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EMPLOYEES' RETIREMENT SYSTEM OF GEORGIA

GEORGIA JUDICIAL RETIREMENT SYSTEM

EXPERIENCE INVESTIGATION FOR THE FIVE-YEAR PERIOD ENDING JUNE 30, 2019

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December 18, 2020

Board of Trustees,
Georgia Judicial Retirement System
Suite 400, Two Northside 75
Atlanta, GA 30318

Members of the Board:

We are pleased to submit the results of an investigation of the economic and demographic experience for the Georgia Judicial Retirement System (JRS) for the five-year period from July 1, 2014 to June 30, 2019. The study was based on the data submitted by JRS for the annual valuation. In preparing this report, we relied, without audit, on the data provided.

The purpose of the investigation was to assess the reasonability of the current economic assumptions and demographic actuarial assumptions for the System. As a result of the investigation, it is recommended that revised economic assumptions and demographic tables be adopted by the Board for future use.

All recommended rates of separation, mortality and salary increase are shown in the attached tables in Appendix D of this report. In the actuary's judgment, the rates recommended are suitable for use until further experience indicates that modifications are desirable.

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

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

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

Respectfully submitted,

Edward J. Koebel, EA, FCA, MAAA
Chief Executive Officer

Cathy Turcot
Principal and Managing Director

Ben Mobley, ASA, EA, MAAA
Senior Actuary

Table of Contents

Section I - Executive Summary

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

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

Cavanaugh Macdonald Consulting, LLC (CMC) has performed a study of the experience of each of the Plans under the ERS' Board of Trustees purview for the five-year period ending June 30, 2019. This report presents the results, analysis, and resulting recommendations of our study for JRS only. Each plan will have its own report. It is anticipated that the changes, if approved, will first be reflected in the June 30, 2020 actuarial valuations.

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

Our Philosophy

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

- **Do Not Overreact**: When we see significant changes in experience, we generally do not adjust our rates to reflect the entire difference. We will typically recommend rates somewhere between the old rates and the new experience. If the experience during the next study period shows the same result, we will probably recognize the trend at that point in time or at least move further in the direction of the observed experience. On the other hand, if experience returns closer to its prior level, we will not have overreacted, possibly causing volatility in the actuarial contribution rates.

- **Anticipate Trends**: If there is an identified trend that is expected to continue, we believe that this should be recognized. An example is the retiree mortality assumption. It is an established trend that people are living longer. Therefore, we believe the best estimate of liabilities in the valuation should reflect the expected increase in life expectancy.

- **Simplify**: In general, we attempt to identify which factors are significant and eliminate or ignore those that do not materially improve the accuracy of the liability projections.

The following summarizes the findings and recommendations regarding the assumptions utilized for JRS. Detailed explanations for the recommendations are found in the sections that follow.

Recommended Economic Assumption Changes

Economic assumptions are some of the most visible and significant assumptions used in the valuation process. The items in the broad economy modeled by these assumptions can be very volatile over short periods of time, as clearly seen in the economic downturn in 2008 followed by the rebound in many financial markets in the years following. Our goal is to try to find the emerging long-term trends in the midst of this volatility so that we can then apply reasonable assumptions.

Most of the economic assumptions used by actuaries are developed through a building-block approach. For example, the expected return on assets is based on the expectation for inflation plus the expected real return on assets. At the core of the economic assumptions is the inflation assumption. As we discuss later in the report, based on recent trends of inflation, the market pricing of inflation, and the Chief Actuary of the Social Security Administration's view of inflation, **we are recommending a decrease in the price inflation assumption from 2.75% to 2.50%**.

We are also recommending a corresponding decrease in the long-term expected return on assets assumption from 7.50% to 7.00%, reflecting the 0.25% decrease in the inflation assumption and a 0.25% decrease in the real rate of return. This will be discussed in detail later in this report, but a real rate of return of 4.50% is supported by the forecasting models developed using the capital market assumptions from Division of Investment Services that oversees JRS' investments and the Board's target asset allocation. Further analysis of the 35 sets of capital market assumptions included in the Horizon Actuarial Services, LLC. Survey conducted in 2020 also support this recommendation.

The current JRS funding policy states that the long-term expected return on assets assumption shall be reduced by 0.10% per year from the immediate prior valuation when the actual rate of return for the fiscal year exceeds the assumed rate. The current asset return assumption is 7.30% and the minimum return assumption is 7.00%. The asset return assumption used in the most recent actuarial valuation is 7.30%. We concur with the Board policy that will continue to reduce the rate of return used in future valuations until a 7.00% return in achieved so, therefore, the recommended rate change does not have any impact on the valuation results expected in the next few years.

Finally, we are recommending that the general wage inflation (payroll growth) assumption used as the underlying payroll growth for active members be decreased from 3.25% to 3.00%, reflecting the 0.25% decrease in the inflation assumption.

The following table summarizes the current and proposed economic assumptions:

Item	Current	Proposed
Price Inflation	2.75%	2.50%
Investment Return*	7.50%	7.00%
Wage Inflation (Payroll Growth)	3.25%	3.00%

* net of investment expenses.

Although we have recommended a change in the set of economic assumptions, we recognize there may be other sets of economic assumptions that are also reasonable for purposes of funding JRS. For example, we have typically reflected conservatism to the degree we would classify as moderate. Actuarial Standards of Practice allow for this difference in approaches and perspective, as long, as the assumptions are reasonable and consistent.

Recommended Demographic Assumption Changes

In the experience study, actual experience for the study period is compared to that expected based on the current actuarial assumption. The analysis is most, commonly performed based on counts, i.e. each member is one exposure to the probability of the event occurring and one count if the event actually occurs. Comparing the actual incidence of the event to what was expected (called the Actual-to-Expected ratio, or A/E ratio) then provides the basis for our analysis.

The issue of future mortality improvement is one that the actuarial profession has become increasingly focused on studying in recent years. This has resulted in changes to the relevant Actuarial Standard of Practice, ASOP 35, *Selection of Demographic and Other Noneconomic Assumptions for Measuring Pension Obligations*. This ASOP requires the pension actuary to make and disclose a specific recommendation with respect to future improvements in mortality after the valuation date. There have been significant improvements in longevity in the past, although there are different opinions about future expectations. We believe it is prudent to anticipate that the trend will continue to some degree in the future. Therefore, we believe it is appropriate to reflect future mortality improvement as part of the mortality assumption.

There are two widely used approaches for reflecting future improvements in mortality:

(1) Static table with "margin"
(2) Generational mortality

The first approach to reflecting mortality improvements is with the use of a static mortality table with "margin." Under this approach, the A/E ratio is intentionally targeted to be over 100% so that mortality can improve without creating actuarial losses. While there is no formal guidance as to the amount of margin required (how far above 100% is appropriate for the A/E ratio), we typically prefer to have a margin of around 10 to 14% at the core ages of the retired members. The goal is still for the general shape of the curve to be a reasonable fit to the observed experience. Depending on the magnitude and duration of actual mortality improvements in the future, the margin may decrease and eventually become insufficient. If that occurs, the assumption would need to be updated.

Another approach, referred to as generational mortality, directly anticipates future improvements in mortality by using a different set of mortality rates for each year of birth, with the rates for later years of birth assuming lower mortality than the rates for earlier years of birth. The varying mortality rates by year of birth create a series of tables that contain "built-in" mortality improvements, e.g., a member who turns age 65 in 2035 has a longer life expectancy than a member who turns age 65 in 2020. When using generational mortality, the A/E ratios for the observed experience are set near 100% since future mortality improvements will be taken into account directly in the actuarial valuation process.

For the mortality decrements, we also analyzed the experience using a liability-weighted approach. This is approximated by using the member's retirement benefit from the data collected. The exposure and actual occurrences are then multiplied by the benefit level to provide the liability-weighted experience. This approach is particularly insightful when analyzing experience from a non-homogenous group. While we reviewed the mortality experience on both a count and liability-weighted basis, we ultimately decided on the liability-weighted results to evaluate experience and develop a new mortality table.

The current post-retirement mortality assumption for healthy lives is a static table, the RP-2000 Combined Mortality Table projected to 2025 with projection scale BB and set forward 2 years for both males and females. This table is currently used by four of the five pension plans overseen by the ERS Board (The Public School Employees Retirement System uses a different mortality table). The results of the experience analysis indicate that this table provided a very reasonable expectation of mortality for the past 5 years. However, we have decided to adopt a generational mortality approach and have selected the mortality assumptions from the recently published Pub-2010 Public Mortality Plans Mortality Tables. These tables, released in 2019, were developed using public pension plan mortality experience only. The recommended table will be used for JRS, Employees Retirement System (ERS), Legislative Retirement System (LRS) and Georgia Military Pension Fund (GMPF). More information will be discussed in the demographic section of this report.

The following table summarizes the other recommended changes to the demographic assumptions specific to JRS:

- **Retirement: Extended fixed retirement age from age 75 to age 78 as more Judges are working past age 75. Minor adjustments in rates of retirement were made to better match experience.**

- **Disability: Decreased rates of disability retirement to reflect continued experience.**

- **Withdrawal: Increased rates of withdrawal slightly at ages below 40 and decreased rates of withdrawal for ages 40 to 55.**

- **Merit Salary Scale: Decreased rates of salary to reflect continued experience.**

Section V of this report will provide more detail to these recommended demographic changes.

Actuarial Methods

The basic actuarial methodologies used in the valuation process include the:

- Actuarial Cost Method
- Asset Valuation Method
- Amortization Method

Based on our review, discussed in full detail in Section IV of this report, we recommend no changes in these actuarial methods at this time.

Other Assumptions

Another assumption that is included in the valuations is the determination of administrative expense component that is added to the total normal cost each year. The current method used to determine the load for administrative expenses is to use the budgeted expenses provided to us by the System for the applicable fiscal year (currently 1.84% of payroll of JRS). **After reviewing the total amount of administrative expenses for the past five years as a dollar amount and as a percentage of payroll, we are recommending a change in this method to a constant percent of payroll. We recommend a decrease in this assumption from 1.84% to 1.35% of payroll for the next 5-year period.** The following table shows actual percentages over the past five years:

Year Ending June 30	Administrative Expenses	Annual Payroll	Percentage
2015	819,000	54,272,296	1.51%
2016	754,000	57,401,313	1.31%
2017	728,000	59,695,102	1.22%
2018	794,000	60,571,786	1.31%
2019	820,000	60,531,960	1.35%

Section II – Financial Impact

Although the assumption changes, if approved, will first be reflected in the 2020 valuations, we have provided the following table which highlights the impact of the recommended changes on the Unfunded Actuarial Accrued Liability (UAAL), Funding Ratio, Amortization Period and Actuarially Determined Employer Contribution on the 2019 valuation results.

