Annual Report to the Comptroller on

ACTUARIAL ASSUMPTIONS

Recommendations by
Aaron Schottin Young, MA, FSA, EA, MAAA
Retirement Systems Chief Actuary

Office of the New York State Comptroller
Thomas P. DiNapoli

NYSLRS
New York State and Local Retirement System

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August 2023

Actuarial Certification

As the Actuary for the New York State and Local Employees' Retirement System (ERS), the New York State and Local Police and Fire Retirement System (PFRS) and the Group Life Insurance Plan (GLIP), known collectively as the "System", it is my duty to ensure that the System properly funds the benefits of member, retirees, and beneficiaries.

The System uses an aggregate funding method which has a funding objective of employer contributions that, over time, are a level percentage of payroll. Every April 1st an Actuarial Valuation is conducted to determine employer contribution requirements for the next succeeding fiscal year. In preparation for the valuation, the System participant data is validated by running reasonableness tests and a participant reconciliation accounting for every individual on a year-over-year basis. The information contained in the financial statements is also reviewed.

Proper funding requires that liabilities and employer contribution rates are developed using reasonable actuarial assumptions and methods. Actuarial assumptions are grouped into two broad categories: demographic assumptions (rates of employee turnover, disability, mortality, and retirement) and economic assumptions (interest rates, inflation, and salary growth).

The Actuary performs annual experience studies, ascertaining how closely the System's experience is conforming to the assumptions. If significant differences occur that the Actuary believes may indicate permanent shifts, the Actuary may recommend assumption changes.

An Actuarial Advisory Committee, for whom this report has been prepared, meets annually to review the actuarial assumptions and the results of the actuarial valuation. The System also retains an external auditor to independently review its financial records every year, as well as engages the services of an outside actuarial consultant to perform a review every five years. Similarly, every five years, the System is audited by the New York State Department of Financial Services. Lastly, the State Comptroller, in his role as sole trustee of the System, established an Office of Internal Audit to help fulfill his fiduciary duties and these auditors periodically review the actuarial bureau's processes.

I hereby certify that, to the best of my knowledge and belief, this report is complete and accurate and has been prepared in accordance with generally recognized and accepted actuarial practices which are consistent with the principles prescribed by the Actuarial Standards Board as well as the Code of Professional Conduct and Qualification Standards for Actuaries Issuing Statements of Actuarial Opinion of the American Academy of Actuaries, of which I am a member. In addition, the assumptions and methods meet the parameters set for disclosures by Governmental Accounting Standards Board (GASB) Statements No. 67 and 68.

Aaron Schottin Young, MA, FSA, EA, MAAA
Retirement Systems Chief Actuary

8/31/2023
Dated

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Executive Summary

This report will detail the assumptions recommended for use in the Actuarial Valuation for fiscal year beginning April 1, 2023 establishing employer billing rates for bills paid February 1, 2025 (local participating employers) or March 1, 2025 (the State of New York).

Should these recommendations be adopted by the New York State Comptroller, the average employer contribution rate is estimated to be 15.2% in the Employees' Retirement System (ERS) and 31.2% in the Police and Fire Retirement System (PFRS) for fiscal year ending March 31, 2025.

This report serves to document the considerations and rationale underpinning the recommendation to maintain all assumptions, in keeping with Actuarial Standards of Practice (ASOPs). The Risk Analysis and Disclosures section was first introduced in 2019 and, partially in response to requests by members of the NYSLRS Actuarial Advisory Committee (AAC), is expanded this year to include additional metrics.

This report, and the recommended assumptions herein, have been shared with the members of the AAC for their review and commentary. The AAC is composed of volunteers who are current or retired actuaries from major insurance companies or pension plans.

Since the last meeting of the Actuarial Advisory Committee (AAC) in August 2022, the NYSLRS has been provided feedback from auditors and independent actuarial consultants. Those recommendations and the response by the NYSLRS have been presented to the AAC members. Finally, a copy of other publications issued by the Actuarial bureau over the prior year were made available to the committee members.

Actuarial funding is a long-term endeavor, intended to accumulate sufficient assets over the next 30 years to provide benefits that are payable over the next 100 years. Therefore, the assumptions used to establish the billing rates are similarly long term in nature. While the assumptions are reviewed annually, a change is only appropriate when the revision is considered material and the revision is expected to better forecast future outcomes.

Recognizing this, the New York State and Local Retirement System (NYSLRS) has a history of revising major assumptions in a five-year cycle. The fiscal year ending 2023 is the third year in the current five-year experience study cycle. All major assumptions have been revised in the past three years.

Major Assumption or Method	Last Changed in Valuation Dated	Assumption at Fiscal Year Beginning 2022
Inflation	April 1, 2022	2.9%
Cost-of-Living Adjustment	April 1, 2022	1.5%
Investment Return	April 1, 2021	5.9%
PFRS Salary Scale	April 1, 2021	Based on System experience FYE 2012 – FYE 2021 (5.7% average expected for FYE 2023 cohort)
ERS Salary Scale	April 1, 2018	Based on System experience FYE 2016 – FYE 2018 (4.3% average expected for FYE 2023 cohort)
Asset Smoothing Method	April 1, 2022	8-year level smoothing of unexpected gain/(loss)
Retiree Mortality	April 1, 2020	Based on System experience FYE 2016 – FYE 2020
Mortality Improvement	April 1, 2022	Society of Actuaries' MP-2021 for retirees only
Active Member Decrements	April 1, 2020	Based on System experience FYE 2016 – FYE 2020

The above assumptions were recommended by the previous Retirement Systems Chief Actuary, Michael R. Dutcher, and adopted by the Comptroller of the State of New York, Thomas P. DiNapoli, in his capacity as administrator, for use in the April 1, 2022 Actuarial Valuation.

Since all the assumptions have been changed in the near-past, further revision is undesirable except where the assumption is considered unreasonable. It is preferable to allow the current assumption-set to run its course, in keeping with their long-term nature.

I have evaluated the appropriateness of each assumption and I consider all to be reasonable. **Therefore, I recommend maintaining all economic and demographic assumptions for the April 1, 2023 Actuarial Valuation.**

Economic Assumptions

Economic assumptions include the valuation discount rate (traditionally, equivalent to the investment rate of return), the inflation rate and cost-of-living adjustment (COLA), and the salary scale assumptions. Economic assumptions are forward-looking, and therefore based more on future expectations and professional judgement than past economic experience. This gives economic assumptions a degree of subjectivity.

While actuaries are well versed in economic and investment considerations, it is not a pension actuary's primary area of expertise. Therefore, setting economic assumptions typically includes consideration of investment professionals and economists. The NYSLRS has a team of investment professionals in the Division of Pension Investment Cash Management (PICM). PICM works with an investment consultant (RVK) to develop expected returns and volatility by asset class. RVK then applies the asset class estimates to the current and target Asset Allocation Policy for the Common Retirement Fund (CRF).

Chapter 775 of the Laws of 2022 increased flexibility in designing the CRF Asset Allocation Policy by easing restrictions on allowable investments by the public pension funds in New York State. In response, PICM initiated an asset allocation study. A natural consequence of any asset allocation study is recommended changes in the CRF's Asset Allocation Policy. While currently underway, a revised Asset Allocation Policy has not been formally adopted by the Comptroller; the analysis used in this report continues to rely upon the existing Asset Allocation Policy, established in January 2020.

A welcome outcome of the asset allocation study includes forecasts for asset-class returns, volatility, and correlations. The forecasts from the 2020 Asset Allocation Policy serve as the primary consideration in evaluating the investment rate of return assumption.

Economic assumptions are inter-connected. Setting these assumptions often includes consideration of a "building block" approach. Based upon the recommended assumptions, the implied building clock components are as follows.

Cost-of-Living Adjustment = Inflation Rate / 2	= 2.9% / 2	= 1.5%
Investment Rate of Return = Inflation Rate + Risk Premium	= 2.9% + 3.0%	= 5.9%
Salary Scale = Inflation Rate + (Merit + Productivity)	= 2.9% + 2.8%	= 5.7% in PFRS
	= 2.9% + 1.4%	= 4.3% in ERS

Since each assumption is built upon the inflation assumption, we will start with the Rate of Inflation assumption and then proceed with the order above (Cost-of-Living Adjustment, Investment Rate of Return, Salary Scales).

Rate of Inflation

Prices for goods and services vary over time. If a "basket" of goods and services is held constant, its change in price over time is attributed to a change in the value of the currency. The Federal Bureau of Labor and Statistics (BLS) measures and tracks this phenomenon. Its Consumer Price Indexes (CPI) program produces monthly data on changes in the prices paid by consumers for a representative basket of goods and services. The two CPI measures of greatest interest today are the CPI for All Urban Consumers (CPI-U) and the Chained CPI for All Urban Consumers (C-CPI-U).

A general and progressive increase in prices is called inflation.
A general and progressive decrease in prices is called deflation.

The CPI-U reflects changes in prices for a fixed "basket" of goods.

Inflation does not impact all socioeconomic levels equally. Those with marginal purchasing power are often purchasing lower-cost goods; when inflation strikes, the cost of those goods increases. In contrast, a person who purchases higher-quality goods at a premium price has the option to purchase lower-quality goods for a lower price, thereby mitigating the impact of inflation.

Similarly, shifts in the relative cost of individual goods can trigger a change in consumer behavior. For example, a spike in the cost of orange juice could trigger increased consumption of another juice where price did not increase.

The C-CPI-U was developed to reflect changes in prices where the "basket" of goods reflected shifts in consumer behavior. The C-CPI-U is considered "a closer approximation to the true cost-of-living index for the average consumer than the CPI-U" according to the BLS. Since consumer behavior tends to counteract inflation, the C-CPI-U generally increases at a slightly lower rate than the CPI-U.

Historically, there have been varying levels of inflation, with occasional brief episodes of deflation. In recent years, increases in consumer spending combined with restricted supply chains following the COVID-19 pandemic have triggered an increase in inflationary forces.

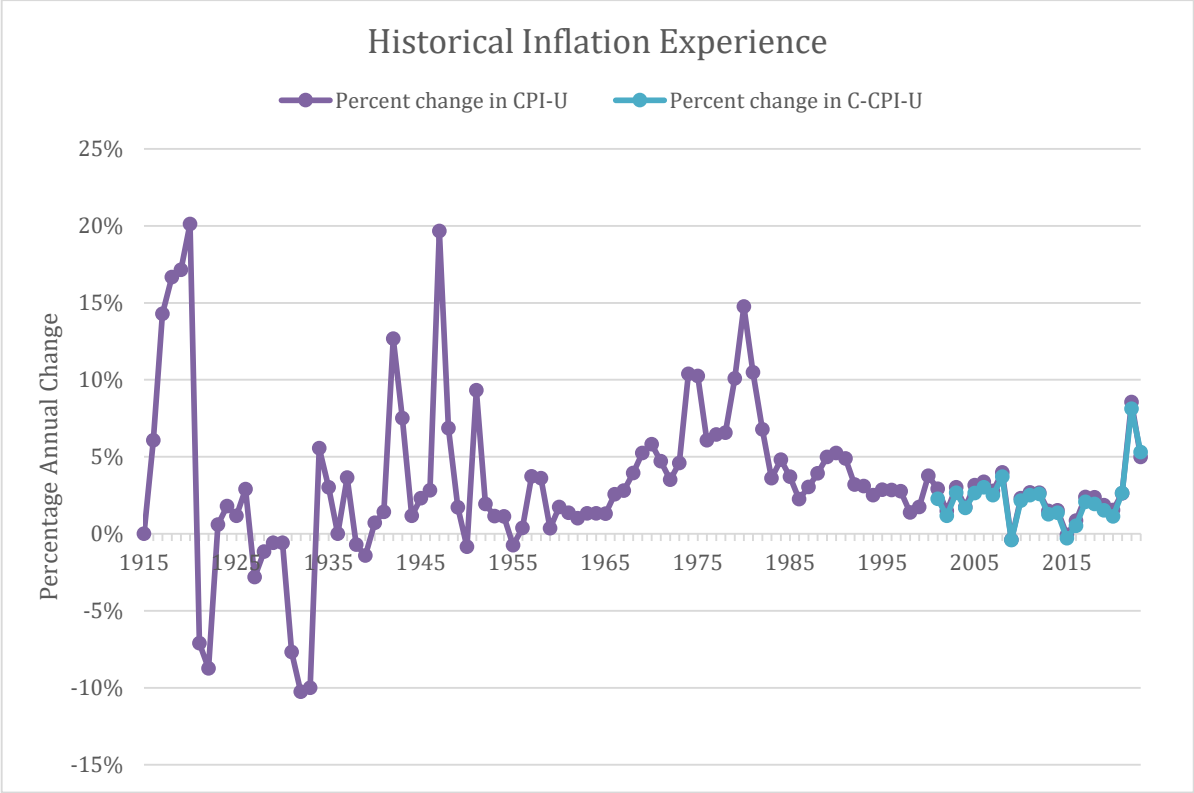
The annualized increase in the C-CPI-U over the past twenty years is given by:

$$(169.364 / 107.9) ^ (1 / 20) – 1 = 2.28\%$$

The annualized increase in the C-CPI-U over the past three years is given by:

$$(169.364 / 144.913) ^ (1 / 3) – 1 = 5.33\%$$

The current level of inflation is neither unprecedented nor is it particularly exceptional when viewed within a longer historical context. This is visualized in the following graph using the CPI-U.



In addition to past experience, consideration is given to four methods that forecast inflation.

1. **Input from the Federal Open Market Committee (FOMC)**

   The FOMC, a key entity of the Federal Reserve (the "Fed") whose membership consists of financial and economic experts, establishes monetary policy with two goals in mind: (1) to pursue maximum employment, and (2) to promote stable prices (that is, control inflation). A change in monetary policy consists of raising or lowering the federal funds rate, which is the interest rate for overnight borrowing for banks. When the economy is slowing or inflation is too low, the FOMC can ease monetary policy by decreasing the federal funds rate. In contrast, if the economy is overheating or inflation is too high, the FOMC can tighten monetary policy by increasing the federal funds rate.

   On January 31, 2023, the FOMC Open Market Committee reaffirmed a target inflation rate of 2.00%.

   The March 3, 2023 Monetary Policy Report, issued by the Fed, summarized recent interest rate increases intended to tighten monetary policy, which demonstrate a strong anti-inflationary stance. At the same time, the report indicated that measures of long-term inflation are consistent with the 2.00% target and inflation is not entrenched.

2. Yields on US Treasury Bills (T-bills) versus Treasury Inflation-Protected Securities (TIPS)

When a T-bill is purchased, the buyer is promised an interest payment every six months, based on the principal and the yield, through the maturity date. At maturity, in addition to the semi-annual interest payment, the principal is paid.

A TIPS is a T-bill where the principal increases with inflation and decreases with deflation, so the semi-annual interest payments are inflation-adjusted. At maturity, the larger of the original principal or the inflation-adjusted principal is paid.

When inflation is higher than expected, the TIPS outperforms the T-bill. When inflation is less than expected, the T-bill outperforms the TIPS. As a result, the difference in yield between the T-bill and the TIPS approximates investor expectations of future inflation in the open market.

Asset Duration	T-bill Yield	TIPS Yield	Breakeven Inflation (T-bill – TIPS)
5 years	3.60%	1.20%	2.40%
7 years	3.55%	1.17%	2.38%
10 years	3.48%	1.16%	2.32%
20 years	3.81%	1.31%	2.50%
30 years	3.67%	1.44%	2.23%

3. PICM and NYSLRS investment consultant

RVK uses an inflation assumption of 2.50% in forecasting asset performance in the asset allocation study currently underway. This forecast reflects a 10-year investment horizon.

In conducting a stochastic simulation of inflation, RVK provided data used to project rates of inflation for 2,000 simulations. The model used ProVal to project annual inflation over 20 years. Model inputs, as of June 30, 2022 included an initial inflation rate of 9.06%, a long-term target of 2.5% with standard deviation of 2.5%, and a serial correlation coefficient of 0.70 based on historical analysis of the CPI-U. Using the model's outputted data, the 20-year annual rate of inflation was 3.3%, when averaged over the 2,000 simulations.

4. Actuarial Bureau Multiple-State Stochastic Model for Inflation Forecasting

The model, built within the actuarial bureau, assumed three possible states:

Increasing	inflation is on the rise, causing an increase in annual inflation of 2%
Normalized	inflation is well managed and gliding toward Fed target of 2%
Decreasing	inflation is dropping, potentially due to Fed combating high inflation

Each year, the modeled state at the beginning of the year (BOY) will influence the modeled state at the end of the year (EOY). A random variable is used to determine the state at EOY according to transition probabilities.

Transition Probabilities		***state at end of year***		
		Increasing	Normalized	Decreasing
state at beginning of year	Increasing	50%	25%	25%
	Normalized	20%	60%	20%
	Decreasing	10%	60%	30%

The change in the rate of inflation is then determined using prescribed rules intended to reflect different scenarios and the historical average change in the CPI-U, especially the standard deviation of average annual change in the CPI-U (SD_Annual), which is 2%.

state at end of year	**Change in Rate of Inflation**
Increasing	Rate of inflation increases by 2%, the SD_Annual
Normalized	Rate of inflation moves half the distance toward the FED long-term target
Decreasing	BOY state of *Increasing* indicates decrease is triggered by Fed Involvement. Rate of inflation decreases by 4%, double the SD_Annual.
	BOY state of *Normalized* indicates the decrease is naturally occurring. Rate of Inflation decreases 1%, half the SD_Annual.
	BOY state of *Decreasing* could mean decrease is natural or triggered by Fed. Rate of inflation decreases half the distance toward 0%, generating a large change when inflation is high and minimal change when inflation is low.

