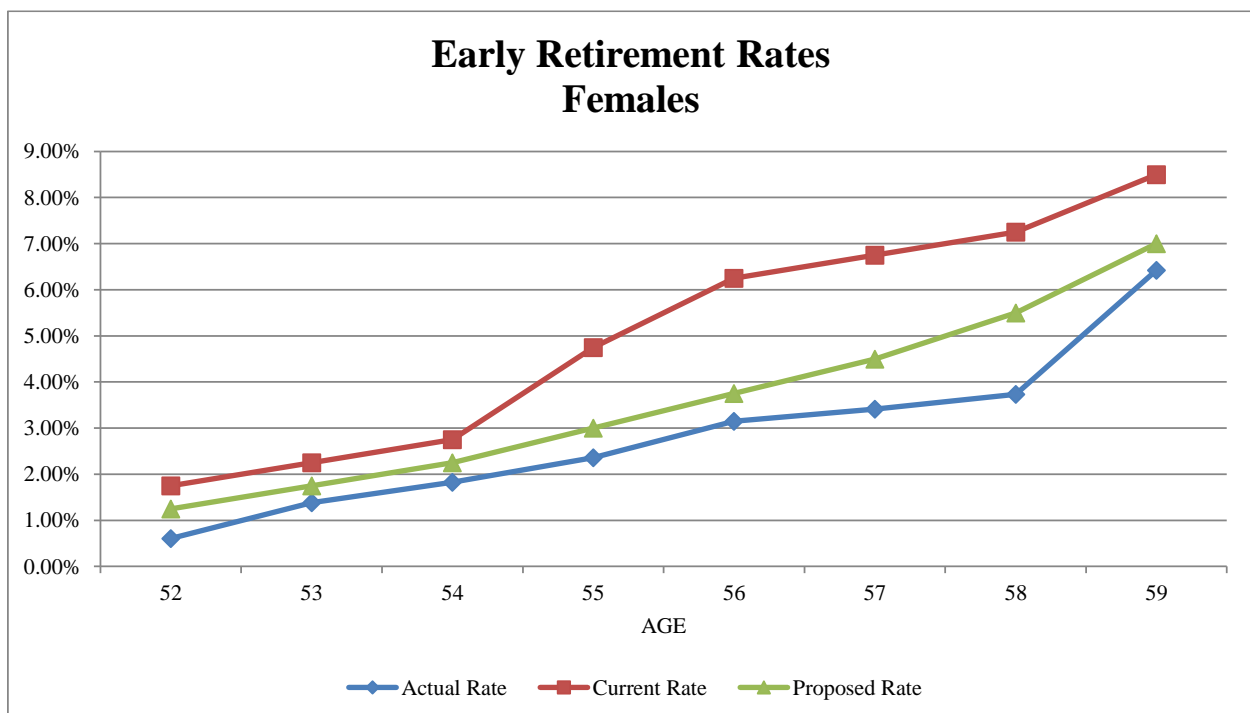
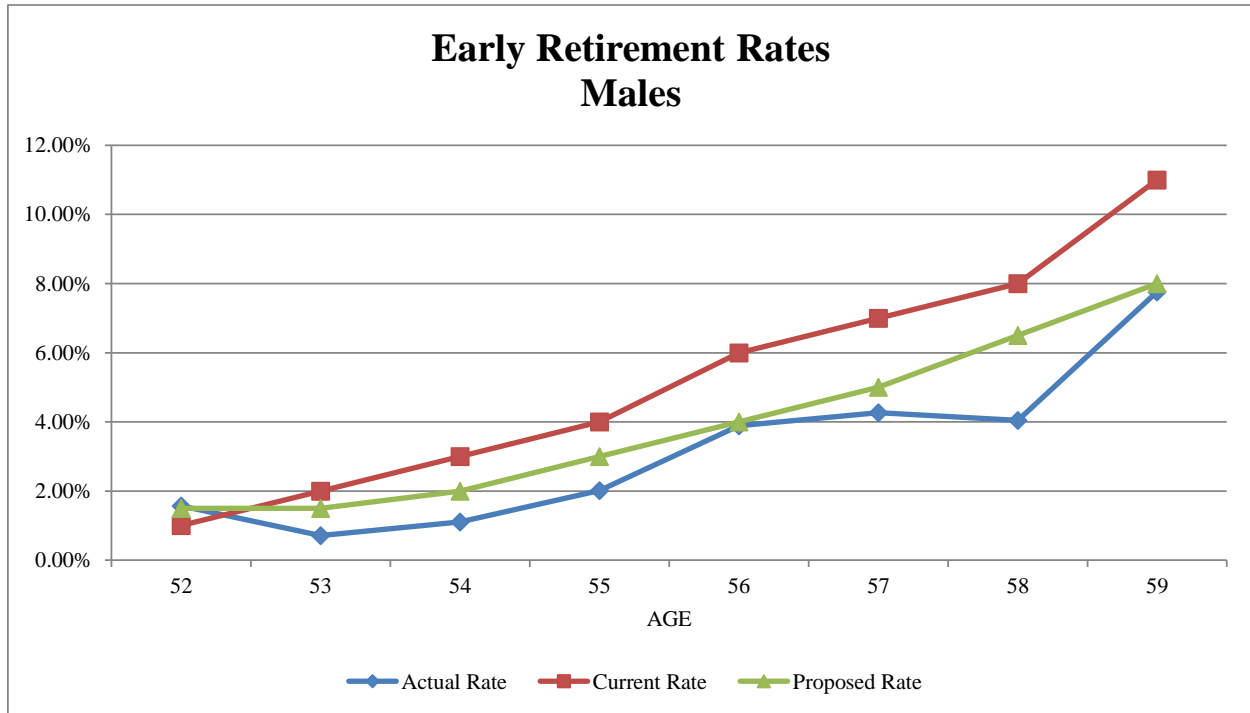
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Females eligible for early retirement				
Age	Actual	Expected	A/E Ratio	
			Count	Weighted
Under 50	5	10.5	0.476	0.438
50	5	8	0.630	0.651
51	6	12.5	0.480	0.491
52	8	20.5	0.391	0.347
53	17	29.4	0.578	0.613
54	26	39.2	0.663	0.665
55	47	95.5	0.492	0.496
56	64	129.3	0.495	0.504
57	65	136.5	0.476	0.505
58	76	141.4	0.538	0.515
59	119	160.5	0.741	0.756
Total	438	783.1	0.559	0.565

Over the study period, there were significantly fewer retirements for both males and females than expected. This continues a trend also seen in the last experience study. We believe a decrease in the current rates are appropriate. The following graphs show the actual rates of retirement by age compared with the current assumed retirement rates as well as the recommended rates.



## Section IV – Demographic Assumptions





## Section IV – Demographic Assumptions

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**Recommendation:** We recommend a decrease in both male and female assumed retirement rates.

The resulting A/E ratios are shown in the following tables.