Impact on Principal Valuation Results		
	Valuation Results 2019	**Recommended Assumptions***
Unfunded Accrued Liability	$(33,338,935)	$(28,554,881)
Funding Ratio	107.6%	106.4%
Actuarially Determined Employer Contribution		
Normal	13.93%	12.91%
Accrued Liability	(5.12)%	(4.59)%
Total	8.81%	8.32%
Amortization Period (in years)	14.3	13.7

* Normal rate includes estimated administrative expenses.

Section III – Economic Assumptions

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

- Price Inflation
- Investment Return
- Wage Inflation

Actuarial Standard of Practice (ASOP) No. 27, *"Selection of Economic Assumptions for Measuring Pension Obligations"* provides guidance to actuaries in selecting economic assumptions for measuring obligations under defined benefit plans. ASOP No. 27 was revised in September 2013, and no longer includes the concept of a "best estimate range". Instead, the revised standard now requires that each economic assumption selected by the actuary should be reasonable which means it has the following characteristics:

- It is appropriate for the purpose of the measurement;
- It reflects the actuary's professional judgment;
- It takes into account historical and current economic data that is relevant as of the measurement date;
- It reflects the actuary's estimate of future experience, the actuary's observation of the estimates inherent in market data, or a combination thereof; and
- It has no significant bias (i.e., it is not significantly optimistic or pessimistic), except when provisions for adverse deviation or plan provisions that are difficult to measure are included and disclosed, or when alternative assumptions are used for the assessment of risk.

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

Section III – Economic Assumptions

In our opinion, the economic assumptions recommended in this report have been developed in accordance with ASOP No. 27. The following table shows our recommendations followed by detailed discussions of each assumption.

Item	Current	Proposed
Price Inflation	2.75%	2.50%
Real Rate of Return*	4.75	4.50
Investment Return	7.50%	7.00%
Price Inflation	2.75%	2.50%
Real Wage Growth	0.50%	0.50%
Wage Inflation	3.25%	3.00%

* Net of investment expenses

Note that future price inflation has an indirect impact on the results of the actuarial valuation through the development of the assumptions for investment return and wage inflation. However, it is not directly used in the valuation process.

Price Inflation

Background

As can be seen from the table on the previous page, assumed price inflation is used as the basis for both the investment return assumption and the wage inflation assumption. These latter two assumptions will be discussed in detail in the following sections.

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

The relationship between price inflation and investment return has long been recognized by economists. The basic principle is that the investor demands a relatively level "real return" – the excess of actual investment return over price inflation. Over the long-term, if inflation rates are expected to be high, investment return rates are also expected to be high, while low inflation rates are expected to result in lower expected investment returns.

The current price inflation assumption is 2.75% per year.

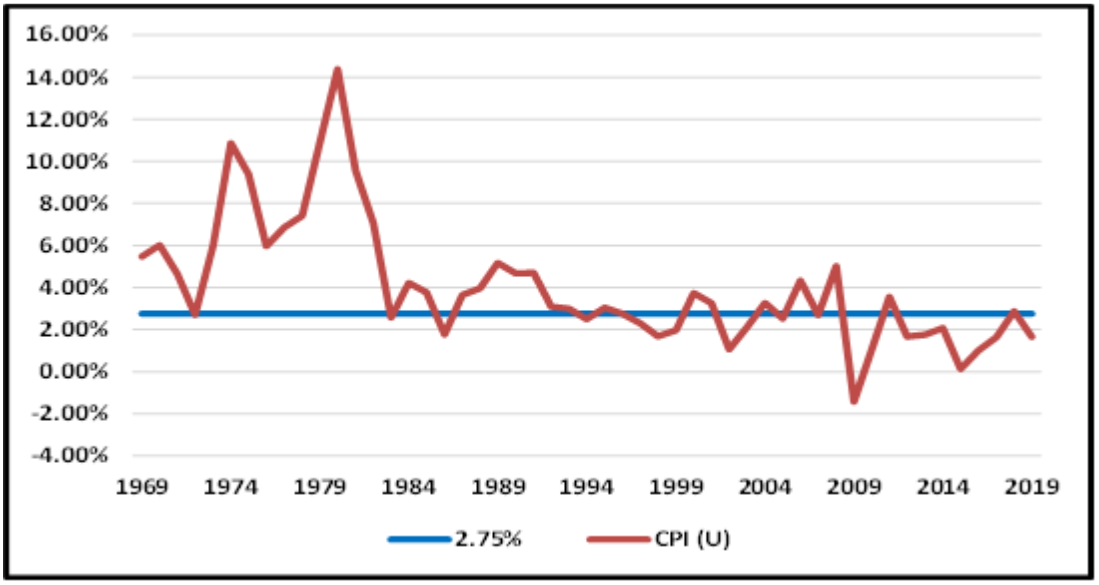
Past Experience

The Consumer Price Index, US City Average, All Urban Consumers, CPI (U), has been used as the basis for reviewing historical levels of price inflation. The table below provides historical annualized rates and annual standard deviation of the CPI-U over periods ending June 30th.

Period	Number of Years	Annualized Rate of Inflation	Annual Standard Deviation
1926 – 2019	93	2.90%	4.06%
1959 – 2019	60	3.69	2.87
1969 – 2019	50	3.97	3.00
1979 – 2019	40	3.21	2.59
1989 – 2019	30	2.44	1.38
1999 – 2019	20	2.19	1.49
2009 - 2019	10	1.73	0.96

The following graph illustrates the historical levels of price inflation measured as of June 30th of each of the last 50 years and compared to the current 2.75% annual rate currently assumed.

Annual Rate of CPI (U) Increases



Over the last 50 years, the average annual rate of increase in the CPI-U has been just below 4.00%. The period of high inflation from 1973 to 1982 has a significant impact on the averages over periods which include these rates. The volatility of the annual rates in the more recent years has been markedly lower as indicated by the significantly lower annual standard deviations. Many experts attribute the lower average annual rates and lower volatility to the increased efforts of the Federal Reserve since the early 1980's to stabilize price inflation.

Forecasts

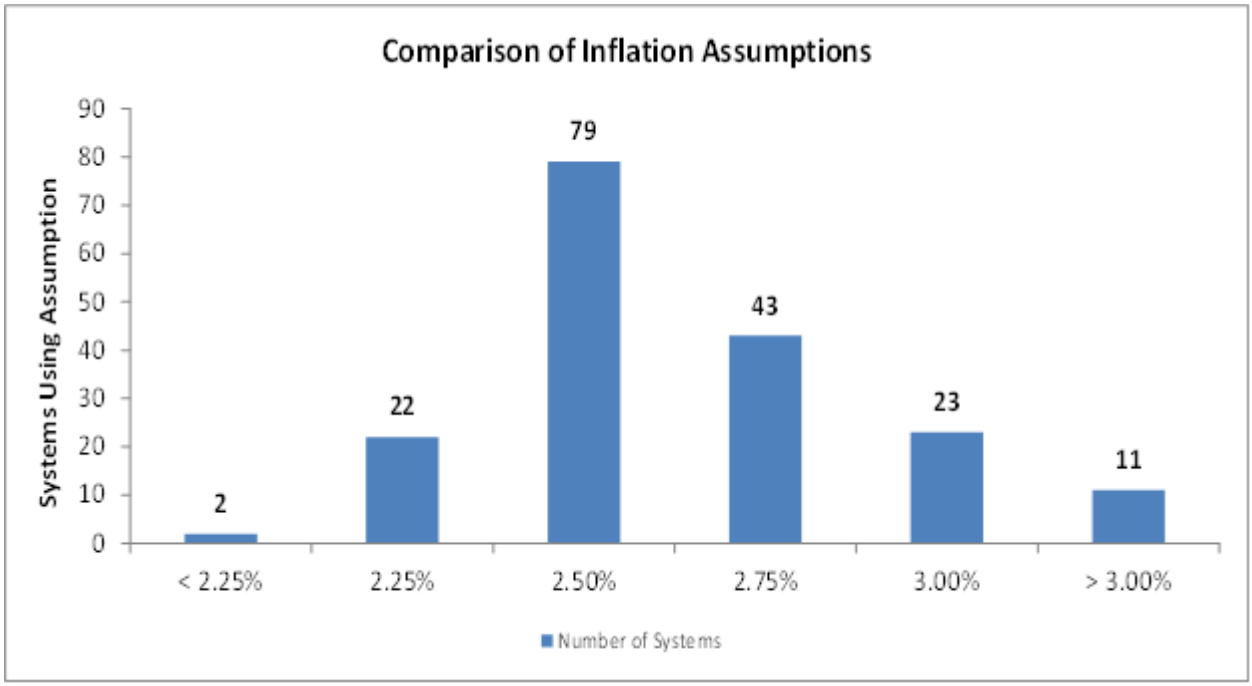
Based upon information contained in the "Survey of Professional Forecasters" for the fourth quarter of 2020 as published by the Philadelphia Federal Reserve Bank, the median expected annual rate of inflation for the next ten years is 2.12%. Although 10 years of future expectation is too short of a period for the basis of our inflation assumption, the information does provide some evidence that the consensus expectations of these experts are for rates of inflation lower than our current assumption of 2.75% for the near term future.

Social Security Administration

Although many economists forecast lower inflation than the assumption used by most retirement plans, they are generally looking at a shorter time horizon than is appropriate for a pension valuation. To consider a longer, similar time frame, we looked at the expected increase in the CPI by the Office of the Chief Actuary for the Social Security Administration. In the 2020 annual report, the projected ultimate average annual increase in the CPI over the next 75 years was estimated to be 2.40%, under the intermediate (best estimate) cost assumption. The range of inflation assumptions used in the Social Security 75-year modeling, which includes a low and high cost scenario, in addition to the intermediate cost projection, was 1.80% to 3.00%. This is a decline of 0.20% in the CPI forecasts from the Social Security Administration from their 2019 annual report.

