At the August 12, 2021 Board of Trustees meeting, the Board adopted all recommend assumption changes contained herein

Teachers' Retirement System of the State of Illinois

ACTUARIAL EXPERIENCE REVIEW

Analysis of Actuarial Experience during the Period July 1, 2017 through June 30, 2020

September 30, 2021 / Kim Nicholl, FSA, MAAA, EA, FCA / Matthew A. Strom, FSA, MAAA, EA / Tanya Dybal, FSA, MAAA, EA

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Via Email

September 30, 2021

Board of Trustees
Teachers' Retirement System of the State of Illinois
2815 West Washington Street
Springfield, IL 62702

Re: Actuarial Experience Review for the Period July 1, 2017 through June 30, 2020

Dear Trustees:

This report presents the results of the actuarial review of the demographic and economic experience of the Teachers' Retirement System of the State of Illinois (TRS) for the period July 1, 2017 through June 30, 2020. This experience review was prepared in accordance with Article 16, Section 176 of the Illinois Pension Code governing the System, which requires the actuary for TRS to make an actuarial investigation into the mortality, service, and other experience of the members, retirees and beneficiaries covered under the System at least once every three years. As recommended by the State Actuary, the economic assumptions for TRS have been reviewed on an annual basis since 2014.

All current actuarial assumptions were reviewed as part of this study. This review is the basis for our recommendation of the assumptions to be used for the June 30, 2021 actuarial valuation.

In preparing the results presented in this report, we have relied upon data that TRS provided to us regarding the membership census data and financial information. While the scope of our engagement did not call for us to perform an audit or independent verification of this information, we have reviewed it for reasonableness. The accuracy of the results presented in this report is dependent upon the accuracy and completeness of the underlying information.

This review recommends assumptions to be used in the valuation to measure the System's financial condition as of a single date. Future actuarial measurements may differ significantly from the current measurements presented in this report due to other assumption sets. This report does not include an analysis of the potential range of such future measurements.

Segal valuation results and experience study analysis are based on proprietary actuarial modeling software. The actuarial valuation models generate a comprehensive set of liability and cost calculations that are presented to meet regulatory, legislative and client requirements. Deterministic cost projections are based on a proprietary forecasting model. Raw experience study analysis of actual and expected decrements are generated by a model, which is used to develop recommended assumption changes. Our Actuarial Technology and Systems unit, comprised of both actuaries and programmers, is responsible for the initial development and maintenance of these models. The models have a modular structure that allows for a high

degree of accuracy, flexibility and user control. The client team programs the assumptions and the plan provisions, validates the models, and reviews test lives and results, under the supervision of the responsible actuaries.

It is worth noting that this experience study analysis is based on census data and information through June 30, 2020. The COVID-19 pandemic may have impacted market and demographic conditions during the first half of 2020. The potential impact of the pandemic on part of the actuarial experience was considered when performing our analysis.

Our analysis was conducted in accordance with generally accepted actuarial principles as prescribed by the Actuarial Standards Board (ASB) and the American Academy of Actuaries. Additionally, the development of all assumptions contained herein is in accordance with ASB Actuarial Standard of Practice (ASOP) No. 27 (*Selection of Economic Assumptions for Measuring Pension Obligations*) and ASOP No. 35 (*Selection of Demographic and Other Non-Economic Assumptions for Measuring Pension Obligations*).

The undersigned actuaries are independent. They are Fellows of the Society of Actuaries, Enrolled Actuaries, and Members of the American Academy of Actuaries, and are experienced in performing experience studies for large public retirement systems. They meet the Qualification Standards of the American Academy of Actuaries.

Respectively submitted,

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Senior Vice President and Actuary

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Teachers' Retirement System of the State of Illinois

Experience Review for the Period July 1, 2017 through June 30, 2020

I. Executive Summary

A. Introduction

Actuarial valuations are prepared annually to determine whether the contributions being made by members and employers are sufficient to fund the Teachers' Retirement System of the State of Illinois (TRS). Each actuarial valuation is highly dependent on the assumptions that the actuary uses to project the benefits expected to be paid in the future to all members of TRS. The projection of expected future benefit payments is based on the characteristics of members as of the valuation date, the benefit provisions in effect on that date, and assumptions of future events and conditions.

The purpose of this report is to present the results of the experience review of the actuarial assumptions used in the actuarial valuation of TRS. With the Board's approval of the recommendations in this report, adopted at the August 12, 2021 Board of Trustees meeting, these assumptions will be first used beginning with the June 30, 2021 actuarial valuation.

The assumptions used in actuarial valuations can be grouped into two categories: (1) economic assumptions – the assumed long-term rate of investment return, inflation, salary increases, and severance pay, and (2) non-economic or demographic assumptions – the assumed rates of termination, disability, retirement, mortality, sick leave credit, optional service purchase, and buyout election percentages. Demographic assumptions are primarily selected on the basis of recent experience (although a change in plan design or the employment environment may suggest otherwise), while economic assumptions rely more on a forward-looking perspective of expected future trends.

In order to determine the probability of an event occurring, we examine the "decrements" and "exposures" of that event. Using termination from active employment, for example, we compare the number of employees (or estimated liability, in the case of liability-weighted analysis) who actually terminate in a certain age and/or service category (i.e., the number of "decrements") with those "who could have terminated" (i.e., the number of "exposures"). For example, if there were 5,000 active employees in the 20-24 age group at the beginning of the year and 500 of them terminate during the year, we would say the probability of termination in that age group is 500 ÷ 5,000 or 10%. Similarly, in a liability-weighted approach, if there were $5,000,000 of active liability in the 20-24 age group and $500,000 of this liability is released due to terminations during the year, we would arrive at the same 10% probability of termination.

When setting the demographic assumptions (other than mortality), we typically develop proposed assumption rates by moving between the current assumption rate and the rate that the experience shows for that particular decrement. For example, if the probability of termination in the 20-24 age group is currently 8%, and the experience during the study period shows that 10% of eligible members actually terminated, we may propose adjusting the termination rate to 9%. We choose this methodology in order to smooth any changes in actual experience in case the experience during the study period is an anomaly.

I: Executive Summary

For the mortality and active retirement assumptions, we have reviewed the experience during the study period on a benefit-weighted/liability-weighted basis. A member who is eligible to retire at any retirement age with a large pension may be more likely to retire than a member of the same age with a smaller benefit.

If actual experience exactly matches the expected experience, the actual annual cost of TRS will equal the annual cost determined by the actuarial valuation. However, this result is virtually never achieved, due to the long-term nature of the benefit projections and the numerous assumptions used in actuarial valuations. TRS recognizes actuarial gains and losses each year, reflecting the net difference between actual experience and anticipated experience. A pattern of gains or losses with respect to one or more assumptions is the basis for recommended changes to the assumptions. Each valuation measures the effectiveness of each assumption and allows for the monitoring of the assumptions.

Actuarial experience studies are undertaken periodically and serve as the basis for recommended changes in actuarial assumptions and methods. A change in assumptions is recommended when it is demonstrated that the current assumptions do not accurately reflect the current trend determined from analysis of the data or anticipated future trends based upon reasonable expectations. The data analyzed include actual experience for demographic assumptions and economic forecasts for economic assumptions. The Actuarial Standards Board (ASB) provides actuaries with standards of practice that provide guidance and recommendations on acceptable methods and techniques to be used in developing both economic and demographic assumptions. Specifically, these are the ASB Actuarial Standard of Practice (ASOP) No. 27 (*Selection of Economic Assumptions for Measuring Pension Obligations*) and ASOP No. 35 (*Selection of Demographic and Other Non-Economic Assumptions for Measuring Pension Obligations*).

This study reviews the actuarial experience of TRS for the three-year period beginning July 1, 2017 and ending June 30, 2020, compares this experience to the current actuarial assumptions, and recommends changes to the assumptions as necessary. Economic assumption recommendations were primarily developed based on inputs related to economic forecasts and capital market expectations.

A summary of the key points of our review and our recommendations follows.

B. Recommendations

The experience review provides an opportunity for the Board, TRS staff, and actuary to consider how specific assumptions or methods affect the funding of the System, including the funded ratio and the adequacy of contributions made by members and employers (as compared to the actuarially determined contribution). We have reviewed both economic and demographic experience of the System as it relates to the expected actuarial experience based on the current plan assumptions. Included are recommendations for changes in assumptions that we believe will more accurately reflect the future experience of TRS.

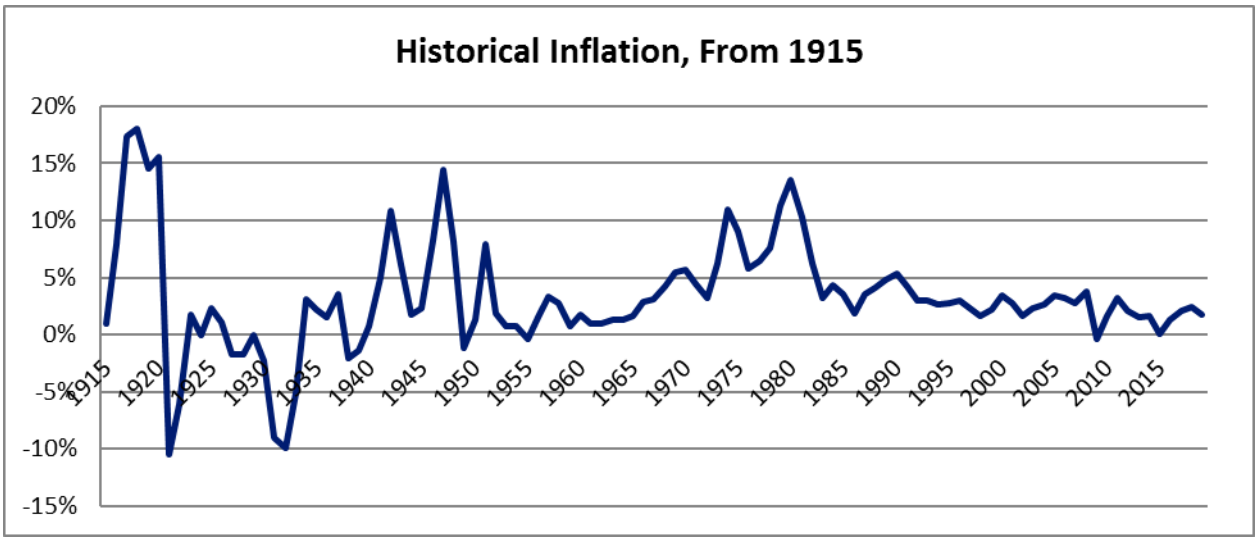
The detailed analysis of each individual assumption is discussed later in this report.

Economic Assumptions

Economic assumptions include inflation, rate of investment return (or discount rate), rate of individual salary increases, new entrant pay increase, Tier 2 cost-of-living adjustments (COLA), Tier 2 pensionable salary cap, and rate of severance pay.

Inflation

Inflation continues at relatively low levels from a historical perspective, as shown in the graph below.



The current inflation assumption is 2.5% per annum. The outlook for inflation is under 2.2% over a 20-year time horizon according to the Horizon Survey of Capital Market Assumptions (2020 Edition) and other professional forecasters. **In light of all sources of inflation expectations reviewed in our study, we recommend lowering the inflation assumption from 2.5% to 2.25%.**

Most other economic assumptions have an underlying inflation component. The investment return assumption is comprised of inflation and the real rate of return for each asset class. The assumed rates of individual salary increases are comprised of inflation and merit and seniority increases. The new entrant pay increase assumption is generally connected to inflation without any merit component. Finally, cost-of-living adjustments and the pensionable salary cap for Tier 2 members are functions of inflation (lesser of 3% and ½ of CPI-U).

I: Executive Summary

Rate of Investment Return

The System has averaged investment returns of 8.2% and 5.7% over the last 10 years and 20 years, respectively. The current assumption is 7.00%.

Based on the System's target allocation and the 10-year and 20-year Capital Market Assumptions (CMA) provided in the Horizon Survey of Capital Market Assumptions (2020 Edition), the net expected real rate of investment return (adjusted for implementation costs of alternative investments, expected benefit payout timing, negative cash flow, and the change in market outlook since 2020) is 4.79%. The current assumption is 4.50%. Since we recommend that the inflation assumption be changed to 2.25%, and the investment return assumption is the combination of expected inflation plus expected real rate of return, the 49th percentile weighted expected return over the next 20 years is 7.0%. Therefore, **we recommend that the current 7.0% investment return assumption remain unchanged.** However, we would also support an investment return assumption of 6.75% because the likelihood of achieving this rate over the next 20 years is 54%.

Rate of Individual Salary Increases

We study the merit and seniority increases separately from inflation. Analysis of the distribution of merit and seniority increases by years of service during the study period shows that these increases were less than expected.

Based on experience, **we recommend decreasing the merit and seniority portion of individual salary increases.** The proposed salary increase assumption represents approximately half of the actual salary increase below expected.

New Entrant Pay Increase

This assumption represents how starting salaries for new entrants increase in the future. Generally, this assumption is connected to the inflation assumption without any merit component.

Based on the proposed 2.25% inflation assumption, **we recommend that the new entrant pay increase assumption be reduced from 3.25% to 2.25%.**

Tier 2 COLA and Pay Cap

The COLA and pensionable salary cap increases for Tier 2 members are based on annual inflation, as annual increases are the lesser of 3% and ½ of CPI-U.

Based on the proposed 2.25% inflation assumption, **we recommend that the average COLA and rate of increase in the pensionable salary cap applicable to Tier 2 members be reduced from 1.25% to 1.125%.**

I: Executive Summary

Severance Pay

Analysis of the severance pay assumption during the study period shows that the percent of retirees receiving severance pay, as well as the actual severance payments, have been less than expected.

Based on experience, **we recommend lowering the percent of retirees assumed to receive severance pay from 20% to 18%, in addition to lowering the average severance payment percent from 10% to 8% of other pensionable earnings in the last year of employment, to better reflect plan experience.**

Demographic Assumptions

The demographic assumptions include mortality, retirement, termination (or withdrawal), disability incidence, spouse information, sick leave service credits, optional service purchase, future service accrual rate, and buyout election percentages.

Mortality

Healthy Post-Retirement Mortality

Currently, TRS uses healthy post-retirement mortality rates based on the RP-2014 Healthy Annuitant Mortality Table (sex-distinct) and the MP-2017 projection scale. For healthy annuitant lives, the mortality table is the RP-2014 White Collar Healthy Annuitant Mortality Table, with adjustments for credibility and gender. For females, the adjustments are a 70% factor applied to the rates for ages below 78 and a 110% factor applied to the rates for ages 78 to 114, projected generationally using the MP-2017 projection scale. For males, the adjustments are a 94% factor applied to the rates for ages below 81 and a 110% factor applied to the rates for ages 81 to 114, projected generationally using the MP-2017 projection scale.

In 2019, the Society of Actuaries published a series of mortality tables derived from public plan experience, called Pub-2010. The published mortality tables are based on three broad categories: teachers (PubT-2010), public safety (PubS-2010), and general employees (PubG-2010). In addition, contingent survivor tables were published.

Analysis of the healthy post-retirement mortality for the past three years reveals that, in total, fewer healthy participants in pay status have died than expected on a benefits-weighted basis, with the exception of male participants age 85 and over.

As such, **we recommend the updating the base tables to the PubT-2010 Retiree Mortality Tables for females using 91% of the rates prior to age 75 and 109% of the rates for ages 75 and older. For males, the mortality table would be updated to the PubT-2010 Retiree Mortality Table using 105% of the rates prior to age 85 and 115% of the rates for ages 85 and older.** In order to reflect future improvements in life expectancy, **we recommend updating the mortality projection scale to MP-2020.**

Beneficiary Mortality

Beneficiary mortality is currently based on the RP-2014 Annuitant Mortality Table (without collar adjustment), projected generationally using Scale MP-2017. Female and male rates are adjusted by 96% and 116%, respectively, for ages 50 to 114. The actual rate of mortality among male and female beneficiaries during the study period was greater than expected in aggregate, though not for all age groups studied. Based on our analysis, **we recommend that the mortality table for healthy beneficiaries be updated to the Pub-2010 Contingent Survivor Mortality Table for females using 98% of the rates for all ages and for males using 110% of the rates for all ages.** In order to reflect future improvements in life expectancy, **we recommend updating the mortality projection scale to MP-2020.**

Disability Mortality

The current mortality table for disabled lives is the RP-2014 Disabled Retirees Table, projected generationally with Scale MP-2017, incorporating a 117% factor for males and females ages 45 to 99. The experience analysis for the past three years reveals that fewer disabled annuitants died than expected on a benefits-weighted basis; however, there was limited experience on which to base the assumption.

Since plan experience is insufficient to set the assumption with full credibility, **we recommend that the mortality table for disabled annuitants be updated to the Pub-2010 Non-Safety Disabled Retiree Table for males and females with no adjustments.** In order to reflect future improvements in life expectancy, **we recommend updating the mortality projection scale to MP-2020.**

Pre-Retirement Mortality

The current mortality table for active and terminated members is the RP-2014 White Collar Employee Table, with female and male rates adjusted by a 104% factor for all ages. The experience over the past three years reveals that fewer actives and terminated members have died than expected on a benefits-weighted basis; however, very few members die in active status and the liability associated with pre-retirement deaths is a small percentage of the total liability. As such, **we recommend that the pre-retirement mortality table be updated to the PubT-2010 Employee Table using 90% of the rates for all ages for both females and males**. In order to reflect future improvements in life expectancy, **we recommend updating the mortality projection scale to MP-2020.**

Retirement

The current retirement rates for active members are based on members' age and years of service at retirement. There are different retirement rates depending on Tier. Analysis of Tier 1 active member retirements over the past three years reveals that, overall, there were more retirements than expected on a benefits-weighted basis.