The initial state was defined as “decreasing” (reflecting the continued Fed action to restrain inflation) with a current rate of inflation of 4.06% (equal to the annualized 1-month rate of inflation ending March 31, 2023).

The 30-year annual rate of inflation resulting from this model was 3.0%, when averaged over the 5,000 simulations, with median 2.8%.

Currently, the inflation assumption is 2.9%.

While past experience and deterministic models suggest the inflation assumption could be lower, the more robust stochastic models used to forecast inflation suggest that the assumption is understated. Similarly, near-term inflation is expected to exceed the 2.9% assumption, even as the Fed continues to demonstrate a commitment to bringing inflation back toward the 2.0% target. With some indicators above and others below, I consider the assumption reasonable.

I recommend maintaining the current inflation assumption of 2.9%.

The Cost-of-Living Adjustment (COLA)

Inflation reduces the buying power of consumers with a fixed income, as is often the case with retirees and beneficiaries.

Chapter 125 of the Laws of 2000 established a permanent COLA program first implemented in September, 2001. The program provides an annual COLA (each September) equal to one-half of the CPI-U increase for the previous fiscal year (April through March). The COLA is rounded to the next highest 0.1%, subject to a 1% floor and a 3% ceiling. The COLA applies to the first $18,000 of benefit for retirees and accidental death benefit recipients, with most spousal beneficiaries entitled to 50% of the retiree's past and future COLA.

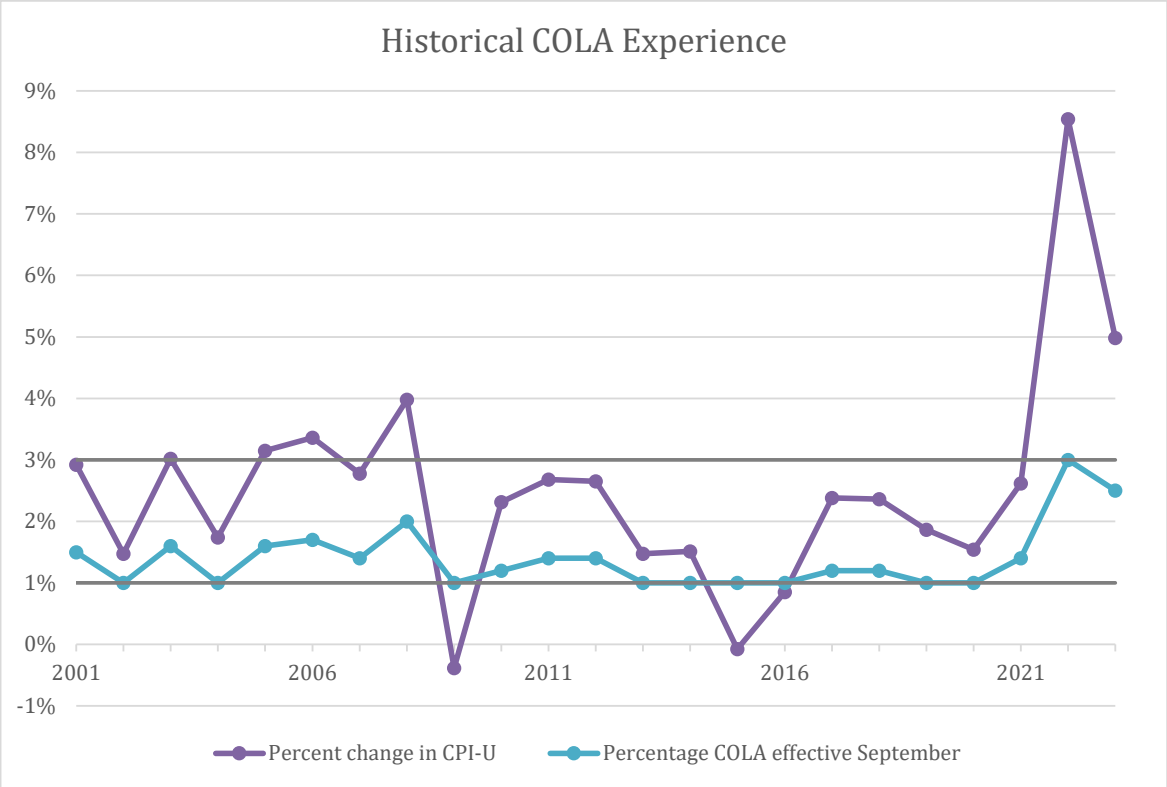
The actuarial valuation must estimate future COLAs, which is done by means of a COLA assumption. The graph below summarizes the percentage COLA data since the program's inception, alongside the annual rate of inflation (as measured by the percentage change in the CPI-U).

The accumulated COLA over the past 20 years is approximately:

1.010 * 1.016 * 1.017 * 1.014 * 1.020 * 1.010 * 1.012 * 1.014 * 1.014 * 1.010
* 1.010 * 1.010* 1.010 * 1.012 * 1.012 * 1.010 * 1.010 * 1.014 * 1.030 * 1.025 – 1 = 32.02%

The level COLA, rounded to tenths of a percent, that best matches this experience is 1.4%.

1.013 ^ 20 – 1 = 29.47%
1.014 ^ 20 – 1 = 32.06%
1.015 ^ 20 – 1 = 34.69%



In addition to past experience, consideration is given to methods that forecast the COLA assumption.

1. **The Inflation Assumption**

   An inflation assumption of 2.9% would project COLAs of 1.5% for all future years:

   2.9% / 2 = 1.45% rounded up to 1.5%

2. **PICM and NYSLRS' investment consultant**

   The inflation assumption of 2.5% used by RVK in forecasting asset performance would imply a COLA of 1.3% for all future years.

   The stochastic simulations performed by RVK to forecast inflation can be used to forecast the annual COLA percentage increase by applying the COLA formula (half the annual rate of inflation, round up, and apply the 1% floor and 3% cap). Using the model's outputted data, the 20-year annualized COLA was 1.83%, when averaged over the 2,000 simulations.

3. **Actuarial Bureau Multiple-state Stochastic Model for Inflation Forecasting**

   This model is described in the Rate of Inflation section of this report. The model can be used to forecast the annual COLA percentage increase by applying the COLA formula (half the annual rate of inflation, round up, and apply the 1% floor and 3% cap). Using the model's outputted data, the 30-year annualized COLA was 1.6%, when averaged over the 5,000 simulations, with median 1.5%.

Currently, the COLA assumption is 1.5%.

The results of this analysis are very similar to the inflation assumption. With some indicators above and others below, I consider the COLA assumption reasonable.

I recommend maintaining the current COLA assumption of 1.5%.

Investment Rate of Return

The actuarial investment rate of return assumption is an assumption concerning the long-term (that is, 30-year) rate of return on pension plan assets. It is used to discount the value of projected contributions and projected benefits.

The concept of discounting is perhaps best understood by way of illustration. Consider the following question:

Who is older, person A, age 50 today, or person B, age 62 ten years from now?

We trust that you answered person B. You probably arrived at your answer by adding ten years to person A's age and comparing 60 with 62, or by subtracting ten years from person B's age, and comparing 50 with 52. In either case, you brought the data to a common date and then made your comparison. You intuitively understood the "time value of age".

Now a second question:

Assuming that you have an investment fund that has an annual rate of return of 5.9%,
which is worth more, $100 today or $115 three years from now?

Your intuition may have led you to select $100 as you reasoned that even at simple interest, $100 earning 5.9% per year adds $17.70 in interest, accumulating to is worth $117.70 after two years.

At compound interest, $100 becomes $100 * 1.059 * 1.059 * 1.059 = $118.76

As with the question about the ages, you brought the data to a common date and made your comparison. Perhaps in this case you were more likely to bring the $100 forward in time (accumulating) than you were to bring the $115 backward in time (discounting), but the idea was the same.

To solve the problem by discounting, you would divide the $115 by 1.059 three times to compare to the $100 today.

$115 / (1.059 * 1.059 * 1.059) = $96.83

These calculations illustrate the concept of the "time value of money". Your answer would have been different if your investment fund had an annual rate of return of 4%.

Hopefully this example illustrates the importance of the discount rate assumption in actuarial valuations, which generally rely on discounting projected cash flows to a valuation date. If the assumption is too optimistic then there will be more investment losses than gains and contributions to the fund will be less timely. If the assumption is too pessimistic then there will be more investment gains than losses and contributions to the fund will be front-loaded.

Historically, the NYSLRS returns by fiscal year (since 1981, the first year of serious commitment to equities) are as follows:

Year	Return	Year	Return	Year	Return	Year	Return	Year	Return
81	16.7%	91	11.7%	01	-8.7%	11	14.6%	21	33.6%
82	3.3%	92	10.7%	02	2.8%	12	6.0%	22	9.5%
83	21.4%	93	12.5%	03	-10.2%	13	10.4%	23	-4.4%
84	7.9%	94	6.9%	04	28.8%	14	13.0%		
85	13.7%	95	8.8%	05	8.5%	15	7.2%		
86	24.0%	96	21.8%	06	14.6%	16	0.2%		
87	17.8%	97	10.9%	07	12.6%	17	11.5%		
88	1.6%	98	30.4%	08	2.6%	18	11.4%		
89	13.4%	99	8.8%	09	-26.4%	19	5.2%		
90	13.9%	00	17.8%	10	25.9%	20	-2.7%		

This produces the following time-weighted annualized returns (gross of expenses) after consideration of benefits paid and contributions collected throughout each fiscal year:

Period ending March 31, 2023	Annualized Return
3 year	12.7%
5 year	7.4%
10 year	7.9%
15 year	6.3%
20 year	8.3%
25 year	6.5%
30 year	8.7%
35 year	9.3%
40 year	9.6%

In addition to past experience, consideration is given to methods that forecast asset returns.

The primary consideration in any forecast of asset returns is the Asset Allocation (AA) Policy.

The Comptroller, as the trustee of the Common Retirement Fund (CRF), establishes the AA Policy. A portfolio's AA Policy is the single most important factor in establishing the fund's long-term rate of return. Pursuing higher returns requires more risk (volatility in returns year-over-year), which triggers volatility in employer contribution rates (potentially putting stress on municipal budgets). In this way, establishing the AA Policy allows the Comptroller to set the risk appetite for PICM and define the level of volatility expected in employer billing rates.

The last trustee-approved AA Report was issued January 6, 2020. The AA Report is based on especially robust analysis by PICM and NYSLRS investment consultant (RVK, since 2010). The AA Report reflects the following risk (*standard deviation*) and reward (*arithmetic return*) relationship by asset class.

Asset Class	(A) Allocation	(B) Arithmetic Return Assumption	Standard Deviation Assumption	(A) * (B)
Broad US Equity	32%	6.80%	17.80%	2.1760%
Broad International Equity	15	8.90	20.95	1.3350
US Agg Fixed Income	23	3.75	6.00	0.8625
CRF Credit	4	6.93	15.04	0.2772
Core Real Estate	9	7.20	17.36	0.6480
CRF Private Equity	10	9.50	23.50	0.9500
CRF Opportunistic	3	7.55	13.89	0.2265
CRF Real Assets	3	8.65	17.62	0.2595
Cash Equivalents	1	3.00	3.00	0.0300
			Expected Arithmetic Return	**6.7647%**

The capital market assumptions used in the report are applicable to a ten-year time frame and are net of investment fees and expenses.

The expected arithmetic return for this portfolio is 6.76%, with a standard deviation of 12.22%, for a geometric return of 6.07%. A discussion of arithmetic returns versus geometric returns can be found later in this report (see *Sidebar: Understanding the difference between Arithmetic Return and Geometric Return* in Appendix C).

The asset returns developed for the AA Report are 10-year expectations. The actuarial assumption estimates the asset return over a 30-year horizon, with the intention of reflecting the asset performance over the entire career of an average new entrant.

Since the asset allocation was established in 2020, the fund has experienced fiscal year asset returns of 33.6%, 9.5%, and -4.4%. Using this recent experience and the initial expectation of 6.76% arithmetic and 6.07% geometric, we can calculate the implied rate of return to be experienced over the next 27 years.

Implied Arithmetic Return: $6.76\% * 30 = (33.6\%+9.5\%-4.4\%) + AR * 27$
$AR \approx 6.1\%$

Implied Geometric Return: $(1+6.07\%)^{30} = (1+33.6\%)*(1+9.5\%)*(1 - 4.4\%)*(1+GR)^{27}$
$GR \approx 5.4\%$

This suggests that, after reflecting the original conditions underpinning the AA Report returns and recent experience, the prospective return expectations may be closer to 6.1% arithmetic and 5.4% geometric.

Currently, the investment rate of return assumption is 5.9%.

Since the current assumption falls between the implied arithmetic return and implied geometric return expected over the next 27 years, I consider the investment rate of return assumption reasonable.

Therefore, I recommend maintaining the current investment rate of return assumption of 5.9%, which will be used to discount future projected contributions and benefits.

The data below is taken from the National Association of State Retirement Administrators (NASRA) website and represents the investment return assumption distribution for public systems in their database. Investment portfolios vary significantly from one system to another, making it impractical to rely upon the assumptions used by other systems. But a comparison to other systems can serve as a reasonability check or reveal trends across the larger group.

Investment Return Assumption	Number of Public Systems			
	July 2023	July 2020	May 2015	March 2010
< 6.00	* 3 *	2	4	0
6.00	2			
6.01 – 6.49	6			
6.50	11	5		
6.51-6.99	24	* 17 *		
7.00	52	32		1
7.01-7.49	29	38	* 43 *	21
7.50	3	26		
7.51-7.99	1	7	36	16
8.00	0	3	34	* 51 *
8.01-8.49	0	0	3	16
8.50	0	0	2	19
Median	7.00%	7.25%	7.75%	7.97%
* NYSLRS *	5.90%	6.80%	7.50%	8.00%

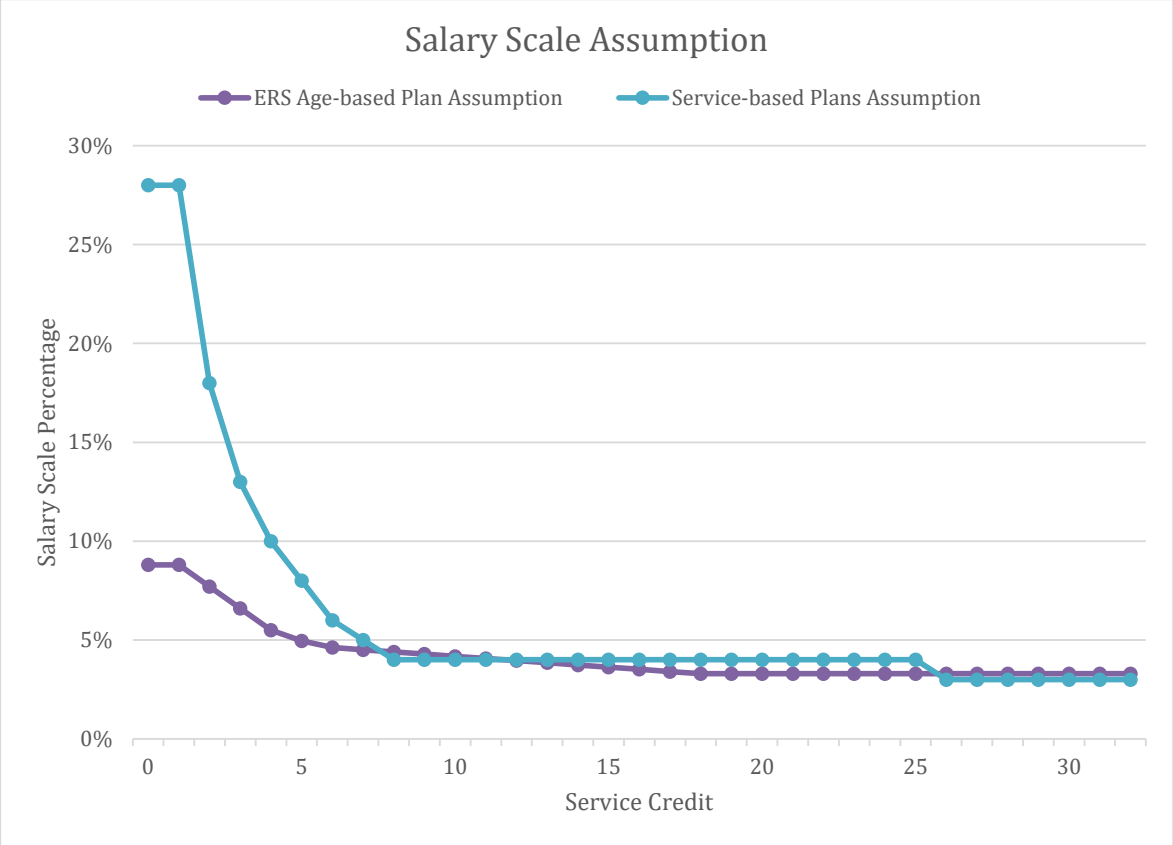
This table shows that there has been a steady shift downward over the past fifteen years.

Finally, it is prudent to be mindful of the position of stakeholders, such as credit rating agencies, and other asset return projections. Some additional discussion can be found in Appendix C.