Peer Comparison

While we do not recommend the selection of any assumption based on what other systems use, it does provide another set of relevant information to consider. The following chart shows the inflation rate assumptions of 180 plans in the Public Plan Database of the Center for Retirement Research. The assumptions are from actuarial valuation reported in FYE 2019.



Recommendation:

It is difficult to predict inflation accurately. Inflation's short-term volatility is illustrated by comparing its average rate over the last 10 and 50 years. Although the 10-year average of 1.73% is lower than the System's assumed rate of 2.75%, the longer 50-year averages of 3.97% is somewhat higher than JRS' current rate. The reasonableness of JRS' assumption is, therefore, dependent upon the emphasis one assigns to the short and long-terms.

Current economic forecasts suggest lower inflation but are generally looking at a shorter time period than appropriate for our purposes. We consider the range included in the Social Security Administration of 1.80% to 3.00% to be reasonable and recommend lowering the inflation assumption for JRS from 2.75% to 2.50%.

Price Inflation Assumption	
Current	2.75%
Recommended	2.50%

Investment Return

Background

The assumed investment return is one of the most significant assumptions in the annual actuarial valuation process as it is used to discount the expected benefit payments for all active, inactive and retired members. Minor changes in this assumption can have a major impact on valuation results. The investment return assumption should reflect the asset allocation target for the funds set by the Board of Trustees.

The current assumption is 7.50%, consisting of a price inflation assumption of 2.75% and a real rate of return assumption of 4.75%. The current JRS funding policy states that the long-term expected return on assets assumption, which was set at 7.50% in the previous experience study, shall be reduced by 0.10% per year from the immediate prior valuation when the actual rate of return for the fiscal year exceeds the assumed rate. The minimum return assumption stated in the funding policy is 7.00%. The asset return assumption used in the most recent actuarial valuation is 7.30%.

Long Term Perspective

Because the economy is constantly changing, assumptions about what may occur in the near term are volatile. Asset managers and investment consultants usually focus on this near-term horizon in order to make prudent choices regarding how to invest the trust funds. For actuarial calculations, we typically consider very long periods of time. For example, a newly, hired employee who is 25 years old may work for 35 years, to age 60, and live another 30 years, to age 90 (or longer). The retirement system would receive contributions for the first 35 years and then pay out benefits for the next 30 years. During the entire 65-year period, the system is investing assets related to the member. For such a typical career employee, more than one-half of the investment income earned on assets accumulated to pay benefits is received after the employee retires. In addition, in an open, ongoing system like JRS, the stream of benefit payments is continually increasing as new hires replace current members who leave covered employment due to death, termination of employment, and retirement. This difference in the time horizon used by actuaries and investment consultants is frequently a source of debate and confusion when setting economic assumptions.

Past Experience

One of the inherent problems with analyzing historical data is that the results can look significantly different depending on the timeframe used, especially if the year-to-year results vary widely. In addition, the asset allocation can also impact the investment returns so comparing results over long periods when different asset allocations were in place may not be meaningful.

The assets for JRS are valued using a widely accepted asset-smoothing methodology that fully recognizes the expected investment income and also recognizes 20% of each year's investment gain or loss (the difference between actual and expected investment income). The recent experience over the last five years is shown in the table below.

Year Ending 6/30	Actuarial Value	Market Value Rate of Return
2015	9.09%	3.72%
2016	7.36	1.26
2017	7.87	12.39
2018	8.40	9.19
2019	6.70	6.74
Average	7.68%	6.59%

While important to review and analyze, historical returns over such a short time period are not credible for the purpose of setting the long-term assumed future rate of return.

Future Expectation Analysis

The Division of Investment Services (DIS) assists the JRS Board with developing investment strategies and providing capital market assumptions for the JRS portfolio. As part of their duties, DIS periodically performs asset-liability studies, along with comprehensive reviews of the expected return of the various asset classes in which the JRS portfolio is invested. We believe it is appropriate to consider the results of DIS' work as one factor in assessing expected future returns.

We also recognize that there can be differences of opinion among investment professionals regarding future return expectations. Horizon Actuarial Services prepares an annual study in which they survey various investment advisors (35 were included in the 2020 study with a 10-year horizon) and provide ranges of results as well as averages. This information provides an additional perspective on what a broad group of investment experts anticipate for future investment returns.

Our forward-looking analysis used the real rates of return in DIS' capital market assumptions and JRS' target asset allocation. Using statistical projections that assume investment returns approximately follow a lognormal distribution with no correlation between years, produces an expected range of real rates of return over a 50-year time horizon. Looking at one year's results produces a mean real return of 6.18%, but also has a high standard deviation or measurement of volatility. By expanding the time horizon, the real return does not change, but the volatility declines significantly. The table below provides a summary of results.

Time Span In Years	Mean Real Return	Standard Deviation	Real Returns by Percentile				
			5th	25th	50th	75th	95th
1	6.18%	13.90%	-15.04%	-3.58%	5.28%	14.95%	30.46%
5	5.46	6.15	-4.35	1.22	5.28	9.50	15.87
10	5.37	4.35	-1.62	2.39	5.28	8.25	12.66
20	5.32	3.07	0.35	3.23	5.28	7.37	10.45
30	5.31	2.51	1.24	3.60	5.28	6.98	9.48
40	5.30	2.17	1.77	3.82	5.28	6.75	8.91
50	5.30	1.94	2.13	3.98	5.28	6.59	8.52

The percentile results are the percentages of random returns over the time span shown that are expected to be less than the amount indicated. For example, for the 10-year time span, 5% of the resulting real rates of return will be below -1.62% and 95% will be above that. As the time span increases, the results begin to converge. Over a 50-year time span, the results indicate there will be a 25% chance that real returns will be below 3.98% and a 25% chance they will be above 6.59%. In other words, there is a 50% chance the real returns will be between 3.98% and 6.59%.

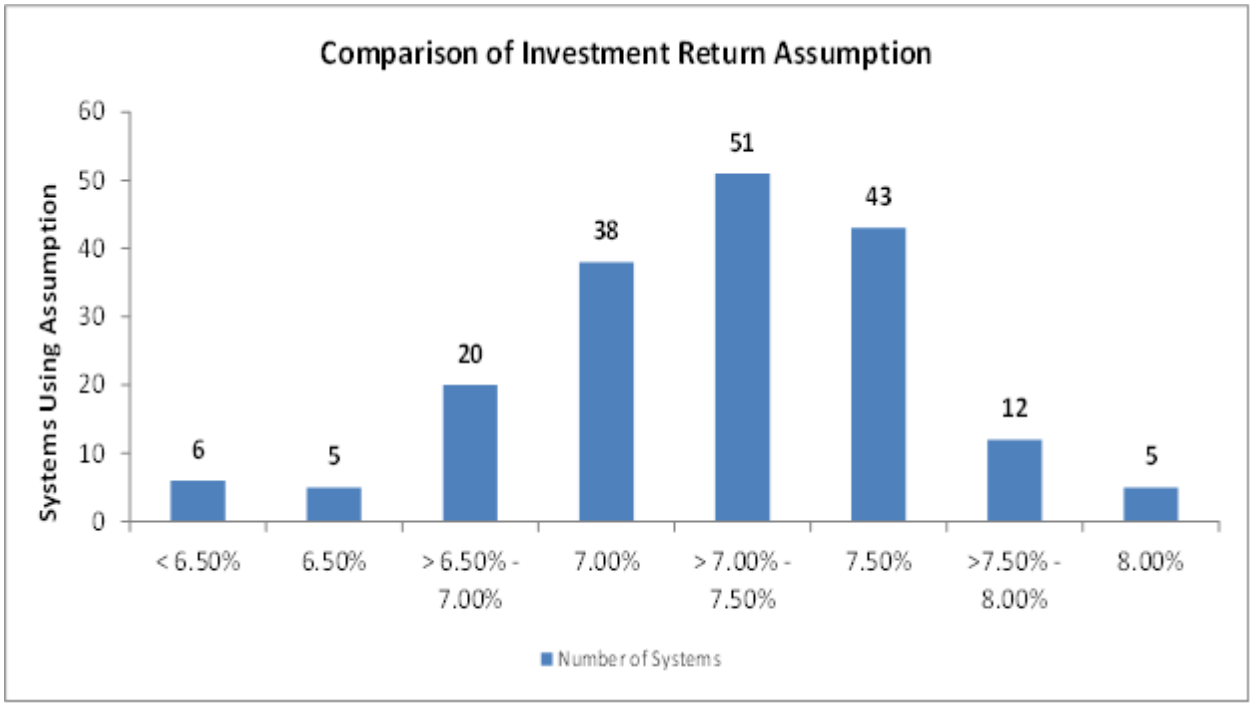
For a broader view of expected returns, we also reviewed the 2020 Survey of Capital Market Assumptions produced by Horizon Actuarial Services, LLC to see what other investment professionals are currently using for capital market assumptions. The Horizon survey includes both 10-year horizon and 20-year horizon capital market assumptions. We applied the same statistical analysis to these survey results as we did the capital market assumption of DIS with the following real return results for the 20-year horizon:

Time Span In Years	Mean Real Return	Standard Deviation	Real Returns by Percentile				
			5th	25th	50th	75th	95th
1	4.85%	11.49%	-12.92%	-3.18%	4.22%	12.19%	24.74%
5	4.35%	5.10%	-3.83%	0.84%	4.22%	7.71%	12.94%
10	4.28%	3.60%	-1.54%	1.82%	4.22%	6.68%	10.32%
20	4.25%	2.55%	0.12%	2.52%	4.22%	5.95%	8.50%
30	4.24%	2.08%	0.86%	2.83%	4.22%	5.63%	7.70%
50	4.23%	1.61%	1.61%	3.14%	4.22%	5.31%	6.90%