Therefore, **we recommend modifying rates to be more consistent with actual experience, along with combining service groupings that had similar experience. We recommend no changes to the Tier 2 retirement rates as there is very limited actual retirement experience to analyze at this point.**

Termination

The current assumption for termination uses Select and Ultimate Tables based on gender, age, and years of service. Separate rates apply to members with less than five years of service and members with five or more years of service. Termination rates for members with 5 or more years of service are offset by rehires to reflect Tier 1 members being replaced by rehired Tier 1 members. The experience shows that actual turnover was less than expected. Therefore, **we recommend decreasing termination rates for all members to better align with recent experience.**

Note that our analysis excludes hourly/substitute teachers because their high turnover rate would overstate the probability of turnover for full-time teachers.

Disability Retirement

The current disability incidence rates are based on members' age and gender. During the experience study period, the number of disabilities was lower than expected. Therefore, **we recommend lowering the disability rates to better match plan experience.**

Other Demographic Assumptions

Other demographic assumptions that affect the valuation are spouse information, the sick leave service credits, optional service purchases, future service accrual rates, and buyout election percentages.

Spouse Information

The current spouse information assumption is that 85% of active members are married with males being three years older than females. We have limited data on spouse information. However, the current assumptions are reasonable and consistent with assumptions used for similar plans. Therefore, **we recommend no changes to the current assumption.**

Sick Leave Service Credit

The current sick leave service credit assumption is based on service at retirement. On average, experience is consistent with the current assumption, although inconsistent for individual service levels. **We recommend slightly adjusting rates to better reflect plan experience.**

Optional Service Purchase

The current optional service purchase assumption is based on service at retirement. On average, experience shows fewer optional service purchases than currently assumed. **We recommend lowering rates to reflect plan experience.**

Future Service Accrual Rate

The current future service accrual rate assumptions are that full-time members accrue 0.961 years of service per year and hourly members accrue 0.250 years of service per year. On average, experience shows that future service accruals are greater than the current assumption. **We recommend increasing the service accrual rate to 0.98 years of service per year for full-time members and 0.275 years of service per year for hourly members.**

Buyout Election Percentages

Public Acts 100-0587 and 101-0010 provide Tier 1 members the option to receive a lump at retirement in exchange for having their automatic annual increase (AAI) based on 1.5% of the originally granted annuity (instead of the current 3% compounded AAI) effective at age 67 (instead of age 61).

The current AAI buyout assumption is 15% of eligible retiring Tier 1 members will elect the buyout. In general, there were more actual AAI buyouts than expected for the period January 1, 2019 through December 31, 2020. Post-2020 experience is limited, though is projected to be similar to known pre-2021 experience. As such, **we recommend increasing the AAI buyout election assumption to 20% to reflect plan experience.**

I: Executive Summary

Public Acts 100-0587 and 101-0010 also provide inactive vested (IV) members the option to receive an immediate lump sum in exchange for their annuity at retirement.

The current IV buyout assumption is 22% of eligible inactive vested members will elect the buyout. In general, there were fewer actual IV buyouts than expected. As such, **we recommend decreasing the IV buyout election assumption to 5% to reflect plan experience.**

Summary of Actuarial Experience

For the three-year period under review, TRS has experienced both actuarial gains and actuarial losses on individual decrements and economic assumptions. Investment returns on the fair value of assets have averaged 8.2% and 5.7% over the last 10 and 20 years, respectively. The imputed return on the actuarial value of assets has produced losses in two of the three years of the study period and a gain in the third. Aggregate experience for non-investment assumptions has produced losses in all three years of the study period. A summary of the historical liability gains and losses (dollars in millions) is shown below.

Demographic Gains/(Losses) 2018 to 2020

Decrement	Actuarial Valuation as of June 30			Total
	2020	2019	2018	
Salary Increases	$41.8	$84.0	$40.3	$166.1
Retirement Experience	(178.2)	(324.4)	(342.0)	(844.6)
Disability experience	17.7	17.8	24.3	59.8
Termination Experience	(49.4)	(60.4)	(19.5)	(129.3)
Mortality Experience	(14.1)	(11.0)	(42.6)	(67.7)
Rehires	(41.3)	(39.5)	(36.3)	(117.1)
New Entrants	10.5	10.9	16.8	38.2
Other	166.1	(29.4)	(18.1)[1]	118.6
Total	**($46.9)**	**($352.0)**	**($377.1)**	**($776.0)**
Actuarial Accrued Liability (AAL)	135,559	131,457	127,019	
Total as a % of AAL	**-0.03%**	**-0.27%**	**-0.30%**	

[1] Does not include $1,001.2 million loss due to programming enhancements

Summary of Assumptions and Recommended Changes

The following table summarizes the actuarial assumptions and methods used in the valuation and the changes recommended in this report.

Description	Current	Proposed
Economic Assumptions		
Inflation	2.50%	2.25%
Tier 2 Pay Cap Increase	1.25% per annum	1.125% per annum
Tier 2 COLA Increase	1.25% per annum	1.125% per annum
Salary Scale	Merit (including productivity) rates based on years of service plus inflation	Decreases to merit (and productivity) portion of individual salary increase based on years of service plus inflation
Investment Return	7.00%	7.00%
Severance Pay	20% assumed to receive severance pay, average of 10% of earnings in final year of employment	18% assumed to receive severance pay, average of 8% of earnings in final year of employment
New Entrant Salary Increase (for projections)	3.25%	2.25%
Demographic Assumptions		
Healthy Post-Retirement Mortality	RP-2014 White Collar Healthy Annuitant Table, female rates multiplied by 70% for ages under 78 and 110% for ages 78-114 and male rates multiplied by 94% for ages under 81 and 110% for ages 81 to 114	PubT-2010 Retiree Mortality Table for females using 91% of the rates prior to age 75 and 109% of the rates for ages 75 and older. For males, 105% of the rates prior to age 85 and 115% of the rates for ages 85 and older
Beneficiary Mortality	RP-2014 Healthy Annuitant Table, female and male rates multiplied by 96% and 116%, respectively, for age 50 to 114	Pub-2010 Contingent Survivor Table for males using 110% of the rates for all ages. For females, 98% of the female rates for all ages
Disabled Mortality	RP-2014 Disabled Retiree Tables, female and male rates multiplied by 117% for ages 45 to 99	PubNS-2010 Non-Safety Disabled Retiree Table
Pre-Retirement Mortality	RP-2014 White Collar Employee Tables, female and male rates multiplied by 104% for all ages	PubT-2010 Employee Mortality Table using 90% of rates for all ages
Mortality Improvement	Generational projection using Scale MP-2017	Generational projection using Scale MP-2020
Active Retirement	Rates based on age and service that range from 0% to 100% from age 54 to age 75, grouped for members with less than 19, 19 to 29, 30 to 31, 32 to 33, and 34 or more years of service	Slight adjustment for rates based on plan experience. Combined 30 to 31 and 32 to 33 years of service groups into 30 to 33 years of service grouping (due to similar actual experience)
Termination	Gender distinct rates based on age and years of service	Adjust rates based on plan experience
Disability	Gender distinct rates based on age	Adjust rates based on plan experience
Sick Leave Service Credit	Rates based on regular service at retirement	Adjust rates based on plan experience

Description	Current	Proposed
Optional Service Purchase	Rates based on regular service at retirement	Adjust rates based on plan experience
Spouse Information	85% of members assumed to be married Male members are assumed to be 3 years older than spouse, female members assumed to be 3 years younger	No changes
Future Service Accrual Rate	0.961 per year for Full-Time 0.250 per year for Hourly	0.98 per year for Full-Time 0.275 per year for Hourly
Automatic Annual Increase Buyout	15% of eligible retiring Tier 1 members assumed to elect buyout	20% of eligible retiring Tier 1 members assumed to elect buyout
Inactive Vested Buyout	22% of eligible inactive vested members are assumed to elect buyout	5% of eligible inactive vested members are assumed to elect buyout
Buyout Period	Buyouts are assumed to be paid through fiscal year 2022	Buyouts are assumed to be paid through fiscal year 2024

Impact of Assumption Changes on Valuation Results

The following tables detail the impact of the recommended assumption changes, using the June 30, 2020 actuarial valuation results for illustrative purposes. When the proposed set of assumptions is used in the June 30, 2021 valuation, the relative impact is expected to be similar to the results shown below (as a percentage of the actuarial accrued liability and normal cost). However, the actual impacts may vary due to underlying changes that occur between valuation dates. The comparability may also be affected by the actual investment return and demographic experience during the year.

($ in Millions) Description	Current Assumptions	Proposed Demographic Assumptions	Proposed Demographic and Economic Assumptions	Total Change
Actuarial Accrued Liability	$135,599	$135,710 +111	$134,941 -769	-$658
Actuarial Value of Assets	54,891	54,891	54,891	
Unfunded Actuarial Accrued Liability	80,708	80,819 +111	80,050 -769	-658
Funded Ratio	40.5%	40.4% -0.1%	40.7% +0.3%	+0.2%
Normal Cost	$2,175	$2,285 +106	$2,191 -90	+$16
FY 2022 Actuarially Determined Contribution[1]	8,850	8,980 +130	8,816 -164	-34
FY 2022 State Contribution[2]	5,694	N/A	5,757 +63	+63

[1] State's portion
[2] Reflects five-year phase-in of effect of assumption changes

I: Executive Summary

The net impact of the recommended demographic assumption changes, using the 2020 valuation for illustrative purposes, would have increased the actuarial accrued liability by approximately $111 million, or 0.1%. The primary driver of the increase in the actuarial accrued liability is the change is the retirement and turnover assumptions.

The net impact of the recommended economic assumption changes would have decreased the actuarial accrued liability by approximately $769 million, or 0.6%. The primary driver of the decrease in the actuarial accrued liability is reduction in the salary increase assumption.

Overall, the recommended demographic and economic assumption changes would decrease the actuarial accrued liability by $658 million, or 0.5%, increase the normal cost by $16 million, or 0.7%, decrease the FY 2022 Actuarial Determined Contribution by $34 million, or 0.4%, and increase the FY 2022 State Contribution by $63 million, or 1.1%.

II. Economic Assumptions

The economic assumptions have a significant impact on the development of plan liabilities. Changes to these assumptions can substantially alter the actuarial valuation results. The goal of an experience study is to produce a consistent set of economic assumptions that appropriately reflect expected future economic trends.

The primary economic assumptions that affect TRS' valuation results are:

- Inflation;
- Rate of Investment Return;
- Rate of Individual Salary Increases;
- New Entrant Pay Increases;
- Tier 2 COLA / Pay Cap; and
- Rate of Severance Pay

The Actuarial Standards Board (ASB) has adopted Actuarial Standard of Practice No. 27 (*Selection of Economic Assumptions for Measuring Pension Obligations*) to provide actuaries guidance in developing economic assumptions.

The inflation component is included in all economic assumptions (except for severance pay), and therefore is key to developing a consistent set of actuarial assumptions. The rate of investment return assumption includes an inflation component and a real rate of return component. The components of the salary increase assumption are inflation, real wage growth, and merit and seniority increases. The new entrant pay increase assumption is generally connected to the inflation assumption without any merit component. The Tier 2 COLA and pensionable salary cap increases are directly tied to actual inflation during the year.

A. Inflation

In developing the recommendation for the assumed inflation component, actuarial standards of practice suggest the actuary review appropriate inflation data. This data may include consumer price indexes, the implicit price deflator, forecasts of inflation, and yields on government securities of various maturities.

The table below shows that recent inflation experience has occurred at a historically low rate.

Historical Consumer Price Index – Averages (U.S. City Average - All Urban Consumers)

Average Annual Change as of April 30, 2021	CPI-U
5-Year Average	2.22%
10-Year Average	1.73%
20-Year Average	2.08%
30-Year Average	2.29%
50-Year Average	3.86%

As can be seen in the table above, the average annual inflation rates had gradually declined over the last 50 years due to a relatively low inflationary period over the past two decades, with a slight up-tick very recently. Historical trend is a less important consideration for the assumed rate of inflation, but assists in determining the reasonable bounds of expected inflation.

Since 2012, Horizon Actuarial Services, LLC has published survey results that summarize the capital market assumptions of various investment firms. Based on the survey results from the 2020 Edition of the Survey of Capital Market Assumptions, the average 10-year inflation assumption across 39 survey respondents was 1.97% and the average 20-year inflation assumption across a subset of 18 survey respondents that provided assumptions for 20 years was 2.16%.

The table below compares the 2020 Horizon Survey results to other sources.

Source	10-Year	20-Year
Federal Reserve Bank of Philadelphia First Quarter 2021 Survey of Professional Forecasters	2.20%	
Segal Marco Advisors	2.00%	2.00%
2020 Horizon Survey of Capital Market Assumptions	1.97%	2.16%

II: Economic Assumptions

Next, we consider the measure of future inflation expectation. An indication of future expectation is a market-based forecast. Treasury Inflation Protection Securities (TIPS) are government bonds, which, in addition to a fixed yield, add the actual percentage change in CPI to the principal value. Therefore, the spread between the TIPS and the Conventional Treasury note/bond of the same maturity is an indication of the market's forecast for inflation.

The following table compares the yields on US Treasury Bonds as of May 31, 2021, with and without inflation indexing.

US Treasury Bonds as of May 31, 2021	10-Year Yield	20-Year Yield	30-Year Yield
Non-Inflation Indexed	1.62%	2.22%	2.30%
Inflation Indexed	-0.84%	-0.29%	-0.05%
Difference	2.46%	2.51%	2.35%

Because of the inflation protection, TIPS' yields are considerably lower than those of regular Treasury securities of similar maturities. As of May 31, 2021, 30-year Treasuries yielded 2.30% while 30-year TIPS yielded -0.05%. In order for 30-year TIPS to match the return of the conventional 30-year Treasury for a buy-and-hold income investor, inflation would have to measure 2.35% per year over the next 30 years. In addition, it is also important to note that the market's view of inflation over 20 years is around 5 basis points greater than the 10-year horizon and is around 15 basis points greater than the 30-year horizon.

The market's expectation of inflation alone is not a definitive basis for an inflation assumption due to other factors that affect the yields of those securities, but is useful as one indicator of future trend.

We also referred to the 2020 report on the financial status of the Social Security program[1]. The projected average increase in price inflation over the next 75 years under the intermediate cost assumptions used in that report was 2.40%. The price inflation measure used in this report is the Consumer Price Index for Urban Wage Earners and Clerical Workers (CPI-W)[2]. Besides projecting the results under the intermediate cost assumptions using an inflation assumption of 2.40%, alternative projections were also made using a lower and a higher inflation assumption of 1.80% and 3.00%, respectively.

Lastly, the Philadelphia Federal Reserve Bank Survey of Professional Forecasters indicates inflation expectations for a 10-year period of 2.20%.

Considering all of this information, **we recommend that the inflation assumption be lowered from 2.50% to 2.25%.**

[1] Source: Social Security Administration – The 2020 Annual Report of the Board of Trustees of the Federal Old-Age and Survivors Insurance and Federal Disability Insurance Trust Funds

[2] The CPI-W is a more specialized index relative to CPI-U and seeks to track retail prices as they affect urban hourly wage earners and clerical workers. It encompasses about 32 percent of the United States' population and is a subset of the CPI-U group. The CPI-W places a slightly higher weight on food, apparel, transportation, and other goods and services. It places a slightly lower weight on housing, medical care, and recreation. The CPI-U is a more general index and seeks to track retail prices as they affect all urban consumers. It encompasses about 87 percent of the United States' population.

B. Rate of Investment Return

The rate of investment return is used to estimate annual investment return and to determine the present value of expected future plan payments. The selection of an investment return assumption considers capital market outlook, the Systems' portfolio mix, and, to a lesser extent, historical returns.

The current assumption is 7.00%, which is comprised of the following components:

- Inflation: 2.50%
- Real Rate of Return: 4.50%

The table below shows the System's actual investment returns on a fair value basis as well as an actuarial value basis.

Average Annual Return as of June 30, 2020	Fair Value of Assets	Actuarial Value of Assets
Past 5 Years	5.1%	6.6%
Past 10 Years	8.2%	6.8%
Past 15 Years	6.1%	6.3%
Past 20 Years	5.7%	5.9%

The average annual rate of return over the past 5, 10, 15, and 20 years has been lower than the current assumption of 7.00% on both an actuarial value of assets basis and fair value of assets basis (with the exception of the 10-year average return on a fair value of assets basis). Historical trend is a less important consideration for the assumed rate of investment return, but assists in determining the reasonable bounds of expected investment return.