Males eligible for early retirement		
Age	Weighted A/E Ratio	
	Curent	Proposed
Under 50	0.000	0.000
50	0.881	0.588
51	0.397	0.264
52	1.573	1.049
53	0.358	0.477
54	0.368	0.551
55	0.503	0.671
56	0.648	0.972
57	0.609	0.853
58	0.505	0.622
59	0.705	0.970
Total	0.596	0.784

Females eligible for early retirement		
Age	Weighted A/E Ratio	
	Curent	Proposed
Under 50	0.438	0.350
50	0.651	0.521
51	0.491	0.491
52	0.347	0.486
53	0.613	0.788
54	0.665	0.812
55	0.496	0.786
56	0.504	0.839
57	0.505	0.758
58	0.515	0.678
59	0.756	0.918
Total	0.565	0.772



## Section IV – Demographic Assumptions

### RATES OF WITHDRAWAL

**Background:** The rates of withdrawal are used to determine the expected number of separations from active service which will occur prior to eligibility for retirement for reasons other than death and disability (e.g., termination of employment). The assumption does not involve the analysis of the election of separating members to receive a refund of eligible funds. There are two separately developed sets of assumed rates for the withdrawal assumption. The first set of rates is the expected rates of withdrawal from active service for each year of service less than 10 years of service. These separating members are entitled to only a full refund of eligible funds. The second set of rates is the expected age-based rates for active members with 10 or more years of service. These separating members are eligible to elect between a full refund of eligible funds or a deferred annuity based upon benefit accrued to date of separation payable as early as age 60.

#### **Rates of Withdrawal with Less than 10 Years of Service**

##### ***Past Experience:***

Males with less than 10 years of service				
Service	Actual	Expected	A/E Ratio	
			Count	Weighted
0	72	34.0	2.116	2.156
1	306	289.1	1.059	1.018
2	214	205.3	1.042	1.013
3	173	153.0	1.131	1.115
4	113	97.6	1.158	1.122
5	92	68.8	1.338	1.407
6	95	57.2	1.660	1.569
7	67	52.7	1.271	1.258
8	79	50.5	1.565	1.680
9	76	55.5	1.370	1.344
Total	1,287	1,063.6	1.210	1.207



## Section IV – Demographic Assumptions

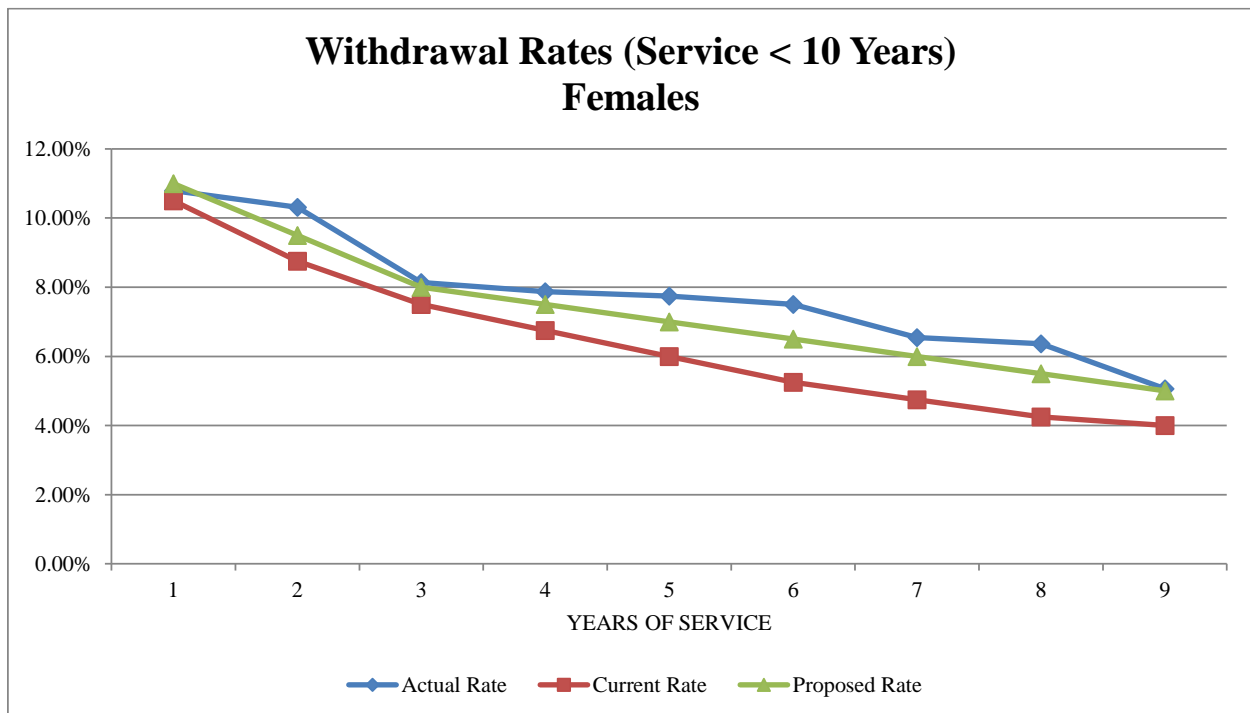
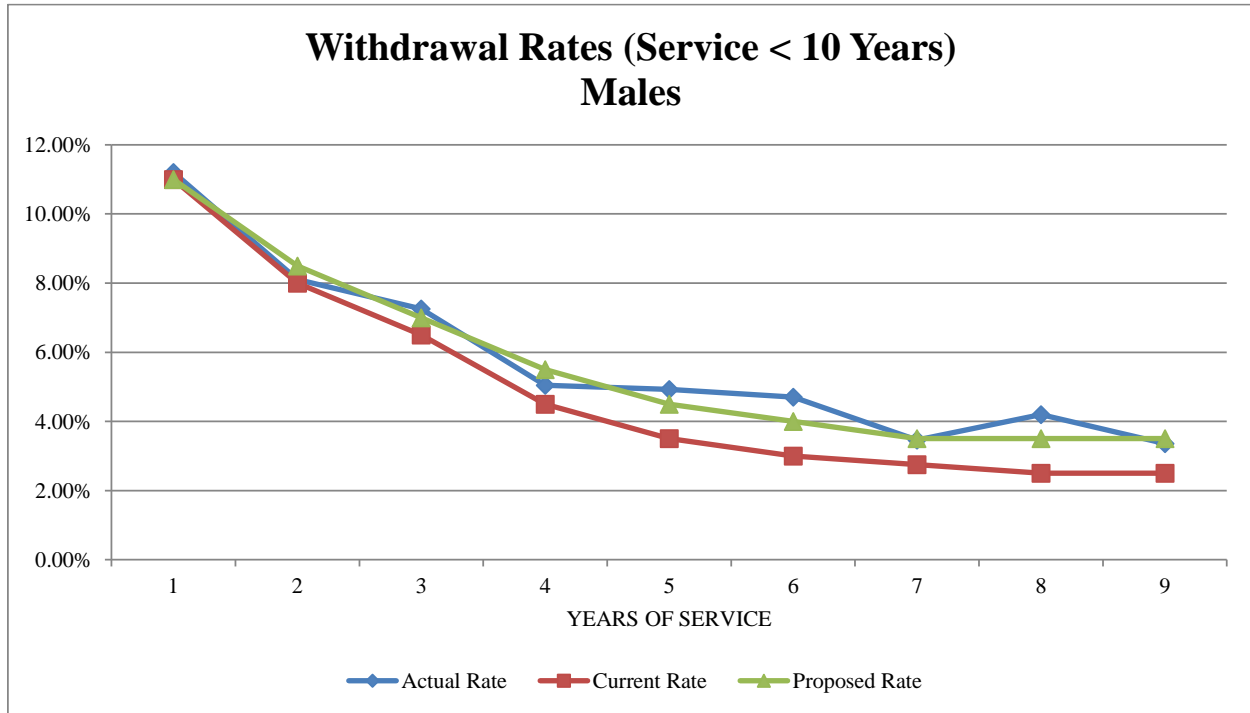
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Females with less than 10 years of service				
Service	Actual	Expected	A/E Ratio	
			Count	Weighted
0	160	91.3	1.752	1.702
1	1,051	1,010.2	1.040	1.028
2	1,003	832.7	1.204	1.178
3	750	664.0	1.130	1.085
4	674	553.7	1.217	1.166
5	575	434.2	1.324	1.291
6	541	361.7	1.496	1.430
7	479	328.8	1.457	1.377
8	480	309.4	1.551	1.497
9	401	307.6	1.304	1.266
Total	6,114	4,893.7	1.249	1.221