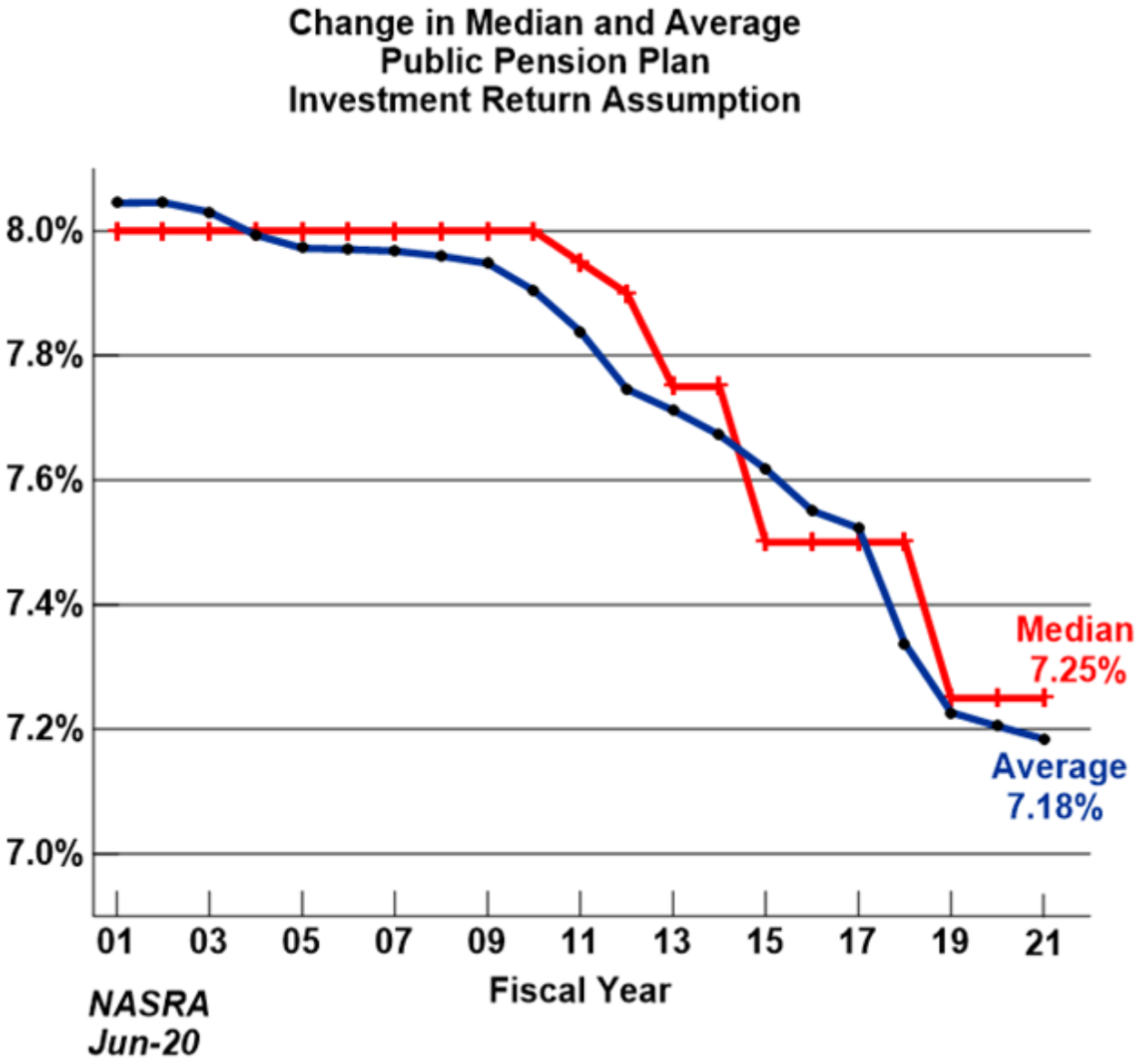
As can be seen from the Horizon survey analysis, the forecast shows that over a 50-year time span, there is a 50% chance that real returns will be between 3.14% and 5.31%. This is slightly lower than the results from DIS' analysis.

Peer Comparison

The following chart shows the nominal investment return assumptions of 180 plans in the Public Plan Database of the Center for Retirement Research. The assumptions are from FYE 2019 reporting.



The following chart shows the changes in expected investment return assumption from the NASRA public plan survey over the last 20 years from 2001.



Recommendation

By actuarial standards, we are required to maintain a long-term perspective in setting all assumptions, including the investment return assumption. Therefore, we believe we must be careful not to let recent experience or the short-term expectations impact our judgment regarding the appropriateness of the current assumption over the long term.

Based on our analysis of DIS' capital market assumptions and the Horizon Survey capital market assumptions, we are recommending a reduction in the real return assumption from 4.75% to 4.50%. Based on our recommended inflation assumption of 2.50%, we are recommending a 7.00% expected long term nominal rate of return assumption.

Investment Return Assumption		
	Current*	**Recommended**
Real Rate of Return*	4.75%	4.50%
Inflation	2.75	2.50
Net Investment Return	7.50%	7.00%

* actual assumption for the 2019 valuation is 7.30% based on the Board funding policy
** net of investment expenses

Wage Inflation

Background

The wage inflation assumption is composed of the price inflation assumption and an assumption for the real rate of wage increases. The salary increase assumption combines the wage inflation assumption with an assumption for promotion and longevity, often called merit increases. Merit assumptions are generally age and or service related and will be dealt with in the demographic assumption section of the report. The excess of wage growth over price inflation is also considered the increase in productivity that labor provides.

The current wage inflation assumption of 3.25% is composed of a 2.75% rate of inflation assumption and a 0.50% real rate of wage inflation.

Past Experience

The Social Security Administration publishes data on wage growth in the United States (see Appendix C). While this is the most comprehensive data available, it is based on all wage earners in the country so it can be influenced by the mix of jobs as well as by changes in certain sectors of the workforce that may not be seen by all segments.

As with our analysis of inflation, we provide below wage inflation and a comparison with price inflation over various time periods. Currently, this wage data is only available through calendar year 2019. We remove the rate of price inflation for each year from the data to result in the historical real rate of wage inflation.

Period	Wage Inflation	Price Inflation	Real Wage Growth
2009-2019	2.88%	1.73%	1.15%
1999-2019	2.91%	2.19%	0.72%
1989-2019	3.36%	2.44%	0.92%
1979-2019	3.95%	3.21%	0.74%
1969-2019	4.53%	3.97%	0.56%

The chart indicates that over the last 50 years, annual real wage growth has averaged 0.56%.

Social Security Administration

The wage index used for the historical analysis is projected forward by the Office of the Chief Actuary of the Social Security Administration in their 75-year projections. In June of 2020, the annual increase in the National Average Wage Index under the intermediate cost assumption (best estimate) was 3.5%, 1.1% higher than the Social Security intermediate inflation assumption of 2.4% per year. The range of the assumed real wage inflation in the 2020 Trustees report was 0.52% to 1.76% per year.

Recommendation

The data the Social Security Administration collects is nationwide and predominantly from the private sector which includes many collectively bargained employees. It is questionable whether public sector employees can match the productivity rates of the private sector. **Therefore, we recommend a 0.25% reduction in total wage inflation growth from 3.25% to 3.00%, in conjunction with the recommendation of lowering the price inflation assumption by 0.25%.**

Wage Inflation Assumption		
	Current	Recommended
Price Inflation	2.75%	2.50%
Real Wage Growth	0.50%	0.50%
Wage Inflation	3.25%	3.00%

Payroll Growth Assumption: The current amortization method is level dollar amortization. **We recommend continued use of this amortization method.**

Actuarial Cost Method

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

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

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

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

Actuarial Value of Assets

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

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

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

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

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

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

These rules or principles prevent the asset valuation methodology from being used to manipulate annual funding patterns. No matter what asset valuation method is used, it is important to note that, like a cost method or actuarial assumptions, the asset valuation method does not affect the true cost of the plan; it only impacts the incidence of cost. The 5-year phase-in methodology that JRS currently uses meets these rules and is, in fact, the most commonly used methodology for plans similar to JRS.

Currently, the actuarial value of assets recognizes a portion of the difference between the market value of assets and the expected market value of assets, based on the assumed valuation rate of return. The amount recognized each year is 20% of the difference between market value and expected market value. **We recommend no change in this methodology.**

Amortization of the Unfunded Actuarial Accrued Liability

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

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

There are a variety of different methods that can be used to amortize the UAAL. Each method results in a different payment stream and, therefore, has cost implications. For each methodology, there are three characteristics:

- The period over which the UAAL is amortized,
- The rate at which the amortization payment increases, and
- The number of components of UAAL (separate amortization bases).

Amortization Period: The amortization period can be either closed or open. If it is a closed amortization period, the number of years remaining in the amortization period declines by one in each future valuation. Alternatively, if the amortization period is an open or rolling period, the amortization period does not decline but is reset to the same number each year. This approach essentially "refinances" the System's debt (UAAL) every year.

Amortization Payment: The level dollar amortization method is similar to the method in which a homeowner pays off a mortgage. The liability, once calculated, is financed by a constant fixed dollar amount, based on the amortization period until the liability is extinguished. This results in the liability steadily decreasing while the payments, though remaining level in dollar terms, in all probability decrease as a percentage of payroll. (Even if a plan sponsor's population is not growing, inflationary salary increases will usually be sufficient to increase the aggregate covered payroll).

The rationale behind the level percentage of payroll amortization method is that since normal costs are calculated to be a constant percentage of pay, the unfunded actuarial accrued liability should be paid off in the same manner. When this method of amortizing the unfunded actuarial accrued liability is adopted, the initial amortization payments are lower than they would be under a level dollar amortization payment method, but the payments increase at a fixed rate each year so that

ultimately the annual payment far exceeds the level dollar payment. The expectation is that total payroll will increase at the same rate so that the amortization payments will remain constant, as a percentage of payroll. In the initial years, the level percentage of payroll amortization payment is often less than the interest accruing on the unfunded actuarial accrued liability meaning that even if there are no experience losses, the dollar amount of the unfunded actuarial accrued liability will grow (called negative amortization). This is particularly true if the plan sponsor is paying off the unfunded actuarial accrued liability over a long period, such as 20 or more years.

Amortization Bases: The UAAL can be amortized either as one single amount or as components or "layers", each with a separate amortization base, payment and period. If the UAAL is amortized as one amount, the UAAL is recalculated each year in the valuation and experience gains/losses or other changes in the UAAL are folded into the single UAAL amortization base. The amortization payment is then the total UAAL divided by an amortization factor for the applicable amortization period.