Our analysis of the expected real rate of return was based on the Horizon Survey of Capital Market Assumptions (2020 Edition). This survey compiles and averages the capital market assumptions of 39 investment consultants (including RVK and Segal Marco Advisors). All investment consultants provided assumptions for a 10-year period and 18 respondents provided assumptions for 20-year periods. The expected arithmetic returns are used to determine the expected return by asset class. The 10-year and 20-year expected geometric real rate of return was generated from the 50th percentile of 10,000 simulated portfolio return trials.

The real return assumptions for the asset classes and the portfolio's expected real return are shown below.

II: Economic Assumptions

10-Year Real Rate of Return

Horizon Study Asset Classes	Horizon Study 10-Year Annual Arithmetic Real Return	Target Allocation	Weighted Real Return
US Equities Large Cap	5.43%	16.70%	0.91%
US Equities Small/Mid Cap	6.79%	2.20%	0.15%
International Equities Developed	6.36%	10.60%	0.67%
Emerging Markets Equities	8.62%	4.50%	0.39%
US Bonds Core	0.78%	3.00%	0.02%
International Debt Developed	-0.39%	1.00%	0.00%
International Debt Emerging	3.79%	4.00%	0.15%
Cash Equivalents	-0.38%	2.00%	-0.01%
TIPS	0.19%	1.00%	0.00%
Real Estate	5.18%	16.00%	0.83%
Hedge Funds	3.11%	10.00%	0.31%
Infrastructure	6.00%	4.00%	0.24%
Private Equities	9.45%	15.00%	1.42%
Private Debt	6.53%	10.00%	0.65%
Total		**100.00%**	**5.73%**
Adjustment to Geometric[1]			(0.88%)
Geometric Real Rate of Return			**4.85%**

20-Year Real Rate of Return

Horizon Study Asset Classes	Horizon Study 20-Year Annual Arithmetic Real Return	Target Allocation	Weighted Real Return
US Equities Large Cap	6.20%	16.70%	1.04%
US Equities Small/Mid Cap	7.38%	2.20%	0.16%
International Equities Developed	6.93%	10.60%	0.73%
Emerging Markets Equities	9.17%	4.50%	0.41%
US Bonds Core	1.58%	3.00%	0.05%
International Debt Developed	0.37%	1.00%	0.00%
International Debt Emerging	4.38%	4.00%	0.18%
Cash Equivalents	0.12%	2.00%	0.00%
TIPS	0.78%	1.00%	0.01%
Real Estate	5.75%	16.00%	0.92%
Hedge Funds	3.94%	10.00%	0.39%
Infrastructure	6.29%	4.00%	0.25%
Private Equities	10.38%	15.00%	1.56%
Private Debt	6.47%	10.00%	0.65%
Total		**100.00%**	**6.35%**
Adjustment to Geometric[1]			(0.89%)
Geometric Real Rate of Return			**5.46%**

[1] Includes adjustment for implementation cost of high-yield alternative investments

II: Economic Assumptions

Adjustment for Expected Benefit Payout Timing

The total present value of projected TRS benefits (excluding projected buyout amounts) is $157.8 billion, as reported in the June 30, 2020 actuarial valuation report dated January 11, 2021. Expected benefit payouts for fiscal 2021 are $7.5 billion. The expected benefit payments increase gradually each year to $13.9 billion per year by fiscal 2040. On a present value basis, TRS is expected to pay out approximately 40% of liabilities over the next 10-year period:

Time Horizon	Total PV of Projected Benefit Payouts (in $B)	% of Total Liability
Next 5 years	$33.8	21.4%
Next 10 years	62.4	39.6%
Next 15 years	86.7	54.9%
Next 20 years	106.8	67.7%
All years	157.8	100.0%

Based on the capital market assumptions from the 2020 Horizon Survey and the TRS target asset allocation, the median 10-year and 20-year annual real rates of return (i.e., excess return over inflation) are 4.85% and 5.46%, respectively. Given that a large portion of liability is expected to be settled in the near term (i.e., the next 10-years), Segal believes it is appropriate to weight return expectations between the 10-year and 20-year median real rates of return.

The expected real rate of return, weighted by the present value of projected benefits over the next 10 years, is 5.22%. In other words, there is a 50% likelihood of earning an annual real rate of return of at least 5.22% based on Horizon's 10-year and 20-year capital market assumptions, weighted by the present value of projected benefits.

Adjustment for Current Market Outlook

Capital market assumptions from the Horizon Survey are aggregated based on investment consultant expectations from the first quarter of 2020. From 2020 to 2021, the investment market outlook has changed and many investment consultants lowered their expectations. For example, using TRS' target asset allocation and weighting the 10-year and 20-year capital market assumptions for the present value of projected benefits over the next 10 years, the change in the 50th percentile return based on Segal Marco Advisors capital market assumptions between January 2020 and January 2021 is a decrease 34 basis points. This current market outlook adjustment is applied to the net weighted real rate of return of 5.22% which results in a modified new weighted real rate of return of 4.88%.

Adjustment for Negative Cash Flow

An additional adjustment was added to take into account negative cash flow of TRS. Since TRS' projected average negative cash flow is 2.3% of assets, an adjustment is made to reflect the fact that not all of the system's assets are available throughout the year to earn investment return on. The resulting downward adjustment is a 9 basis point reduction to the weighted real rate of return.

II: Economic Assumptions

The following table summarizes the components of the current and proposed investment return assumption.

Component	Current Assumption	Proposed Assumption
Inflation	2.50%	2.25%
Weighted Net Real Rate of Return	4.50%	5.22%[1]
Adjustment for Market Outlook	N/A	(0.34%)
Adjustment for Negative Cash Flow	N/A	(0.09%)
Total Expected Rate of Return	**7.00%**	**7.04%**
Adjustment	N/A	(0.04%)[2]
Total Return Assumption	**7.00%**	**7.00%**
Confidence Level	**50%**	**51%**

Based on this analysis, **we recommend no change to the 7.00% investment return assumption.**

[1] Weighted 40%/60% between 10-year and 20-year time horizons, based on comparison of present value of expected benefit payments over a 10-year period and the total present value of benefits of the System.

[2] Adjusting the real rate of return for adverse deviation increases the likelihood of meeting the expected return from 50% to 51%.

C. Rate of Individual Salary Increase

The rate of individual salary increase is used to determine members' benefits provided by the System. Generally, a member's salary will change over the long term in accordance with inflation, productivity, and merit and seniority increases. The actuary should review available compensation data when selecting this assumption, including the school districts' current compensation practices and any anticipated changes, historical compensation increases and practices of the school districts and other employers in the same industry or geographic area, and historical national wage increases and productivity growth.

The estimated rate of individual salary increases consists of the following components:

- Inflation
- Productivity
- Merit and seniority increases

The inflation component represents the "across the board" average annual increase in salaries shown in the experience data. The merit and seniority component includes productivity and the additional increases in salary due to performance, seniority, promotions, etc.

Since merit and seniority increases are unique to each retirement system, it is appropriate to base this assumption on recent experience. We study the merit and seniority increases (plus productivity) separately from inflation, which represents "non-inflation" increases in individual salaries.

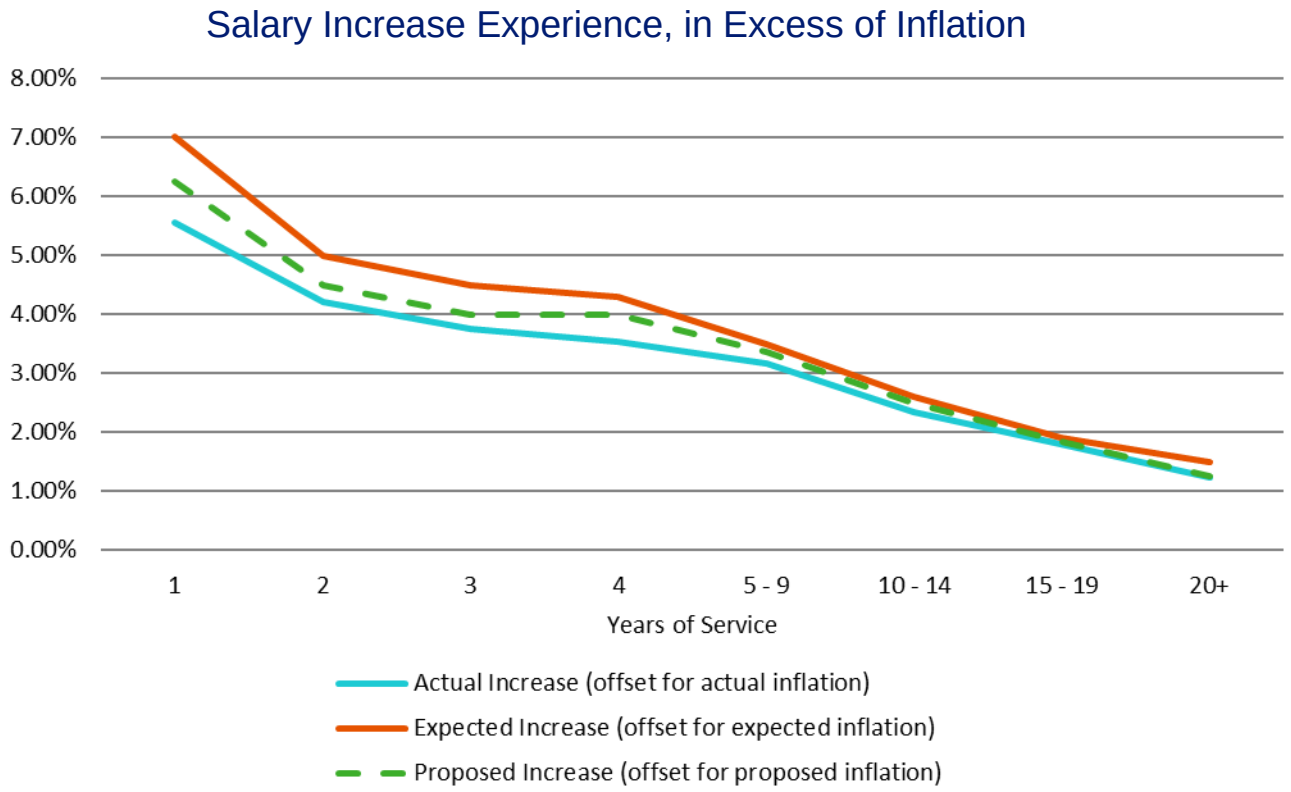
The current salary increase assumption (including inflation) uses service-based rates that range from 9.50% at one year of service to 4.00% at 20 or more years of service. The historical compensation data, adjusted by inflation during the study period, was evaluated based on age and service. The strongest relationship continues to be based on members' service.

The actual historical compensation data for the experience period (shown in the following table) have been adjusted by approximately 2% to account for actual inflation during the study period. The expected salary increase rates have been adjusted by 2.50% to account for the current assumed rate of inflation. The proposed salary increase rates reflect our proposed assumption for inflation of 2.25%. Proposed non-inflationary increases have been developed based on weighting the current assumption (i.e., historical experience) and recent experience by 50%.

The following table and graph compare the actual, expected and proposed individual salary increases during the period of the experience study, adjusted to remove inflation.

II: Economic Assumptions

Years of Service	Prior Year Salaries (in $000s)	Actual Salaries[1] (in $000s)	Actual Salary Increase Rate	Expected Salaries[2] (in $000s)	Expected Salary Increase Rate	Proposed Salary Increase Rate
1	760,790	803,081	5.56%	814,046	7.00%	6.25%
2	842,139	877,514	4.20%	884,247	5.00%	4.50%
3	870,292	902,913	3.75%	909,455	4.50%	4.00%
4	900,618	932,373	3.53%	939,344	4.30%	4.00%
5 - 9	4,435,262	4,576,027	3.17%	4,590,782	3.50%	3.35%
10 - 14	6,036,759	6,177,975	2.34%	6,192,794	2.60%	2.50%
15 - 19	5,947,796	6,054,692	1.80%	6,061,041	1.90%	1.85%
20+	7,984,693	8,083,712	1.24%	8,104,463	1.50%	1.25%
Total	**27,778,349**	**28,408,287**	**2.27%**	**28,496,172**	**2.58%**	**2.39%**



As shown above, the actual rate of individual salary increases above inflation was lower than the expected rate for all service bands. Based on this experience, **we recommend decreasing the aggregate non-inflationary component of the individual salary increases.** The table showing the proposed total rates of individual salary increases is included in Appendix A.

[1] Adjusted for actual average inflation of approximately 2.00% during the experience period.
[2] Adjusted for assumed inflation of 2.50%.

D. New Entrant Pay Increase Assumption

The new entrant pay increase assumption is used to project the starting salary for new entrants for future years for projection purposes. Generally, this assumption is equal to the inflation assumption and does not include any merit component.

The current assumption is that new entrant pay will increase by 3.25% per year. **We recommend that the new entrant pay increase assumption be lowered to 2.25% per year to align with proposed inflation assumption.**

Under the proposed assumption, the projected payroll through 2045 will be lower than compared to the current assumption. This will change the pattern of projected State contributions, which are determined as a level percentage of projected payroll, to be higher in the short-term, but lower in the long-term.

E. Tier 2 COLA / Pay Cap

The COLA and pensionable salary cap increases for Tier 2 members are based on annual inflation, as annual increases are the lesser of 3% and ½ of CPI-U. The table below shows a history of the COLA and pensionable salary cap increases since its inception in 2011.

Fiscal Year Ending June 30	Prior Year CPI-U	½ CPI-U	Tier 2 COLA	Tier 2 Pensionable Salary Limit
2011				$106,800
2012	3.90%	1.95%	1.95%	$108,883
2013	2.00%	1.00%	1.00%	$109,971
2014	1.20%	0.60%	0.60%	$110,631
2015	1.70%	0.85%	0.85%	$111,572
2016	0.00%	0.00%	0.00%	$111,572
2017	1.50%	0.75%	0.75%	$112,408
2018	2.20%	1.10%	1.10%	$113,645
2019	2.30%	1.15%	1.15%	$114,952
2020	1.70%	0.85%	0.85%	$115,929
2021	1.40%	0.70%	0.70%	$116,740

Since we recommend reducing the current inflation assumption of 2.50% to 2.25%, **we recommend that the Tier 2 COLA and rate of increase in the pensionable salary cap be reduced from 1.25% to 1.125%, which is half of the 2.25% proposed inflation assumption.** Since the minimum is 0% and the maximum is 3%, stochastically modeling the likely range of this assumption results in approximately the same 50th percentile outcome.

F. Severance Pay

Additional compensation in the final year of employment prior to retirement is referred to as "severance pay." This may include payment for unused vacation days, unused sick or personal leave, retirement incentives, 403(b) or 457(b) contributions, and bonuses for performance, good attendance, longevity, etc.

The current assumption is that 20% of retirees will receive, on average, 10% of pensionable earnings in the last year of employment prior to retirement.

The following table compares the actual versus expected plan experience of severance pay during the period of the experience study.

Percent of retirees receiving severance pay

Total Active Retirements	Actual Retirees Paid Severance	Expected Retirees Paid Severance	Ratio of Actual to Expected	Proposed Retirees Paid Severance	Ratio of Actual to Proposed
9,872	1,673	1,974	85%	1,777	94%

Amount of average severance pay

Actual Severance	Expected Severance	Ratio of Actual to Expected	Proposed Severance	Ratio of Actual to Proposed
$13,206,976	$18,739,232	70%	$14,991,386	88%

As shown above, 9,872 members retired from active status during the study period, of which 1,673 received severance pay (or 17.0% of active retirements). Given that recent plan experience is lower with the current assumption, **we recommend lowering the percent of retirees expected to receive severance pay from 20% to 18%.**

In addition, the current assumption of the average severance payment (10% of other pensionable earnings in the last year of employment) produces an assumed severance payment of approximately $19 million, compared to an actual severance payment of approximately $13 million, during the study period. Therefore, **we recommend lowering the average severance payment from 10% to 8% of other pensionable earnings in the last year of employment.**

III. Demographic Assumptions

The demographic assumptions used to value TRS reflect the expected occurrences of various events among members of the System. The assumptions should reflect specific characteristics of TRS and produce reasonable results. A reasonable assumption is one that is expected to model the contingency being measured and not expected to produce significant gains and losses. The types of demographic assumptions used to measure pension obligations include, but are not limited to, the following:

- Mortality;
- Retirement;
- Termination;
- Disability incidence; and
- Other assumptions such as spouse information, sick leave service credit, optional service purchase, future service accrual rate, and buyout election percentages.

The Actuarial Standards Board (ASB) has adopted Actuarial Standard of Practice No. 35 (*Selection of Demographic and Other Non-Economic Assumptions for Measuring Pension Obligations*) to provide actuaries guidance in developing demographic assumptions. The standard recommends the actuary follow a general procedure for selecting demographic assumptions. The first step is to identify the types of assumptions to use. The actuary should consider relevant plan provisions that will affect timing and value of any potential benefit payments, all contingencies that give rise to benefits or loss of benefits, and the characteristics of the covered group. The next step is to identify the relevant assumption universe. The assumption universe may include prior experience studies or general studies of trends relevant to the type of demographic assumption in addition to plan experience to the extent that it is credible. The third step is to consider the assumption format. The format may include different tables for different segments of the covered population (i.e., different termination tables for males/females). The final step is to select the specific assumption and evaluate the reasonableness of each assumption. The specific experience of the System should be incorporated but not given undue weight to past experience if recent experience is attributable to a phenomenon that is unlikely to continue. For example, if recent rates of termination were due to a one-time reduction in workforce it may be unreasonable to assume that such rates will continue.