Over the study period, there were significantly more withdrawals for both males and females than expected. This continues a trend also seen in the last experience study when rates were increased. We believe another increase in the current rates, though maybe not as significant, is appropriate. The following graphs show the actual rates of withdrawal by years of service compared with the current assumed withdrawal rates as well as the recommended rates.



## Section IV – Demographic Assumptions







## Section IV – Demographic Assumptions

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**Recommendation:** We recommend an increase in both male and female assumed withdrawal rates.

The resulting A/E ratios are shown in the following tables.

Males with less than 10 years of service		
Service	Weighted A/E Ratio	
	Curent	Proposed
0	2.156	2.012
1	1.018	1.018
2	1.013	0.953
3	1.115	1.036
4	1.122	0.918
5	1.407	1.094
6	1.569	1.177
7	1.258	0.988
8	1.680	1.200
9	1.344	0.960
Total	1.207	1.051

Females with less than 10 years of service		
Service	Weighted A/E Ratio	
	Curent	Proposed
0	1.702	1.702
1	1.028	0.981
2	1.178	1.085
3	1.085	1.017
4	1.166	1.050
5	1.291	1.106
6	1.430	1.155
7	1.377	1.091
8	1.497	1.156
9	1.266	1.013
Total	1.221	1.073



## Section IV – Demographic Assumptions

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### Rates of Withdrawal with 10 or More Years of Service

#### *Past Experience:*

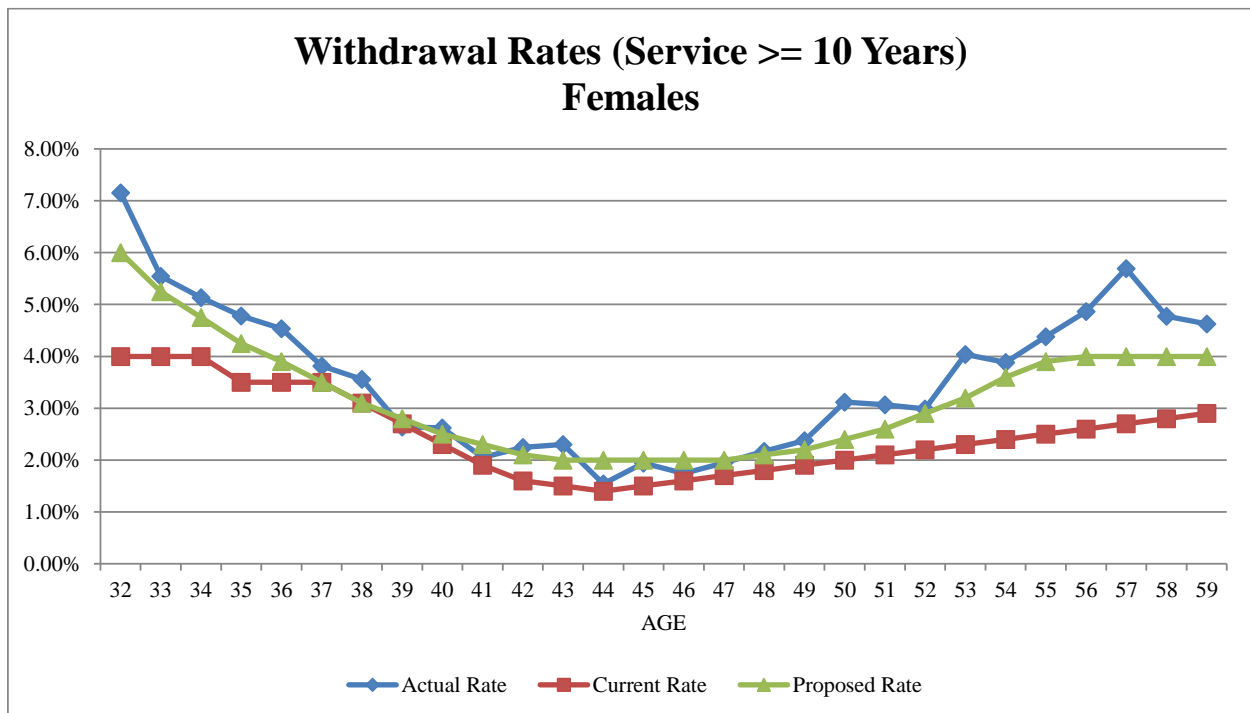
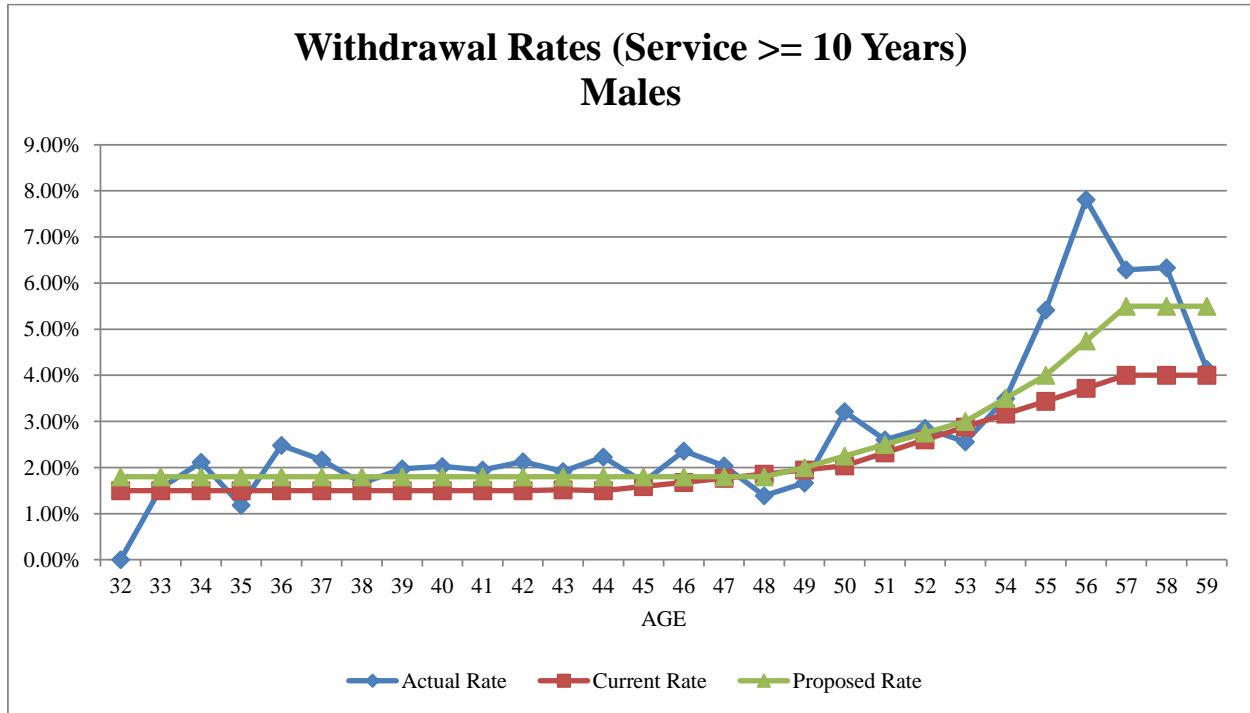
Males with 10 or more years of service				
Age	Actual	Expected	A/E Ratio	
			Count	Weighted
Under 35	21	15.3	1.373	1.241
35-39	111	82.7	1.342	1.281
40-44	154	110.1	1.399	1.365
45-49	140	128.7	1.087	1.052
50-54	127	109.7	1.158	1.158
55-59	119	77.6	1.533	1.584
Total	672	524.1	1.282	1.256