If separate amortization bases are maintained, the UAAL is composed of multiple amortization bases, each with its own payment schedule and remaining amortization period. In each valuation, the unexpected change in the UAAL is established as a new amortization base over the appropriate amortization period beginning on that valuation date. The UAAL is then the sum of all the outstanding amortization bases on the valuation date and the UAAL payment is the sum of all the amortization payments on the existing amortization bases. This approach provides transparency in that the current UAAL is paid off over a fixed period and the remaining components of the UAAL are clearly identified. Adjustments to the UAAL in future years are also separately identified in each future year. One downside of this approach is that it can create some discontinuities in contribution rates when UAAL layers/components are fully paid off. If this occurs, it likely would be far in the future, with adequate time to address any adjustments needed.

Recommendation

In the current JRS Board funding policy, an actuarially determined employer contribution (ADEC) is calculated during each annual valuation. The methodology in calculating the ADEC is as follows:

- Amortization Period – Closed period with maximum period of 20 years for new bases
- Amortization Payment – Level percent of payroll
- Amortization Bases – Separate bases for all experience gains and losses, assumption changes or benefit changes

We recommend no changes in these methods.

Section V – Demographic Assumptions

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

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

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

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

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

If the actual experience differs significantly from the overall expected results, or if the pattern of actual decrements, or rates of decrement, by age, gender, or service does not follow the expected pattern, new assumptions are recommended. Recommended changes usually do not follow the exact actual experience during the observation period. Judgment is required to extrapolate future experience from past trends and current member behavior.

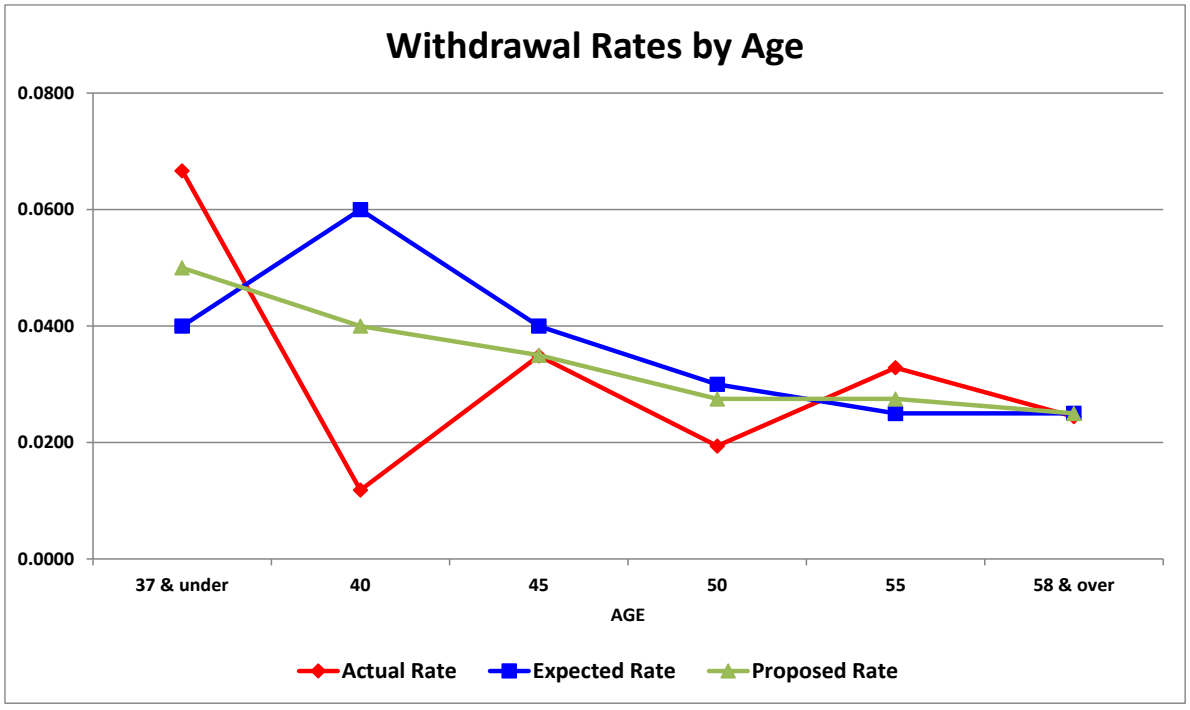
The remainder of this section presents the results of the demographic study. We have prepared tables that show a comparison of the actual and expected decrements and the overall ratio of actual to expected results (A/E Ratios) under the current assumptions. If a change is being proposed, the revised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

RATES OF WITHDRAWAL

COMPARISON OF ACTUAL AND EXPECTED WITHDRAWALS FROM ACTIVE SERVICE

CENTRAL AGE OF GROUP	NUMBER OF WITHDRAWALS CURRENT RATES		
	Actual	Expected	Ratio of Actual to Expected
37 & under	3	1.8	1.667
40	2	10.1	0.198
45	12	13.8	0.870
50	6	9.3	0.645
55	14	10.7	1.308
58 & over	11	11.3	0.973
TOTAL	**48**	**57.0**	**0.842**

The rates of withdrawal adopted by the Board are used to determine the expected number of separations from active service which will occur as a result of resignation or dismissal. The experience indicates that during the period studied, there were fewer withdrawals than expected overall and in most age categories. This pattern is similar to the experience shown in the last experience study. We, therefore, recommend that we further lower the rates at some ages to partially reflect the experience. The following graph shows a comparison of the current expected, actual, and proposed rates of withdrawal for actives.



The tables below provide our recommended changes to this assumption and the resulting A/E (actual to expected) ratio.

COMPARATIVE RATES OF WITHDRAWAL

RATES OF WITHDRAWAL		
AGE	**Present**	**Proposed**
37 & under	4.00%	5.00%
40	6.00%	4.00%
45	4.00%	3.50%
50	3.00%	2.75%
55	2.50%	2.75%
58 & over	2.50%	2.50%

COMPARISON OF ACTUAL AND EXPECTED WITHDRAWALS BASED ON PROPOSED RATES

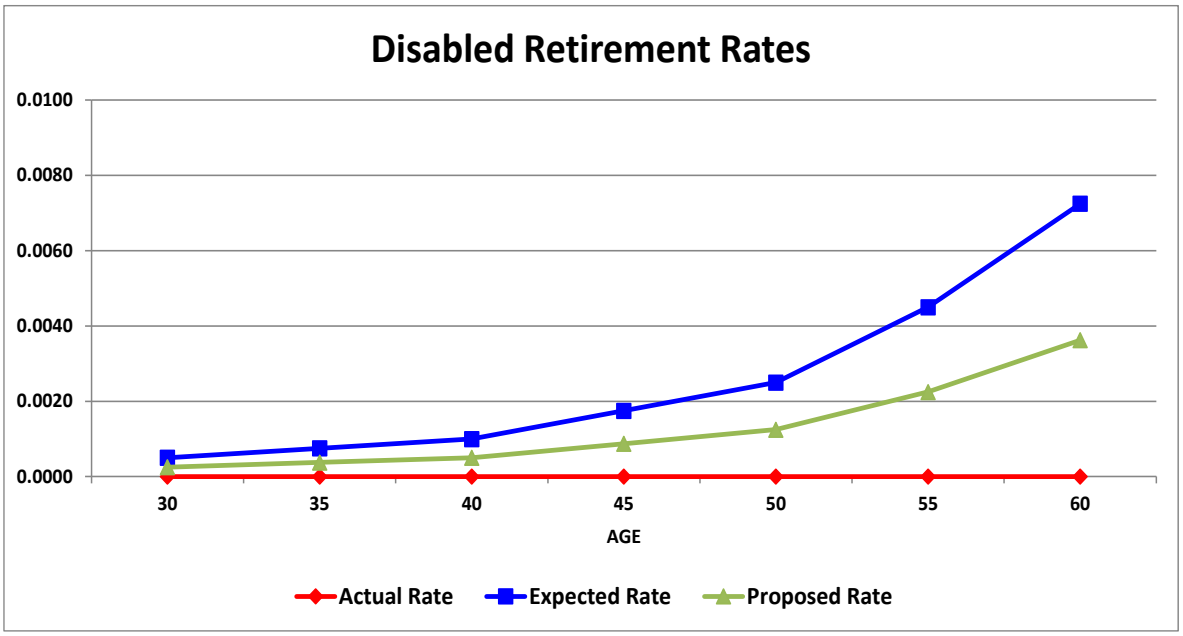
CENTRAL AGE OF GROUP	NUMBER OF WITHDRAWALS PROPOSED RATES		
	Actual	**Expected**	**Ratio of Actual to Expected**
37 & under	3	2.2	1.364
40	2	6.8	0.294
45	12	12.0	1.000
50	6	8.5	0.706
55	14	11.7	1.197
58 & over	11	11.3	0.973
TOTAL	**48**	**52.5**	**0.914**

RATES OF DISABILITY RETIREMENT

COMPARISON OF ACTUAL AND EXPECTED DISABILITY RETIREMENTS

NUMBER OF DISABILITY RETIREMENTS			
CENTRAL AGE OF GROUP	CURRENT RATES		
	Actual	Expected	Ratio of Actual to Expected
30	0	0.0	0.000
35	0	0.0	0.000
40	0	0.2	0.000
45	0	0.6	0.000
50	0	0.8	0.000
55	0	1.9	0.000
60	0	1.9	0.000
65	0	1.7	0.000
TOTAL	**0**	**7.1**	**0.000**

During the period under investigation, there were no disability retirements. In the last experience study period, there were also no disability retirements. Therefore, we recommend the rates of disability retirement be further decreased to partially reflect the experience of the System. The following graph shows a comparison of the present, actual, and proposed rates of disability retirements.



The following tables show a comparison between the present disability retirement rates and the proposed rates.