A. Mortality

One of the most significant actuarial assumptions is the probability of death, which drives expectations of annuitant longevity and, therefore, the duration of pension payments. The mortality assumption takes the form of a mortality table that contains for each age in the table a probability of a person dying between that age and the next. TRS currently uses four sets of mortality tables for its population: post-retirement mortality, beneficiary mortality, disabled mortality, and pre-retirement mortality.

In 2019, the Society of Actuaries (SOA) published a series of mortality tables derived from public plan experience, referred to as Pub-2010. The published mortality tables are based on three broad categories: teachers, public safety, and general employees. In addition, the study concluded that surviving annuitants demonstrated worse mortality than the primary annuitants. As a result, separate contingent survivor tables were developed.

We analyzed the experience by weighting the probability of death with each annuitant's pension benefit amount. This methodology takes into consideration the correlation between the annuitant mortality and the level of benefit.

In 2008, the SOA published an article recommending that mortality assumptions include an adjustment for credibility. Under this approach, the number of actual deaths in a sub-group needed for "full credibility" is 1,082. Full credibility in this context means 90% confidence that the actual experience will be within 5% of the expected value. Partial credibility can be assigned where actual deaths in a group or sub-group are less than 1,082. Partially credible results can be blended with an appropriate, unadjusted published base table. In some instances we combine male and female experience of a particular group to improve credibility. While in these instances we show the results of the analysis in this report using male and female experience combined, the actual proposed tables to be used in the actuarial valuations will rely on sex distinct mortality tables with the same adjustment applied to each gender.

When reviewing the actual experience under each of the four categories below, we compared actual experience with the current mortality table and with the applicable Pub-2010 mortality table. We recommend updating the base tables to the appropriate Pub-2010 mortality tables, with adjustments for TRS-specific experience where credible data exists. We also recommend the use of the Pub-2010 Contingent Survivor Mortality Table. In order to reflect future improvements in mortality, we recommend using the mortality projection scale to MP-2020.

Post-Retirement Healthy Mortality

The mortality experience among retirees determines the durations over which retirement benefits are paid. Lower mortality rates mean longer benefit payment periods and, therefore, higher benefit costs.

Currently, TRS uses healthy post-retirement mortality rates based on the RP-2014 White Collar Annuitant Mortality Table (sex-distinct), with adjustments for credibility and gender, projected generationally using Scale MP-2017. For females, the adjustments are a 70% factor for ages under 78 and a 110% factor for ages 78 to 114. For males, the adjustments are a 94% factor for ages under 81 and a 110% factor for ages 81 to 114.

III: Demographic Assumptions

During the experience study period, there were 4,524 female deaths and 2,820 male deaths, broken out as follows:

Age	Female	
	Deaths	Credibility
<75	972	94.8%
75+	3,552	100.0%
Total	**4,524**	**n/a**

Age	Male	
	Deaths	Credibility
<85	1,623	100.0%
85+	1,197	100.0%
Total	**2,820**	**n/a**

We used these credibility adjustments to develop the recommended mortality assumption on a sex-distinct basis for rates before and after age 75 for females and age 85 for males.

The following table provides a summary of mortality experience for healthy annuitants by gender for the study period:

Gender	Exposures	Actual Deaths	Expected Deaths	Ratio of Actual to Expected
Benefits Basis (in 000's)				
Female	**12,229,476**	**184,541**	**189,264**	**98%**
<75	9,231,428	49,539	54,137	92%
75+	2,998,048	135,002	135,127	100%
Male	**6,703,835**	**171,163**	**167,410**	**102%**
<85	6,212,548	105,515	106,610	99%
85+	491,287	65,648	60,800	108%
Total	**18,933,311**	**355,704**	**356,674**	**100%**

The experience during the study period shows that, in total, fewer female participants in pay status have died than expected. On a benefits-weighted basis, the actual amount of benefits released due to deaths was 98% of expected. For males, on a benefits-weighted basis, more benefits in pay status were released due to deaths than expected; the ratio of actual-to-expected was 102%.

The total amount of benefits released due to healthy post-retirement mortality among the retiree population was $355,704,000. Applying the exposures to the unadjusted PubT-2010 Retiree Mortality Table would result in $335,370,000 in benefits released due to mortality, for an aggregate actual-to-proposed ratio of 106%. When compared to the unadjusted PubT-2010 mortality tables, we continue to see a difference in mortality rates before and after age 75 for females and age 85 for males. Applying credibility-weighted adjustments by gender and age (pre and post age 75 for females and 85 for males) results in a better fit of the published table to this group's own experience, as shown in the following table:

III: Demographic Assumptions

Gender	Actual Deaths	Unadjusted PubT-2010 Deaths	Ratio of Actual to Unadjusted	Credibility Applied to Actual	Credibility Weighted Deaths	Ratio of Actual to Weighted
Benefits Basis (in 000's)						
Female	**184,541**	**177,964**	**104%**		**184,796**	**100%**
<75	49,539	54,420	91%	94.8%	49,794	100%
75+	135,002	123,544	109%	100.0%	135,002	100%
Male	**171,163**	**157,406**	**109%**		**171,163**	**100%**
<85	105,515	100,132	105%	100.0%	105,515	100%
85+	65,648	57,274	115%	100.0%	65,648	100%
Total	**355,704**	**335,370**	**106%**		**355,959**	**100%**

The adjustments applied to the mortality rates are calculated using Ratio of Actual to Unadjusted and Credibility Applied to Actual. For example, for females below age 75, the adjustment is 91% = (91% x 94.8% +100% x 5.2%).

The credibility weightings as outlined above applied to the exposures would result in $355,959,000 in benefits released due to mortality, for an aggregate actual-to-weighted rate of 100%. Therefore, **we recommend that the mortality table for healthy female retirees be updated to PubT-2010 Retiree Mortality Table for females using 91% of the rates prior to age 75 and 109% of the rates for ages 75 and older. For males, the mortality table would be updated to the PubT-2010 Retiree Mortality Table for males using 105% of the rates prior to age 85 and 115% of the rates for ages 85 and older**.

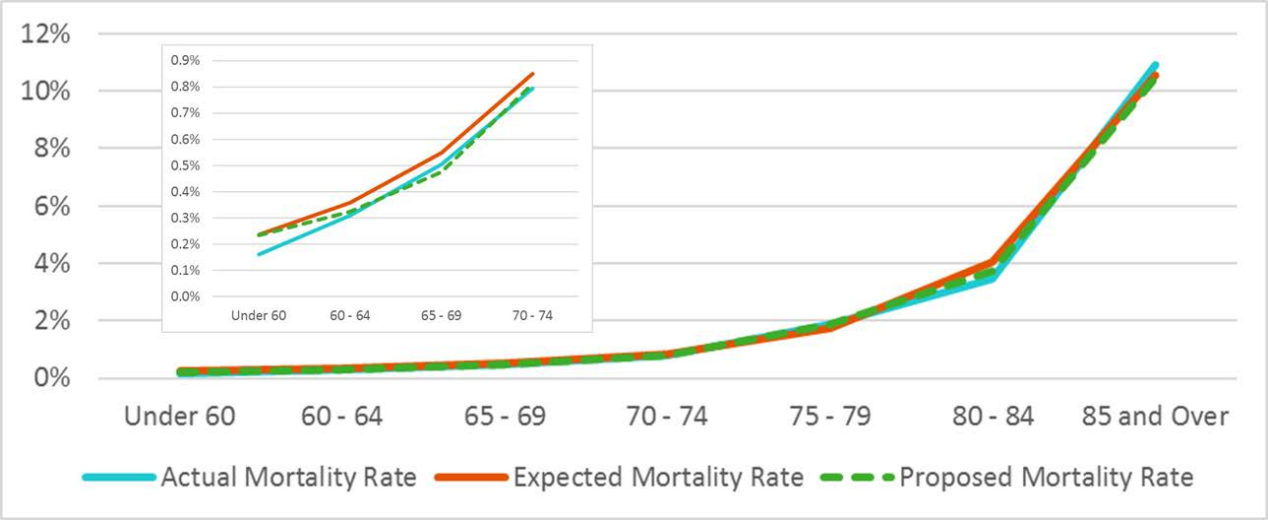
In order to reflect future improvements in life expectancy, **we recommend updating the mortality projection scale to MP-2020**.

The proposed healthy post-retirement mortality rates are included in Appendix B.

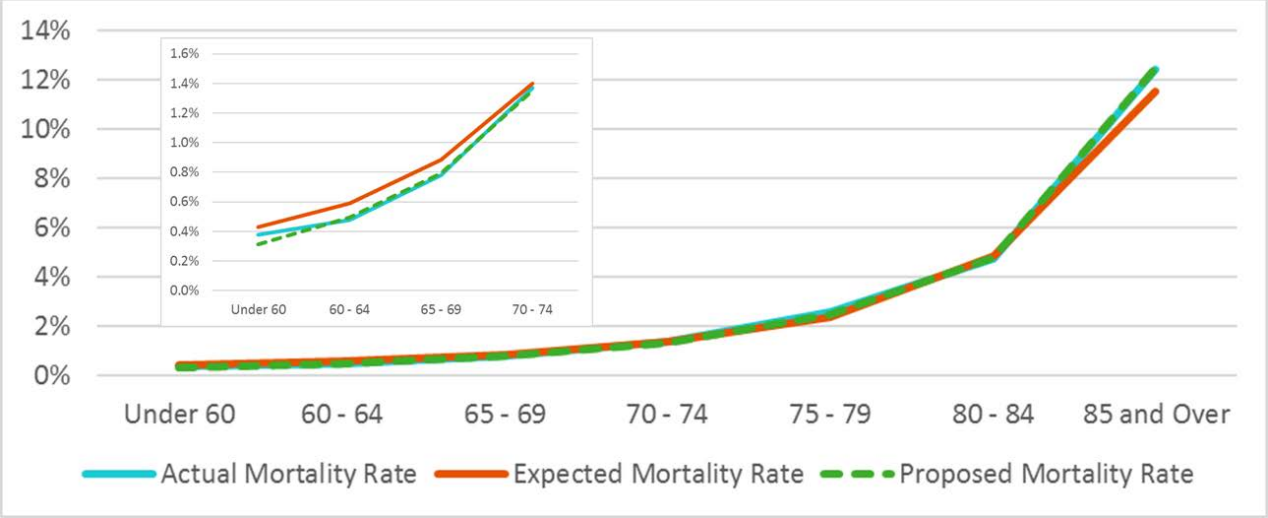
The following graphs show the actual mortality rate, expected mortality rate, and proposed mortality rates for females and males.

III: Demographic Assumptions

Actual Versus Proposed Experience, Benefits-Weighted Basis Healthy Post-Retirement Mortality – **Female**



Actual Versus Proposed Experience, Benefits-Weighted Basis Healthy Post-Retirement Mortality – **Male**



Beneficiary Mortality

Mortality experience among beneficiaries in pay status is studied separately from retirees. Beneficiary mortality is currently based on the RP-2014 Annuitant Mortality Table (sex-distinct), with adjustments for credibility and gender, projected generationally using Scale MP-2017. Female and male rates are adjusted by 96% and 116%, respectively, for ages 50 to 114.

During the experience study period, there were 1,229 female and 814 male beneficiary deaths, broken out as follows:

Age	Female		Male		Total	
	Deaths	Credibility	Deaths	Credibility	Deaths	Credibility
Total	**1,229**	**100.0%**	**814**	**86.7%**	**2,043**	**n/a**

We used these credibility adjustments to develop the recommended mortality assumption on a sex-distinct basis.

The following table summarizes the beneficiary annuitant mortality experience by gender for the study period:

Gender	Exposures	Actual Deaths	Expected Deaths	Ratio of Actual to Expected
Benefits Basis (in 000's)				
Female	621,832	29,135	27,642	105%
Male	246,066	15,223	14,493	105%
Total	**867,898**	**44,358**	**42,135**	**105%**

The beneficiary mortality experience during the study period shows that, for both males and females, more beneficiaries in-pay status have died than expected. For females and males, on a benefit-weighted basis, the actual number of deaths was 105% of expected.

The total amount of benefits released due to healthy post-retirement mortality among the beneficiary population was $44,358,000. Applying the TRS beneficiary exposures to the unadjusted Pub-2010 Contingent Survivor Table would result in $43,404,000 in benefits released due to mortality, for an aggregate actual-to-proposed ratio of 102%. Applying credibility-weighted adjustments by gender results in a better fit of the published table to this group's own experience, as shown in the following table:

III: Demographic Assumptions

Gender	Actual Deaths	Unadjusted Pub-2010 Contingent Survivor Deaths	Ratio of Actual to Unadjusted	Credibility Applied to Actual	Credibility Weighted Deaths	Ratio of Actual to Weighted
Benefits Basis (in 000's)						
Female	**29,135**	**29,584**	**98%**	**100.0%**	**29,135**	**100%**
Male	**15,223**	**13,820**	**110%**	**86.7%**	**15,036**	**101%**
Total	**44,358**	**43,404**	**102%**		**44,171**	**100%**

The adjustments applied to the mortality rates are calculated using Ratio of Actual to Unadjusted and Credibility Applied to Actual. For example, for males, the adjustment is 109% = (110% x 86.7% +100% x 13.3%).

The credibility weightings as outlined above applied to the TRS beneficiary exposures would result in $44,171,000 in benefits released due to mortality, for an aggregate actual-to-weighted rate of 100%. Therefore, **we recommend that the mortality table for female beneficiaries be updated to the Pub-2010 Contingent Survivor Mortality Table for females using 98% of the rates for all ages. For males, the mortality table would be updated to the Pub-2010 Contingent Survivor Table for males using 109% of the rates for all ages**.

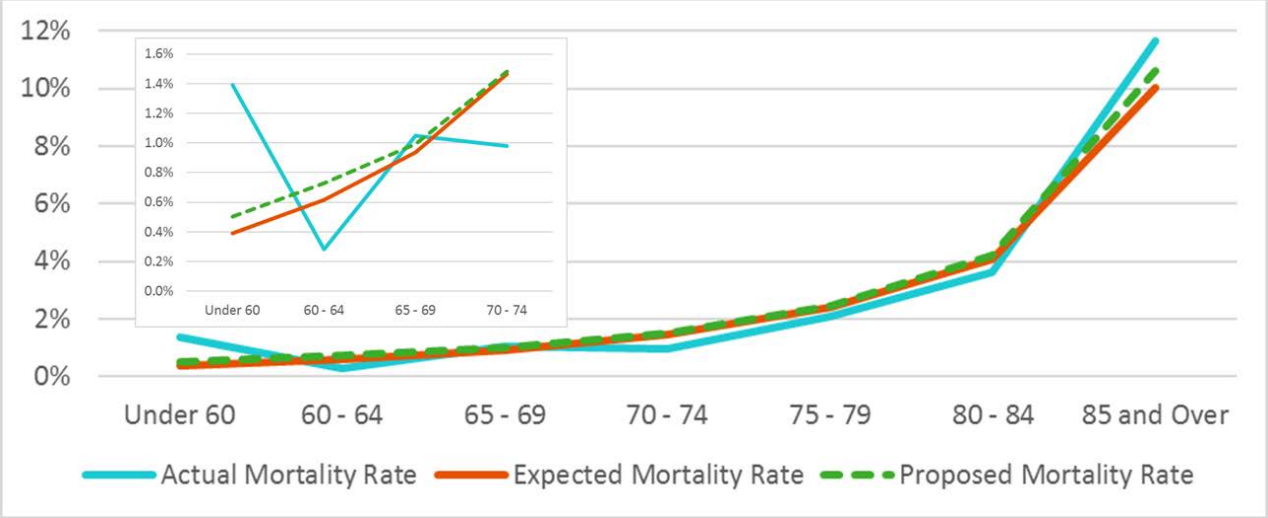
In order to reflect future improvements in life expectancy, **we recommend updating the mortality projection scale to MP-2020**.

The proposed beneficiary post-retirement mortality rates are included in Appendix B.

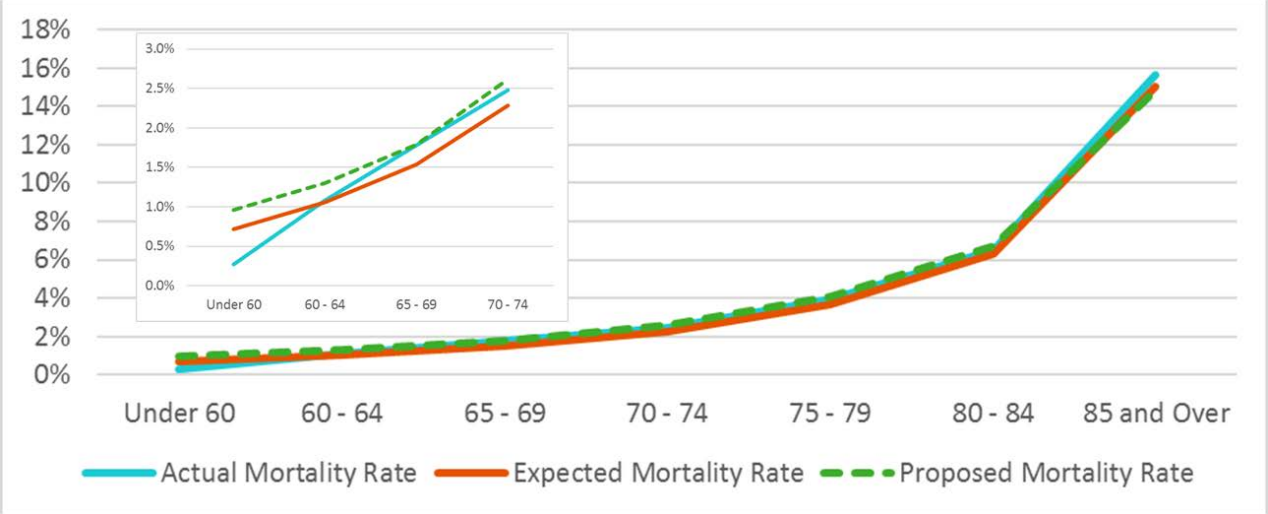
The following graphs show the actuarial mortality rate, expected mortality rate, and proposed mortality rate for females and males.