Females with 10 or more years of service				
Age	Actual	Expected	A/E Ratio	
			Count	Weighted
Under 35	214	150.2	1.425	1.362
35-39	679	547.8	1.239	1.167
40-44	445	336.2	1.324	1.239
45-49	401	321.4	1.248	1.195
50-54	418	266.6	1.568	1.549
55-59	388	210.6	1.843	1.808
Total	2,545	1,832.7	1.389	1.333

Here as well, there were significantly fewer withdrawals for both males and females than expected. This was also seen in the last experience study when rates were increased. We believe another increase in the current rates, though maybe not as significant, is appropriate. The following graphs show the actual rates of withdrawal by age compared with the current assumed withdrawal rates as well as the recommended rates.



## Section IV – Demographic Assumptions





## Section IV – Demographic Assumptions

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**Recommendation:** We recommend an increase in both male and female assumed withdrawal rates.

The resulting A/E ratios are shown in the following tables.

Males with 10 or more years of service		
Age	Weighted A/E Ratio	
	Current	Proposed
Under 35	1.241	1.035
35-39	1.281	1.067
40-44	1.365	1.141
45-49	1.052	1.009
50-54	1.158	1.075
55-59	1.584	1.207
Total	1.256	1.051

Females with 10 or more years of service		
Age	Weighted A/E Ratio	
	Current	Proposed
Under 35	1.362	1.081
35-39	1.167	1.095
40-44	1.239	0.985
45-49	1.195	0.982
50-54	1.549	1.167
55-59	1.808	1.224
Total	1.333	1.073



## Section IV – Demographic Assumptions

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### RATES OF DISABILITY

**Background:** The rates of disability are used to anticipate the expected number of separations due to disabilities of eligible active members. As rates of disability are very small, the number of disabilities incurred and expected is small relative to other decrements. When a disability does occur, it will result in an increase in the plan liability to reflect the immediate annuity payable to eligible disabled members at typically earlier ages.

**Past Experience:**

Males				
Central	A/E Ratio			
Age	Actual	Expected	Count	Weighted
30	0	2.1	0.000	0.000
35	2	3.0	0.678	0.699
40	1	5.0	0.202	0.204
45	5	10.9	0.460	0.504
50	9	14.6	0.615	0.608
55	4	17.3	0.231	0.245
60	7	11.2	0.627	0.700
Total	28	64.0	0.437	0.464