COMPARATIVE RATES OF DISABILITY RETIREMENTS

RATES OF DISABILITY RETIREMENT		
AGE	**Present**	**Proposed**
30	0.05%	0.03%
35	0.08%	0.04%
40	0.10%	0.05%
45	0.18%	0.09%
50	0.25%	0.13%
55	0.45%	0.23%
60	0.73%	0.36%
65	1.18%	0.59%

COMPARISON OF ACTUAL AND EXPECTED DISABILITY RETIREMENTS BASED ON PROPOSED RATES

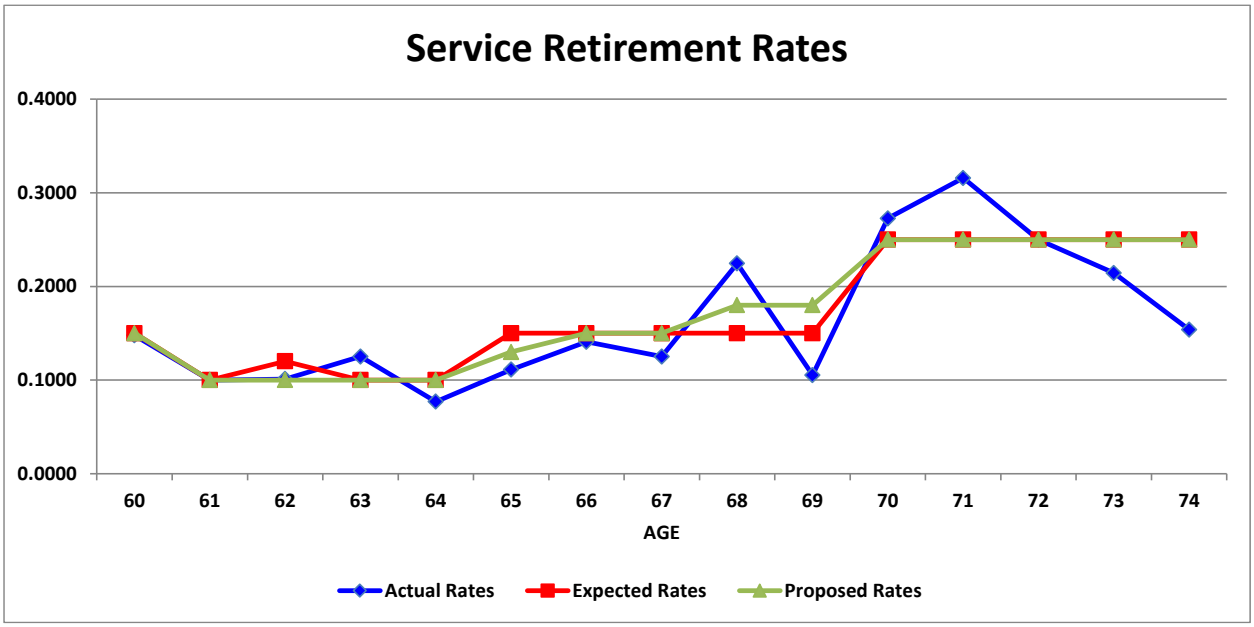
NUMBER OF DISABILITY RETIREMENTS			
CENTRAL AGE OF GROUP	**CURRENT RATES**		
	Actual	**Expected**	**Ratio of Actual to Expected**
30	0	0.0	0.000
35	0	0.0	0.000
40	0	0.1	0.000
45	0	0.3	0.000
50	0	0.4	0.000
55	0	1.0	0.000
60	0	1.0	0.000
65 & Over	0	0.9	0.000
TOTAL	**0**	**3.7**	**0.000**

RATES OF RETIREMENT

COMPARISON OF ACTUAL AND EXPECTED RETIREMENTS

NUMBER OF SERVICE RETIREMENTS			
CENTRAL AGE OF GROUP	CURRENT RATES		
	Actual	Expected	Ratio of Actual to Expected
60	13	13.2	0.985
61	9	9.0	1.000
62	10	11.9	0.840
63	11	8.8	1.250
64	6	7.8	0.769
65	9	12.2	0.738
66	10	10.7	0.935
67	7	8.4	0.833
68	11	7.4	1.486
69	4	5.7	0.702
70	9	8.3	1.084
71	6	4.8	1.250
72	5	5.0	1.000
73	3	3.5	0.857
74	2	3.3	0.606
SUBTOTAL	**115**	**120.0**	**0.958**
75 & over	7	29.0	0.241
TOTAL	**122**	**149.0**	**0.819**

The analysis of the experience reflects that the current assumed rates of retirement were close to expected at most ages and in aggregate for those under age 75. We did notice that more Judges are working past age 75. We recommend minor adjustments to the rates to reflect the experience as well as maintain a reasonable degree of margin. We also recommend extending the fixed retirement age from age 75 to age 78. The following graph shows a comparison of the present, actual, and proposed rates of service retirements.



The following tables show a comparison of the present and proposed rates of service retirement.

COMPARATIVE RATES OF RETIREMENT

RATES OF WITHDRAWAL		
AGE	**Present**	**Proposed**
60	15%	15%
61	10%	10%
62	12%	10%
63 – 64	10%	10%
65	15%	13%
66 – 67	15%	15%
68 – 69	15%	18%
70 – 74	25%	25%
75 – 77	100%	25%
78 & over	100%	100%

COMPARISON OF ACTUAL AND EXPECTED RETIREMENTS BASED ON PROPOSED RATES OF RETIREMENT

NUMBER OF SERVICE RETIREMENTS			
CENTRAL AGE OF GROUP	PROPOSED RATES		
	Actual	Expected	Ratio of Actual to Expected
60	13	13.2	0.985
61	9	9.0	1.000
62	10	9.9	1.010
63	11	8.8	1.250
64	6	7.8	0.769
65	9	10.5	0.857
66	10	10.7	0.935
67	70	8.4	0.833
68	11	9.8	1.122
69	4	7.6	0.526
70	9	8.3	1.084
71	6	4.8	1.250
72	5	5.0	1.000
73	3	3.5	0.857
74	2	3.3	0.606
75	2	2.3	0.870
76	2	2.0	1.000
77	1	1.0	1.000
78	2	3.0	0.667
79	0	1.0	0.000
80 & over	0	4.0	0.000
TOTAL	**122**	**133.9**	**0.911**

RATES OF MORTALITY

Post-Retirement Mortality Rates

Since the Fund has minimal post-retirement mortality experience, we recommend that the rates of post-retirement mortality be revised to the same mortality tables used for the Employees' Retirement System of Georgia. We believe the new Pub-2010 tables would be a good choice and we recommend changing the mortality basis for JRS so that all ERS plans can share a common family of tables. We also recommend the most recent mortality improvement scale, MP-2019, be used to anticipate future mortality improvements in the valuation process through at least the next experience study.

Therefore, our recommended mortality assumption for service retirees is based on the Pub-2010 healthy annuitant tables, with adjustments as outlined below to better fit actual experience, projected generationally with the MP-2019 scale.

Group	Membership Table	Set Forward (+)/ Setback (-)	Adjustment to Rates
Service Retirees	General	Male: +1, Female: +1	Male: 105%, Female: 108%
Beneficiaries	General	Male: +2, Female: +2	Male: 106%, Female: 105%
Disability Retirees	General	Male: -3, Female: 0	Male: 103%, Female: 106%

Pre-Retirement Mortality

Since the Fund has minimal pre-retirement mortality experience, we recommend that the rates of mortality in active service for both males and females be changed to the same mortality table that is used for the Employees' Retirement Fund of Georgia. The recommended table is the Pub-2010 General Employee Table, with no adjustments, projected generationally with the MP-2019 scale.

RATES OF SALARY INCREASE

COMPARISON OF ACTUAL AND EXPECTED RATES OF SALARY INCREASE OF ACTIVE MEMBERS

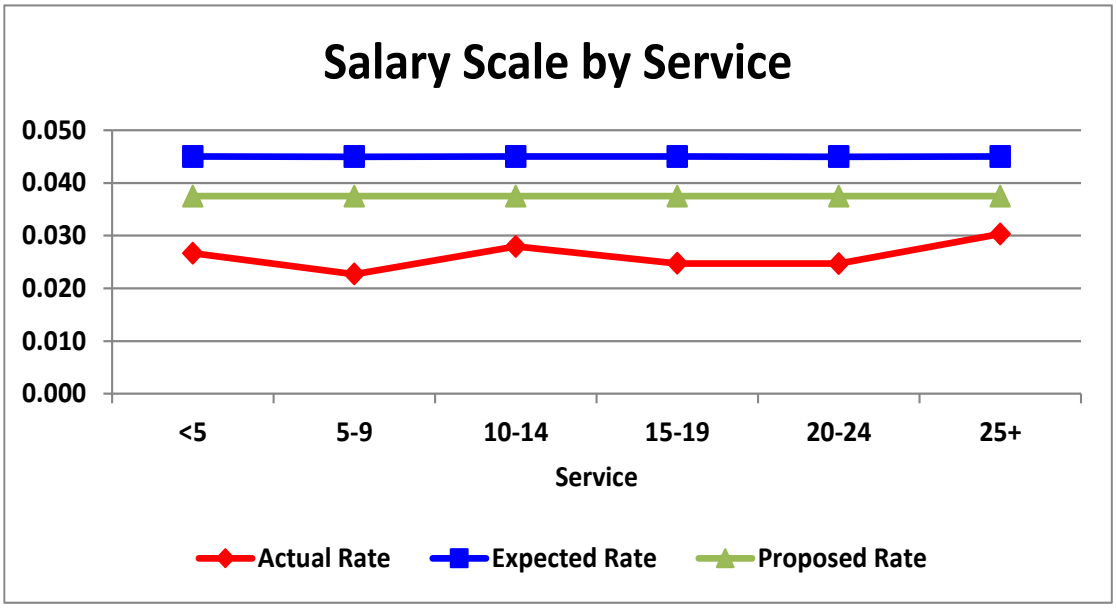
RATES OF SALARY INCREASE			
CENTRAL AGE OF GROUP	CURRENT RATES		
	Actual	Expected	Ratio of Actual to Expected
30	3.39%	4.50%	0.752
35	3.35%	4.50%	0.744
40	2.66%	4.50%	0.591
45	3.51%	4.50%	0.780
50	2.80%	4.50%	0.623
55	2.28%	4.50%	0.507
60	2.59%	4.50%	0.576
65	2.59%	4.50%	0.576
68 & over	2.58%	4.50%	0.572
TOTAL	**2.70%**	**4.50%**	**0.600**

The current annual assumed rate of salary increases of 4.50% per year at all ages was significantly greater than the actual rates of increase averaged over the study period in all age categories. We recommend a change to the long-term current salary increase assumption.

Earlier in this report, we recommended using a 3.00% wage inflation assumption (2.50% price inflation and 0.50% real wage growth). The merit scale will be added to the applicable wage inflation assumption to develop the total individual salary increase assumption.