III: Demographic Assumptions

Actual Versus Proposed Experience, Benefits-Weighted Basis
Healthy Beneficiary Mortality – **Female**



Actual Versus Proposed Experience, Benefits-Weighted Basis
Healthy Beneficiary Mortality – **Male**



Disabled Mortality

Mortality experience among disabled annuitants is studied separately from healthy retirees because of characteristically high levels of mortality exhibited by disability retirees. The current mortality table for all disabled lives is based on the RP-2014 Disabled Retiree Table, projected generationally using Scale MP-2017. Female and male rates are adjusted by 117% for ages 45 to 99.

During the experience study period, there were 83 female and 19 male disabled deaths, broken out as follows:

Age	Female		Male		Total	
	Deaths	Credibility	Deaths	Credibility	Deaths	Credibility
Total	83	27.7%	19	13.3%	102	30.7%

Due to limited experience during the study period, we believe the data is not sufficiently credible to apply any adjustment to the base table.

The following table summarizes the disabled annuitant mortality experience for the study period:

Gender	Exposures	Actual Deaths	Expected Deaths	Ratio of Actual to Expected
Benefits Basis (in 000's)				
Total	79,854	2,561	2,477	103%

The experience during the study period shows that more benefits for disabled annuitants have been released due to mortality than expected. On a benefit-weighted basis, the ratio of actual to expected was 103%.

The total amount of benefits released due to mortality among the disability retiree population was $2,561,000. Applying the TRS disability exposures to the unadjusted Pub-2010 Non-Safety Disabled Retiree Mortality Table would result in $2,178,000 in benefits released due to mortality, for an aggregate actual-to-proposed ratio of 118%.

Gender	Actual Deaths	Unadjusted Pub-2010 Non-Safety Disabled Deaths	Ratio of Actual to Unadjusted	Credibility Applied to Actual	Credibility Weighted Deaths	Ratio of Actual to Weighted
Benefits Basis (in 000's)						
Total	2,561	2,178	118%	N/A	N/A	N/A

We recommend that the mortality table for disability retirees be updated to the Pub-2010 Non-Safety Disabled Retiree Table with no adjustments.

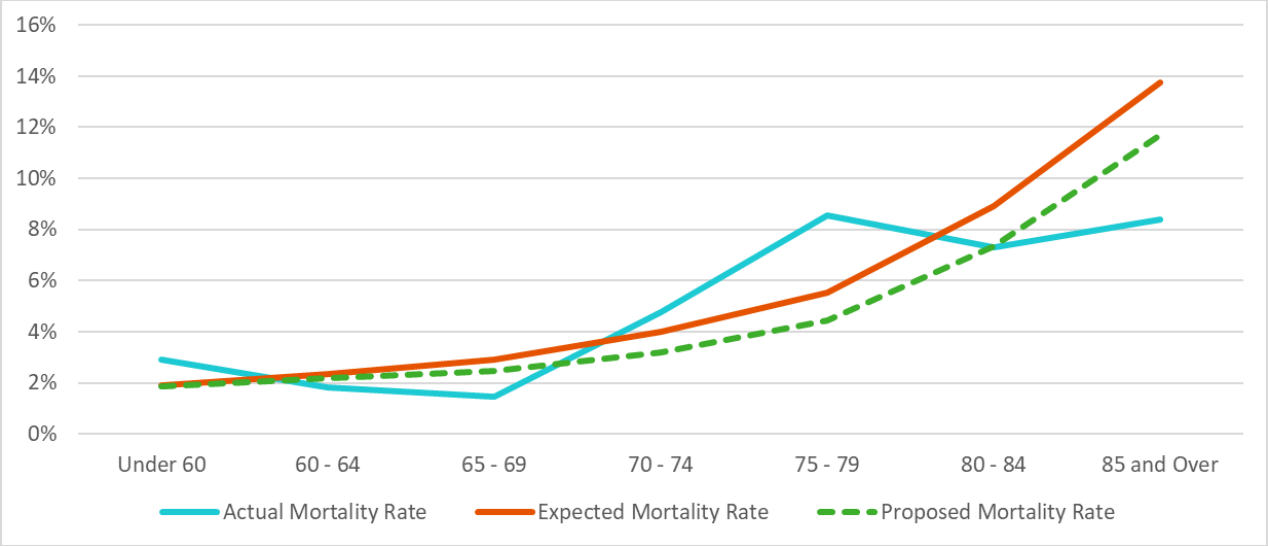
III: Demographic Assumptions

In order to reflect future improvements in life expectancy, **we recommend updating the mortality projection scale to MP-2020**.

The proposed disabled post-retirement mortality rates are included in Appendix B.

The following graph shows the actual mortality rate, expected mortality rate, and proposed mortality rate for males and females combined (although as noted earlier, the mortality table will be applied on a sex-distinct basis for valuation purposes).

Actual Versus Proposed, Benefits-Weighted Basis
Disabled Retiree Mortality – **Unisex**



Pre-Retirement Mortality

The mortality experience of active and terminated vested members should be considered for several reasons. First, in combination with termination and disability rates, the pre-retirement mortality table enables the actuary to estimate the number of individuals who will eventually be eligible for a service retirement benefit, and thereby estimate the liability for those individuals. In addition, the death of a member before retirement may result in a benefit payable to a beneficiary, and the liability for these benefits must be taken into account in the valuation.

The current mortality assumption for active and terminated vested members is based on the RP-2014 White Collar Employee Mortality Table, projected generationally using Scale MP-2017. Female and male rates are adjusted by 104% for all ages.

During the experience study period, there were 191 female and 115 male pre-retirement deaths, broken out as follows:

Age	Female		Male		Total	
	Deaths	Credibility	Deaths	Credibility	Deaths	Credibility
Total	191	42.0%	115	32.6%	306	53.2%

We used these credibility adjustments to develop the recommended mortality assumption on a unisex basis.

The following table summarizes the pre-retirement mortality experience for the study period:

Gender	Exposures	Actual Deaths	Expected Deaths	Ratio of Actual to Expected
Benefits Basis (in 000's)				
Total	9,282,799	6,742	10,064	67%

The pre-retirement mortality experience during the study period shows that there were fewer benefits released due to death than expected. On a benefit-weighted basis, the ratio of actual to expected was 67%.

The total amount of benefits released due to mortality among the pre-retirement population was $6,742,000. Applying the TRS active and terminated vested exposures to the unadjusted Pub-2010 Employee Mortality Table would result in $8,180,000 in benefits released due to mortality, for an aggregate actual-to-proposed ratio of 82%. Applying credibility-weighted adjustments on a unisex basis results in a better fit of the published table to this group's own experience, as shown in the following table:

III: Demographic Assumptions

Gender	Actual Deaths	Unadjusted Pub-2010 Employee Deaths	Ratio of Actual to Unadjusted	Credibility Applied to Actual	Credibility Weighted Deaths	Ratio of Actual to Weighted
Benefits Basis (in 000's)						
Total	**6,742**	**8,180**	**82%**	**53.2%**	**7,415**	**92%**

The adjustments applied to the mortality rates are calculated using Ratio of Actual to Unadjusted and Credibility Applied to Actual. For example, the unisex adjustment is 90% = (82% x 53.2% + 100% x 46.8%).

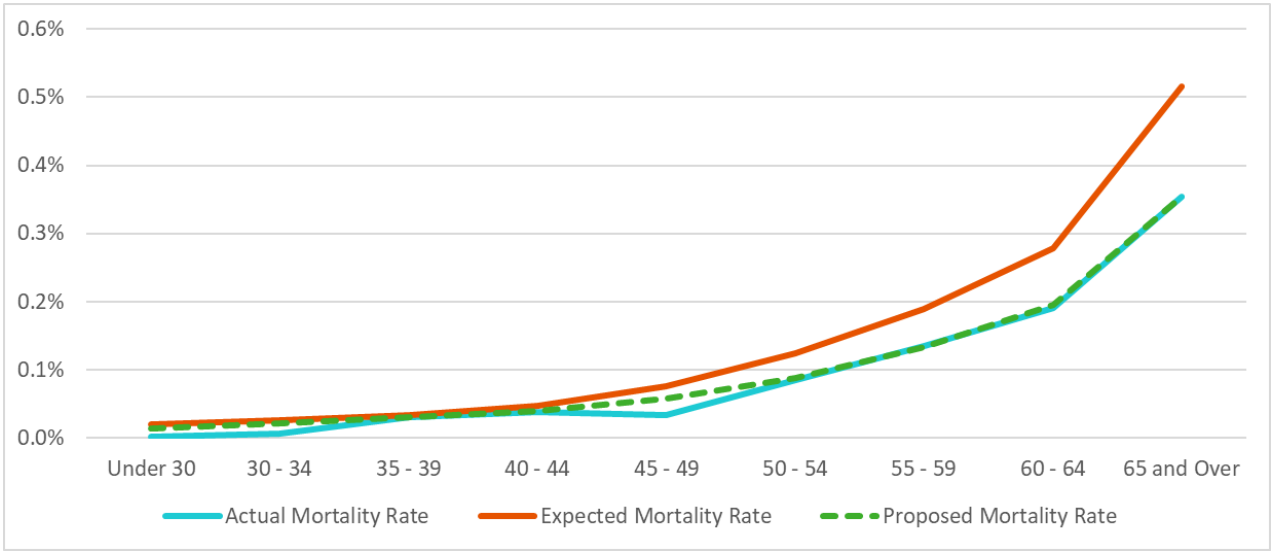
The credibility weightings as outlined above applied to the TRS active and terminated vested exposures would result in $7,451,000 in benefits released due to mortality, for an aggregate actual-to-weighted rate of 91%. Therefore, **we recommend that the mortality table for healthy active and terminated vested members be updated to the PubT-2010 Employee Table for females and males using 90% of the rates for all ages**. In aggregate, this assumption would result in $7,362,000 in benefits released due to mortality and is close to the number of credibility-weighted benefits released due to mortality during the study period.

In order to reflect future improvements in mortality, **we recommend updating the mortality projection scale to MP-2020**.

The proposed healthy pre-retirement mortality rates are included in Appendix B.

The following graphs show the actual mortality rate, expected mortality rate, and proposed mortality rate males and females combined (although as noted earlier, the mortality table will be applied on a sex-distinct basis for valuation purposes).

Actual Versus Proposed, Benefits-Weighted Basis
Pre-Retirement Mortality – **Unisex**



B. Retirement

Active Retirement

Under the plan, members are eligible to retire following attainment of various eligibilities. The normal retirement eligibility conditions for the various tiers are:

- Tier 1: Age 60 with 10 years of service or Age 62 with 5 years of service
- Tier 2: Age 67 with 10 years of service

Participants are allowed to retire early with a reduced benefit if they meet the following eligibility:

- Tier 1: Age 55 with 20 years of service (unreduced for members who retire prior to age 60 with 35 years of service)
- Tier 2: Age 62 with 10 years of service

Currently, the retirement assumption used in the valuation is based on the member's age and service. We did examine experience by gender to determine whether there is enough difference in male and female experience to warrant using separate sex-distinct tables for the retirement assumption. However, we did not see a large enough difference in the experience data to recommend a change in this regard.

The current assumption for Tier 1 retirement uses five unisex tables of age-based rates for members from age 54 to 70, based on the following service bands:

- Less than 19 years of service
- 19 – 29 years of service
- 30 – 31 years of service
- 32 – 33 years of service
- 34 or more years of service

The current assumption for Tier 2 retirement uses a similar set of unisex, age-based tables for members starting at age 62 and ceasing at 100% probability of retirement at age 70. Note that the service bands used for Tier 2 members are slightly different than those employed for Tier 1. Tier 2 service bands remain unchanged from the inception of Tier 2 and the rate structure established at that time.

We have analyzed retirement experience on a benefit-weighted basis. Actual experience for Tier 1 members under each service band was slightly greater than expected. Therefore, **we recommend adjusting these retirement rates to reflect recent plan experience, including combining the 30 – 31 and 32 – 33 service bands into one service band of 30 – 33**. There has been very limited experience for Tier 2 members, so **we recommend continued use of the current Tier 2 retirement assumption**. We believe the current assumed pattern of retirement for Tier 2 members is not unreasonable, and we will continue to track actual Tier 2 retirement experience as it emerges.

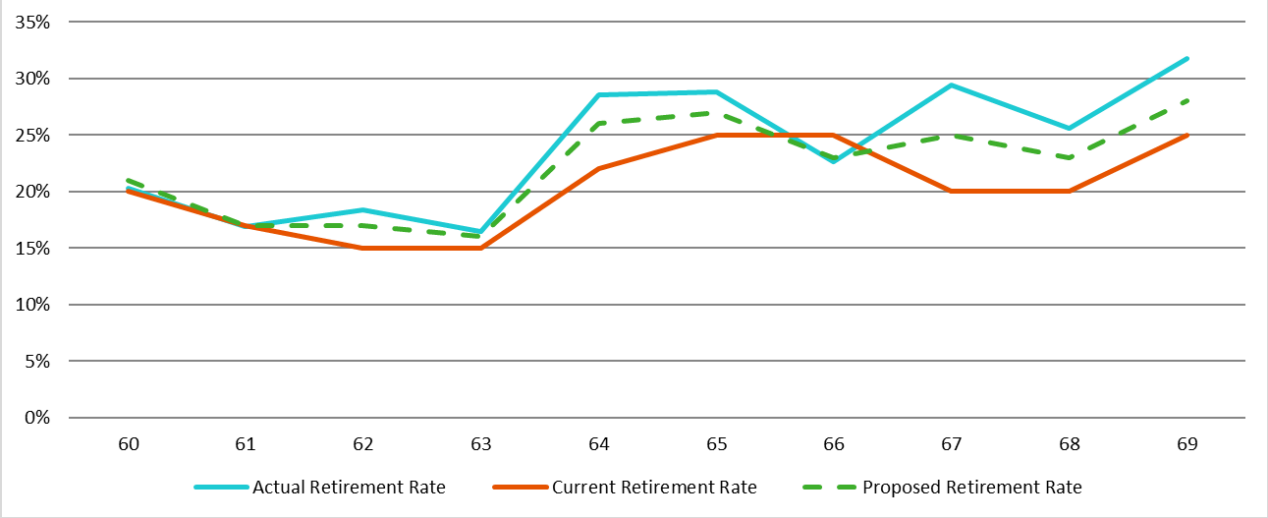
III: Demographic Assumptions

The following tables and graphs show the actual active retirement experience for the study period compared to the current and proposed assumptions. The proposed Tier 1 active retirement rates for all ages and service bands are included in Appendix C.