## Section IV – Demographic Assumptions

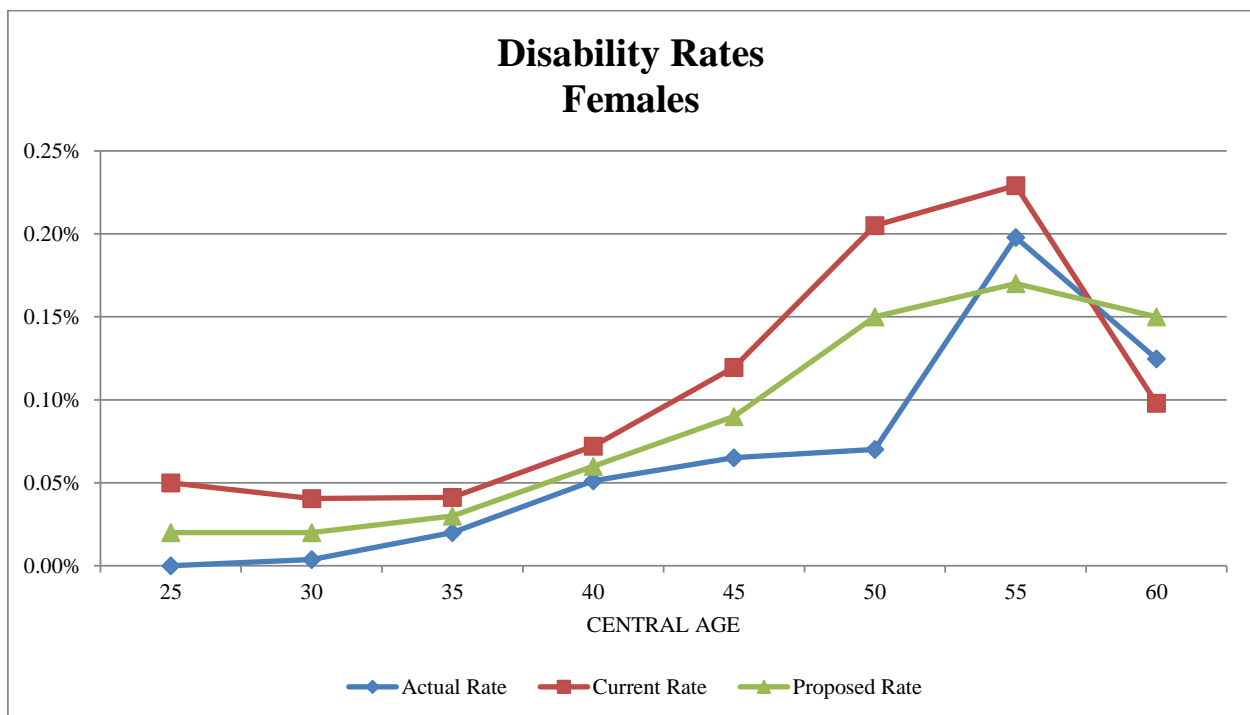
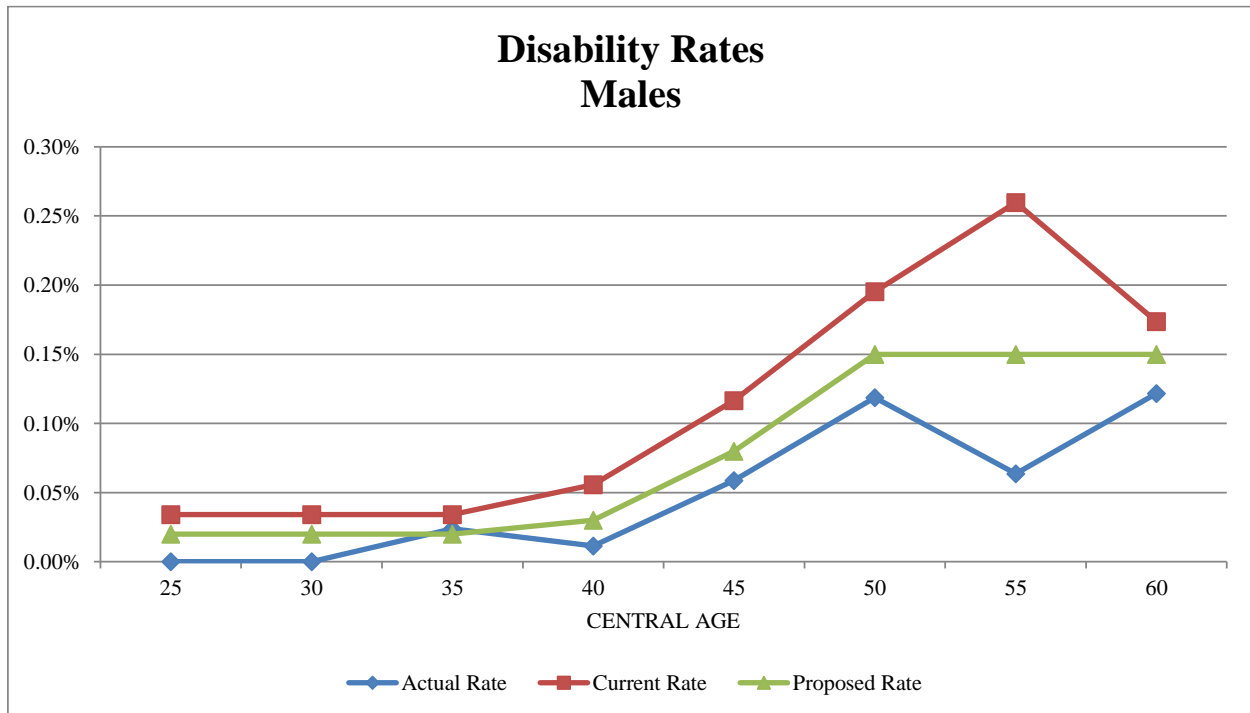
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Females				
Central			A/E Ratio	
Age	Actual	Expected	Count	Weighted
30	1	9.8	0.102	0.093
35	5	11.2	0.446	0.486
40	13	18.7	0.697	0.710
45	17	31.4	0.542	0.545
50	17	49.2	0.346	0.342
55	45	53.2	0.846	0.864
60	25	22.4	1.115	1.274
Total	123	195.8	0.628	0.660

Current experience shows slightly fewer disabilities than expected. This continues a trend also seen in the last experience study when rates were decreased. We believe it is appropriate to decrease these rates again. The following graphs show the actual rates of disability by age compared with the current assumed disability rates as well as the recommended rates.



## Section IV – Demographic Assumptions





## Section IV – Demographic Assumptions

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**Recommendation:** We recommend a decrease in both male and female assumed disability rates.

The resulting A/E ratios are shown in the following tables.

Central Age	Males	
	Weighted A/E Ratio	
	Curent	Proposed
30	0.000	0.000
35	0.699	1.192
40	0.204	0.379
45	0.504	0.733
50	0.608	0.791
55	0.245	0.425
60	0.700	0.810
Total	0.464	0.674

Central Age	Females	
	Weighted A/E Ratio	
	Curent	Proposed
30	0.093	0.187
35	0.486	0.666
40	0.710	0.853
45	0.545	0.724
50	0.342	0.468
55	0.864	1.164
60	1.274	0.832
Total	0.660	0.794





## *Section IV – Demographic Assumptions*

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### **RATES OF SALARY INCREASE**

**Background:** The assumed rates of salary increase provide the expected growth in future salaries both for approximating the future benefits to be provided and the future amounts expected to be contributed to the System through normal cost contributions of members and the employer. Therefore, this assumption is very material to valuation results. The actuarial standards of practice recommend a “building block” approach to developing this assumption. Under this approach, the assumption is composed of an assumption for wage inflation (the “across the board” increases of active salaries), and an assumed salary increase scale based on the years of service.

The first step in developing the service based rates of increase is to subtract the apparent wage inflation component from the actual salary rates of increase as measured over the study period. The average annual rate of inflation over the five-year period ending June 30, 2019 was 1.45% and the apparent real rate of wage inflation (wage increases above price inflation or CPI) in the data was 0.49%. The sum of these components equals an apparent annual rate of wage inflation of 1.94% over the five year period. The apparent rate of wage inflation is first removed from the actual rates of salary increase and the remaining rates reflect the apparent service based increases in salaries due to step increases, promotions, and educational increases. Next, we assess the current assumed rates of service-based salary increases and recommend adjustments where necessary.