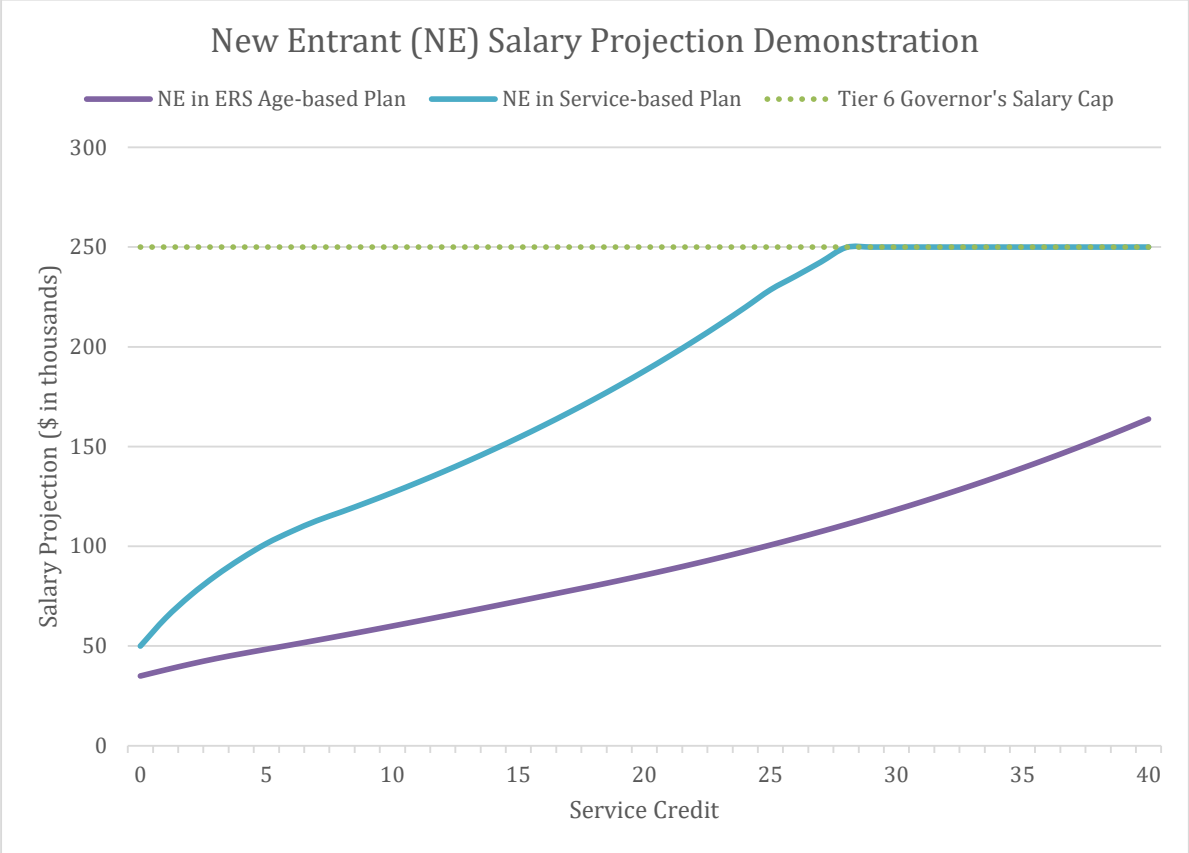
Salary Scales

The purpose of the salary scale assumption is to project future billable salary and estimate a member's final average salary (FAS) and future benefits.

There are two salary scale assumptions, one applies to members of ERS who must attain age 55 to be eligible for a service retirement benefit (called an age-based plan), and the second salary scale applies to everyone else, including all members of PFRS and members of ERS who become retirement eligible upon attaining 20 or 25 years of service credit (called a service-based plan). In both cases, the salary scale factor varies by service credit. The current assumption is illustrated in the graph below.



Notice that salary increases are very high for new entrants with little service credit, dropping off rather quickly over 8 years and stabilizing through retirement. The assumptions are intentionally simplistic, intended to predict the salary of the cohort, not any one individual. Predicting the general trajectory of pensionable earnings will result in accurate estimates of billable salary and average benefits for similarly positioned members at retirement. Additional granularity does not materially change results.



The ERS age-based plan assumptions reflect the members' experience for the 5-year period ending 3/31/2021. (The ERS salary scale assumption was adopted with the valuation dated April 1, 2018[1] and is reasonably consistent with the more recent 5-year experience ending 3/31/2021.) The service-based plan assumptions reflect the PFRS members' experience for the 10-years period ending 3/31/2021. A longer lookback was necessary for service-based plans because of limited exposure. (The ERS service-based plan experience was not used to set the assumption because sporadic contract settlements caused volatility.)

Experience over the past three years has been erratic, likely owed to disruptions due to COVID where accelerated retirements and impeded hiring created pent-up demand for new hires, now driving a strong labor market. Add to this an increased rate of inflation, and we see all elements of the salary scale building blocks increasing.

[1] The salary scale set with the 4/1/2018 valuation is equal to a 10% increase of the experience measured over the 5-year period ending 3/31/2015.

Fiscal Year Ending	ERS			PFRS			The Fed Median Wage Growth (Full-time)
	Actual	Expected	A/E	Actual	Expected	A/E	
2021	2.301%	4.484%	0.513	3.971%	5.865%	0.677	3.5%
2022	7.571%	4.356%	1.738	8.532%	5.570%	1.532	4.8%
2023	6.183%	4.343%	1.424	8.542%	5.612%	1.522	6.4%
Combined 2021 - 2023	**5.316%**	**4.395%**	**1.210**	**7.027%**	**5.682%**	**1.237**	**4.9%**

When salary grows faster than assumed (an A/E ratio greater than 1.000), projected benefits will grow faster than projections in billable salary. This will create upward pressure on billing rates.

In addition to recent experience, consideration is given to recent contract settlements. The State of New York represents approximately 40% of all billable salary in ERS. NYS employees are typically represented by the Civil Service Employees Association (CSEA), the Public Employees Federation (PEF), or the Organization of Management Confidential Employees (OMCE). Existing collective bargaining agreements and pay legislation provide prospective salary increases.

	CSEA	PEF & OMCE
Date Ratified	**June 2022**	**July 2023**
Increase effective FYB 2023	3%	3%
Increase effective FYB 2024	3%	3%
Increase effective FYB 2025	3%	*3%*

These organizations negotiated a one-time $3,000 payment in 2023 (April for CSEA, August for PEF and OMCE) but this payment is not pensionable.

While this may seem to suggest that a salary scale of just 3% is more suitable for ERS, the salary scale is not limited to increases in base pay. For example, promotions and “steps” (automatic pay increases after assuming a higher-level position at a hiring rate) will cause an individual’s salary to increase beyond the fixed 3% negotiated in employment contracts.

While experience over the past two years suggests that the salary scale assumption may be understated, more time is needed to let the assumptions play out as the consequences of COVID continue to resolve. Excessive tinkering is unnecessary; to the extent that near term salary increases exceed expectations, there will be upward pressure on the billing rates in the form of actuarial losses.

Therefore, I recommend maintaining the salary scale assumptions.

Asset Valuation Method

Pension fund managers could direct all assets to be invested in a fixed income portfolio. While this would greatly reduce investment income volatility, it would also increase the expected employer contribution rates.

In general, one expects to profit more as an owner (that is an investor in equities) than as a lender (that is an investor in bonds), especially if the equity ownership can be diversified and held. Thus pension funds invest in equity index funds. Unfortunately, this introduces volatility in investment income.

The basic equation governing pension funding is: $C + I = B + E$

where, C = Contributions (both employer and employee)
I = Investment income
B = Benefits
E = Expenses [In NYSLRS, administrative expenses are funded independently of the benefits.]

The basic funding equation highlights the fact that volatility in investment income translates into volatility in employer contributions. The right side of the equation (benefits plus expenses) is highly predicable and, barring a major change in assumptions, fluctuates little year-over-year. Employee contributions are defined in law and are therefore predictable year-over-year. As a result, any volatility in investment income is countered by a change in future employer contributions.

Asset valuation methods "smooth" the investment income volatility by phasing in both "unexpected" gains and "unexpected" losses. The amount deemed "unexpected", and the period of smoothing are defined by the method.

The NYSLRS asset valuation method was revised in 2022 and has the following features:

1. expect a gain of the assumed rate of return on the plan net position and fiscal year cash flows,
2. recognize (smooth) the unexpected gain (= actual gain – expected gain) over 8 years in equal annual portions
3. does not apply a market value corridor.

A market value corridor would require the actuarial value of assets (AVA) to remain within a certain range around the market value of assets (MVA). This can result generate increased employer contribution requirements after experiencing market losses, and reduced employer contribution requirements after experiencing market gains. That is, it reinforces contribution rates that are cyclical with investment markets, giving rate relief when least necessary and rate increases when least affordable. This conflicts with the System objective of smooth employer contribution rates.

I recommend that we maintain the current asset valuation method.

The table below provides a summary of key values related to the Asset Smoothing Method and metrics related to funding progress. Definitions are provided below the table.

Market Value of Assets (MVA) vs. Actuarial Value of Assets (AVA)

FY	MVA[a]	AVA	AL_{EAN}	UAL_{EAN}	Roll-forward TPL_{EAN}	GASB 67 Ratio
2015	$ 189.3	$ 184.2	$ 196.5	$ 12.4	$ 193.1	98.0%
2016	183.5	190.6	203.0	12.4	202.7	90.6
2017	197.5	198.0	210.1	12.1	209.1	94.5
2018	212.0	206.7	217.6	10.9	216.3	98.0
2019	215.2	212.8	224.0	11.2	223.9	96.1
2020	198.1	214.1	231.9	17.8	229.9	86.2
2021[b]	260.1	260.1	260.4	0.3	~~237.9~~ 261.9	99.3
2022	273.7	267.2	270.9	2.8	266.1	102.9
2023	$ 249.5	$ 269.6	$ 281.1	$ 11.5	276.5	90.3%
2024					$ 286.8	

[a] Financial Statement Plan Net Position (that is Invested Assets + Receivables)

[b] The market restart led to recomputing the TPL_{EAN} under new assumptions.

Accrued Liability under the Entry Age Normal actuarial funding method (AL_{EAN})

The present value of future benefits (PVFB) is the current cost of the ultimate benefit payable. The PVFB can be split into the part earned to date and the part expected to be earned in the future. The accrued liability is the part of the PVFB earned as of the valuation date. That is, the "past cost" of the benefit promise.

The actuarial funding method decides what portion of the PVFB is a "past cost" and what portion is a "future cost". The entry age normal method allocates the PVFB on a level basis over the member's career (from entry age through assumed exit age). As a member collects salary, the benefit is accrued and the PVFB shifts from a "future cost" to a "past cost". When the member leaves active employment and a benefit is payable, the PVFB is fully accrued and therefore equal to the AL.

Put simply, the AL_{EAN} is a measure of the pension benefits earned by members and retirees as of the valuation date.

Unfunded Accrued Liability under the Entry age Normal actuarial funding method (UAL_{EAN})

The unfunded accrued liability is the portion of the system accrued liability that is not covered by current Actuarial Value of Assets. Therefore, $UAL_{EAN} = AL_{EAN} - AVA$.

Total Pension Liability under the Entry age Normal actuarial funding method (TPL_{EAN})

The total pension liability is the sum of all accrued liabilities (for active members and those collecting benefits) plus certain dedicated liabilities. This value is rolled-forward from the prior year valuation to allow auditors time to review the calculation.

Governmental Accounting Standards Board Statement No. 67 Ratio (GASB 67 Ratio)

GASB 67 amended GASB 27, changing financial reporting required by public pension plans. The GASB 67 Ratio was first reported for the fiscal year ending 2015 and is equal to the plan net position (equal to the MVA) divided by the total pension liability. Therefore, GASB 67 Ratio = MVA / TPL_{EAN}

Demographic Assumptions

Demographic assumptions include retiree mortality, retiree mortality improvement, and assumptions estimating the method and timing of an active member separating from service (called active member *decrements*). While demographic assumptions are forward-looking, they are generally best estimated by recent experience of similarly positioned individuals.

What is meant by *similarly positioned individuals*?

> The type of work performed by civil servants can vary widely. The career of firefighters, correction officers, and clerks are not likely to mirror one another. When evaluating relevant experience, consideration must be given to differences in job duties and plan provisions. Accordingly, it is preferrable to set assumptions based on specific retiree and member cohorts rather than to rely upon the experience of non-participants (such as Social Security recipients or the Bureau of Labor Statistics workforce measurements).

What is meant by *recent experience*?

> Member behavior is influenced by outside forces, such as legislative decisions (for example, retirement incentives) and economic forces (such as opportunities in private sector). As conditions change, so will member behavior and demographic experience. Generally, the more recent the experience, the more reliable in predicting future experience.
>
> However, COVID fueled a particularly intense collection of outside forces. The workplace was in a state of flux, responding to societal changes, law changes, and the impact of unique economic conditions on the labor markets. As a result, COVID has developed a challenging environment for assumption setting.
>
> Ultimately, the recent COVID experience may not prove predictive of the future.

The accuracy of demographic assumptions in predicting actual experience is evaluated annually by conducting an *experience study*. Ideally, the ratio of "actual to expected" (called an A/E ratio) is close to 1.000. A large divergence suggests the assumptions are not closely predicting experience. As a result, actuarial gains or losses could lead to fluctuation in the annual billing rates, especially when assumptions are updated.

Retiree Mortality Experience

The most significant demographic assumption is retiree mortality. Our retiree mortality tables are not developed on a "by number" basis, but on a "by liability" basis.

For example, a retiree mortality rate of 1% for age 65 retirees does not mean that we expect 1 in every 100 age 65 retirees to expire within the year, rather it means that we expect $1 in every $100 age 65 retiree liabilities to expire within a year.

The *by liability* method is preferred over the *by number* method because the valuation is concerned with the cessation of benefit obligations, not necessarily the cessation of benefit recipients. Generally, mortality by number and mortality by liability should be roughly equivalent. However, experience studies have shown that retirees with more lucrative benefits enjoy better longevity than those with lesser benefits. Thus, mortality by number would undervalue the present value of future benefits.

Currently, the retiree mortality assumption is based on the NYSLRS retiree experience from April 1, 2015 through March 31, 2020 with mortality improvement under the SOA's MP-2021 scale. Historically, retiree mortality experience was determined to be best reflected by the recent experience of the NYSLRS retirees. And this is still true, in general. However, recent COVID experience may present challenges.

As of March 31, 2020, the US had reported 3,900 deaths due to COVID, with New York State reporting 1,550 of those deaths. The White House reported that 100,000 to 240,000 might die from COVID as the country began implementing social distancing and stay-home mandates. With most of these NYS early-COVID deaths attributable to NYC residents, it is unlikely that they bore any weight on the current mortality assumption.

Over the next three years, the World Health Organization reported approximately 1,115,000 cumulative deaths in the United States due to COVID. New York State Department of Health reported 79,887 deaths as of July 20, 2023. This is approximately 7.2% of all COVID deaths occurring in the US.

As of July 19, 2023, the WHO estimates 340 deaths per 100,000 people in the United States, or an excess mortality rate of approximately 0.34% over nearly 3.5 years. This is estimated to be an annual mortality rate of 0.10%. For New York State, which represents 7.2% of COVID deaths but only 6% of the US population, the excess mortality rate is closer to 0.12% (≈ 0.1% * 7.2%/6.0%). This is reflected in NYSLRS retiree mortality experience measured through March 31, 2023.

Retiree Deaths[2]	FYE 2023			FYE 2021 – FYE 2023		
	Actual	Expected	A/E	Actual	Expected	A/E
ERS Service (Males)	$ 163.960	$ 151.608	1.081	$ 468.704	$ 435.774	1.076
ERS Service (Females)	112.894	100.483	1.124	314.383	287.805	1.092
ERS Disability	14.384	12.893	1.116	41.627	38.616	1.078
PFRS All Plans	34.685	31.569	1.099	92.250	89.657	1.029
ERS & PFRS Beneficiaries	25.415	23.960	1.061	67.775	68.417	0.991
All Retiree Mortality	**$ 351.337**	**$ 320.514**	**1.096**	**$ 984.738**	**$ 920.269**	**1.070**

The A/E for All Retiree Mortality over the three-year period is 1.070, which implies actual mortality is 7% higher than the base mortality assumption predicted. This is not directly comparable to the excess mortality rates discussed earlier. An increase in the base mortality assumption of 0.15% (slightly more than the rough approximation of 0.12% for the broader NYS population) is sufficient to accurately predict the mortality experience of NYSLRS retirees over the past three years.

For setting assumptions, the question becomes: does mortality experience over the past three years represent a permanent change in prospective mortality? The answer is no. The extreme nature of COVID is not permanent, as evidenced by the success of vaccines and the steady decline in COVID deaths. Therefore, updating the retiree mortality assumptions based upon NYSLRS more recent 3-year experience period is not appropriate.

A logical follow-up question might be: if adjustments were applied to the recent experience, would it better reflect prospective mortality than NYSLRS FYE 2016 – FYE 2020 experience study? There is still a lot of debate about how COVID has impacted future mortality rates. For example:

1. ***IF*** COVID becomes a second "flu-like" disease, persistently adding additional deaths ***THEN*** mortality might be higher than pre-COVID experience (but still not so extreme as the past three years).

2. ***IF*** COVID accelerated deaths by a year or two ***THEN*** mortality might be lower than pre-COVID experience for a short time before returning to pre-COVID experience.