Tier 1 Active Member Retirement, Less Than 19 Years of Service – **Unisex**

Age	Exposures (Benefits in 000s)	Actual Retirement Rate	Expected Retirement Rate	Ratio of Actual to Expected	Proposed Retirement Rate	Ratio of Actual to Proposed
60	30,953	20.28%	20.00%	101%	21.00%	97%
61	23,973	16.93%	17.00%	100%	17.00%	100%
62	22,067	18.42%	15.00%	123%	17.00%	108%
63	17,341	16.50%	15.00%	110%	16.00%	103%
64	13,484	28.55%	22.00%	130%	26.00%	110%
65	9,834	28.83%	25.00%	115%	27.00%	107%
66	6,243	22.62%	25.00%	90%	23.00%	98%
67	4,639	29.44%	20.00%	147%	25.00%	116%
68	3,061	25.58%	20.00%	128%	23.00%	111%
69	2,349	31.76%	25.00%	127%	28.00%	112%
Total	**133,944**	**21.09%**	**18.88%**	**112%**	**20.20%**	**104%**

Actual Versus Proposed Experience, Benefit-Weighted Basis
Tier 1 Active Member Retirement, Less Than 19 Years of Service – **Unisex**

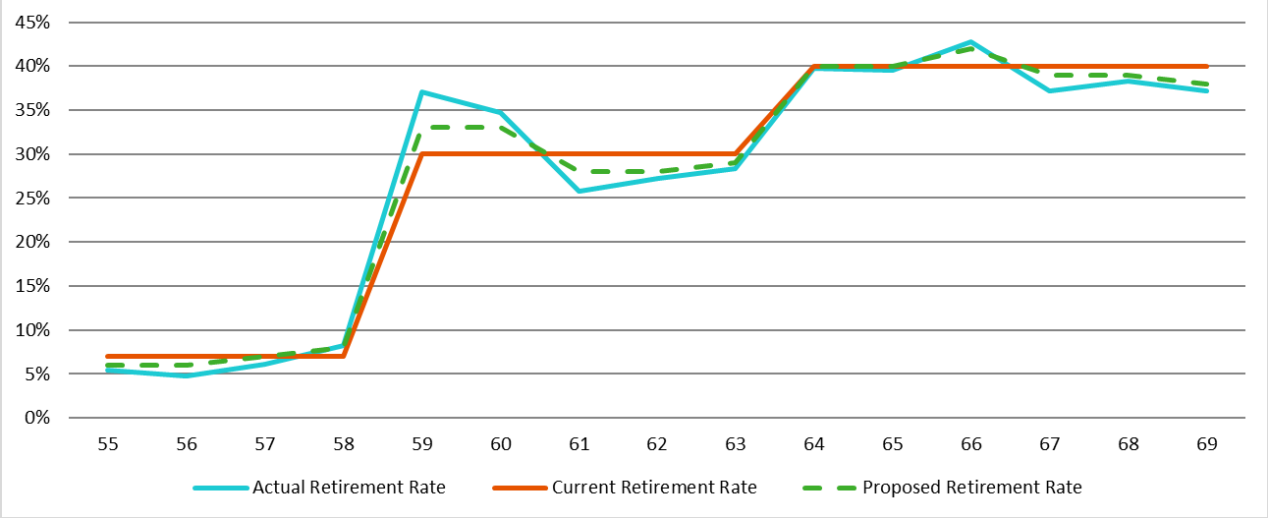


III: Demographic Assumptions

Tier 1 Active Member Retirement, 19 – 29 Years of Service – **Unisex**

Age	Exposures (Benefits in 000s)	Actual Retirement Rate	Expected Retirement Rate	Ratio of Actual to Expected	Proposed Retirement Rate	Ratio of Actual to Proposed
55	107,138	5.39%	7.00%	77%	6.00%	90%
56	97,355	4.77%	7.00%	68%	6.00%	79%
57	90,754	6.10%	7.00%	87%	7.00%	87%
58	85,370	8.28%	7.00%	118%	8.00%	103%
59	81,687	37.12%	30.00%	124%	33.00%	113%
60	72,682	34.75%	30.00%	116%	33.00%	105%
61	54,908	25.75%	30.00%	86%	28.00%	92%
62	47,063	27.28%	30.00%	91%	28.00%	97%
63	37,259	28.38%	30.00%	95%	29.00%	98%
64	30,202	39.76%	40.00%	99%	40.00%	99%
65	21,278	39.56%	40.00%	99%	40.00%	99%
66	14,625	42.76%	40.00%	107%	42.00%	101%
67	10,439	37.20%	40.00%	93%	39.00%	95%
68	7,633	38.26%	40.00%	96%	39.00%	98%
69	4,622	37.13%	40.00%	93%	38.00%	98%
Total	**763,015**	**19.84%**	**19.69%**	**101%**	**19.84%**	**100%**

Actual Versus Proposed Experience, Benefit-Weighted Basis
Tier 1 Active Member Retirement, 19 – 29 Years of Service – **Unisex**

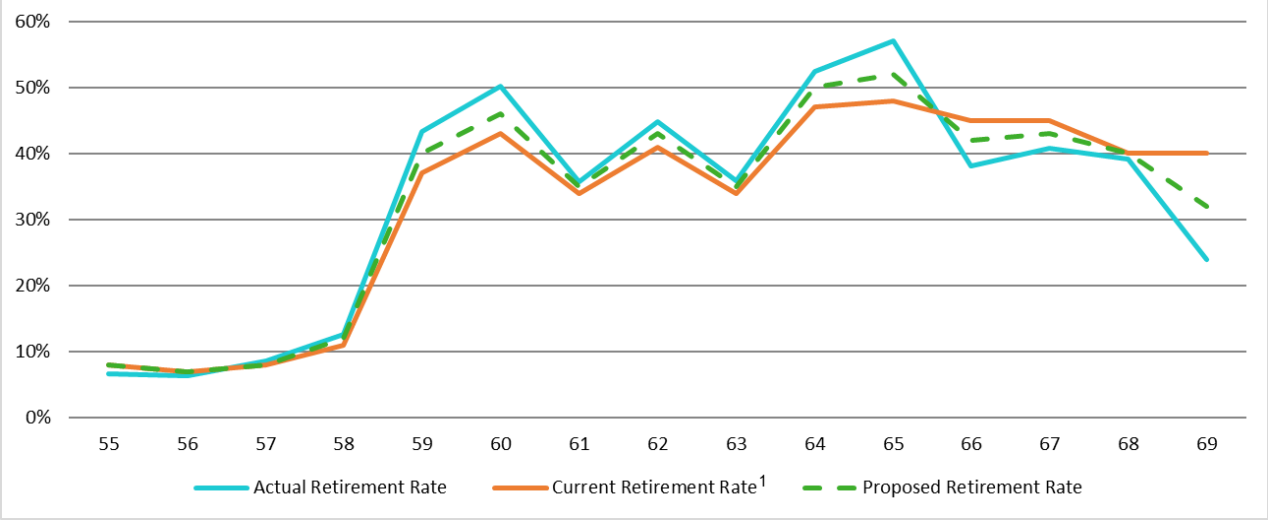


III: Demographic Assumptions

Tier 1 Active Member Retirement, 30 – 33 Years of Service – **Unisex**

Age	Exposures (Benefits in 000s)	Actual Retirement Rate	Expected Retirement Rate[1]	Ratio of Actual to Expected	Proposed Retirement Rate	Ratio of Actual to Proposed
55	113,194	6.70%	8.00%	84%	8.00%	87%
56	87,171	6.38%	7.00%	91%	7.00%	96%
57	69,002	8.62%	8.00%	108%	8.00%	103%
58	54,936	12.57%	11.00%	114%	12.00%	105%
59	47,900	43.27%	37.00%	117%	40.00%	109%
60	30,079	50.22%	43.00%	117%	46.00%	109%
61	18,503	35.69%	34.00%	105%	35.00%	103%
62	13,725	44.79%	41.00%	109%	43.00%	104%
63	11,307	35.92%	34.00%	106%	35.00%	103%
64	9,775	52.48%	47.00%	112%	50.00%	106%
65	5,087	57.10%	48.00%	119%	52.00%	109%
66	3,879	38.06%	45.00%	85%	42.00%	91%
67	3,148	40.80%	45.00%	91%	43.00%	94%
68	2,406	39.09%	40.00%	98%	40.00%	98%
69	1,579	23.93%	40.00%	60%	32.00%	74%
Total	**471,691**	**19.24%**	**18.01%**	**107%**	**18.65%**	**103%**

Actual Versus Proposed Experience, Benefit-Weighted Basis
Tier 1 Active Member Retirement, 30 – 33 Years of Service – **Unisex**



[1] Reflects a composite of the prior assumptions for 30-31 and 32-33 service bands

III: Demographic Assumptions

Tier 1 Active Member Retirement, 34 or More Years of Service – **Unisex**

Age	Exposures (Benefits in 000s)	Actual Retirement Rate	Expected Retirement Rate	Ratio of Actual to Expected	Proposed Retirement Rate	Ratio of Actual to Proposed
55	86,430	43.90%	45.00%	98%	44.00%	99%
56	89,138	46.65%	45.00%	104%	46.00%	101%
57	77,263	46.89%	45.00%	104%	46.00%	102%
58	62,127	48.81%	40.00%	122%	45.00%	109%
59	48,855	56.34%	40.00%	141%	48.00%	118%
60	30,732	47.77%	40.00%	119%	44.00%	109%
61	20,378	41.12%	40.00%	103%	41.00%	102%
62	16,991	42.29%	40.00%	106%	41.00%	103%
63	12,034	48.73%	40.00%	122%	44.00%	110%
64	9,662	40.18%	40.00%	100%	40.00%	99%
65	8,387	44.87%	40.00%	112%	43.00%	105%
66	7,301	35.79%	40.00%	89%	38.00%	94%
67	6,482	30.47%	45.00%	68%	38.00%	81%
68	4,957	25.06%	45.00%	56%	35.00%	72%
69	3,428	42.44%	45.00%	94%	44.00%	97%
70	2,088	33.13%	30.00%	110%	31.00%	107%
71	1,556	48.00%	30.00%	160%	39.00%	124%
72	896	17.66%	30.00%	59%	24.00%	79%
73	904	41.34%	30.00%	138%	36.00%	115%
74	394	42.90%	30.00%	143%	36.00%	119%
Total	**490,003**	**46.28%**	**42.61%**	**109%**	**44.48%**	**104%**

Actual Versus Proposed Experience, Benefit-Weighted Basis
Tier 1 Active Member Retirement, 34 or More Years of Service – **Unisex**

C. Termination

The termination rates used in annual actuarial valuations project the percentage of employees at each age or service duration that are expected to terminate membership before retirement. These rates take account of possible terminations for all causes other than retirement, death, or disability. They include both voluntary and involuntary withdrawals from service.

Terminations before retirement give rise to some benefit rights, but may also involve the forfeiture of a portion of previously accrued benefits. Forfeitures resulting from turnover are anticipated in advance and help finance benefits that become payable to other members. In some cases, members who leave the plan with five or more years of service and are eligible for deferred vested benefits withdraw their deposits, thus forfeiting the portion of their accrued benefit rights based on employer contributions.

The termination experience studied includes all terminations of active employment for members not vested at termination (since such members are not eligible for other benefits, termination of employment will, most likely, result in a withdrawal of employee contributions), and terminations of membership for members who were vested and either withdrew their contributions or are eligible for future benefits. Rehired members offset these terminations in order to determine the "net" terminations for each year of the study period. Note that this analysis excludes hourly and substitute teachers due to their high turnover rate that would overstate the probability of turnover for full-time teachers.

The current assumption for termination uses sex-distinct "select and ultimate" tables based on the members' age and service. The current assumption has separate age-based rates for members with less than five years of service and for members with five or more years of service. We have analyzed the experience to determine if the select period should be extended or eliminated and recommend that the current select period be retained. The proposed rates of termination have been developed based on weighting the current assumption (i.e., historical experience) and recent experience by one-half.

Select Termination Rates

The current select termination assumptions are sex-distinct and based on members' age. Based on our analysis, **we recommend that the sex-distinct basis be retained and that the select termination rates be decreased**.

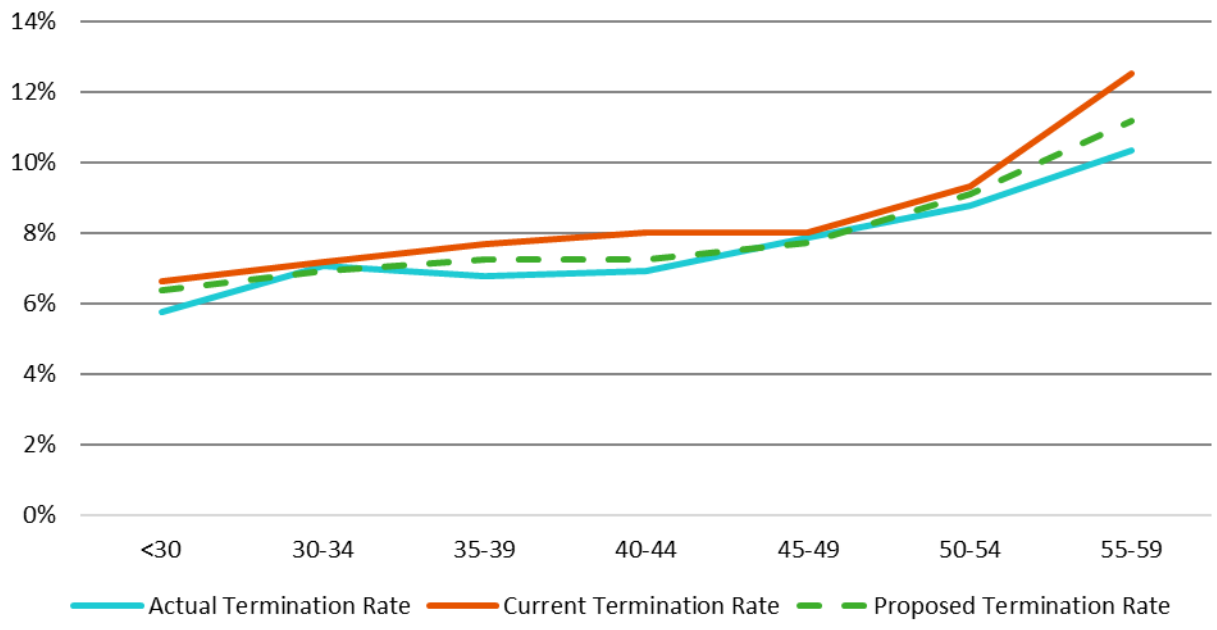
The following tables and graphs show the actual, expected, and proposed select termination rates based on age and gender.

III: Demographic Assumptions

Select Period Termination, Less Than Five Years of Service – **Females**

Age Range	Exposures	Actual Termination Rate	Expected Termination Rate	Ratio of Actual to Expected	Proposed Termination Rate	Ratio of Actual to Proposed
Less Than 30	31,589	5.75%	6.64%	87%	6.39%	90%
30 – 34	11,144	7.08%	7.17%	99%	6.92%	102%
35 – 39	6,668	6.78%	7.69%	88%	7.25%	94%
40 – 44	4,927	6.92%	8.00%	87%	7.25%	95%
45 – 49	3,818	7.86%	8.00%	98%	7.73%	102%
50 – 54	2,218	8.79%	9.31%	94%	9.11%	96%
55 – 59[1]	1,188	10.35%	12.52%	83%	11.19%	92%
Total	**61,552**	**6.53%**	**7.25%**	**90%**	**6.92%**	**94%**

Actual Versus Proposed Experience
Select Period Termination, Less Than Five Years of Service – **Females**



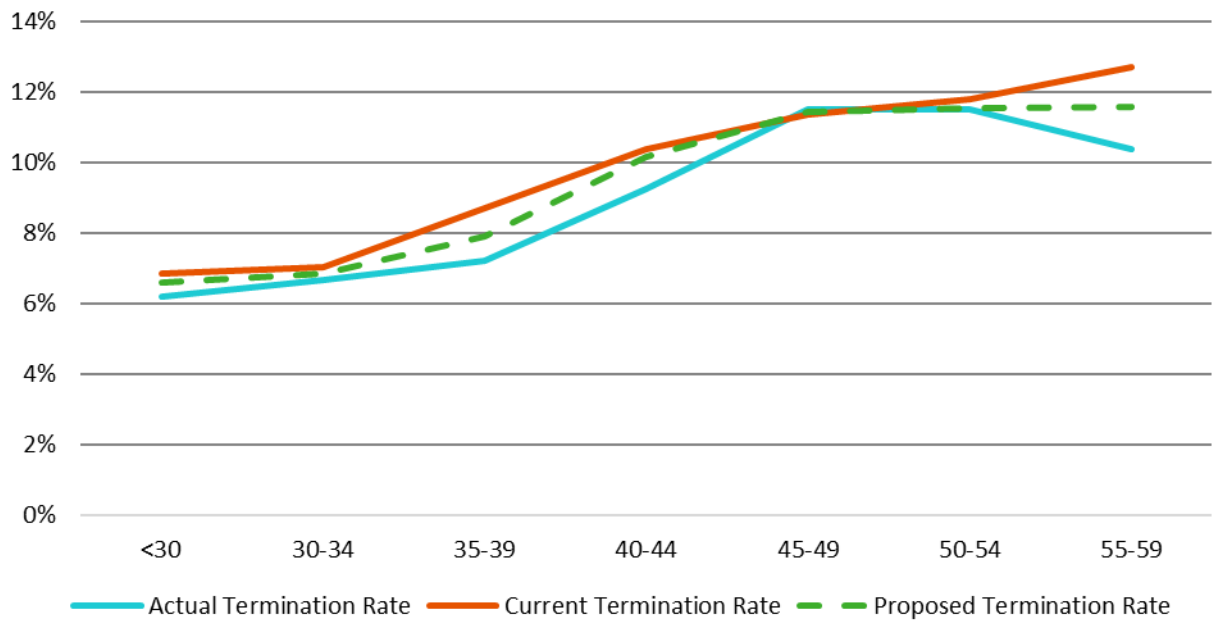
[1] Excludes terminations from members who are eligible for retirement.

III: Demographic Assumptions

Select Period Termination, Less Than Five Years of Service – **Males**

Age Range	Exposures	Actual Termination Rate	Expected Termination Rate	Ratio of Actual to Expected	Proposed Termination Rate	Ratio of Actual to Proposed
Less Than 30	7,455	6.18%	6.84%	90%	6.58%	94%
30 – 34	3,600	6.67%	7.04%	95%	6.84%	97%
35 – 39	2,158	7.23%	8.72%	83%	7.90%	92%
40 – 44	1,329	9.26%	10.38%	89%	10.16%	91%
45 – 49	816	11.52%	11.37%	101%	11.44%	101%
50 – 54	547	11.52%	11.81%	98%	11.56%	100%
55 – 59[1]	347	10.37%	12.71%	82%	11.60%	89%
Total	**16,252**	**7.22%**	**7.94%**	**91%**	**7.62%**	**95%**

Actual Versus Proposed Experience
Select Period Termination, Less Than Five Years of Service – **Males**



[1] Excludes terminations from members who are eligible for retirement.