We also recommend a reduction in the merit scale for JRS from 1.25% to 0.75% to better match the experience of the Plan. Therefore, the total individual salary increase assumption will decrease from 4.50% to 3.75%. This recommended rate is still higher than the actual rates of salary increase observed in the 5-year experience study, but it leaves some margin of conservatism.

The following graph show a comparison of the present, actual, and proposed rates of salary increase.


Salary Scale by Service
0.050
0.040
0.030
0.020
0.010
0.000
<5
5-9
10-14
15-19
20-24
25+
Service
Actual Rate
Expected Rate
Proposed Rate

ADMINISTRATIVE EXPENSES: Currently, budgeted administrative expenses for the fiscal year are added to the normal cost. **We recommend that a rate of 1.35% of payroll be added to normal cost.**

OPTION FACTORS: The option factors currently used by the Retirement System are based on the mortality tables used in the valuation. **We recommend that the factors be revised to be based on the mortality table recommended for the valuation.**

PERCENT MARRIED: For members hired on and after July 1, 2012, 100% are assumed to be married with husbands three years older than their wives. **We recommend no change to this assumption.**

Appendix A – Historical June CPI(U) Index

Year	CPI (U)	Year	CPI (U)
1961	29.8	1991	136.0
1962	30.2	1992	140.2
1963	30.6	1993	144.4
1964	31.0	1994	148.0
1965	31.6	1995	152.5
1966	32.4	1996	156.7
1967	33.3	1997	160.3
1968	35.7	1998	163.0
1969	34.7	1999	166.2
1970	38.8	2000	172.4
1971	40.6	2001	178.0
1972	41.7	2002	179.9
1973	44.2	2003	183.7
1974	49.0	2004	189.7
1975	53.6	2005	194.5
1976	56.8	2006	202.9
1977	60.7	2007	208.352
1978	65.2	2008	218.815
1979	72.3	2009	215.693
1980	82.7	2010	217.965
1981	90.6	2011	225.722
1982	97.0	2012	229.478
1983	99.5	2013	233.504
1984	103.7	2014	238.343
1985	107.6	2015	238.638
1986	109.5	2016	241.018
1987	113.5	2017	244.955
1988	118.0	2018	251.989
1989	124.1	2019	256.143
1990	129.9	2020	257.797

As Provided by the System

Arithmetic Rates of Return and Standard Deviations by Asset Class

Asset Class	Expected Rate of Return*	Standard Deviation
Fixed Income	1.4%	2.3%
US Large Stocks	12.1%	19.8%
US Small Stocks	16.3%	31.5%
Int'l Developed Mkt Stocks	12.1%	21.8%
Int'l Emerging Mkt Stocks	13.3%	31.7%
Alternatives	13.5%	27.9%

*Includes 2.90% assumed inflation

Asset Class Correlation Coefficients

Asset Class	Fixed Income	US Large Stocks	US Small Stocks	Int'l Dev Mkt Stocks	Int'l EM Mkt Stocks	Alts
Fixed Income	1.00					
US Large Stocks	0.01	1.00				
US Small Stocks	(0.09)	0.79	1.00			
Int'l Developed Mkt Stocks	(0.11)	0.67	0.51	1.00		
Int'l Emerging Mkt Stocks	(0.11)	0.67	0.51	0.72	1.00	
Alternatives	0.31	0.74	0.74	0.64	0.62	1.00

Asset Allocation Targets

Asset Class	Asset Allocation
Fixed Income	30.0%
US Large Stocks	46.4%
US Small Stocks	1.1%
Int'l Developed Mkt Stocks	11.7%
Int'l Emerging Mkt Stocks	5.8%
Alternatives	5.0%

As Determined by the 2020 Horizon Actuarial Services, LLC. Survey of Capital Market Assumptions (20-year Horizon)

Arithmetic Rates of Return and Standard Deviations by Asset Class

Asset Class	Expected Rate of Return*	Standard Deviation
Fixed Income	2.28%	1.78%
US Large Stocks	8.36%	16.22%
US Small Stocks	9.54%	20.22%
Int'l Developed Mkt Stocks	9.09%	18.05%
Int'l Emerging Mkt Stocks	11.33%	24.23%
Alternatives (Private Equity)	12.54%	21.99%

*Includes 2.17% assumed inflation

Asset Class Correlation Coefficients

Asset Class	Fixed Income	US Large Stocks	US Small Stocks	Int'l Dev Mkt Stocks	Int'l EM Mkt Stocks	Alts
Fixed Income	1.00					
US Large Stocks	(0.08)	1.00				
US Small Stocks	(0.08)	0.89	1.00			
Int'l Developed Mkt Stocks	(0.07)	0.84	0.76	1.00		
Int'l Emerging Mkt Stocks	(0.06)	0.73	0.69	0.80	1.00	
Alternatives (Private Equity)	(0.06)	0.73	0.71	0.67	0.59	1.00

Appendix C – Social Security Administration Wage Index

Year	Wage Index	Annual Increase	Year	Wage Index	Annual Increase
1960	$4,007.12	3.92%	1991	$21,811.60	3.73%
1961	4,086.76	1.99	1992	22,935.42	5.15
1962	4,291.40	5.01	1993	23,132.67	0.86
1963	4,396.64	2.45	1994	23,753.53	2.68
1964	4,576.32	4.09	1995	24,705.66	4.01
1965	4,658.72	1.80	1996	25,913.90	4.89
1966	4,938.36	6.00	1997	27,426.00	5.84
1967	5,213.44	5.57	1998	28,861.44	5.23
1968	5,571.76	6.87	1999	30,469.84	5.57
1969	5,893.76	5.78	2000	32,154.82	5.53
1970	6,186.24	4.96	2001	32,921.92	2.39
1971	6,497.08	5.02	2002	33,252.09	1.00
1972	7,133.80	9.80	2003	34,064.95	2.44
1973	7,580.16	6.26	2004	35,648.55	4.65
1974	8,030.76	5.94	2005	36,952.94	3.66
1975	8,630.92	7.47	2006	38,651.41	4.60
1976	9,226.48	6.90	2007	40,405.48	4.54
1977	9,779.44	5.99	2008	41,334.97	2.30
1978	10,556.03	7.94	2009	40,711.61	-1.51
1979	11,479.46	8.75	2010	41,673.83	2.36
1980	12,513.46	9.01	2011	42,979.61	3.13
1981	13,773.10	10.07	2012	44,321.67	3.12
1982	14,531.34	5.51	2013	44,888.16	1.28
1983	15,239.24	4.87	2014	46,481.52	3.55
1984	16,135.07	5.88	2015	48,098.63	3.48
1985	16,822.51	4.26	2016	48,642.15	1.13
1986	17,321.82	2.97	2017	50,321.89	3.45
1987	18,426.51	6.38	2018	52,145.80	3.62
1988	19,334.04	4.93	2019	54,099.99	3.75
1989	20,099.55	3.96			
1990	21,027.98	4.62			

TABLE 1

RATES OF SEPARATION FROM ACTIVE SERVICE

AGE	RATES OF WITHDRAWAL	RATES OF DISABILITY	RATES OF DEATH*		RATES OF SERVICE RETIREMENT
			MALES	FEMALES	
25	0.0500	0.000125	0.00028	0.00009	
26	0.0500	0.000250	0.00030	0.00010	
27	0.0500	0.000250	0.00031	0.00011	
28	0.0500	0.000250	0.00033	0.00012	
29	0.0500	0.000250	0.00034	0.00013	
30	0.0500	0.000250	0.00036	0.00015	
31	0.0500	0.000250	0.00038	0.00016	
32	0.0500	0.000250	0.00040	0.00018	
33	0.0500	0.000250	0.00042	0.00019	
34	0.0500	0.000375	0.00044	0.00021	
35	0.0500	0.000375	0.00047	0.00023	
36	0.0500	0.000375	0.00050	0.00025	
37	0.0500	0.000375	0.00053	0.00028	
38	0.0400	0.000500	0.00057	0.00030	
39	0.0400	0.000500	0.00061	0.00033	
40	0.0400	0.000500	0.00066	0.00036	
41	0.0400	0.000500	0.00071	0.00040	
42	0.0400	0.000625	0.00077	0.00043	
43	0.0350	0.000750	0.00083	0.00047	
44	0.0350	0.000750	0.00090	0.00051	
45	0.0350	0.000875	0.00098	0.00056	
46	0.0350	0.000875	0.00107	0.00061	
47	0.0350	0.001000	0.00116	0.00066	
48	0.0275	0.001125	0.00127	0.00071	
49	0.0275	0.001250	0.00138	0.00077	
50	0.0275	0.001250	0.00149	0.00083	
51	0.0275	0.001375	0.00162	0.00090	
52	0.0275	0.001500	0.00175	0.00097	
53	0.0275	0.001750	0.00189	0.00105	
54	0.0275	0.002000	0.00203	0.00113	
55	0.0275	0.002250	0.00219	0.00123	
56	0.0275	0.002500	0.00236	0.00133	
57	0.0275	0.002750	0.00255	0.00144	
58	0.0250	0.003000	0.00275	0.00156	
59	0.0250	0.003250	0.00296	0.00170	
60	0.0250	0.003625	0.00319	0.00186	0.15
61	0.0250	0.004000	0.00344	0.00203	0.10
62	0.0250	0.004375	0.00371	0.00222	0.10
63	0.0250	0.004875	0.00401	0.00244	0.10
64	0.0250	0.005375	0.00433	0.00269	0.10
65	0.0250	0.005875	0.00468	0.00296	0.13
66	0.0250	0.006375	0.00506	0.00327	0.15
67	0.0250	0.006875	0.00548	0.00362	0.15
68	0.0250	0.007375	0.00594	0.00400	0.18
69	0.0250	0.008000	0.00646	0.00442	0.18
70	0.0250	0.008000	0.00703	0.00489	0.25
71	0.0250	0.008000	0.00767	0.00541	0.25
72	0.0250	0.008000	0.00837	0.00598	0.25
73	0.0250	0.008000	0.00915	0.00661	0.25
74	0.0250	0.008000	0.01001	0.00731	0.25
75	0.0250	0.008000	0.01096	0.00808	0.25
76	0.0250	0.008000	0.01200	0.00893	0.25
77	0.0250	0.008000	0.01315	0.00986	0.25
78	0.0000	0.000000	0.01440	0.01090	1.00
79	0.0000	0.000000	0.01578	0.01204	1.00
80	0.0000	0.000000	0.01730	0.01330	1.00

***Base mortality rates as of 2010 before application of the improvement scale**

TABLE 2

RATES OF SALARY INCREASES

Assumed 3.75% annual increases at all ages.