3. ***IF*** COVID deaths disproportionately impacted those with a shorter life expectancy ***THEN*** mortality might be lower than pre-COVID experience as survivors express superior longevity.

Regardless of which theory is preferred, there is general agreement that more time is needed before drawing conclusions.

Therefore, I recommend maintaining the retiree mortality assumption, which is based on NYSLRS retiree experience beginning April 1, 2015 and ending March 31, 2020.

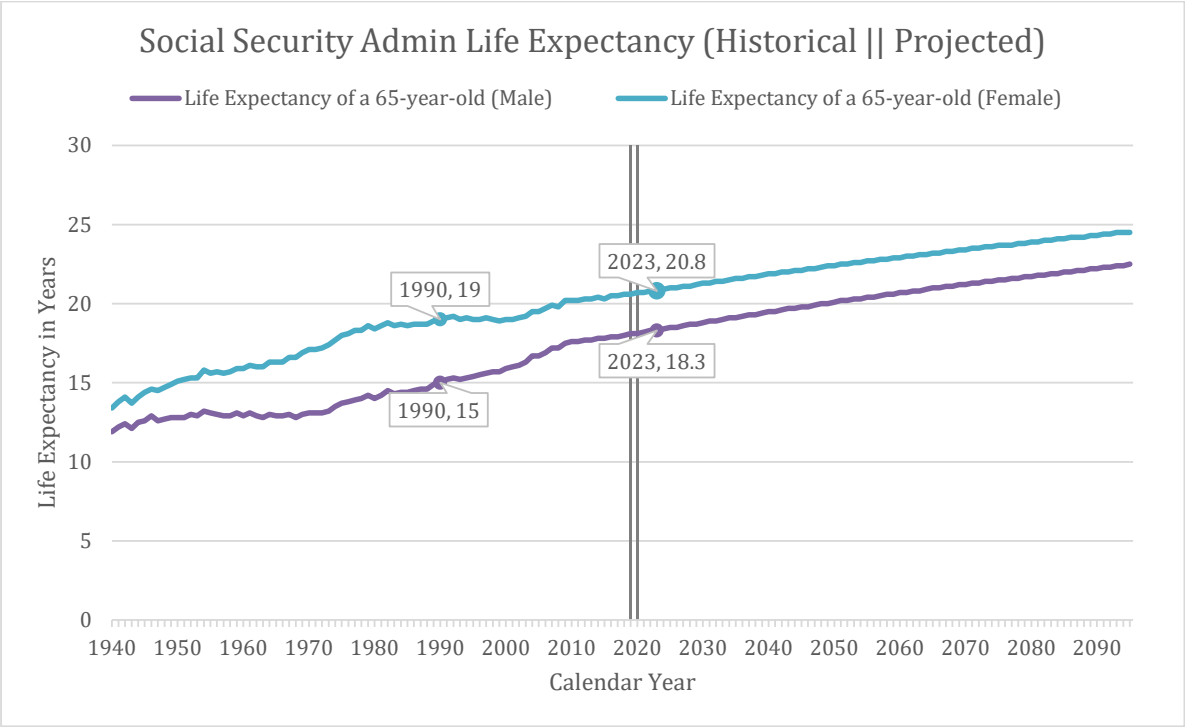
[2] Retiree Mortality is studied in 10 groupings (ERS service retirees are grouped by Legal Sex and collar color, ERS disability retirees are grouped by Legal Sex, PFRS retirees are grouped by retirement type, and beneficiaries are grouped by Legal Sex) but these groups are combined for display purposes in this table.

Retiree Mortality Improvement Assumption

A second feature of the retiree mortality assumption is the inclusion of a projection regarding mortality improvement. The interaction of the (static) mortality assumption and the mortality improvement assumption is best demonstrated with real-world context.

> Pretend it is 1990. How long do we expect a 65-year-old to live? Well, the social security administration estimated life expectancy as 15 years for a male and 19 years for a female.
>
> Flashforward to 2020 and ignore the potential bias from COVID. Do we expect a 65-year-old to live longer or shorter? It is generally agreed that the medical advancements of the past thirty years have resulted in longer life expectancy, including dramatic improvements in heart disease, reduced rates of tobacco use, and improvements in vehicular safety.
>
> But in 1990, to calculate the future retirement benefit payable, the Actuary needed to estimate the life expectancy of a 65-year-old (newly retired, perhaps) and the 35-year-old (newly hired, perhaps) who would be 65 in 2020. To do this, a mortality improvement factor is applied.

Without a mortality improvement assumption, the life expectancy of all 65-year-olds would be the same, regardless of when the person turns 65. The mortality improvement assumption essentially says, "given two people survive to age 65, the person that was born later in time will survive longer."



The guidance issued by S&P Global Ratings suggests the use of an up-to-date generational improvement projection, citing that the incremental updates possible with generational scales minimize the impact on employer billing rates.

The debate about how COVID will impact future mortality experience is also fundamental to the mortality improvement assumption. Currently, NYSLRS relies upon a mortality improvement scale developed by the Society of Actuaries denoted MP-2021, which is developed by the Retirement Plans Experience Committee (RPEC). RPEC decided not to issue an updated "MP-2022" because the 2020 COVID experience generated illogical results when included in the model. RPEC's official statement said:

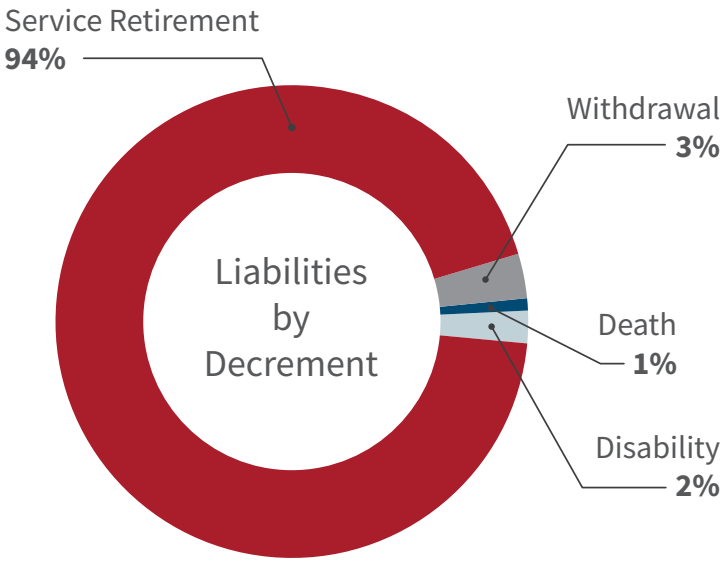
> *"The committee does not believe it would be appropriate to incorporate, without adjustment, the substantially higher rates of mortality experience from 2020 into the graduation and projection models used by RPEC to forecast future mortality…adjusting the experience data to give reduced or no weight to deaths specifically identified as caused by COVID-19, even if possible from the underlying datasets, would not completely adjust for the indirect impact of the pandemic on other causes of death nor reflect any potential mis-reporting of COVID-19 deaths as other causes."*

So, the current generational mortality improvement assumption is the most recent.

Therefore, I recommend maintaining the mortality improvement assumption, which is the Society of Actuaries' Mortality Projection Scale MP-2021.

Active Member Experience

Active Members separate from service in one of four ways: withdrawal, death, disablement, or retirement. These are called *decrements*. Whenever a member separates from service, they are entitled to a benefit from NYSLRS. Sometimes the benefit is simply a return of member contributions, other times a lump sum payment. In most cases, a monthly benefit is paid for life (called an annuity). The benefit amount and form of payment are defined in the Retirement and Social Security Law, but will vary by plan, service, and salary.



Assumptions are needed to estimate the timing and type of benefit payable under each decrement. Like retiree deaths, an annual experience study is conducted to compare the fiscal year experience to the assumptions. Unlike retiree mortality, this experience study is done on a by number basis. That is, number of people (not dollars) are counted.

Active member decrements were determined to be best reflected by the recent experience of the NYSLRS retirees. While this is still true, recent COVID experience may present challenges.

While the past three years of experience diverge significantly from the assumptions, this does not in itself motivate a change to the current assumption sets. As with retiree mortality, the COVID experience may not be a reliable predictor of the future.

I recommend maintaining the active member decrement assumptions, which are based on the NYSLRS active member experience from April 1, 2015 through March 31, 2020.

A review of each active member decrement experience follows.

Withdrawals

When a member withdraws from active service, the form of benefit depends upon the service credit accrued. If less than 5 years, the member is not vested, and the benefit is a return of the member's contributions. If more than 10 years, the member is vested, and the benefit is a deferred annuity benefit payable after attaining age 55. A member with service credit between 5 and 10 years is allowed to choose either the non-vested benefit or the vested benefit.

Generally, when members withdraw, actuarial gains apply downward pressure on the billing rates. As shown in the table below, NYSLRS members are withdrawing at greater rates than expected.

Withdrawals[3]	FYE 2023				FYE 2021 – FYE 2023			
	Exposures	Actual	Expected	A/E	Exposures	Actual	Expected	A/E
ERS Regular Plans	282,622	35,365	15,358	2.303	879,276	89,279	49,567	1.801
PFRS All Plans	28,594	24	14	1.714	88,725	71	42	1.614

Chapter 56 of the Laws of 2022 changed Tiers 5 and 6 from 10-year vesting to 5-year vesting. The April 1, 2022 Actuarial Valuation revised Tiers 5 and 6 withdrawal assumptions to match earlier Tiers.

Active Member Deaths

When an active member dies, a benefit is payable to a named beneficiary or a statutory beneficiary (spouse, child(ren), dependent parents). Ordinary death benefits are payable as a lump sum while accidental death benefits are often payable for the life of the beneficiary.

Excess deaths can result in downward pressure on the billing rates. Like retiree mortality, active member deaths have exceeded expectations, as shown in the table below.

Active Member Deaths[4]	FYE 2023				FYE 2021 – FYE 2023			
	Exposures	Actual	Expected	A/E	Exposures	Actual	Expected	A/E
ERS	378,941	610	550	1.109	1,184,650	2,145	1,716	1.250
PFRS	28,594	24	14	1.714	88,725	71	42	1.614

[3] Rates of withdrawal for ERS regular plans are defined by age and service credit while assumptions for PFRS plans are defined by service credit. To summarize experience, similar groups are combined.

[4] Active member deaths are studied in four groupings (ERS accidental, ERS ordinary, PFRS accidental, and PFRS ordinary) with assumptions defined by age. To summarize system system-level mortality experience, the different benefit types are combined.

Disability Retirements

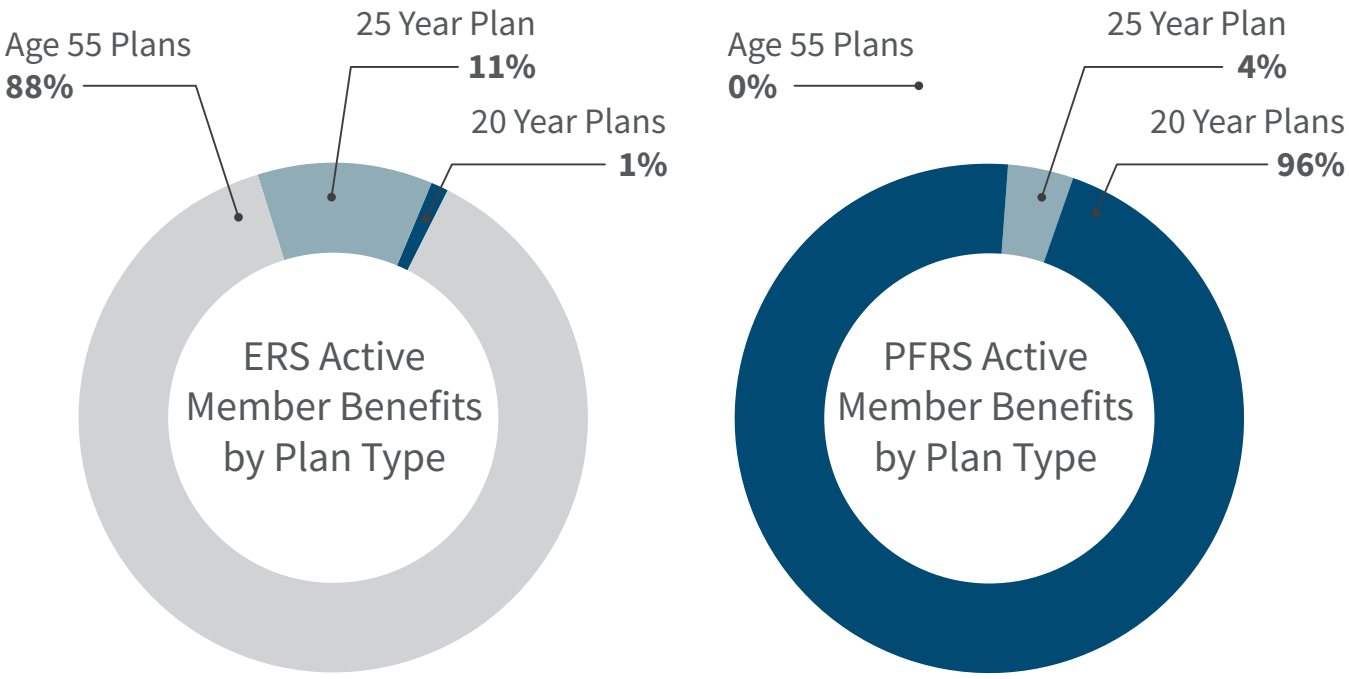
When an active member becomes permanently disabled, typically annuity (lifetime) benefits become payable. There are three types of disability, although not all plans provide all three types. An accidental disability generally requires a *sudden, fortuitous mischance, out of the ordinary and injurious on impact*. An injury emanating from risks inherent in an employee's regular duties does not constitute an accident but may suffice for a disability in the performance of duty (POD). An ordinary disability benefit is payable after a member attains 10 years of service credit.

Disability Retirements		FYE 2023				FYE 2021 – FYE 2023			
		Exposures	Actual	Expected	A/E	Exposures	Actual	Expected	A/E
ERS	Accidental	179,377	0	5	0.000	561,362	0	14	0.000
	Ordinary	101,914	23	189	0.121	317,090	96	593	0.162
PFRS	Accidental	28,594	76	47	1.625	88,725	172	147	1.173
	Ordinary	10,101	3	2	1.219	31,333	10	8	1.317
	POD	28,594	62	47	1.326	88,725	121	147	0.825

Chapter 55 of the Laws of 2023, Part LL, allows accidental disability benefits to be paid to certain members of ERS and all members of PFRS when the disability is caused by diseases of the heart, even if the definition of an accident has not been met.

Service Retirements

When a member does not withdraw, die, or become disabled, they file for a service retirement benefit. Service retirement benefits represent approximately 94% of all active member liabilities making these assumptions the most important active member assumptions. There are a variety of different assumptions based on plan provisions (such as 20-year plans, 25-year plans, and provisions for additional accruals after initial eligibility) and population (such as public safety, correction officers, and others).



Service retirement benefits are most costly when members retire at first eligibility for an unreduced benefit. Therefore, actual service retirements exceeding expectations will create an upward pressure on billing rates. As shown the table below, NYSLRS members are retiring at greater rates than expected.

Service Retirements[5]	FYE 2023				FYE 2021 – FYE 2023			
	Exposures	Actual	Expected	A/E	Exposures	Actual	Expected	A/E
ERS	98,824	16,795	12,866	1.305	313,895	55,352	41,018	1.349
PFRS	6,235	1,357	809	1.678	19,986	4,259	2,639	1.614

Service retirement experience for Tier 5 and 6 members lacks sufficient credibility to be used in defining tier-specific rates. Instead, adjustments are applied to the credible experience of earlier tiers to capture differences in plan provisions. These adjustments are detailed in Appendix B.

[5] Rates of service retirement for age-based plans are defined by age and attainment of service milestones (which occur upon attaining 20 years and 30 years of service credit) while assumptions for service-based plans are defined by service credit. To summarize system-level experience, different plans are combined.

Effect on Contributions

The table below summarizes the projected average employer contribution rates for the most recent valuations.