III: Demographic Assumptions

Ultimate Termination Rates

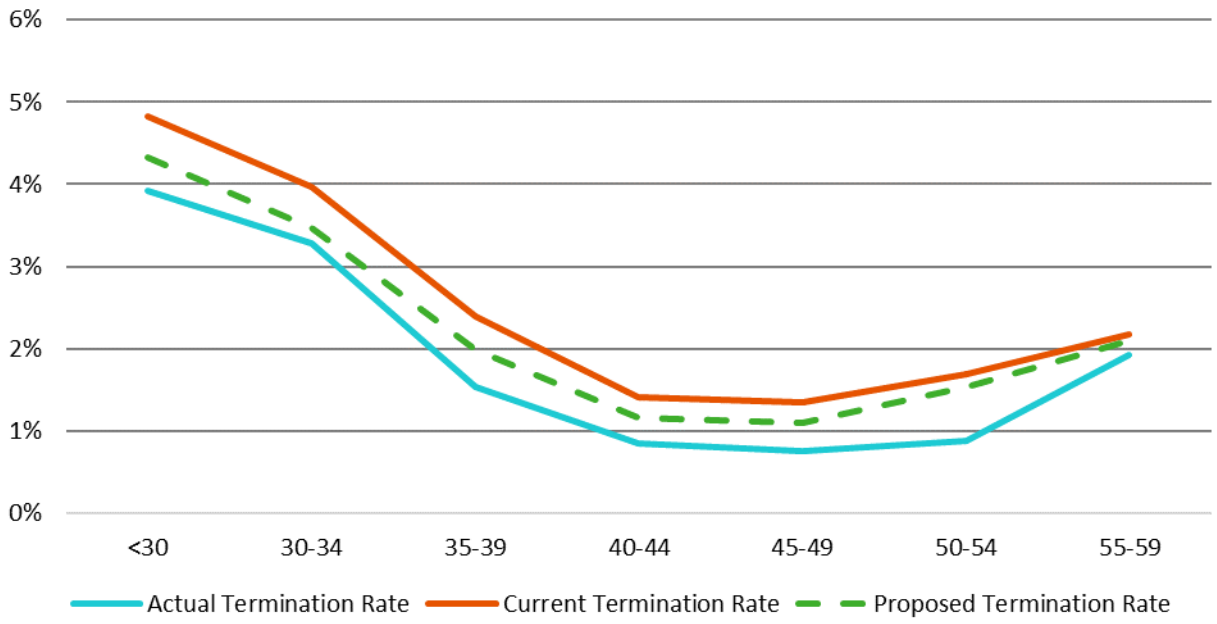
The current ultimate termination assumptions are sex-distinct and based on members' age. Based on our analysis, **we recommend that the sex-distinct basis be retained and that the ultimate termination rates be changed (primarily decreased)**.

The following tables and graphs show the actual, expected, and proposed ultimate termination rates based on age and gender.

Ultimate Period Termination, Five or More Years of Service – **Females**

Age Range	Exposures	Actual Termination Rate	Expected Termination Rate	Ratio of Actual to Expected	Proposed Termination Rate	Ratio of Actual to Proposed
Less Than 30	8,967	3.91%	4.83%	81%	4.33%	90%
30 – 34	34,869	3.29%	3.98%	83%	3.48%	95%
35 – 39	46,508	1.53%	2.39%	64%	1.99%	77%
40 – 44	44,463	0.85%	1.40%	61%	1.15%	74%
45 – 49	42,044	0.76%	1.35%	56%	1.10%	69%
50 – 54	34,280	0.88%	1.69%	52%	1.53%	57%
55 – 59	11,371	1.92%	2.18%	88%	2.09%	92%
Total	**222,502**	**1.54%**	**2.22%**	**69%**	**1.92%**	**80%**

Actual Versus Proposed Experience
Ultimate Period Termination, Five or More Years of Service – **Females**

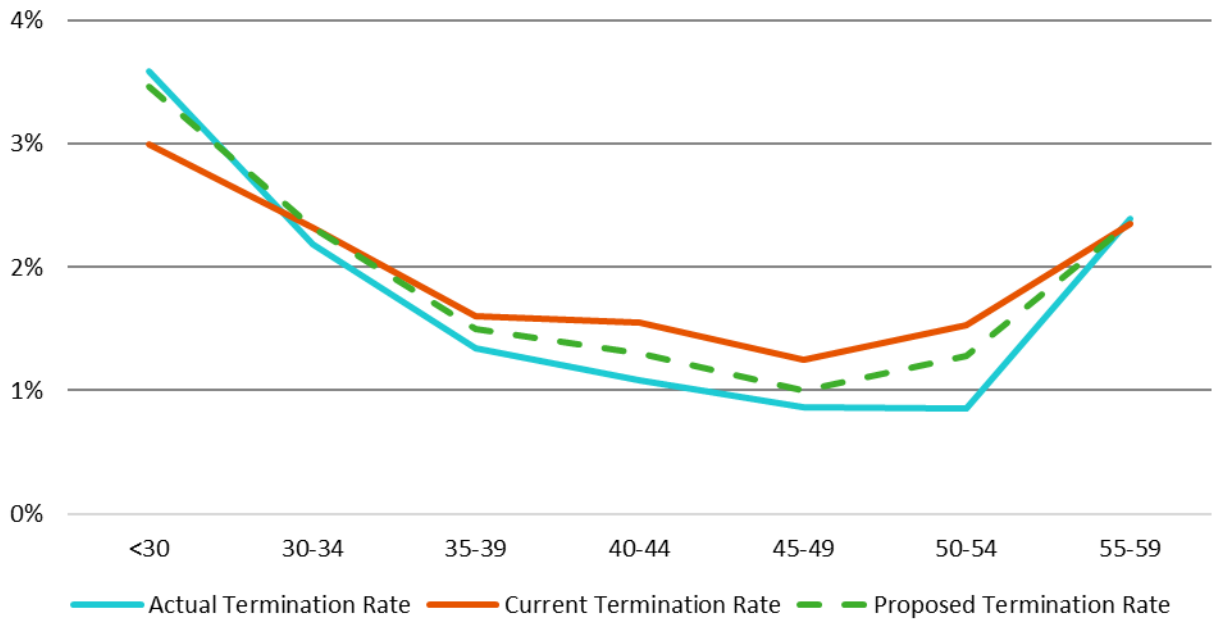


III: Demographic Assumptions

Ultimate Period Termination, Five or More Years of Service – **Males**

Age Range	Exposures	Actual Termination Rate	Expected Termination Rate	Ratio of Actual to Expected	Proposed Termination Rate	Ratio of Actual to Proposed
Less Than 30	2,062	3.59%	3.00%	120%	3.47%	103%
30 – 34	10,110	2.19%	2.32%	94%	2.32%	94%
35 – 39	15,371	1.34%	1.60%	84%	1.50%	89%
40 – 44	15,589	1.08%	1.55%	69%	1.30%	83%
45 – 49	14,649	0.86%	1.25%	69%	1.00%	86%
50 – 54	11,415	0.86%	1.53%	56%	1.28%	67%
55 – 59	2,297	2.39%	2.35%	102%	2.36%	101%
Total	**71,493**	**1.33%**	**1.67%**	**79%**	**1.52%**	**87%**

Actual Versus Proposed Experience
Ultimate Period Termination, Five or More Years of Service – **Males**



D. Disability Retirement

Disability rate tables function in the same way as retirement rate tables. The rate at each age indicates the probability of becoming disabled before the next age. Disability rates add liability for the value of the disability benefits, but lessen the value of retirement benefits ultimately payable, since anyone who becomes disabled is not projected to receive retirement benefits other than the disability benefit.

The current disability rates are based on members' age and gender and range from 0.025% at age 20 to 0.30% at age 69 for females and 0.01% at age 20 to 0.25% at age 69 for males. The following table summarizes the disability experience for the plan during the study period. Overall, the number of actual male and females disabilities were less than the number of assumed disabilities.

Gender	Exposures	Actual Disabilities	Expected Disabilities	Ratio of Actual to Expected
Male	105,516	46	63	73%
Female	345,020	238	368	65%
Total	**450,536**	**284**	**431**	**66%**

In light of the above, considering the small sample size, **we recommend maintaining a sex-distinct, age-based table with a uniform reduction of 15% for females and 25% for males applied to the current disability rates for all ages to better match recent plan experience**. The complete listing of the proposed disability rates are included in Appendix E.

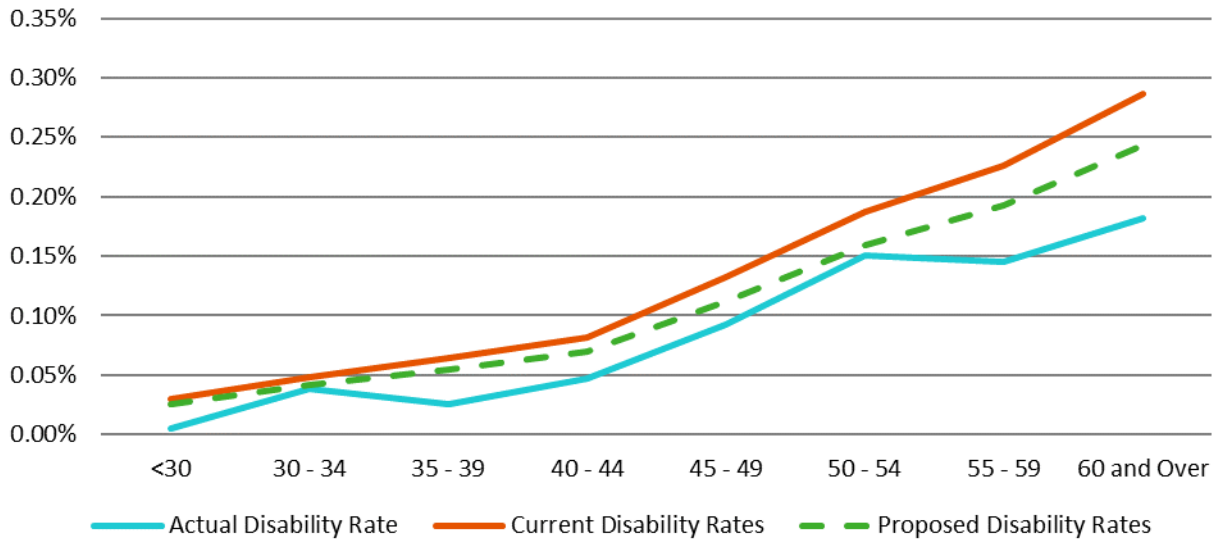
The following tables and graphs show the actual, expected, and proposed select termination rates based on age and gender.

III: Demographic Assumptions

Disability Retirement – **Females**

Age Range	Exposures	Actual Disability Rate	Expected Disability Rate	Ratio of Actual to Expected	Proposed Disability Rate	Ratio of Actual to Proposed
Less Than 30	44,801	0.00%	0.03%	15%	0.03%	17%
30 – 34	48,840	0.04%	0.05%	80%	0.04%	95%
35 – 39	57,989	0.03%	0.06%	40%	0.05%	48%
40 – 44	55,871	0.05%	0.08%	57%	0.07%	67%
45 – 49	53,329	0.09%	0.13%	70%	0.11%	82%
50 – 54	43,302	0.15%	0.19%	80%	0.16%	94%
55 – 59	33,733	0.15%	0.23%	64%	0.19%	76%
60 & Over	7,155	0.18%	0.29%	63%	0.24%	75%
Total	**345,020**	**0.07%**	**0.11%**	**65%**	**0.09%**	**76%**

Actual Versus Proposed Experience
Disability Retirement – **Females**

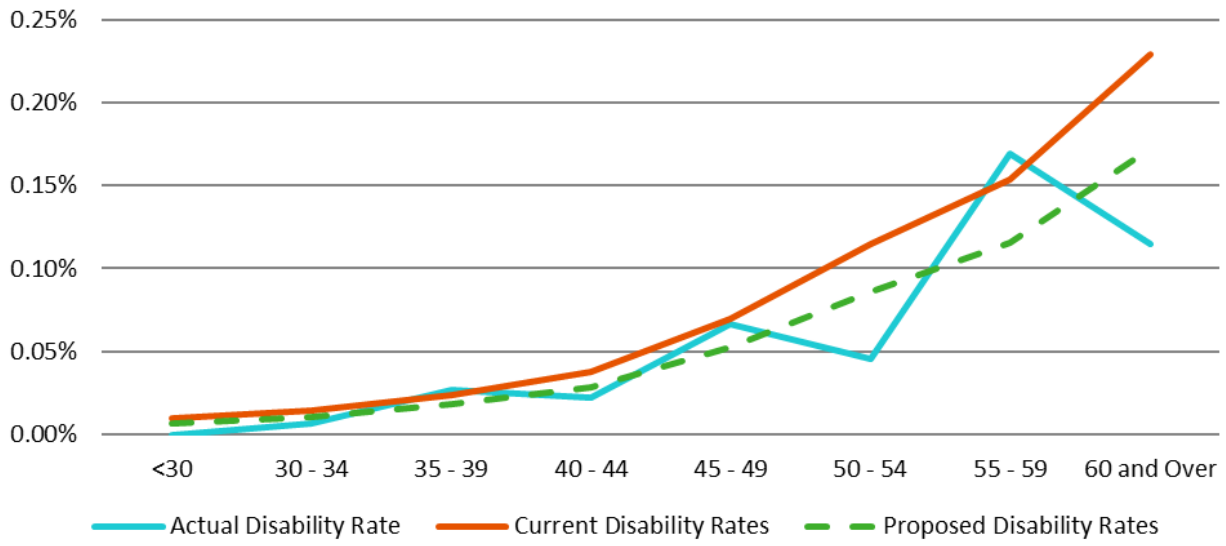


III: Demographic Assumptions

Disability Retirement – **Males**

Age Range	Exposures	Actual Disability Rate	Expected Disability Rate	Ratio of Actual to Expected	Proposed Disability Rate	Ratio of Actual to Proposed
Less Than 30	12,179	0.00%	0.01%	0%	0.01%	0%
30 – 34	14,859	0.01%	0.01%	47%	0.01%	62%
35 – 39	18,482	0.03%	0.02%	113%	0.02%	149%
40 – 44	17,850	0.02%	0.04%	59%	0.03%	78%
45 – 49	16,591	0.07%	0.07%	95%	0.05%	126%
50 – 54	13,187	0.05%	0.12%	40%	0.09%	53%
55 – 59	8,872	0.17%	0.15%	110%	0.12%	147%
60 & Over	3,496	0.11%	0.23%	50%	0.17%	66%
Total	**105,516**	**0.04%**	**0.06%**	**73%**	**0.04%**	**97%**

Actual Versus Proposed Experience
Disability Retirement – **Males**



E. Other Demographic Assumptions

Spouse Information

Spouse information assumptions that affect the valuation include the percentage of members married and the age difference of spouses. The current assumptions are:

- 85% of active members are married
- Male spouses are three years older than female spouses
- 100% of spouses are of the opposite gender

We have limited data on marital status and spouse information. However, the current assumptions are reasonable and consistent with assumptions used for similar plans. Therefore, **we recommend no changes to the current assumptions**.

Sick Leave Service Credit

The liability for retirement benefits for active members is increased to cover assumed unused and uncompensated sick leave service credit at retirement. The current assumption is based on service at retirement.

The following table summarizes the experience for the plan during the study period.

Actual Sick Leave Credit	Expected Sick Leave Credit	Actual to Expected	Proposed Sick Leave Credit	Ratio of Actual to Proposed
10,541	10,308	102%	10,315	102%

Overall, plan experience, on average, is fairly consistent with the current assumption, although it is inconsistent at individual service levels (e.g., assumed service credit for low-service retirements are overstated while high-service retirements are understated). In light of the above, **we recommend slightly adjusting sick leave service credit rates to better reflect plan experience**. The proposed sick leave service credits have been developed based on weighting the current assumption (i.e., historical experience) and recent experience by one-half.

The complete listing of the proposed sick leave service credit rates are included in Appendix F.

Optional Service Purchase

The liability for retirement benefits for active members who have not previously purchased optional service is increased to cover the employer cost of out-of-system service purchased in the last two years prior to retirement. The current assumption is based on service at retirement.

The following table summarizes the experience for the plan during the study period. Overall, plan experience, on average, shows less optional service years purchased than currently assumed.

Actual Optional Service Years Purchased	Expected Optional Service Years Purchased	Actual to Expected	Proposed Optional Service Years Purchased	Ratio of Actual to Proposed
3,460	4,759	73%	4,371	79%

In light of the above, **we recommend slightly adjusting optional service purchase rates to better reflect plan experience**. The proposed optional service purchases have been developed based on weighting the current assumption (i.e., historical experience) and recent experience by one-half.

The complete listing of the proposed optional service purchase rates are included in Appendix G.

Future Service Accrual Rate

The current assumptions are:

- Full-Time members assumed to accrue 0.961 years of service per year
- Hourly members assumed to accrue 0.250 years of service per year

The following table summarizes the experience for the plan during the study period. Overall, plan experience, on average, shows slightly greater service accruals than expected for both full-time and hourly members.