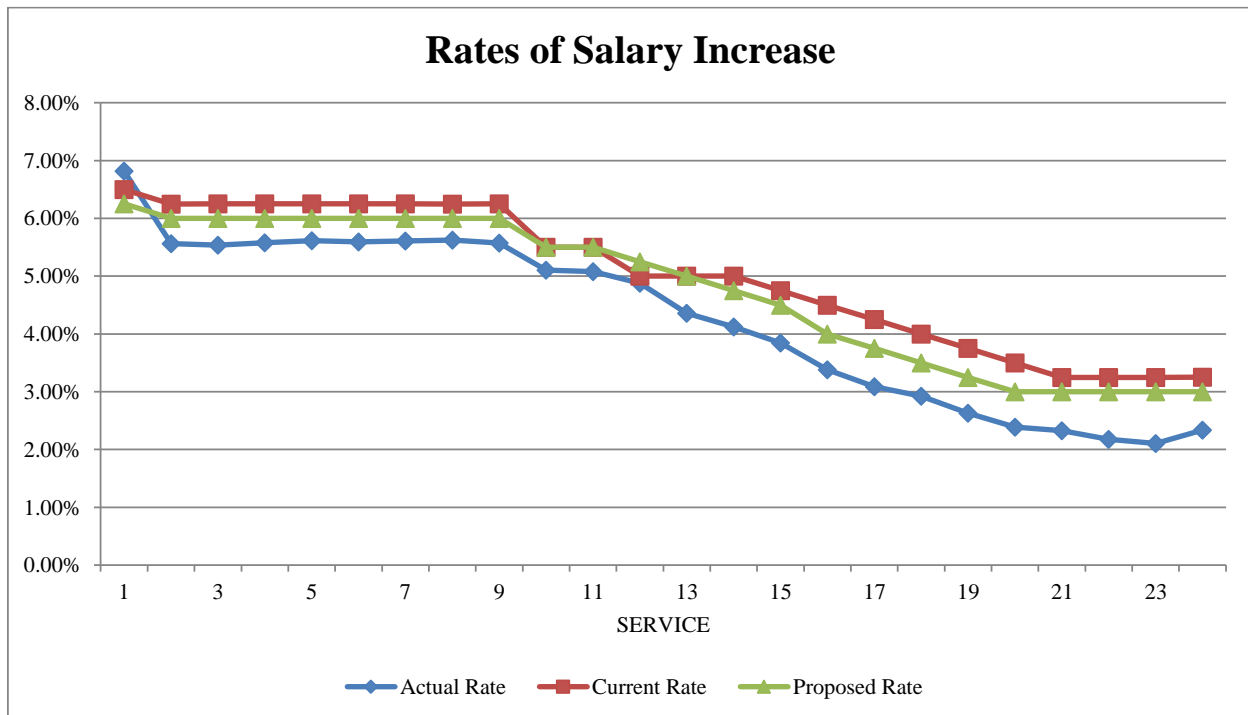
Again, the focus of this assumption is the long-term expectation and should not be significantly affected by short-term fluctuations. The actuary then combines the wage inflation assumption with the assumed rates of service based increases to produce the rates of assumed salary increases based upon years of service.



## Section IV – Demographic Assumptions

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*Past Experience:* Total salary increases averaged 3.9% per year compared with 4.8% expected increases in salaries over the five year period. We note that wage inflation or the “across the board” rate of increase has been consistently lower than the 3.25% assumed rate of increase.



**Recommendation:** Based upon our analysis, we recommend a 0.25% reduction in the wage inflation assumption from 3.25% to 3.00% as discussed previously in the economic assumptions as well as some minor adjustments to the service-based merit scale



## ***Section IV – Demographic Assumptions***

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### **OTHER ASSUMPTIONS**

#### **Percent Married:**

Currently 85% of active male members and 75% of active female members are assumed to be married with the male spouse three years older than the female spouse. This is a common and reasonable assumption and we recommend maintaining this assumption.

#### **Cost of Living Increases:**

For teachers who retired prior to September 1, 1992, pension benefit adjustments are made in accordance with increases in the Consumer Price Index, with a minimum of 3% and a maximum of 5% per annum. These members are currently assumed to receive an annual Cost-of-Living Adjustment (COLA) of 3.0%.

For teachers who were members of the Teachers' Retirement System before July 1, 2007, and retire on or after September 1, 1992, pension benefit adjustments are made that are consistent with those provided for Social Security benefits on January 1 of the year granted, with a maximum of 6% per annum. If the return on assets in the previous year was less than 8.5%, the maximum increase is 1.5%. These members are currently assumed to receive an annual COLA of 2.0%.

For teachers who were members of the Teachers' Retirement System after July 1, 2007, pension benefit adjustments are made that are consistent with those provided for Social Security benefits on January 1 of the year granted, with a maximum of 5% per annum. If the return on assets in the previous year was less than 11.5%, the maximum increase is 3%, and if the return on the assets in the previous year was less than 8.5%, the maximum increase is 1.0%. These members are currently assumed to receive an annual COLA of 1.75%.

Because we are recommending maintaining the assumed rate of inflation, we recommend maintaining these assumptions.



## ***Section IV – Demographic Assumptions***

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### **Plan N Partial Refund Option (Normal Form of Payment):**

For any member who retires prior to July 1, 2019, upon death, the member's beneficiary will receive a lump sum payment of the member's contributions with interest to the member's date of retirement less 25% of the total payments received to the member's date of death. We recommend a 12-year Certain and Life payment form be used to approximate the Plan N option where available data does not allow liabilities to be calculated directly.

For any member who retires on or after July 1, 2019, upon death, the member's beneficiary will receive a lump sum payment of the member's contributions with interest to the member's date of retirement less 50% of the total payments received to the member's date of death. We recommend a 9-year Certain and Life payment form be used to approximate the Plan N option where available data does not allow liabilities to be calculated directly.



## Appendix A – Recommended Rates

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TABLE 1 - RATES OF MORTALITY WHILE IN ACTIVE SERVICE

Age	Male	Female	Age	Male	Female
20	0.00034	0.00013	46	0.00074	0.00053
21	0.00030	0.00012	47	0.00082	0.00058
22	0.00025	0.00010	48	0.00091	0.00063
23	0.00021	0.00009	49	0.00100	0.00068
24	0.00018	0.00009	50	0.00111	0.00073
25	0.00016	0.00009	51	0.00122	0.00079
26	0.00017	0.00010	52	0.00133	0.00086
27	0.00018	0.00010	53	0.00146	0.00092
28	0.00019	0.00011	54	0.00159	0.00099
29	0.00021	0.00012	55	0.00172	0.00107
30	0.00022	0.00014	56	0.00187	0.00115
31	0.00024	0.00015	57	0.00203	0.00124
32	0.00025	0.00016	58	0.00221	0.00135
33	0.00027	0.00017	59	0.00241	0.00147
34	0.00028	0.00019	60	0.00264	0.00161
35	0.00030	0.00020	61	0.00291	0.00177
36	0.00032	0.00022	62	0.00321	0.00196
37	0.00034	0.00024	63	0.00354	0.00217
38	0.00037	0.00026	64	0.00392	0.00242
39	0.00039	0.00029	65	0.00435	0.00270
40	0.00042	0.00031	66	0.00481	0.00302
41	0.00046	0.00034	67	0.00532	0.00338
42	0.00050	0.00037	68	0.00587	0.00380
43	0.00055	0.00041	69	0.00647	0.00429
44	0.00060	0.00044	70	0.00709	0.00485
45	0.00067	0.00048			