Valuation 4/1	Local Employer Billing Date 2/1	ERS Avg Rate (reg plan GLIP)	PFRS Avg Rate (GLIP)	Employer Contributions/ FY Benefits ($ billions)	CSP Mitigated Rates (does not apply to GLIP, ~~strikethrough~~ => no amortizing)				CSP Balance (billions)
					ERS		PFRS		
					Original	Alternate	Original	Alternate	
2009	2011	11.9 (0.4)	18.2 (0.1)	$ 3.6 / 8.5	9.5%		17.5%		
2010	2012	16.3 (0.4)	21.6 (0.0)	4.9 / 8.9	10.5		18.5		
2011	2013	18.9 (0.4)	25.8 (0.1)	5.5 / 9.5	11.5		19.5		$ 0.3
2012	2014	20.9 (0.4)	28.9 (0.0)	6.2 / 10.0	12.5	12.0%	20.5	20.0%	1.1
2013	2015	20.1 (0.4)	27.6 (0.1)	6.1 / 10.5	13.5	12.0	21.5	20.0	2.1
2014	2016	18.2 (0.5)	24.7 (0.0)	5.5 / 11.1	14.5	12.5	22.5	20.5	3.3
2015	2017	15.5 (0.4)	24.3 (0.0)	4.8 / 11.5	~~15.1~~	13.0	23.5	21.0	4.1
2016	2018	15.3 (0.4)	24.4 (0.1)	4.9 / 12.1	~~14.9~~	13.5	~~24.3~~	21.5	4.2
2017	2019	14.9 (0.5)	23.5 (0.0)	4.9 / 12.8	~~14.4~~	14.0	~~23.5~~	22.0	3.8
2018	2020	14.6 (0.4)	23.5 (0.0)	4.9 / 13.4	~~14.2~~	~~14.2~~	~~23.5~~	22.5	3.3
2019	2021	14.6 (0.5)	24.4 (0.0)	5.1 / 14.0	~~14.1~~	~~14.1~~	~~24.4~~	23.0	2.9
2020	2022	16.2 (0.4)	28.3 (0.0)	5.9 / 14.7	15.1	14.6	25.4	23.5	2.3
2021	2023	11.6 (0.2)	27.0 (0.0)	4.4 / 15.4	~~14.1~~	~~14.1~~	26.4	24.0	0.8
2022	2024	13.1 (0.7)	27.8 (0.1)	5.1 / 16.2	~~13.1~~	~~13.6~~	27.4	24.5	0.5
2023	2025	15.2 (0.4)	31.2 (0.1)	$ 6.2 / 17.4	14.1%	14.1%	28.4%	25.0%	$ 0.2

The new entrant rate for the:

- ERS A15 Tier 6 plan is 9.3% normal cost + 1.4% GLIP & Admin = 10.7% total rate
- ERS valuation cohort is 9.9% normal cost + 1.4% GLIP & Admin = 11.2% total rate
- PFRS 384D contrib Tier 6 plan is 18.0% normal cost + 1.0% GLIP & Admin = 19.0% total rate
- PFRS valuation cohort is 18.4% normal cost + 1.0% GLIP & Admin = 19.4% total rate

The March 31, 2023 Contribution Stabilization Program (CSP) amortization balance is $0.20 billion, all held by local employers.

Employers participating in the CSP are always required to pay their graded rate (plus GLIP and amortization payments). For FY 2025, the graded rate is less than the system average rate under both versions of the program and in both systems. This means all employers participating in the Original or Alternate CSP will be eligible to amortize a portion of their invoice. Those employers who have a reserve fund balance will also be eligible to apply a portion of their reserve fund towards their invoice.

Chapter 55 of the Laws of 2023, Part W, amended the CSP to allow greater flexibility within the program.

- Reserve fund balance is capped at the employer's actuarial contribution in the prior fiscal year.
- The reserve fund may be applied to an employer's invoice when the employer's actuarial rate exceeds the employer's graded rate (that is, when the employer is eligible to amortize).
- Employers are now able to leave the program if all prior amortizations are paid off. Termination becomes effective in the fiscal year following the year of application. Graded payments will cease upon termination. The employer's reserve fund will continue to be applied to future invoices, when eligible, until the fund is depleted. An employer may re-enter the Original CSP only in a year when the employer is eligible to amortize and if the reserve fund has been depleted.

Gain/Loss Analysis

	ERS	PFRS
2024 Estimated Contributions (Feb 1, 2024 Payment)	**13.1%**	**27.8%**
Changes Due to Gains/Losses In:		
FYE 2023 Benefit Improvements	0.0%	0.1%
FYE 2022 Investment Performance (9.5% v 5.9%)	-0.3%	-0.3%
FYE 2023 Investment Performance (-4.4% v 5.9%)	1.1%	1.2%
FY Member Experience: Demographics	0.5%	1.2%
FY Member Experience: Salary	0.5%	0.5%
FY Retiree Experience: COLA	0.2%	0.2%
New Entrant	-0.6%	-1.1%
Administrative Contributions	0.5%	0.5%
GLIP Contributions	-0.2%	0.0%
Data Extraction Improvements	0.6%	1.0%
Miscellaneous	-0.2%	0.1%
Net Change	**2.1%**	**3.4%**
2025 Estimated Contributions (Feb 1, 2025 Payment)	**15.2%**	**31.2%**

The fiscal year ending 2023 was tough for NYSLRS billing rates, which are experiencing an upward pressure from economic forces (investments, inflation, and salary increases), demographic shifts, and improved processing following the redesign project (administrative rate increase, and actuarial data extraction improvements). Some rate relief was provided by the FYE 2022 investment returns, and new entrants with less lucrative benefits.

Summary of Assumptions and Methods

I recommend maintaining all assumptions used in the Actuarial Valuation dated April 1, 2022.

Major Assumption or Method	Last Changed in Valuation Dated	Assumption Recommended for the Actuarial Valuation dated April 1, 2023
Inflation	April 1, 2022	2.9%
Cost of Living Adjustment	April 1, 2022	1.5%
Investment Return	April 1, 2021	5.9%
PFRS Salary Scale	April 1, 2021	Based on System experience FYE 2012 – FYE 2021 (5.8% average expected for FYE 2023 cohort)
ERS Salary Scale	April 1, 2018	Based on System experience FYE 2016 – FYE 2018 (4.2% average expected for FYE 2023 cohort)
Asset Smoothing Method	April 1, 2022	8-year level smoothing of unexpected gain/(loss)
Retiree Mortality	April 1, 2020	Based on System experience FYE 2016 – FYE 2020
Mortality Improvement	April 1, 2022	Society of Actuaries' MP-2021 for retirees only
Active Member Decrements	April 1, 2020	Based on System experience FYE 2016 – FYE 2020

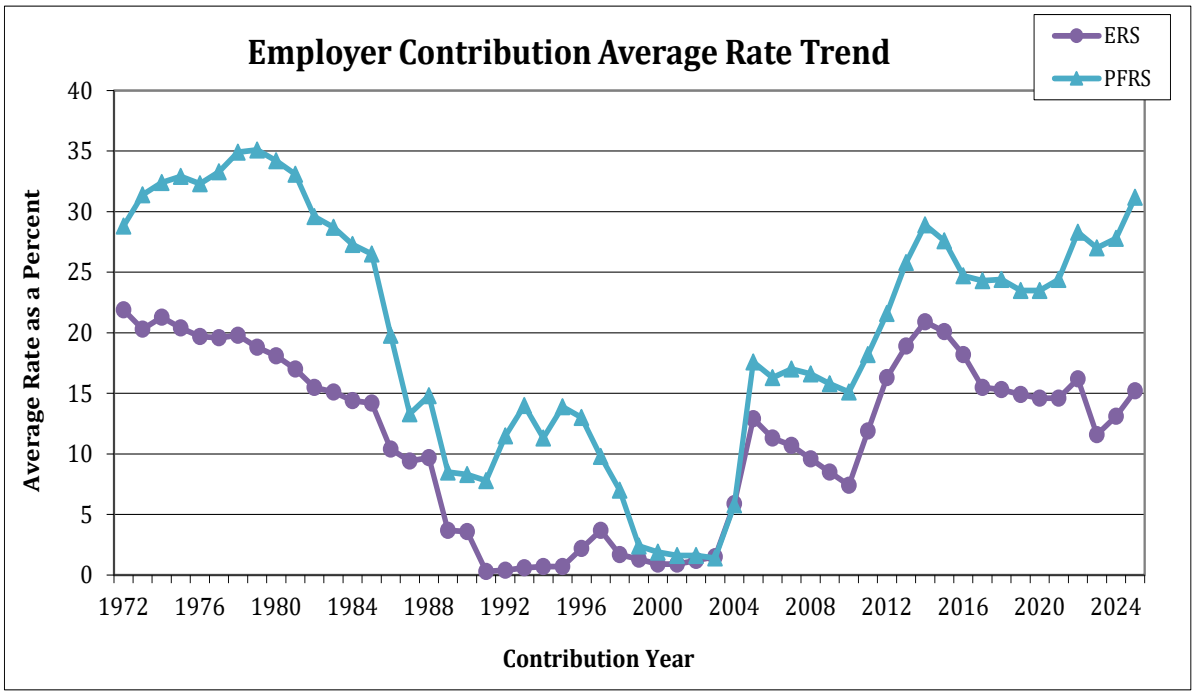
This recommendation was reviewed by the Actuarial Advisory Committee (AAC) in a meeting on August 9, 2023.

Historic Employer Contribution Average Rate

Average Rate		
Year	ERS	PFRS
1972	21.9	28.8
1973	20.3	31.4
1974	21.3	32.4
1975	20.4	32.9
1976	19.7	32.3
1977	19.6	33.3
1978	19.8	34.9
1979	18.8	35.1
1980	18.1	34.2
1981	17.0	33.1
1982	15.5	29.6
1983	15.1	28.7
1984	14.4	27.3
1985	14.2	26.5
1986	10.4	19.8
1987	9.4	13.3
1988	9.7	14.8
1989	3.7	8.5
1990	3.6	8.3

Average Rate		
Year	ERS	PFRS
1991	0.3	7.8
1992	0.4	11.5
1993	0.6	14.0
1994	0.7	11.3
1995	0.7	13.9
1996	2.2	13.0
1997	3.7	9.8
1998	1.7	7.0
1999	1.3	2.4
2000	0.9	1.9
2001	0.9	1.6
2002	1.2	1.6
2003	1.5	1.4
2004	5.9	5.8
2005	12.9	17.6
2006	11.3	16.3
2007	10.7	17.0
2008	9.6	16.6
2009	8.5	15.8

Average Rate		
Year	ERS	PFRS
2010	7.4	15.1
2011	11.9	18.2
2012	16.3	21.6
2013	18.9	25.8
2014	20.9	28.9
2015	20.1	27.6
2016	18.2	24.7
2017	15.5	24.3
2018	15.3	24.4
2019	14.9	23.5
2020	14.6	23.5
2021	14.6	24.4
2022	16.2	28.3
2023	11.6	27.0
2024	13.1	27.8
2025	15.2	31.2



Risk Disclosures

Why should a governmental entity take on defined benefit (DB) pension risk? DB plans are an economically efficient means of attracting and retaining employees. For example, in the matter of public safety, special plans offer half-pay at 20 or 25 years of service guarantee income in later middle age when physicality may wane while tasks remain grueling. During their career, disability and death benefits provide income protection to those who risk their lives in service to the public.

Optimizing the economic efficiencies of a DB plan requires prefunding the benefit promises, ideally by way of smooth employer contribution rates. Actuarial Standard of Practice No. 51 (ASOP 51 "Assessment and Disclosure of Risk Associated with measuring Pension Obligations and Determining Pension Plan Contributions") requires assessment and disclosure of risks inherent in the funding of DB plans. The two primary forms of risk are 1) insufficient employer contributions to fund the benefits, and 2) intolerable volatility in the employer contribution rate.

Employer Contribution Sufficiency Risk

Contribution Fulfillment Risk

In New York State, employers are required to pay the actuarially determined contribution. Employers who are delinquent are pursued and interest is charged on any late payments. Thus, there is very little risk that employer contributions will not be paid. This is the most significant component of a well-funded DB plan. Poorly funded DB plans invariably have a stretch of time when employer contributions are neglected.

Actuarial Assumptions

Actuarial assumptions and methods determine the allocation of benefit costs over time; they do not, however, determine the ultimate benefit costs. The ultimate cost of benefits is based on the lucrativeness of the promises and the performance of the assets.

The expected long-term employer contribution rate is the rate that would be charged if all assumptions were met annually. As experience deviates from what was assumed, the employer contribution rates deviate from the expected long-term rate. When billing rates are greater than the expected long-term rates, the current taxpayer is funding benefits earned in prior years. When billing rates are less than the expected long-term rates, the current taxpayer is benefiting from contributions collected in prior years. The more conservative a set of assumptions, the more quickly contributions are collected, possibly levying too great a cost to current taxpayers. The less conservative a set of assumptions, the more likely contributions will increase, possibly levying too great a cost to future taxpayers. The best assumptions decrease the likelihood of deviations in one direction persisting over long periods. In so doing, governmental services are compensated by the taxpayers benefitting from those services (that is, there is intergenerational equity).

New York State Retirement and Social Security Law (NYS RSSL) requires a review of all assumptions at least once every five years. To comply, the New York State and Local Retirement System (NYSLRS) undertakes a quinquennial comprehensive experience study with a reasonableness review every year. Any emerging trends that are believed to continue in the future may warrant an assumption adjustment between quinquennial studies. Assumptions are reviewed annually by the Comptroller's Actuarial Advisory Committee and quinquennially by a consulting firm. The annual online publishing of the actuarial assumptions provides transparency to interested parties.

Assumed Investment Return Expectation Risk

Employer contribution rates are most sensitive to the assumed investment return. The following table shows the FY 2025 system average billing rates and April 1, 2023 total pension liability (actuarial accrued liability under the Entry Age Normal method + dedicated assets) for various assumed investment returns using the April 1, 2023 valuation cohort. The exceedance column shows the probability of exceeding the assumed return over a 30-year period. The Division of Pension and Investment Cash Management (PICM) is currently in the process of completing a comprehensive asset/liability analysis. The capital market assumptions are from the current 2023 analysis, but the Asset Allocation Policy is not yet finalized so the trustee-approved allocation from 2020 was used.

	Employees' Retirement System		Police and Fire Retirement System		2023 CAPM Assumptions
Assumed Rate	FYE 2025 System Average Billing Rate	April 1, 2023 TPL ($ in billions)	FYE 2025 System Average Billing Rate	April 1, 2023 TPL ($ in billions)	Probability of Assumed Rate Exceedance
3.90%*	44.9%	$299.3	72.1%	$57.7	89.7%
4.40%	36.9%	$281.3	60.9%	$54.1	84.6%
4.90%	29.3%	$264.9	50.4%	$50.8	77.6%
5.40%	22.1%	$249.9	40.6%	$47.8	69.4%
5.90%	**15.2%**	**$236.3**	**31.2%**	**$45.0**	**60.5%**
6.90%	2.3%	$212.3	13.8%	$40.3	39.5%

*ASOP 4 requires disclosure of a low-default risk obligation measure (LDROM). It represents the funding liability if the plan invested solely in high-quality bonds with cash flows matching future benefit payments. An all-bond investment strategy is approximated by an assumed rate of return of 3.9% resulting in a liability of approximately $299.3 billion in ERS and $57.7 billion in PFRS. Under the current assumed rate of return, which reflects the plan's diversified portfolio, the pension liability is approximately $236.3 billion in ERS and $45.0 in PFRS. The difference between these liability measures represents the expected tax savings due to investment in the plan's diversified portfolio instead of solely in high-quality bonds. If the plan switched to investing in high-quality bonds, the higher LDROM implies higher employer contribution rates. Unnecessarily high contribution rates in the near term may not be affordable and could jeopardize sustainability of the DB plan.

Inflation and Salary Scale Expectation Risk

The inflation assumption is used to compute COLA (cost-of-living adjustment) payments to retirees and beneficiaries. The COLA program provides payments equal to one-half of the inflation rate based on the first $18,000 of the single life allowance. A floor of 1% and a cap of 3% reduces the risk of significant gains or losses in this valuation component.

The salary scale assumption is used to project future increases in a member's salary to estimate the final average salary at retirement as well as determine billable salary over a member's career. If members receive greater salary increases than assumed, greater benefits will be paid out in the future than expected, requiring an increase in employer contributions to make up for the shortfall. Salary increases vary within a relatively narrow range, so there is minor risk of significant gains or losses in this valuation component.

Demographic Expectation Risks

Demographic assumptions estimate member behavior with regard to decrements (that is, change in status) such as retiring, withdrawing or dying. Since the NYSLRS is sufficiently large (over 1.1 million participants), these assumptions are developed with a high degree of credibility using the NYSLRS' own experience. Actual/Expected (A/E) ratios are displayed earlier in this report to show how actual retiree mortality and active member decrements track expectations. Decrements vary within a relatively narrow range, so there is minor risk of significant gains or losses in this valuation component.

The NYSLRS is not large enough to develop in-house mortality improvement assumptions and thus relies on mortality improvement scales based on nationwide experience derived from data collected from the Social Security Administration by the Society of Actuaries (SOA). This report recommends using scale MP-2021 for the April 1, 2023 valuation. More recent SOA tables vary within a relatively narrow range so there is minor risk of significant gains or losses in this valuation component.

Employer Contribution Volatility Risk

Investment Volatility Risk

Employer contribution rate smoothness is most sensitive to the investment return experience. We can evaluate exposure to investment volatility risk using the following Asset Leverage Ratio:

$$\textit{Asset Leverage Ratio} = \frac{\textit{Market Value of Assets (MVA)}}{\textit{Present Value of Valuation Cohort Billable Salary (PVBS)}}$$

The following table displays the ratio and its components in the middle of the last four decades and for the most recent year (dollar amounts in billions).

	FYE	1985	1995	2005	2015	2023
ERS	MVA	$22.8	$53.3	$108.7	$161.2	$211.2
	PVBS	$102.0	$158.2	$176.1	$203.1	$287.1
	Asset Leverage Ratio	22%	34%	62%	79%	74%
	Smoothing Period	5	5	5	5	8
	Smoothed Asset Leverage Ratio	4.5%	6.7%	12.3%	15.9%	9.2%
PFRS	MVA	$4.1	$9.8	$19.3	$28.2	$38.3
	PVBS	$11.9	$16.5	$27.0	$30.9	$47.1
	Asset Leverage Ratio	34%	59%	71%	91%	81%
	Smoothing Period	5	5	5	5	8
	Smoothed Asset Leverage Ratio	6.9%	11.9%	14.3%	18.3%	10.2%

The ratio is zero at plan inception but increases as assets accumulate. Poor investment performance in a new plan is not problematic as there was not much asset value to lose and there was plenty of billable salary to collect contributions and accumulate assets before benefits become due. In a more mature fund with a high asset leverage ratio, investment volatility has a greater impact on the employer contribution rate. The NYSLRS is now a mature plan with the associated significant exposure to investment volatility risk.