Member Type	Actual Average Service Accrual	Expected Average Service Accrual	Actual to Expected	Proposed Average Service Accrual	Ratio of Actual to Proposed
Full-Time	0.993	0.961	103%	0.980	101%
Hourly	0.317	0.250	127%	0.275	115%

In light of the above, **we recommend increasing the rate of service accrual for full-time members to 0.980 years of service per year and increasing the rate of service accrual for hourly members to 0.275 years of service per year**. The proposed future service accrual rates have been developed based on weighting the current assumption (i.e., historical experience) and recent experience by one-half.

Automatic Annual Increase (AAI) Buyout

Public Acts 100-0587 and 101-0010 provide Tier 1 members the option to receive a lump sum at retirement in exchange for having their AAI based on 1.5% of the originally granted annuity (instead of 3% compounded) effective at the age 67 (instead of age 61).

The current AAI buyout assumption is 15% of eligible retiring Tier 1 members will elect the buyout.

The following table summarizes the experience for the plan from January 1, 2019 through December 31, 2020. Experience after December 31, 2020 is limited, although it is projected to

be similar to pre-2021 experience. Overall, plan experience, on average, shows more actual AAI buyouts than expected.

Actual AAI Buyout	Expected AAI Buyout	Actual to Expected	Proposed AAI Buyout	Ratio of Actual to Proposed
1,596	1,203	133%	1,603	100%

In light of the above, **we recommend increasing the AAI buyout election assumption to 20% to reflect plan experience**.

Inactive Vested (IV) Buyout

Public Acts 100-0587 and 101-0010 provide inactive vested members the option to receive an immediate lump sum in exchange for their annuity at retirement.

The current IV buyout assumption is 22% of eligible inactive vested members will elect the buyout.

In general, there were fewer actual IV buyouts than expected. Approximately 10% of all inactive vested members as of the effective starting date of the buyout program elected the IV buyout and approximately 15% of new vested terminations elected the IV buyout during the fiscal year ended June 30, 2020.

The current administrative practice is to provide a one-time offer at the time of termination without any subsequent offers. However, for valuation purposes, we apply the IV buyout election percentage assumption to the entire inactive vested population (not just new terminations). On average, new vested terminations comprise approximately 10% of the total IV population. In order to address the discrepancy between valuation methodology and administrative practices, the proposed assumption is further adjusted to reflect that IV buyouts will be elected by future terminations only.

As such, **we recommend decreasing the IV buyout election assumption to 5% (applied to the entire inactive vested population) to better align with recent experience**.

IV. Appendix

Appendix A: Proposed Salary Increases

Service	Current Total Salary Increase Rate	Proposed Total Salary Increase Rate[1]
1	9.50%	8.50%
2	7.50%	6.75%
3	7.00%	6.25%
4	6.75%	6.25%
5	6.50%	6.00%
6	6.25%	5.75%
7	6.00%	5.50%
8	5.75%	5.50%
9	5.50%	5.25%
10	5.50%	5.00%
11	5.25%	5.00%
12	5.00%	4.75%
13	5.00%	4.50%
14	4.75%	4.50%
15	4.75%	4.50%
16	4.50%	4.25%
17	4.50%	4.00%
18	4.25%	4.00%
19	4.00%	3.75%
20 or More	4.00%	3.50%

[1] Includes proposed 2.25% inflation.

Appendix B: Proposed Mortality Rates

Healthy Post-Retirement Mortality[1]

	Male		Female	
Age	Current Mortality Rates	Proposed Mortality Rates	Current Mortality Rates	Proposed Mortality Rates
50	0.24%	0.11%	0.14%	0.08%
55	0.35%	0.23%	0.19%	0.18%
60	0.49%	0.39%	0.28%	0.28%
65	0.71%	0.63%	0.45%	0.39%
70	1.13%	1.05%	0.70%	0.63%
75	1.89%	1.94%	1.16%	1.45%
80	3.31%	3.71%	3.20%	2.89%
85	7.16%	7.79%	5.80%	5.64%
90	13.29%	14.48%	10.69%	10.63%
95	22.23%	24.34%	18.47%	18.91%
100	33.36%	34.94%	29.05%	29.75%

Beneficiary Post-Retirement Mortality[1]

	Male		Female	
Age	Current Mortality Rates	Proposed Mortality Rates	Current Mortality Rates	Proposed Mortality Rates
50	0.44%	0.72%	0.25%	0.30%
55	0.64%	0.89%	0.35%	0.45%
60	0.90%	1.16%	0.51%	0.65%
65	1.28%	1.55%	0.76%	0.85%
70	1.88%	2.20%	1.17%	1.19%
75	2.95%	3.39%	1.90%	1.92%
80	4.90%	5.42%	3.20%	3.30%
85	8.55%	9.01%	5.61%	5.95%
90	15.09%	15.06%	9.97%	10.73%
95	24.20%	23.79%	16.61%	17.53%
100	35.18%	34.38%	25.35%	26.75%

[1] Current and proposed mortality rates above are sample rates for 2020. For actuarial valuation purposes, proposed mortality rates will be projected from 2010 on a generational basis using MP-2020 improvement scale.

Appendix B: Proposed Mortality Rates

Disabled Post-Retirement Mortality[1]

	Male		Female	
Age	Current Mortality Rates	Proposed Mortality Rates	Current Mortality Rates	Proposed Mortality Rates
40	1.34%	0.81%	0.66%	0.73%
45	1.93%	1.04%	1.04%	0.96%
50	2.23%	1.51%	1.34%	1.40%
55	2.62%	2.06%	1.69%	1.80%
60	3.10%	2.61%	2.03%	2.07%
65	3.71%	3.09%	2.40%	2.17%
70	4.57%	3.66%	3.12%	2.58%
75	6.01%	4.73%	4.53%	3.65%
80	8.47%	6.76%	6.82%	5.66%
85	12.61%	10.13%	10.22%	8.97%
90	19.37%	15.44%	15.05%	13.21%
95	27.61%	22.40%	22.15%	18.57%

Healthy Pre-Retirement Mortality[1]

	Male		Female	
Age	Current Mortality Rates	Proposed Mortality Rates	Current Mortality Rates	Proposed Mortality Rates
25	0.03%	0.02%	0.02%	0.01%
30	0.03%	0.03%	0.02%	0.02%
35	0.04%	0.03%	0.03%	0.02%
40	0.05%	0.05%	0.04%	0.03%
45	0.07%	0.06%	0.06%	0.04%
50	0.11%	0.09%	0.09%	0.06%
55	0.19%	0.15%	0.15%	0.10%
60	0.34%	0.25%	0.22%	0.15%
65	0.60%	0.40%	0.32%	0.23%
70	1.04%	0.60%	0.53%	0.39%
75	1.79%	0.88%	0.93%	0.75%
80	3.17%	1.76%	1.64%	1.55%

[1] Current and proposed mortality rates above are sample rates for 2020. For actuarial valuation purposes, proposed mortality rates will be projected from 2010 on a generational basis using MP-2020 improvement scale.

Appendix C: Proposed Retirement Rates

Proposed Tier 1 Retirement (Unisex)

	Less than 19 Years of Service		19-29 Years of Service		30-33 Years of Service		34+ Years of Service	
Age	**Current**	**Proposed**	**Current**	**Proposed**	**Current**	**Proposed**	**Current**	**Proposed**
54	0%	0%	7%	7%	N/A	8%	45%	45%
55	0%	0%	7%	6%	N/A	8%	45%	44%
56	0%	0%	7%	6%	N/A	7%	45%	46%
57	0%	0%	7%	7%	N/A	8%	45%	46%
58	0%	0%	7%	8%	N/A	12%	40%	45%
59	0%	0%	30%	33%	N/A	40%	40%	48%
60	20%	21%	30%	33%	N/A	46%	40%	44%
61	17%	17%	30%	28%	N/A	35%	40%	41%
62	15%	17%	30%	28%	N/A	43%	40%	41%
63	15%	16%	30%	29%	N/A	35%	40%	44%
64	22%	26%	40%	40%	N/A	50%	40%	40%
65	25%	27%	40%	40%	N/A	52%	40%	43%
66	25%	23%	40%	42%	N/A	42%	40%	38%
67	20%	25%	40%	39%	N/A	43%	45%	38%
68	20%	23%	40%	39%	N/A	40%	45%	35%
69	25%	28%	40%	38%	N/A	32%	45%	44%
70	100%	100%	100%	100%	N/A	100%	30%	31%
71							30%	39%
72							30%	24%
73							30%	36%
74							30%	36%
75							100%	100%

Appendix D: Proposed Termination Rates

Select Table (Less than Five Years of Service)

	Male		Female	
Age	Current Rate of Termination	Proposed Rate of Termination	Current Rate of Termination	Proposed Rate of Termination
25	7.00%	6.50%	6.50%	6.25%
26	6.90%	6.55%	6.60%	6.35%
27	6.80%	6.60%	6.70%	6.45%
28	6.70%	6.65%	6.80%	6.55%
29	6.60%	6.70%	6.90%	6.65%
30	6.50%	6.75%	7.00%	6.75%
31	6.80%	6.80%	7.10%	6.85%
32	7.10%	6.85%	7.20%	6.95%
33	7.40%	6.90%	7.30%	7.05%
34	7.70%	6.95%	7.40%	7.15%
35	8.00%	7.00%	7.50%	7.25%
36	8.40%	7.50%	7.60%	7.25%
37	8.80%	8.00%	7.70%	7.25%
38	9.20%	8.50%	7.80%	7.25%
39	9.60%	9.00%	7.90%	7.25%
40	10.00%	9.50%	8.00%	7.25%
41	10.20%	9.85%	8.00%	7.25%
42	10.40%	10.20%	8.00%	7.25%
43	10.60%	10.55%	8.00%	7.25%
44	10.80%	10.90%	8.00%	7.25%
45	11.00%	11.25%	8.00%	7.25%
46	11.20%	11.35%	8.00%	7.50%
47	11.40%	11.45%	8.00%	7.75%
48	11.60%	11.55%	8.00%	8.00%
49	11.80%	11.65%	8.00%	8.25%
50	12.00%	11.75%	8.00%	8.50%
51	11.90%	11.65%	8.75%	8.85%
52	11.80%	11.55%	9.50%	9.20%
53	11.70%	11.45%	10.25%	9.55%
54	11.60%	11.35%	11.00%	9.90%
55	11.50%	11.25%	11.75%	10.25%
56	12.20%	11.45%	12.20%	10.80%
57	12.90%	11.65%	12.65%	11.35%
58	13.60%	11.85%	13.10%	11.90%
59	14.30%	12.05%	13.55%	12.45%
60	15.00%	12.25%	14.00%	13.00%
61	18.00%	15.65%	17.00%	13.75%
62	21.00%	19.05%	23.75%	19.75%
63	24.00%	22.45%	24.75%	23.25%
64	27.00%	25.85%	28.25%	27.75%
65	30.00%	29.25%	30.00%	32.50%

Appendix D: Proposed Termination Rates

Ultimate Table (Five or More Years of Service)

	Male		Female	
Age	Current Rate of Termination	Proposed Rate of Termination	Current Rate of Termination	Proposed Rate of Termination
25	3.00%	4.50%	5.00%	4.50%
26	3.00%	4.20%	4.95%	4.45%
27	3.00%	3.90%	4.90%	4.40%
28	3.00%	3.60%	4.85%	4.35%
29	3.00%	3.30%	4.80%	4.30%
30	3.00%	3.00%	4.75%	4.25%
31	2.70%	2.70%	4.40%	3.90%
32	2.40%	2.40%	4.05%	3.55%
33	2.10%	2.10%	3.70%	3.20%
34	1.80%	1.80%	3.35%	2.85%
35	1.50%	1.50%	3.00%	2.50%
36	1.55%	1.50%	2.70%	2.25%
37	1.60%	1.50%	2.40%	2.00%
38	1.65%	1.50%	2.10%	1.75%
39	1.70%	1.50%	1.80%	1.50%
40	1.75%	1.50%	1.50%	1.25%
41	1.65%	1.40%	1.45%	1.20%
42	1.55%	1.30%	1.40%	1.15%
43	1.45%	1.20%	1.35%	1.10%
44	1.35%	1.10%	1.30%	1.05%
45	1.25%	1.00%	1.25%	1.00%
46	1.25%	1.00%	1.30%	1.05%
47	1.25%	1.00%	1.35%	1.10%
48	1.25%	1.00%	1.40%	1.15%
49	1.25%	1.00%	1.45%	1.20%
50	1.25%	1.00%	1.50%	1.25%
51	1.40%	1.15%	1.60%	1.40%
52	1.55%	1.30%	1.70%	1.55%
53	1.70%	1.45%	1.80%	1.70%
54	1.85%	1.60%	1.90%	1.85%
55	2.00%	1.75%	2.00%	2.00%
56	2.20%	2.10%	2.10%	2.05%
57	2.40%	2.45%	2.20%	2.10%
58	2.60%	2.80%	2.30%	2.15%
59	2.80%	3.15%	2.40%	2.20%
60	3.00%	3.50%	2.50%	2.25%
61	3.00%	3.50%	2.00%	2.30%
62	3.00%	3.50%	2.25%	2.35%
63	3.00%	3.50%	2.50%	2.40%
64	3.00%	3.50%	2.75%	2.45%
65	3.00%	3.50%	3.00%	2.50%

Appendix E: Proposed Disability Retirement Rates

	Male		Female	
Age	Current Disability Rates	Proposed Disability Rates	Current Disability Rates	Proposed Disability Rates
25	0.01%	0.01%	0.03%	0.02%
26	0.01%	0.01%	0.03%	0.02%
27	0.01%	0.01%	0.03%	0.03%
28	0.01%	0.01%	0.03%	0.03%
29	0.01%	0.01%	0.04%	0.03%
30	0.01%	0.01%	0.04%	0.03%
31	0.01%	0.01%	0.04%	0.04%
32	0.01%	0.01%	0.05%	0.04%
33	0.02%	0.01%	0.05%	0.04%
34	0.02%	0.01%	0.06%	0.05%
35	0.02%	0.02%	0.06%	0.05%
36	0.02%	0.02%	0.06%	0.05%
37	0.02%	0.02%	0.06%	0.05%
38	0.03%	0.02%	0.07%	0.06%
39	0.03%	0.02%	0.07%	0.06%
40	0.03%	0.02%	0.07%	0.06%
41	0.03%	0.03%	0.08%	0.07%
42	0.04%	0.03%	0.08%	0.07%
43	0.04%	0.03%	0.09%	0.08%
44	0.05%	0.04%	0.09%	0.08%
45	0.05%	0.04%	0.10%	0.09%
46	0.06%	0.05%	0.12%	0.10%
47	0.07%	0.05%	0.13%	0.11%
48	0.08%	0.06%	0.15%	0.13%
49	0.09%	0.07%	0.16%	0.14%
50	0.10%	0.08%	0.18%	0.15%
51	0.11%	0.08%	0.18%	0.16%
52	0.12%	0.09%	0.19%	0.16%
53	0.12%	0.09%	0.19%	0.16%
54	0.13%	0.10%	0.20%	0.17%
55	0.14%	0.11%	0.20%	0.17%
56	0.15%	0.11%	0.21%	0.18%
57	0.16%	0.12%	0.23%	0.19%
58	0.16%	0.12%	0.24%	0.21%
59	0.17%	0.13%	0.26%	0.22%
60	0.18%	0.14%	0.27%	0.23%
61	0.19%	0.15%	0.28%	0.23%
62	0.21%	0.16%	0.28%	0.24%
63	0.22%	0.17%	0.29%	0.24%
64	0.24%	0.18%	0.29%	0.25%
65	0.25%	0.19%	0.30%	0.26%

Appendix F: Proposed Sick Leave Service Credits

Service	Current Assumption	Proposed Assumption
9	0.286	0.229
10	0.416	0.330
11	0.517	0.422
12	0.522	0.506
13	0.582	0.582
14	0.650	0.652
15	0.716	0.716
16	0.799	0.774
17	0.816	0.827
18	0.916	0.876
19	0.937	0.921
20	0.953	0.963
21	1.031	1.004
22	1.032	1.042
23	1.089	1.080
24	1.146	1.117
25	1.137	1.154
26	1.204	1.193
27	1.229	1.233
28	1.232	1.275
29	1.311	1.320
30	1.376	1.369
31	1.348	1.422
32	1.514	1.479
33	1.652	1.543
34	1.387	1.612

Appendix G: Proposed Optional Service Purchases

Service	Current Assumption	Proposed Assumption
9	0.221	0.158
10	0.107	0.158
11	0.167	0.169
12	0.419	0.189
13	0.324	0.218
14	0.529	0.253
15	0.299	0.293
16	0.322	0.337
17	0.371	0.385
18	0.597	0.434
19	0.507	0.483
20	0.445	0.531
21	0.745	0.577
22	0.605	0.619
23	0.698	0.657
24	0.746	0.688
25	0.752	0.712
26	0.873	0.727
27	0.934	0.732
28	0.695	0.725
29	0.978	0.706
30	0.841	0.673
31	0.740	0.625
32	0.561	0.560
33	0.353	0.477
34	0.000	0.000

END OF REPORT