## Appendix A – Recommended Rates

TABLE 2 - RATES OF MORTALITY FOR HEALTHY RETIREES

Age	Male	Female	Age	Male	Female
50	0.00111	0.00073	86	0.08608	0.06304
51	0.00122	0.00079	87	0.09737	0.07154
52	0.00133	0.00086	88	0.10992	0.08110
53	0.00146	0.00092	89	0.12385	0.09185
54	0.00159	0.00099	90	0.13923	0.10392
55	0.00223	0.00193	91	0.15602	0.11747
56	0.00245	0.00209	92	0.17409	0.13251
57	0.00269	0.00226	93	0.19329	0.14899
58	0.00296	0.00245	94	0.21343	0.16678
59	0.00325	0.00265	95	0.23430	0.18569
60	0.00357	0.00287	96	0.25568	0.20554
61	0.00393	0.00312	97	0.27735	0.22609
62	0.00434	0.00339	98	0.29912	0.24713
63	0.00479	0.00370	99	0.32085	0.26850
64	0.00532	0.00405	100	0.34239	0.29005
65	0.00592	0.00446	101	0.36368	0.31173
66	0.00662	0.00492	102	0.38472	0.33353
67	0.00743	0.00546	103	0.40534	0.35529
68	0.00837	0.00609	104	0.42538	0.37678
69	0.00945	0.00683	105	0.44470	0.39784
70	0.01070	0.00770	106	0.46319	0.41827
71	0.01214	0.00871	107	0.48075	0.43795
72	0.01379	0.00988	108	0.49732	0.45671
73	0.01569	0.01124	109	0.51285	0.47449
74	0.01785	0.01281	110	0.52500	0.49121
75	0.02031	0.01461	111	0.52500	0.50681
76	0.02312	0.01668	112	0.52500	0.51500
77	0.02629	0.01903	113	0.52500	0.51500
78	0.03015	0.02183	114	0.52500	0.51500
79	0.03457	0.02503	115	0.52500	0.51500
80	0.03960	0.02868	116	0.52500	0.51500
81	0.04537	0.03287	117	0.52500	0.51500
82	0.05199	0.03765	118	0.52500	0.51500
83	0.05901	0.04286	119	0.52500	0.51500
84	0.06698	0.04878	120	1.00000	1.00000
85	0.07598	0.05548			



**Appendix A – Recommended Rates**

**TABLE 3 - RATES OF MORTALITY FOR IN PAY BENEFICIARIES**

Age	Male	Female	Age	Male	Female
20	0.00030	0.00012	71	0.02562	0.01619
21	0.00025	0.00010	72	0.02811	0.01777
22	0.00021	0.00009	73	0.03084	0.01953
23	0.00018	0.00009	74	0.03382	0.02151
24	0.00016	0.00009	75	0.03706	0.02371
25	0.00017	0.00010	76	0.04060	0.02619
26	0.00018	0.00010	77	0.04450	0.02898
27	0.00019	0.00011	78	0.04880	0.03214
28	0.00021	0.00012	79	0.05360	0.03573
29	0.00022	0.00014	80	0.05897	0.03985
30	0.00024	0.00015	81	0.06498	0.04455
31	0.00025	0.00016	82	0.07169	0.04994
32	0.00027	0.00017	83	0.07915	0.05611
33	0.00028	0.00019	84	0.08743	0.06316
34	0.00030	0.00020	85	0.09658	0.07122
35	0.00032	0.00022	86	0.10665	0.08030
36	0.00034	0.00024	87	0.11768	0.09041
37	0.00037	0.00026	88	0.12978	0.10146
38	0.00039	0.00029	89	0.14418	0.11329
39	0.00042	0.00031	90	0.15947	0.12596
40	0.00046	0.00034	91	0.17555	0.13952
41	0.00050	0.00037	92	0.19236	0.15401
42	0.00055	0.00041	93	0.20986	0.16946
43	0.00060	0.00044	94	0.22800	0.18590
44	0.00549	0.00262	95	0.24674	0.20332
45	0.00572	0.00273	96	0.26601	0.22169
46	0.00596	0.00284	97	0.28574	0.24094
47	0.00621	0.00296	98	0.30581	0.26097
48	0.00646	0.00308	99	0.32609	0.28160
49	0.00701	0.00320	100	0.34636	0.30265
50	0.00724	0.00342	101	0.36640	0.32382
51	0.00747	0.00366	102	0.38604	0.34494
52	0.00771	0.00391	103	0.40512	0.36581
53	0.00797	0.00417	104	0.42352	0.38625
54	0.00824	0.00446	105	0.44113	0.40609
55	0.00854	0.00476	106	0.45786	0.42519
56	0.00887	0.00508	107	0.47364	0.44341
57	0.00924	0.00543	108	0.48843	0.46067
58	0.00965	0.00581	109	0.50000	0.47690
59	0.01012	0.00622	110	0.50000	0.49205
60	0.01067	0.00667	111	0.50000	0.50000
61	0.01130	0.00717	112	0.50000	0.50000
62	0.01202	0.00772	113	0.50000	0.50000
63	0.01286	0.00833	114	0.50000	0.50000
64	0.01384	0.00899	115	0.50000	0.50000
65	0.01497	0.00973	116	0.50000	0.50000
66	0.01628	0.01053	117	0.50000	0.50000
67	0.01776	0.01143	118	0.50000	0.50000
68	0.01943	0.01242	119	1.00000	1.00000
69	0.02129	0.01353	120	1.00000	1.00000
70	0.02335	0.01478			



**Appendix A – Recommended Rates**

**TABLE 4 - RATES OF MORTALITY FOR DISABLED RETIREES**

Age	Male	Female	Age	Male	Female
20	0.00412	0.00233	71	0.04113	0.03039
21	0.00386	0.00215	72	0.04344	0.03239
22	0.00352	0.00194	73	0.04599	0.03464
23	0.00316	0.00176	74	0.04880	0.03718
24	0.00289	0.00164	75	0.05192	0.04003
25	0.00278	0.00164	76	0.05537	0.04322
26	0.00292	0.00179	77	0.05921	0.04678
27	0.00306	0.00196	78	0.06347	0.05075
28	0.00321	0.00215	79	0.06822	0.05517
29	0.00337	0.00235	80	0.07348	0.06007
30	0.00354	0.00257	81	0.07929	0.06550
31	0.00372	0.00281	82	0.08565	0.07150
32	0.00391	0.00307	83	0.09259	0.07811
33	0.00411	0.00336	84	0.10010	0.08536
34	0.00434	0.00367	85	0.10815	0.09331
35	0.00458	0.00401	86	0.11678	0.10163
36	0.00486	0.00438	87	0.12605	0.11014
37	0.00518	0.00479	88	0.13603	0.11878
38	0.00555	0.00524	89	0.14861	0.12757
39	0.00597	0.00574	90	0.16253	0.13665
40	0.00645	0.00629	91	0.17681	0.14617
41	0.00700	0.00689	92	0.19126	0.15635
42	0.00763	0.00754	93	0.20588	0.16740
43	0.00834	0.00825	94	0.22078	0.17955
44	0.00916	0.00902	95	0.23617	0.19298
45	0.01007	0.00985	96	0.25226	0.20784
46	0.01109	0.01073	97	0.26924	0.22444
47	0.01221	0.01167	98	0.28723	0.24226
48	0.01342	0.01267	99	0.30624	0.26135
49	0.01470	0.01373	100	0.32609	0.28160
50	0.01605	0.01483	101	0.34636	0.30265
51	0.01712	0.01535	102	0.36640	0.32382
52	0.01818	0.01587	103	0.38604	0.34494
53	0.01921	0.01640	104	0.40512	0.36581
54	0.02020	0.01692	105	0.42352	0.38625
55	0.02114	0.01742	106	0.44113	0.40609
56	0.02201	0.01789	107	0.45786	0.42519
57	0.02280	0.01833	108	0.47364	0.44341
58	0.02355	0.01874	109	0.48843	0.46067
59	0.02428	0.01914	110	0.50000	0.47690
60	0.02503	0.01956	111	0.50000	0.49205
61	0.02584	0.02000	112	0.50000	0.50000
62	0.02677	0.02051	113	0.50000	0.50000
63	0.02785	0.02110	114	0.50000	0.50000
64	0.02908	0.02178	115	0.50000	0.50000
65	0.03044	0.02256	116	0.50000	0.50000
66	0.03193	0.02346	117	0.50000	0.50000
67	0.03353	0.02450	118	0.50000	0.50000
68	0.03524	0.02569	119	0.50000	0.50000
69	0.03706	0.02706	120	1.00000	1.00000
70	0.03901	0.02862			