Increasing Plan Maturity

Pension plans mature slowly with a regular infusion of new entrants and release of liabilities as retirees decease. A pension plan becomes mature when those collecting a benefit (retirees) outweigh those contributing to the plan (active members). The following ratio of the retiree actuarial accrued liability to total actuarial accrued liability shows the scales tipping in favor of the retiree population.

Ratio of Inactive Liability to Total Accrued Liability by Fiscal Year

FYE	1985	1995	2005	2010	2015	2020	2023
ERS	21%	26%	45%	47%	54%	60%	61%
PFRS	20%	36%	54%	56%	58%	64%	67%

As the NYSLRS becomes more heavily steeped in inactive liability (retirees and beneficiaries) shortfalls of assets will trigger a larger increase in the billing rates, as a smaller contribution base must recoup the shortfall for a larger inactive population. Since active members must support the retiree population liability after a market decline, it may be necessary to limit investment risk. Liquidity risk also becomes a concern if the cash contributions are not enough to pay benefit payments as they come due.

Liquidity Risk

Cash assets are required to fulfill benefit promises when due. As a plan matures and more benefits are being paid out of the fund, there is a cash flow concern. The net cash flow is the difference between the cash inflows (employer contributions, member contributions, and member loan repayments) and the cash outflows (benefit payments and administrative expenses). A positive net cash flow indicates that assets are accumulating. A negative net cash flow will require the drawdown of assets to pay benefits.

$$\textit{Net Benefits Cash Flow Ratio} = \frac{\textit{Contributions — Benefit Payments and Expenses}}{\textit{Market Value of Assets}}$$

The NYSLRS has had a negative net cash flow over recent years, but this does not indicate a financial hardship. The purpose of prefunding a pension plan is to accumulate assets, which are then drawn down to settle benefits. In fact, negative net cash flows are expected when a system is well-funded, because employer contributions (the largest source of cash inflow) are relatively lower.

However, a slow and steady change in the membership demographics changes liquidity needs and influences a pension system's risk exposure. To monitor exposure to liquidity risk over time, we can use the Net Cash Flow Ratio.

Net Benefit Cash Flow Ratio by Fiscal Year

FYE	1995	2005	2010	2015	2020	2023
ERS	-3.1%	-1.8%	-3.8%	-2.3%	-4.2%	-4.4%
PFRS	-2.1%	-2.3%	-3.9%	-2.4%	-3.9%	-3.3%

Because the net cash flow is relatively small compared to its assets, the ability of the NYSLRS to make timely benefit payments is not impaired and there is little concern of liquidity risk in the near term. Liquidity concerns are further mitigated by cash flows available from assets (interest, dividends, bond maturities and rental income from real estate) and the ability to sell highly liquid assets to meet benefit requirements.

A negative Net Cash Flow Ratio does make the system more sensitive to short-term investment performance. After a market decline, liquid assets may be drawn down to continue benefit payments. This can compete with an investment strategy directing liquid assets to be sold to finance the purchase of cheap equity investments in anticipation of a market recovery, potentially constraining the flexibility of the NYSLRS. More conservative asset allocations may limit exposure to market declines, while larger cash allocation could improve flexibility. But both would be expected to reduce the expected investment return in the long term, which informs the actuary's assumed liability discount rate and could lead to increased contribution requirements.

The negative Net Cash Flow Ratio can also be viewed in terms of continued accumulation of assets. Cash inflows are directed toward benefits, so the fund is reliant upon investment income to continue asset accumulation. This increases exposure to investment risk.

COVID Demographic Experience Risk

Every five years, the NYSLRS conducts a comprehensive study of demographic experience and revises assumptions to reflect the most recent five years of experience. Typically, any change in assumptions is relatively small.

The COVID-19 pandemic impacted all aspects of society, the consequences of which are evident in the demographic experience of NYSLRS members and retirees over the past three years. Should member behavior continue to diverge from current assumptions, the rate consequences in 2025 will be more severe than in the past. The following approximates the rate impact of aligning assumptions to reflect the past three years of experience, focusing on three categories:

1. Rates of withdrawal: members are separating from service at higher levels than expected.
2. Salary Scale: salary increases have exceeded expectations, resulting in higher projected benefits at retirement.
3. Rates of retirement: members have been retiring more quickly than expected reducing billable salary and increasing benefits payable in retirement.

Assumption	ERS Rate Impact	PFRS Rate Impact
Withdrawals	– 1.0%	– 1.4%
Salary Scale	+ 2.7%	+ 4.1%
Service Retirements	+ 0.3%	+ 1.9%

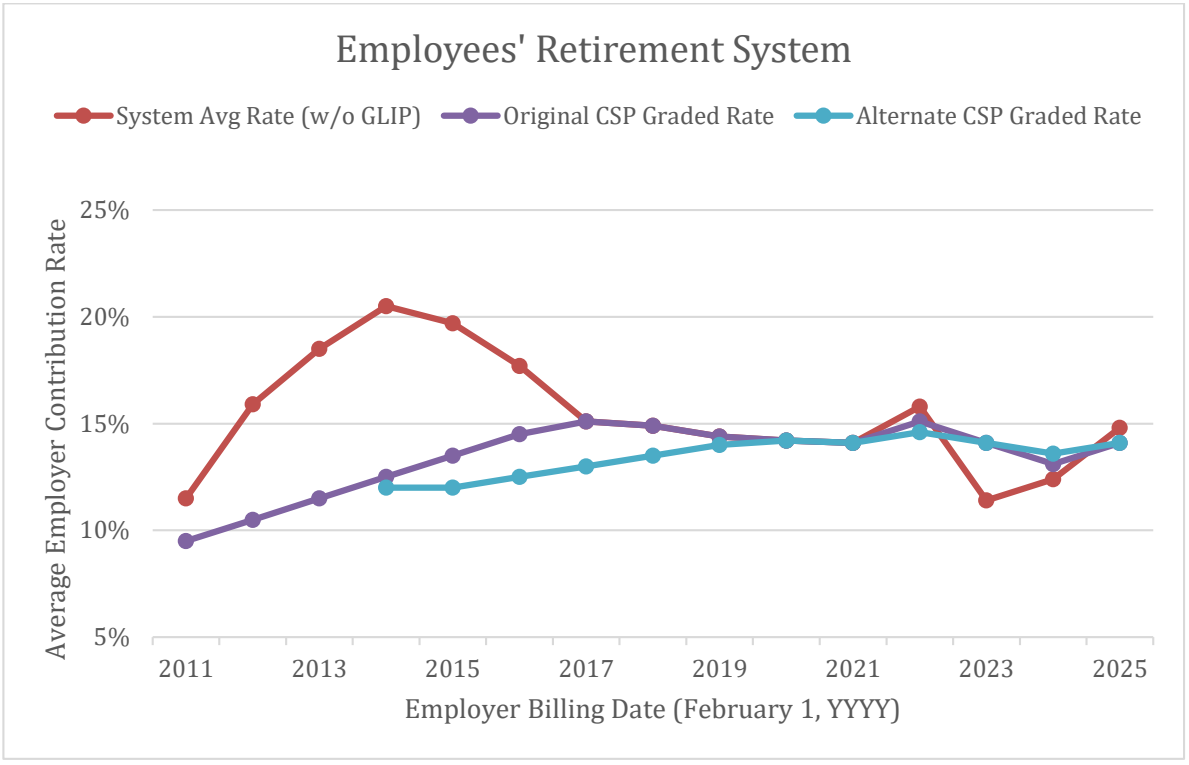
In evaluating if and how assumptions should be changed, the underlying raw data measurements may need to be adjusted before drawing conclusions. These adjustments represent greater uncertainty and increase the degree of subjectivity. This could limit the precision of future assumption changes, so future demographic shifts may contribute more volatility than experienced in prior periods.

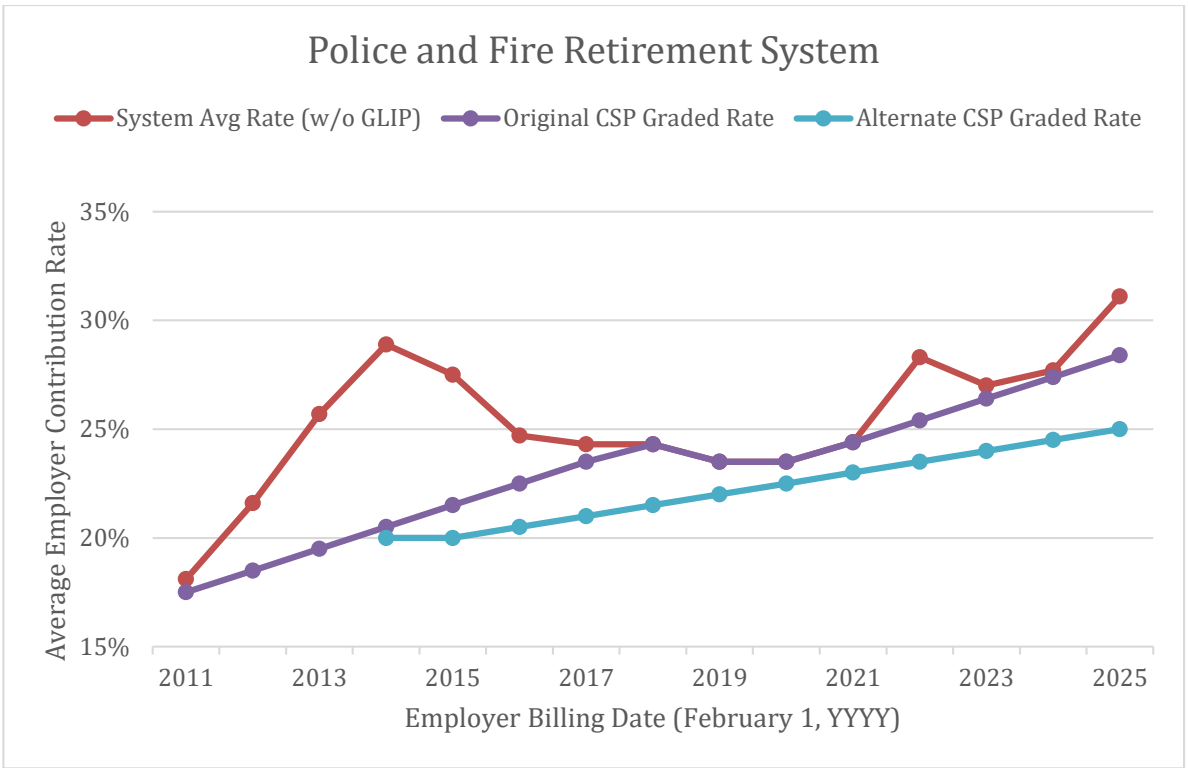
Mitigating Employer Contribution Volatility Risk

The NYSLRS currently employs two methods to reduce employer contribution rate volatility. An 8-year smoothing method is used to dampen annual investment return volatility. Any deviations from the current expected return of 5.9% are recognized in equal increments over a period of eight years. Note that 8-year smoothing in 2023 has the same impact as 5-year smoothing in the late 1990s for PFRS, and early 2000s in ERS.

The Contribution Stabilization Program (CSP) was signed into law in 2010. The Alternate Contribution Stabilization Program (Alternate CSP) was signed in 2014 and had a one-year opt-in window. The CSP provides an optional additional layer of employer contribution rate smoothing. Under the CSP, on the billing date, a participating employer is required to remit a graded rate contribution and permitted to amortize over a 10-year period the balance between the actuarial contribution and the graded rate contribution (12-year period for the Alternate CSP). The graded rate increases or decreases up to 1% each year (0.5% for the Alternate CSP) in the direction of the system average contribution rate. During "ordinary" investment periods, the actuarial and graded rates converge. Large deviations may occur when there is extraordinary asset performance, such as after the Global Financial Crisis of 2008 or the COVID pandemic.

The following graphs show the graded rates versus the system average rates over the course of both programs. The system average rates are much more volatile than the graded rates. The graded rates peak lower and later than the system average rates. Therefore, employers in the CSP experience less contribution risk due to increased stability of billing rates.


Employees' Retirement System
System Avg Rate (w/o GLIP)
Original CSP Graded Rate
Alternate CSP Graded Rate
Average Employer Contribution Rate
25%
20%
15%
10%
5%
2011
2013
2015
2017
2019
2021
2023
2025
Employer Billing Date (February 1, YYYY)


Police and Fire Retirement System
System Avg Rate (w/o GLIP)
Original CSP Graded Rate
Alternate CSP Graded Rate
Average Employer Contribution Rate
35%
30%
25%
20%
15%
2011
2013
2015
2017
2019
2021
2023
2025
Employer Billing Date (February 1, YYYY)

Appendices

Appendix A: History of Cashflows, Assets, and Billing Rates

FYE 3/31	Contributions* [C]		Benefits* [B]	Invested Assets* [CRF]	(C-B)/CRF	S&P 500		Assumed CRF Return	Average Employer Contribution Rate	
	Employer	Employee							ERS	PFRS
1970	$ 299.2	$ 75.0	$ 158.2	$ 3,532.6	6.1%	89.63	NYSLRS has large positive net cash flow	4.87%	18.9%	22.2%
1971	346.0	77.4	194.3	3,888.2	5.9	100.31		4.87	19.8	23.9
1972	490.8	80.4	243.2	4,389.5	7.5	107.20		4.87	21.9	28.8
1973	553.0	73.0	287.9	5,167.8	6.5	111.52		4.87	20.3	31.4
1974	664.5	61.6	334.6	5,393.0	7.3	93.98		4.87	21.3	32.4
1975	749.3	52.9	373.4	5,915.3	7.2	83.36		5.50	20.4	32.9
1976	872.2	48.0	431.0	7,080.7	6.9	102.77		5.50	19.7	32.3
1977	981.3	41.7	461.3	7,852.0	7.2	98.42		5.50	19.6	33.3
1978	1,001.4	71.7	516.8	8,812.5	6.3	89.21		5.50	19.8	34.9
1979	1,020.6	61.2	568.8	10,326.7	5.0	101.59		5.50	18.8	35.1
1980	1,296.7	34.5	631.4	11,725.9	6.0	102.09	Asset allocation shifting to more equities, Inflation drops significantly	5.50	18.1	34.2
1981	1,296.0	47.8	695.5	14,194.6	4.6	136.00		5.50	17.0	33.1
1982	1,363.9	61.5	755.8	15,088.5	4.4	111.96		7.50	15.5	29.6
1983	1,481.3	84.0	840.3	18,626.5	3.9	152.96		7.50	15.1	28.7
1984	1,496.1	97.5	940.5	20,618.3	3.2	159.18		7.50	14.4	27.3
1985	1,610.5	116.0	1,063.4	24,062.3	2.8	180.66		7.50	14.2	26.5
1986	1,277.0	132.3	1,157.0	29,926.1	0.8	238.90		8.00	10.4	19.8
1987	1,174.0	151.2	1,275.8	35,621.8	0.1	291.70		8.00	9.4	13.3
1988	1,321.3	188.5	1,381.9	35,812.5	0.4	258.89		8.00	9.7	14.8
1989	759.4	194.7	1,624.7	40,280.6	-1.7	294.87		8.75	3.7	8.5
1990	412.2	229.9	1,670.4	45,189.3	-2.3	339.94		8.75	3.6	8.3
1991	-72.4	255.3	1,834.2	48,945.5	-3.4	375.22		8.75	0.3	7.8
1992	356.8	287.0	2,067.7	51,925.8	-2.7	403.69	Oil is inexpensive, Gov't a lower % of GDP	8.75	0.4	11.5
1993	369.8	284.1	2,267.9	56,428.9	-2.9	451.67		8.75	0.6	14.0
1994	530.1	307.5	2,393.7	58,416.8	-2.7	445.77		8.75	0.7	11.3
1995	315.1	334.0	2,527.9	63,406.6	-3.0	500.71		8.75	0.7	13.9
1996	776.9	341.9	2,877.9	74,827.9	-2.4	645.50		8.75	2.2	13.0
1997	903.5	348.2	3,122.0	82,333.8	-2.3	757.12		8.75	3.7	9.8
1998	462.6	369.4	3,305.0	104,921.8	-2.4	1,101.75		8.50	1.7	7.0
1999	291.7	399.8	3,482.0	111,008.7	-2.5	1,286.37		8.50	1.3	2.4
2000	164.5	422.7	3,720.2	127,138.9	-2.5	1,498.58		8.50	0.9	1.9
2001	214.8	319.1	4,181.0	112,432.9	-3.2	1,160.33	Enron & 9/11	8.00	0.9	1.6
2002	263.8	210.2	4,488.3	111,168.5	-3.6	1,147.39	Housing Bubble	8.00	1.2	1.6
2003	651.9	219.2	4,984.6	95,598.3	-4.3	848.18		8.00	1.5	1.4
2004	1,286.5	221.9	5,347.5	119,245.0	-3.2	1,126.21		8.00	5.9	5.8
2005	2,964.8	227.3	5,674.7	126,083.5	-2.0	1,180.59		8.00	12.9	17.6
2006	2,782.2	241.2	6,028.9	140,453.3	-2.1	1,294.87		8.00	11.3	16.3
2007	2,718.6	250.2	6,383.4	154,575.5	-2.2	1,420.86		8.00	10.7	17.0
2008	2,648.4	265.7	6,835.6	153,877.7	-2.5	1,322.70	Financial Crisis	8.00	9.6	16.6
2009	2,456.2	273.3	7,212.1	108,960.7	-4.1	797.87		8.00	8.5	15.8
2010	2,344.2	284.3	7,718.9	132,500.2	-3.8	1,169.43	Rebound and Fed support	8.00	7.4	15.1
2011	4,164.6	286.2	8,520.2	147,237.0	-2.8	1,325.83		7.50	11.9	18.2
2012	4,585.2	273.2	8,937.8	150,658.9	-2.7	1,408.47		7.50	16.3	21.6
2013	5,336.0	269.1	9,521.5	160,660.8	-2.4	1,569.19		7.50	18.9	25.8
2014	6,064.1	281.4	9,977.5	176,835.1	-2.1	1,872.34		7.50	20.9	28.9
2015	5,797.4	284.8	10,513.7	184,502.0	-2.4	2,067.89		7.50	20.1	27.6
2016	5,140.2	306.6	11,060.5	178,639.7	-3.1	2,059.74		7.00	18.2	24.7
2017	4,787.0	328.8	11,508.3	192,410.6	-3.3	2,362.72	Tax Cuts and Deregulation	7.00	15.5	24.3
2018	4,823.3	349.4	12,128.9	207,416.0	-3.4	2,640.87		7.00	15.3	24.4
2019	4,744.3	386.5	12,833.9	210,523.7	-3.7	2,834.40		6.80	14.9	23.5
2020	4,782.7	453.7	13,311.1	194,317.2	-4.2	2,584.59	Bear Market	6.80	14.6	23.5
2021	5,029.8	492.3	14,122.0	258,135.8	-3.3	3,972.89	COVID Pandemic	6.80	14.6	24.4
2022	5,627.7	577.6	14,905.0	272,121.3	-3.4	4,530.41		5.90	16.2	28.3
2023	$ 4,404.1	$ 656.8	$15,174.3	$248,524.9	-4.1%	4,109.31		5.90%	11.4%	27.0%

*millions of dollars

Appendix B: Assumption Details

This section strives to disclose all material assumptions, and details various decrement rates used in the valuation.