TABLE 3

RATES OF MORTALITY FOR MEMBERS RETIRED ON ACCOUNT OF SERVICE*

AGE	MALES	FEMALES	AGE	MALES	FEMALES
19	0.000389	0.000140	71	0.019992	0.014418
20	0.000378	0.000130	72	0.022355	0.016168
21	0.000347	0.000119	73	0.025032	0.018133
22	0.000326	0.000108	74	0.028046	0.020336
23	0.000305	0.000097	75	0.031448	0.022799
24	0.000294	0.000097	76	0.035291	0.025574
25	0.000315	0.000108	77	0.039638	0.028706
26	0.000326	0.000119	78	0.044552	0.032249
27	0.000347	0.000130	79	0.050127	0.036288
28	0.000357	0.000140	80	0.056427	0.040900
29	0.000378	0.000162	81	0.063546	0.046181
30	0.000399	0.000173	82	0.071516	0.052207
31	0.000420	0.000194	83	0.080388	0.059119
32	0.000441	0.000205	84	0.090206	0.067014
33	0.000462	0.000227	85	0.100958	0.076043
34	0.000494	0.000248	86	0.112697	0.086260
35	0.000525	0.000270	87	0.125444	0.097697
36	0.000557	0.000302	88	0.139230	0.110333
37	0.000599	0.000324	89	0.154056	0.124060
38	0.000641	0.000356	90	0.169785	0.138596
39	0.000693	0.000389	91	0.186323	0.153781
40	0.000746	0.000432	92	0.203616	0.169582
41	0.000809	0.000464	93	0.221624	0.186062
42	0.000872	0.000508	94	0.240324	0.203310
43	0.000945	0.000551	95	0.259676	0.221454
44	0.001029	0.000605	96	0.279657	0.240602
45	0.001124	0.000659	97	0.300184	0.260788
46	0.001218	0.000713	98	0.321153	0.282020
47	0.001334	0.000767	99	0.342395	0.304128
48	0.001449	0.000832	100	0.363678	0.326862
49	0.003129	0.002398	101	0.384720	0.349726
50	0.003371	0.002516	102	0.405342	0.372535
51	0.003633	0.002657	103	0.425376	0.395075
52	0.003906	0.002797	104	0.444696	0.417150
53	0.004211	0.002938	105	0.463187	0.438577
54	0.004526	0.003089	106	0.480753	0.459205
55	0.004861	0.003251	107	0.497322	0.478883
56	0.005219	0.003434	108	0.512852	0.497524
57	0.005597	0.003629	109	0.525000	0.515052
58	0.006017	0.003866	110	0.525000	0.531414
59	0.006458	0.004147	111	0.525000	0.540000
60	0.006941	0.004493	112	0.525000	0.540000
61	0.007487	0.004903	113	0.525000	0.540000
62	0.008085	0.005400	114	0.525000	0.540000
63	0.008778	0.005962	115	0.525000	0.540000
64	0.009587	0.006620	116	0.525000	0.540000
65	0.010532	0.007366	117	0.525000	0.540000
66	0.011634	0.008208	118	0.525000	0.540000
67	0.012905	0.009169	119	1.000000	1.000000
68	0.014364	0.010260	120	1.000000	1.000000
69	0.016023	0.011480			
70	0.017882	0.012863			

***Base mortality rates as of 2010 before application of the improvement scale**

TABLE 4

RATES OF MORTALITY FOR BENEFICIARIES OF DECEASED MEMBERS*

AGE	MALES	FEMALES	AGE	MALES	FEMALES
19	0.000382	0.000126	71	0.029797	0.018659
20	0.000350	0.000116	72	0.032690	0.020507
21	0.000329	0.000105	73	0.035849	0.022586
22	0.000307	0.000095	74	0.039284	0.024896
23	0.000297	0.000095	75	0.043036	0.027500
24	0.000318	0.000105	76	0.047170	0.030429
25	0.000329	0.000116	77	0.051728	0.033747
26	0.000350	0.000126	78	0.056816	0.037517
27	0.000360	0.000136	79	0.062508	0.041843
28	0.000382	0.000157	80	0.068879	0.046778
29	0.000403	0.000168	81	0.075991	0.052437
30	0.000424	0.000189	82	0.083899	0.058916
31	0.000445	0.000200	83	0.092676	0.066318
32	0.000466	0.000221	84	0.102375	0.074781
33	0.000498	0.000242	85	0.113049	0.084315
34	0.000530	0.000263	86	0.124741	0.094931
35	0.000562	0.000294	87	0.137567	0.106533
36	0.000604	0.000315	88	0.152831	0.118955
37	0.000647	0.000347	89	0.169038	0.132258
38	0.000700	0.000378	90	0.186083	0.146496
39	0.000753	0.000420	91	0.203902	0.161711
40	0.000816	0.000452	92	0.222452	0.177933
41	0.000880	0.000494	93	0.241680	0.195195
42	0.000954	0.000536	94	0.261544	0.213486
43	0.005819	0.002751	95	0.281971	0.232775
44	0.006063	0.002866	96	0.302884	0.252987
45	0.006318	0.002982	97	0.324159	0.274019
46	0.006583	0.003108	98	0.345655	0.295680
47	0.006848	0.003234	99	0.367142	0.317782
48	0.007431	0.003360	100	0.388384	0.340011
49	0.007674	0.003591	101	0.409202	0.362187
50	0.007918	0.003843	102	0.429427	0.384101
51	0.008173	0.004106	103	0.448931	0.405563
52	0.008448	0.004379	104	0.467598	0.426395
53	0.008734	0.004683	105	0.485332	0.446450
54	0.009052	0.004998	106	0.502058	0.465581
55	0.009402	0.005334	107	0.517736	0.483704
56	0.009794	0.005702	108	0.530000	0.500745
57	0.010229	0.006101	109	0.530000	0.516652
58	0.010727	0.006531	110	0.530000	0.525000
59	0.011310	0.007004	111	0.530000	0.525000
60	0.011978	0.007529	112	0.530000	0.525000
61	0.012741	0.008106	113	0.530000	0.525000
62	0.013632	0.008747	114	0.530000	0.525000
63	0.014670	0.009440	115	0.530000	0.525000
64	0.015868	0.010217	116	0.530000	0.525000
65	0.017257	0.011057	117	0.530000	0.525000
66	0.018826	0.012002	118	1.000000	1.000000
67	0.020596	0.013041	119	1.000000	1.000000
68	0.022567	0.014207	120	1.000000	1.000000
69	0.024751	0.015519			
70	0.027157	0.017000			

***Base mortality rates as of 2010 before application of the improvement scale**

TABLE 5

RATES OF MORTALITY FOR MEMBERS RETIRED ON ACCOUNT OF DISABILITY*

AGE	MALES	FEMALES	AGE	MALES	FEMALES
19	0.000237	0.002597	71	0.036297	0.032213
20	0.000319	0.00247	72	0.038172	0.034333
21	0.004151	0.002279	73	0.040180	0.036718
22	0.004336	0.002056	74	0.042364	0.039411
23	0.004244	0.001866	75	0.044743	0.042432
24	0.003976	0.001738	76	0.047370	0.045813
25	0.003626	0.001738	77	0.050264	0.049587
26	0.003255	0.001897	78	0.053478	0.053795
27	0.002977	0.002078	79	0.057031	0.058480
28	0.002863	0.002279	80	0.060986	0.063674
29	0.003008	0.002491	81	0.065374	0.069430
30	0.003152	0.002724	82	0.070267	0.075790
31	0.003306	0.002979	83	0.075684	0.082797
32	0.003471	0.003254	84	0.081669	0.090482
33	0.003646	0.003562	85	0.088220	0.098909
34	0.003832	0.003890	86	0.095368	0.107728
35	0.004027	0.004251	87	0.103103	0.116748
36	0.004233	0.004643	88	0.111395	0.125907
37	0.004470	0.005077	89	0.120283	0.135224
38	0.004717	0.005554	90	0.129831	0.144849
39	0.005006	0.006084	91	0.140111	0.154940
40	0.005335	0.006667	92	0.153068	0.165731
41	0.005717	0.007303	93	0.167406	0.177444
42	0.006149	0.007992	94	0.182114	0.190323
43	0.006644	0.008745	95	0.196998	0.204559
44	0.007210	0.009561	96	0.212056	0.220310
45	0.007859	0.010441	97	0.227403	0.237906
46	0.008590	0.011374	98	0.243255	0.256796
47	0.009435	0.012370	99	0.259828	0.277031
48	0.010372	0.013430	100	0.277317	0.298496
49	0.011423	0.014554	101	0.295847	0.320809
50	0.012576	0.015720	102	0.315427	0.343249
51	0.013823	0.016271	103	0.335873	0.365636
52	0.015141	0.016822	104	0.356751	0.387759
53	0.016531	0.017384	105	0.377392	0.409425
54	0.017634	0.017935	106	0.397621	0.430455
55	0.018725	0.018465	107	0.417274	0.450701
56	0.019786	0.018963	108	0.436226	0.470015
57	0.020806	0.019430	109	0.454364	0.488310
58	0.021774	0.019864	110	0.471596	0.505514
59	0.022670	0.020288	111	0.487849	0.521573
60	0.023484	0.020734	112	0.503083	0.530000
61	0.024257	0.021200	113	0.515000	0.530000
62	0.025008	0.021741	114	0.515000	0.530000
63	0.025781	0.022366	115	0.515000	0.530000
64	0.026615	0.023087	116	0.515000	0.530000
65	0.027573	0.023914	117	0.515000	0.530000
66	0.028686	0.024868	118	0.515000	0.530000
67	0.029952	0.025970	119	0.515000	0.530000
68	0.031353	0.027231	120	1.000000	1.000000
69	0.032888	0.028684			
70	0.034536	0.030337			

***Base mortality rates as of 2010 before application of the improvement scale**