**Appendix A – Recommended Rates**

**TABLE 5 - RATES OF RETIREMENT FROM ACTIVE SERVICE**

Age	<u>Unreduced</u>				<u>Proratable</u>		<u>Early</u>	
	<u>Less than 35 years of service</u>		<u>35 or more years of service</u>		Male	Female	Male	Female
	Male	Female	Male	Female				
50			0.3500	0.3000			0.0150	0.0125
51			0.3500	0.3000			0.0150	0.0125
52			0.3500	0.3000			0.0150	0.0125
53			0.3500	0.3000			0.0150	0.0175
54			0.3500	0.3000			0.0200	0.0225
55			0.3500	0.3000			0.0300	0.0300
56			0.3500	0.3000			0.0400	0.0375
57			0.3500	0.3000			0.0500	0.0450
58			0.3500	0.3000			0.0650	0.0550
59			0.3500	0.3000			0.0800	0.0700
60	0.2000	0.2000	0.3000	0.3000	0.0600	0.0500		
61	0.2000	0.2000	0.3000	0.3000	0.0600	0.0600		
62	0.2250	0.2000	0.3000	0.3000	0.0600	0.0700		
63	0.2250	0.2000	0.3000	0.3000	0.0900	0.0800		
64	0.2500	0.2500	0.3000	0.3000	0.1200	0.0900		
65	0.2750	0.3250	0.3500	0.3750	0.1500	0.1200		
66	0.2750	0.3000	0.3500	0.3750	0.1800	0.1500		
67	0.2750	0.3000	0.3000	0.3250	0.1800	0.1500		
68	0.2750	0.3000	0.3000	0.3250	0.1800	0.1500		
69	0.2750	0.3000	0.3000	0.3250	0.2850	0.1500		
70	0.2750	0.3000	0.3000	0.3250	0.2850	0.1500		
71	0.2750	0.3000	0.3000	0.3250	0.2850	0.1500		
72	0.2750	0.3000	0.3000	0.3250	0.2850	0.1500		
73	0.2750	0.3000	0.3000	0.3250	0.2850	0.1500		
74	0.2750	0.3000	0.3000	0.3250	0.2850	0.1500		
75	1.0000	1.0000	1.0000	1.0000	0.2850	0.1500		
76					0.2850	0.1500		
77					0.2850	0.1500		
78					0.2850	0.1500		
79					0.2850	0.1500		
80					1.0000	1.0000		



**Appendix A – Recommended Rates**

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**TABLE 6 - RATES OF WITHDRAWAL FROM ACTIVE SERVICE**

<u>Less than 10 years of service</u>			<u>10 or more years of service</u>		
<b>Years of Service</b>	<b>Male</b>	<b>Female</b>	<b>Age</b>	<b>Male</b>	<b>Female</b>
0	0.1500	0.1200	25	0.0180	0.0600
1	0.1100	0.1100	26	0.0180	0.0600
2	0.0850	0.0950	27	0.0180	0.0600
3	0.0700	0.0800	28	0.0180	0.0600
4	0.0550	0.0750	29	0.0180	0.0600
5	0.0450	0.0700	30	0.0180	0.0600
6	0.0400	0.0650	31	0.0180	0.0600
7	0.0350	0.0600	32	0.0180	0.0600
8	0.0350	0.0550	33	0.0180	0.0525
9	0.0350	0.0500	34	0.0180	0.0475
			35	0.0180	0.0425
			36	0.0180	0.0390
			37	0.0180	0.0350
			38	0.0180	0.0310
			39	0.0180	0.0280
			40	0.0180	0.0250
			41	0.0180	0.0230
			42	0.0180	0.0210
			43	0.0180	0.0200
			44	0.0180	0.0200
			45	0.0180	0.0200
			46	0.0180	0.0200
			47	0.0180	0.0200
			48	0.0180	0.0210
			49	0.0200	0.0220
			50	0.0225	0.0240
			51	0.0250	0.0260
			52	0.0275	0.0290
			53	0.0300	0.0320
			54	0.0350	0.0360
			55	0.0400	0.0390
			56	0.0475	0.0400
			57	0.0550	0.0400
			58	0.0550	0.0400
			59	0.0550	0.0400



**Appendix A – Recommended Rates**

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**TABLE 7 - RATES OF DISABILITY WHILE IN ACTIVE SERVICE**

Age	Male	Female
20	0.00020	0.00020
21	0.00020	0.00020
22	0.00020	0.00020
23	0.00020	0.00020
24	0.00020	0.00020
25	0.00020	0.00020
26	0.00020	0.00020
27	0.00020	0.00020
28	0.00020	0.00020
29	0.00020	0.00020
30	0.00020	0.00020
31	0.00020	0.00022
32	0.00020	0.00024
33	0.00020	0.00026
34	0.00020	0.00028
35	0.00020	0.00030
36	0.00022	0.00036
37	0.00024	0.00042
38	0.00026	0.00048
39	0.00028	0.00054
40	0.00030	0.00060
41	0.00040	0.00066
42	0.00050	0.00072
43	0.00060	0.00078
44	0.00070	0.00084
45	0.00080	0.00090
46	0.00094	0.00102
47	0.00108	0.00114
48	0.00122	0.00126
49	0.00136	0.00138
50	0.00150	0.00150
51	0.00150	0.00154
52	0.00150	0.00158
53	0.00150	0.00162
54	0.00150	0.00166
55	0.00150	0.00170
56	0.00150	0.00166
57	0.00150	0.00162
58	0.00150	0.00158
59	0.00150	0.00154
60	0.00150	0.00150



*Appendix A – Recommended Rates*

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**TABLE 8 - RATES OF SALARY INCREASES**

<b>Years of Service</b>	
0	0.0650
1	0.0625
2	0.0600
3	0.0600
4	0.0600
5	0.0600
6	0.0600
7	0.0600
8	0.0600
9	0.0600
10	0.0550
11	0.0550
12	0.0525
13	0.0500
14	0.0475
15	0.0450
16	0.0400
17	0.0375
18	0.0350
19	0.0325
20	0.0300
21+	0.0300