Some miscellaneous assumptions in the Employees' Retirement System (ERS) include:

- When a disability benefit is subject to a workers' compensation offset, we assume the offset is 15% of final average salary.
- Some members can convert unused sick leave at retirement into additional service credit. We assume that 3 days are credited for each year of service.
- Members in Tiers 5 and 6 are subject to a narrower definition of how much overtime can be included in their final average salary. For Tier 5, the limit increases 3% each year. For Tier 6, the limit is indexed to inflation. Therefore, we assume no valuation impact.
- For Tier 6 members, each year's salary used in computing the final average salary is capped at the Governor's Salary, currently $225,000. The Governor's Salary is assumed to increase at the rate of inflation each year.
- For projecting the billable salary base, tier specific assumptions are used, as shown below.

Tier	1	2	3	4	5	6
Projection Factor	0.75	0.75	0.80	0.96	1.01	1.20

- Chapter 56 of the Laws of 2022, effective 4/9/2022, changed the vesting schedule for members of Tiers 5 and 6 from 10-year cliff vesting to 5-year cliff vesting, aligning with the Tier 1-4 vesting schedule. Before this law change, it was possible and necessary to develop two sets of withdrawal assumptions to reflect different vesting schedules. So, although all members now become fully vested upon attaining 5 years of service credit, withdrawal assumptions are obtained by applying multipliers, below, to the rates reported in Table 12.

Vesting	0 ≤ Srv < 2	2 ≤ Srv < 3	3 ≤ Srv < 4	4 ≤ Srv < 5	5 ≤ Srv < 10	10 ≤ Srv < 11	11 ≤ Srv
5-year	1.30	1.30	1.30	1.30	1.20	1.00	1.00
10-year	1.00	0.95	0.95	0.90	0.85	1.70	0.85

Additionally, for Tiers 1, 2, 3, and 4, when service < 10, the age 58 central rate is used for all ages ≥ 58.

Some miscellaneous assumptions in the Police and Fire Retirement system (PFRS) include:

- When a disability benefit is subject to a workers' compensation offset, we assume the offset is 5% of final average salary. For accidental death benefits, we assume the workers' compensation offset is 18% of final average salary, and we assume the social security offset is 6% of salary.
- Some members can convert unused sick leave at retirement into additional service credit. We assume that 4 days are credited for each year of service, subject to a maximum of 165 days.
- Some members are entitled to a benefit based upon a 1-year final average salary (FAS). In these cases, salary is seen to increase faster than the assumed salary scale in the year prior to retirement. A factor (OneYearFAS) is multiplied by the plan's usual FAS calculation to estimate the 1-year FAS. For Tier 1 members with date of membership prior to April 1, 1972, OneYearFAS is 1.08. For Tiers 5 and 6, OneYearFAS is 1.09. And for all others, OneYearFAS is 1.18.
- Members in tiers 5 and 6 are subject to a narrower definition of how much overtime can be included in their final average salary. The active valuation includes an OTLimit factor that trims PFRS Tier 5 liabilities by 5% and PFRS Tier 6 liabilities by 10%.
- For Tier 6 members, each year's salary used in computing the final average salary is capped at the Governor's Salary, currently $225,000. The Governor's Salary is assumed to increase at the rate of inflation each year.
- For projecting the billable salary base, tier specific assumptions are used, as shown below.

Tier	**1**	**2**	**3**	**4**	**5**	**6**
Projection Factor	0.75	0.97	0.75	N/A	1.04	1.25

The remainder of this appendix provides the assumed decrement rates for retiree mortality (including beneficiary mortality) and active member decrements (withdrawal, death, disability, service retirement) and salary scale assumptions, for both systems.

Assumption sets are presented in a series of tables organized by system and decrement type.

Table 1	Employees' Retirement System **Male Clerk Service** Retiree Mortality[1]
Table 2	Employees' Retirement System **Female Clerk Service** Retiree Mortality[1]
Table 3	Employees' Retirement System **Male Laborer Service** Retiree Mortality[1]
Table 4	Employees' Retirement System **Female Laborer Service** Retiree Mortality[1]
Table 5	Employees' Retirement System **Male Disability** Retiree Mortality[1]
Table 6	Employees' Retirement System **Female Disability** Retiree Mortality[1]
Table 7	Police & Fire Retirement System **Service** Retiree Mortality[1]
Table 8	Police & Fire Retirement System **Disability** Retiree Mortality[1]
Table 9	Retirement System **Male Beneficiary** Mortality[1 2]
Table 10	Retirement System **Female Beneficiary** Mortality[1 3]
Table 11	Employees' Retirement System **Death and Disability** Central Rates of Decrement
Table 12	Employees' Retirement System **Withdrawal** Central Rates of Decrement
Table 13	Employees' Retirement System **Age-Based Plans Retirement** Central Rates of Decrement
Table 14	Employees' Retirement System **Service-Based Plans Retirement** Central Rates of Decrement
Table 15	Police & Fire Retirement System **Death and Disability** Central Rates of Decrement
Table 16	Police & Fire Retirement System **Withdrawal** Central Rates of Decrement
Table 17	Police & Fire Retirement System **Age-Based Plans Retirement** Central Rates of Decrement
Table 18	Police & Fire Retirement System **Service-Based Plans Retirement** Central Rates of Decrement
Table 19	Employees' Retirement System **Salary Scale**
Table 20	Police & Fire Retirement System **Salary Scale**

[1] The base mortality (q_x) is generally only changed once every five years, with the quinquennial review. Mortality Improvement is applied from the midpoint of the experience study period (10/1/2017) through to the valuation date (4/1/2023). Therefore, the mortality improvement factors will change each year as an additional year of improvement is applied. This causes the valuation mortality rates (Val q_x) to change year-over-year.

[2] In the active valuation, it is assumed that all beneficiaries will be female. The liability impact is immaterial.

[3] In the active valuation, it is assumed that beneficiaries are two years younger than the member.

TABLE 1: Employees' Retirement System Male Clerk Service Retiree Mortality
Effective 4/1/2023 (For Valuation Purposes Only)

Age	q_x	MP-2021 Factor	2023 Val q_x
0	0.000190	1.048505	0.000199
1	0.000190	1.048505	0.000199
2	0.000190	1.048505	0.000199
3	0.000190	1.048505	0.000199
4	0.000190	1.048505	0.000199
5	0.000190	1.048505	0.000199
6	0.000190	1.048505	0.000199
7	0.000190	1.048505	0.000199
8	0.000190	1.048505	0.000199
9	0.000190	1.048505	0.000199
10	0.000190	1.048505	0.000199
11	0.000190	1.048505	0.000199
12	0.000190	1.048505	0.000199
13	0.000190	1.048505	0.000199
14	0.000190	1.048505	0.000199
15	0.000190	1.048505	0.000199
16	0.000200	1.048505	0.000210
17	0.000220	1.048505	0.000231
18	0.000230	1.048505	0.000241
19	0.000240	1.048505	0.000252
20	0.000260	1.048505	0.000273
21	0.000270	1.049206	0.000283
22	0.000290	1.051962	0.000305
23	0.000300	1.057150	0.000317
24	0.000320	1.065218	0.000341
25	0.000340	1.075687	0.000366
26	0.000360	1.088136	0.000392
27	0.000380	1.102948	0.000419
28	0.000400	1.118720	0.000447
29	0.000420	1.135095	0.000477
30	0.000450	1.151504	0.000518
31	0.000470	1.167205	0.000549
32	0.000500	1.181824	0.000591
33	0.000530	1.195066	0.000633
34	0.000560	1.206186	0.000675
35	0.000590	1.214816	0.000717
36	0.000620	1.220207	0.000757
37	0.000660	1.222057	0.000807
38	0.000690	1.219646	0.000842
39	0.000730	1.213021	0.000886
40	0.000780	1.201915	0.000937
41	0.000820	1.186888	0.000973
42	0.000870	1.168456	0.001017
43	0.000920	1.147450	0.001056
44	0.000970	1.124406	0.001091
45	0.001020	1.100573	0.001123
46	0.001080	1.077149	0.001163
47	0.001140	1.054159	0.001202
48	0.001210	1.032904	0.001250
49	0.001280	1.014100	0.001298
50	0.001350	0.997996	0.001347
51	0.001924	0.985087	0.001895
52	0.002498	0.975619	0.002437
53	0.003072	0.969707	0.002979
54	0.003646	0.966980	0.003526
55	0.004220	0.967173	0.004081
56	0.004579	0.969897	0.004441
57	0.004965	0.974607	0.004839
58	0.005376	0.980638	0.005272
59	0.005809	0.987121	0.005734
60	0.006261	0.993814	0.006222
61	0.006730	0.999721	0.006728
62	0.007216	1.004630	0.007249
63	0.007722	1.008076	0.007784
64	0.008260	1.009541	0.008339
65	0.008842	1.009068	0.008922
66	0.009490	1.006608	0.009553
67	0.010225	1.002122	0.010247
68	0.011075	0.996154	0.011032
69	0.012063	0.989272	0.011934
70	0.013218	0.982008	0.012980
71	0.014565	0.974935	0.014200
72	0.016131	0.968342	0.015620
73	0.017947	0.962924	0.017282
74	0.020047	0.958738	0.019220
75	0.022475	0.955964	0.021485
76	0.025282	0.954303	0.024127
77	0.028533	0.953750	0.027213
78	0.032304	0.954255	0.030826
79	0.036691	0.955459	0.035057
80	0.041796	0.956929	0.039996
81	0.047727	0.959149	0.045777
82	0.054585	0.961471	0.052482
83	0.062463	0.963797	0.060202
84	0.071442	0.966323	0.069036
85	0.081582	0.968707	0.079029
86	0.092925	0.971048	0.090235
87	0.105497	0.973173	0.102667
88	0.119307	0.975107	0.116337
89	0.134353	0.976920	0.131252
90	0.150626	0.978221	0.147346
91	0.168112	0.979278	0.164628
92	0.186795	0.979819	0.183025
93	0.206658	0.979720	0.202467
94	0.227684	0.979180	0.222944
95	0.249859	0.977902	0.244338
96	0.273113	0.977902	0.267078
97	0.297118	0.978098	0.290611
98	0.321122	0.978442	0.314199
99	0.345127	0.979032	0.337890
100	0.369131	0.979942	0.361727
101	0.394636	0.981073	0.387167
102	0.422391	0.982255	0.414896
103	0.453897	0.983438	0.446380
104	0.490654	0.984845	0.483218
105	0.534162	0.985932	0.526647
106	0.587422	0.987242	0.579928
107	0.653435	0.988653	0.646020
108	0.738201	0.989842	0.730703
109	0.849972	0.991157	0.842456
110	1.000000	n/a	1.000000

TABLE 2: Employees' Retirement System Female Clerk Service Retiree Mortality
Effective 4/1/2023 (For Valuation Purposes Only)

Age	q_x	MP-2021 Factor	2023 Val q_x
0	0.000190	1.060483	0.000201
1	0.000190	1.060483	0.000201
2	0.000190	1.060483	0.000201
3	0.000190	1.060483	0.000201
4	0.000190	1.060483	0.000201
5	0.000190	1.060483	0.000201
6	0.000190	1.060483	0.000201
7	0.000190	1.060483	0.000201
8	0.000190	1.060483	0.000201
9	0.000190	1.060483	0.000201
10	0.000190	1.060483	0.000201
11	0.000190	1.060483	0.000201
12	0.000190	1.060483	0.000201
13	0.000190	1.060483	0.000201
14	0.000190	1.060483	0.000201
15	0.000190	1.060483	0.000201
16	0.000200	1.060483	0.000212
17	0.000220	1.060483	0.000233
18	0.000230	1.060483	0.000244
19	0.000240	1.060483	0.000255
20	0.000260	1.060483	0.000276
21	0.000270	1.063263	0.000287
22	0.000290	1.067310	0.000310
23	0.000300	1.072689	0.000322
24	0.000320	1.079204	0.000345
25	0.000340	1.087542	0.000370
26	0.000360	1.096959	0.000395
27	0.000380	1.107691	0.000421
28	0.000400	1.119331	0.000448
29	0.000420	1.130960	0.000475
30	0.000450	1.142272	0.000514
31	0.000470	1.152671	0.000542
32	0.000500	1.161260	0.000581
33	0.000530	1.167186	0.000619
34	0.000560	1.169788	0.000655
35	0.000590	1.168932	0.000690
36	0.000620	1.163884	0.000722
37	0.000660	1.154998	0.000762
38	0.000690	1.142535	0.000788
39	0.000730	1.127168	0.000823
40	0.000780	1.109187	0.000865
41	0.000820	1.089584	0.000893
42	0.000870	1.069308	0.000930
43	0.000920	1.048716	0.000965
44	0.000970	1.028984	0.000998
45	0.001020	1.010313	0.001031
46	0.001080	0.993236	0.001073
47	0.001140	0.977968	0.001115
48	0.001210	0.965125	0.001168
49	0.001280	0.955067	0.001222
50	0.001350	0.947605	0.001279
51	0.001903	0.943405	0.001795
52	0.002456	0.942215	0.002314
53	0.003009	0.944360	0.002842
54	0.003562	0.949378	0.003382
55	0.004115	0.956895	0.003938
56	0.004118	0.966232	0.003979
57	0.004121	0.976377	0.004024
58	0.004181	0.986982	0.004127
59	0.004287	0.996536	0.004272
60	0.004443	1.004190	0.004462
61	0.004657	1.008795	0.004698
62	0.004938	1.010291	0.004989
63	0.005293	1.008463	0.005338
64	0.005730	1.003497	0.005750
65	0.006257	0.996129	0.006233
66	0.006878	0.986993	0.006789
67	0.007601	0.976943	0.007426
68	0.008431	0.967389	0.008156
69	0.009374	0.958541	0.008985
70	0.010437	0.951342	0.009929
71	0.011627	0.945980	0.010999
72	0.012955	0.942428	0.012209
73	0.014439	0.940787	0.013584
74	0.016104	0.940740	0.015150
75	0.017982	0.942097	0.016941
76	0.020113	0.944337	0.018993
77	0.022548	0.947394	0.021362
78	0.025342	0.950699	0.024093
79	0.028559	0.954158	0.027250
80	0.032265	0.957723	0.030901
81	0.036528	0.961445	0.035120
82	0.041424	0.965131	0.039980
83	0.047032	0.968657	0.045558
84	0.053434	0.971974	0.051936
85	0.060717	0.975080	0.059204
86	0.068961	0.977875	0.067435
87	0.078243	0.980554	0.076722
88	0.088625	0.982918	0.087111
89	0.100162	0.984769	0.098636
90	0.112896	0.986054	0.111322
91	0.126865	0.986944	0.125209
92	0.142099	0.987266	0.140290
93	0.158626	0.987267	0.156606
94	0.176472	0.986302	0.174055
95	0.195656	0.984993	0.192720
96	0.220591	0.984795	0.217237
97	0.246330	0.984771	0.242579
98	0.272069	0.984894	0.267959
99	0.297808	0.985042	0.293353
100	0.323547	0.985660	0.318907
101	0.350894	0.986451	0.346140
102	0.380655	0.987341	0.375836
103	0.414438	0.988183	0.409540
104	0.453850	0.989074	0.448891
105	0.500502	0.990041	0.495517
106	0.557611	0.990909	0.552542
107	0.628393	0.991902	0.623304
108	0.719284	0.992796	0.714102
109	0.839131	0.993741	0.833879
110	1.000000	n/a	1.000000

TABLE 3: Employees' Retirement System Male Laborer Service Retiree Mortality
Effective 4/1/2023 (For Valuation Purposes Only)

Age	q_x	MP-2021 Factor	2023 Val q_x
0	0.000190	1.048505	0.000199
1	0.000190	1.048505	0.000199
2	0.000190	1.048505	0.000199
3	0.000190	1.048505	0.000199
4	0.000190	1.048505	0.000199
5	0.000190	1.048505	0.000199
6	0.000190	1.048505	0.000199
7	0.000190	1.048505	0.000199
8	0.000190	1.048505	0.000199
9	0.000190	1.048505	0.000199
10	0.000190	1.048505	0.000199
11	0.000190	1.048505	0.000199
12	0.000190	1.048505	0.000199
13	0.000190	1.048505	0.000199
14	0.000190	1.048505	0.000199
15	0.000190	1.048505	0.000199
16	0.000200	1.048505	0.000210
17	0.000220	1.048505	0.000231
18	0.000230	1.048505	0.000241
19	0.000240	1.048505	0.000252
20	0.000260	1.048505	0.000273
21	0.000270	1.049206	0.000283
22	0.000290	1.051962	0.000305
23	0.000300	1.057150	0.000317
24	0.000320	1.065218	0.000341
25	0.000340	1.075687	0.000366
26	0.000360	1.088136	0.000392
27	0.000380	1.102948	0.000419
28	0.000400	1.118720	0.000447
29	0.000420	1.135095	0.000477
30	0.000450	1.151504	0.000518
31	0.000470	1.167205	0.000549
32	0.000500	1.181824	0.000591
33	0.000530	1.195066	0.000633
34	0.000560	1.206186	0.000675
35	0.000590	1.214816	0.000717
36	0.000620	1.220207	0.000757
37	0.000660	1.222057	0.000807
38	0.000690	1.219646	0.000842
39	0.000730	1.213021	0.000886
40	0.000780	1.201915	0.000937
41	0.000820	1.186888	0.000973
42	0.000870	1.168456	0.001017
43	0.000920	1.147450	0.001056
44	0.000970	1.124406	0.001091
45	0.001020	1.100573	0.001123
46	0.001080	1.077149	0.001163
47	0.001140	1.054159	0.001202
48	0.001210	1.032904	0.001250
49	0.001280	1.014100	0.001298
50	0.001350	0.997996	0.001347
51	0.002548	0.985087	0.002510
52	0.003747	0.975619	0.003656
53	0.004945	0.969707	0.004795
54	0.006144	0.966980	0.005941
55	0.007342	0.967173	0.007101
56	0.007403	0.969897	0.007180
57	0.007541	0.974607	0.007350
58	0.007761	0.980638	0.007611
59	0.008072	0.987121	0.007968
60	0.008482	0.993814	0.008430
61	0.009003	0.999721	0.009000
62	0.009644	1.004630	0.009689
63	0.010418	1.008076	0.010502
64	0.011336	1.009541	0.011444
65	0.012415	1.009068	0.012528
66	0.013672	1.006608	0.013762
67	0.015122	1.002122	0.015154
68	0.016774	0.996154	0.016709
69	0.018633	0.989272	0.018433
70	0.020704	0.982008	0.020332
71	0.022999	0.974935	0.022423
72	0.025536	0.968342	0.024728
73	0.028344	0.962924	0.027293
74	0.031455	0.958738	0.030157
75	0.034910	0.955964	0.033373
76	0.038755	0.954303	0.036984
77	0.043042	0.953750	0.041051
78	0.047830	0.954255	0.045642
79	0.053187	0.955459	0.050818
80	0.059189	0.956929	0.056640
81	0.065922	0.959149	0.063229
82	0.073481	0.961471	0.070650
83	0.081960	0.963797	0.078993
84	0.091452	0.966323	0.088372
85	0.102044	0.968707	0.098851
86	0.113820	0.971048	0.110525
87	0.126859	0.973173	0.123456
88	0.141232	0.975107	0.137716
89	0.157002	0.976920	0.153378
90	0.174219	0.978221	0.170425
91	0.192921	0.979278	0.188923
92	0.213135	0.979819	0.208834
93	0.234873	0.979720	0.230110
94	0.258139	0.979180	0.252764
95	0.282929	0.977902	0.276677
96	0.309235	0.977902	0.302402
97	0.337048	0.978098	0.329666
98	0.366363	0.978442	0.358465
99	0.397175	0.979032	0.388847
100	0.429480	0.979942	0.420865
101	0.463277	0.981073	0.454509
102	0.498564	0.982255	0.489717
103	0.535340	0.983438	0.526474
104	0.573605	0.984845	0.564912
105	0.613358	0.985932	0.604729
106	0.655889	0.987242	0.647521
107	0.708086	0.988653	0.700051
108	0.775748	0.989842	0.767868
109	0.868542	0.991157	0.860862
110	1.000000	n/a	1.000000

TABLE 4: Employees' Retirement System Female Laborer Service Retiree Mortality
Effective 4/1/2023 (For Valuation Purposes Only)

Age	q_x	MP-2021 Factor	2023 Val q_x
0	0.000190	1.060483	0.000201
1	0.000190	1.060483	0.000201
2	0.000190	1.060483	0.000201
3	0.000190	1.060483	0.000201
4	0.000190	1.060483	0.000201
5	0.000190	1.060483	0.000201
6	0.000190	1.060483	0.000201
7	0.000190	1.060483	0.000201
8	0.000190	1.060483	0.000201
9	0.000190	1.060483	0.000201
10	0.000190	1.060483	0.000201
11	0.000190	1.060483	0.000201
12	0.000190	1.060483	0.000201
13	0.000190	1.060483	0.000201
14	0.000190	1.060483	0.000201
15	0.000190	1.060483	0.000201
16	0.000200	1.060483	0.000212
17	0.000220	1.060483	0.000233
18	0.000230	1.060483	0.000244
19	0.000240	1.060483	0.000255
20	0.000260	1.060483	0.000276
21	0.000270	1.063263	0.000287
22	0.000290	1.067310	0.000310
23	0.000300	1.072689	0.000322
24	0.000320	1.079204	0.000345
25	0.000340	1.087542	0.000370
26	0.000360	1.096959	0.000395
27	0.000380	1.107691	0.000421
28	0.000400	1.119331	0.000448
29	0.000420	1.130960	0.000475
30	0.000450	1.142272	0.000514
31	0.000470	1.152671	0.000542
32	0.000500	1.161260	0.000581
33	0.000530	1.167186	0.000619
34	0.000560	1.169788	0.000655
35	0.000590	1.168932	0.000690
36	0.000620	1.163884	0.000722
37	0.000660	1.154998	0.000762
38	0.000690	1.142535	0.000788
39	0.000730	1.127168	0.000823
40	0.000780	1.109187	0.000865
41	0.000820	1.089584	0.000893
42	0.000870	1.069308	0.000930
43	0.000920	1.048716	0.000965
44	0.000970	1.028984	0.000998
45	0.001020	1.010313	0.001031
46	0.001080	0.993236	0.001073
47	0.001140	0.977968	0.001115
48	0.001210	0.965125	0.001168
49	0.001280	0.955067	0.001222
50	0.001350	0.947605	0.001279
51	0.001785	0.943405	0.001684
52	0.002220	0.942215	0.002092
53	0.002655	0.944360	0.002507
54	0.003090	0.949378	0.002934
55	0.003525	0.956895	0.003373
56	0.004275	0.966232	0.004131
57	0.004979	0.976377	0.004861
58	0.005637	0.986982	0.005564
59	0.006254	0.996536	0.006232
60	0.006834	1.004190	0.006863
61	0.007388	1.008795	0.007453
62	0.007925	1.010291	0.008007
63	0.008457	1.008463	0.008529
64	0.008999	1.003497	0.009030
65	0.009570	0.996129	0.009533
66	0.010190	0.986993	0.010057
67	0.010884	0.976943	0.010633
68	0.011682	0.967389	0.011301
69	0.012617	0.958541	0.012094
70	0.013716	0.951342	0.013049
71	0.015003	0.945980	0.014193
72	0.016497	0.942428	0.015547
73	0.018216	0.940787	0.017137
74	0.020179	0.940740	0.018983
75	0.022412	0.942097	0.021114
76	0.024947	0.944337	0.023558
77	0.027835	0.947394	0.026371
78	0.031141	0.950699	0.029606
79	0.034945	0.954158	0.033343
80	0.039337	0.957723	0.037674
81	0.044415	0.961445	0.042703
82	0.050273	0.965131	0.048520
83	0.056995	0.968657	0.055209
84	0.064646	0.971974	0.062834
85	0.073273	0.975080	0.071447
86	0.082903	0.977875	0.081069
87	0.093547	0.980554	0.091728
88	0.105204	0.982918	0.103407
89	0.117868	0.984769	0.116073
90	0.131538	0.986054	0.129704
91	0.146218	0.986944	0.144309
92	0.161917	0.987266	0.159855
93	0.178643	0.987267	0.176368
94	0.196403	0.986302	0.193713
95	0.215200	0.984993	0.211970
96	0.239529	0.984795	0.235887
97	0.264642	0.984771	0.260612
98	0.289756	0.984894	0.285379
99	0.314870	0.985042	0.310160
100	0.339983	0.985660	0.335108
101	0.366666	0.986451	0.361698
102	0.395704	0.987341	0.390695
103	0.428666	0.988183	0.423600
104	0.467121	0.989074	0.462017
105	0.512639	0.990041	0.507534
106	0.568360	0.990909	0.563193
107	0.637422	0.991902	0.632260
108	0.726105	0.992796	0.720874
109	0.843040	0.993741	0.837763
110	1.000000	n/a	1.000000

TABLE 5: Employees' Retirement System Male Disability Retiree Mortality
Effective 4/1/2023 (For Valuation Purposes Only)

Age	q_x	MP-2021 Factor	2023 Val q_x
0	0.001900	1.048505	0.001992
1	0.001900	1.048505	0.001992
2	0.001900	1.048505	0.001992
3	0.001900	1.048505	0.001992
4	0.001900	1.048505	0.001992
5	0.001900	1.048505	0.001992
6	0.001900	1.048505	0.001992
7	0.001900	1.048505	0.001992
8	0.001900	1.048505	0.001992
9	0.001900	1.048505	0.001992
10	0.001900	1.048505	0.001992
11	0.001900	1.048505	0.001992
12	0.001900	1.048505	0.001992
13	0.001900	1.048505	0.001992
14	0.001900	1.048505	0.001992
15	0.001900	1.048505	0.001992
16	0.002000	1.048505	0.002097
17	0.002200	1.048505	0.002307
18	0.002300	1.048505	0.002412
19	0.002400	1.048505	0.002516
20	0.002600	1.048505	0.002726
21	0.002700	1.049206	0.002833
22	0.002900	1.051962	0.003051
23	0.003000	1.057150	0.003171
24	0.003200	1.065218	0.003409
25	0.003400	1.075687	0.003657
26	0.003600	1.088136	0.003917
27	0.003800	1.102948	0.004191
28	0.004000	1.118720	0.004475
29	0.004200	1.135095	0.004767
30	0.004500	1.151504	0.005182
31	0.004700	1.167205	0.005486
32	0.005000	1.181824	0.005909
33	0.005300	1.195066	0.006334
34	0.005600	1.206186	0.006755
35	0.005900	1.214816	0.007167
36	0.006677	1.220207	0.008147
37	0.007454	1.222057	0.009109
38	0.008230	1.219646	0.010038
39	0.009007	1.213021	0.010926
40	0.009784	1.201915	0.011760
41	0.010427	1.186888	0.012376
42	0.010710	1.168456	0.012514
43	0.011405	1.147450	0.013087
44	0.012238	1.124406	0.013760
45	0.012836	1.100573	0.014127
46	0.013298	1.077149	0.014324
47	0.013950	1.054159	0.014706
48	0.014410	1.032904	0.014884
49	0.015279	1.014100	0.015494
50	0.016265	0.997996	0.016232
51	0.017056	0.985087	0.016802
52	0.017894	0.975619	0.017458
53	0.018594	0.969707	0.018031
54	0.019243	0.966980	0.018608
55	0.019747	0.967173	0.019099
56	0.020273	0.969897	0.019663
57	0.020958	0.974607	0.020426
58	0.021756	0.980638	0.021335
59	0.022415	0.987121	0.022126
60	0.023078	0.993814	0.022935
61	0.023986	0.999721	0.023979
62	0.024796	1.004630	0.024911
63	0.025585	1.008076	0.025792
64	0.026329	1.009541	0.026580
65	0.027349	1.009068	0.027597
66	0.028422	1.006608	0.028610
67	0.029547	1.002122	0.029610
68	0.030844	0.996154	0.030725
69	0.032439	0.989272	0.032091
70	0.034461	0.982008	0.033841
71	0.036696	0.974935	0.035776
72	0.039382	0.968342	0.038135
73	0.042397	0.962924	0.040825
74	0.045826	0.958738	0.043935
75	0.049728	0.955964	0.047538
76	0.054175	0.954303	0.051699
77	0.059245	0.953750	0.056505
78	0.064984	0.954255	0.062011
79	0.071465	0.955459	0.068282
80	0.078654	0.956929	0.075266
81	0.086410	0.959149	0.082880
82	0.095026	0.961471	0.091365
83	0.104369	0.963797	0.100591
84	0.114448	0.966323	0.110594
85	0.125068	0.968707	0.121154
86	0.137334	0.971048	0.133358
87	0.150178	0.973173	0.146149
88	0.162252	0.975107	0.158213
89	0.176289	0.976920	0.172220
90	0.191767	0.978221	0.187591
91	0.207896	0.979278	0.203588
92	0.226604	0.979819	0.222031
93	0.243525	0.979720	0.238586
94	0.264342	0.979180	0.258838
95	0.281410	0.977902	0.275191
96	0.303686	0.977902	0.296975
97	0.326681	0.978098	0.319526
98	0.349676	0.978442	0.342138
99	0.372671	0.979032	0.364857
100	0.395666	0.979942	0.387730
101	0.420098	0.981073	0.412147
102	0.446686	0.982255	0.438760
103	0.476866	0.983438	0.468968
104	0.512077	0.984845	0.504316
105	0.553756	0.985932	0.545966
106	0.604776	0.987242	0.597060
107	0.668011	0.988653	0.660431
108	0.749212	0.989842	0.741602
109	0.856282	0.991157	0.848710
110	1.000000	n/a	1.000000

TABLE 6: Employees' Retirement System Female Disability Retiree Mortality
Effective 4/1/2023 (For Valuation Purposes Only)

Age	q_x	MP-2021 Factor	2023 Val q_x
0	0.001900	1.060483	0.002015
1	0.001900	1.060483	0.002015
2	0.001900	1.060483	0.002015
3	0.001900	1.060483	0.002015
4	0.001900	1.060483	0.002015
5	0.001900	1.060483	0.002015
6	0.001900	1.060483	0.002015
7	0.001900	1.060483	0.002015
8	0.001900	1.060483	0.002015
9	0.001900	1.060483	0.002015
10	0.001900	1.060483	0.002015
11	0.001900	1.060483	0.002015
12	0.001900	1.060483	0.002015
13	0.001900	1.060483	0.002015
14	0.001900	1.060483	0.002015
15	0.001900	1.060483	0.002015
16	0.002000	1.060483	0.002121
17	0.002200	1.060483	0.002333
18	0.002300	1.060483	0.002439
19	0.002400	1.060483	0.002545
20	0.002600	1.060483	0.002757
21	0.002700	1.063263	0.002871
22	0.002900	1.067310	0.003095
23	0.003000	1.072689	0.003218
24	0.003200	1.079204	0.003453
25	0.003400	1.087542	0.003698
26	0.003600	1.096959	0.003949
27	0.003800	1.107691	0.004209
28	0.004000	1.119331	0.004477
29	0.004200	1.130960	0.004750
30	0.004500	1.142272	0.005140
31	0.004700	1.152671	0.005418
32	0.005000	1.161260	0.005806
33	0.005300	1.167186	0.006186
34	0.005600	1.169788	0.006551
35	0.005900	1.168932	0.006897
36	0.007452	1.163884	0.008673
37	0.009004	1.154998	0.010400
38	0.010555	1.142535	0.012059
39	0.012107	1.127168	0.013647
40	0.013659	1.109187	0.015150
41	0.015211	1.089584	0.016574
42	0.016763	1.069308	0.017925
43	0.018315	1.048716	0.019207
44	0.019866	1.028984	0.020442
45	0.021418	1.010313	0.021639
46	0.022970	0.993236	0.022815
47	0.022990	0.977968	0.022483
48	0.023096	0.965125	0.022291
49	0.023024	0.955067	0.021989
50	0.022770	0.947605	0.021577
51	0.022645	0.943405	0.021363
52	0.022625	0.942215	0.021318
53	0.022604	0.944360	0.021346
54	0.022544	0.949378	0.021403
55	0.022539	0.956895	0.021567
56	0.022533	0.966232	0.021772
57	0.022537	0.976377	0.022005
58	0.022546	0.986982	0.022252
59	0.022608	0.996536	0.022530
60	0.022726	1.004190	0.022821
61	0.022925	1.008795	0.023127
62	0.023228	1.010291	0.023467
63	0.023641	1.008463	0.023841
64	0.024197	1.003497	0.024282
65	0.024864	0.996129	0.024768
66	0.025679	0.986993	0.025345
67	0.026586	0.976943	0.025973
68	0.027637	0.967389	0.026736
69	0.028838	0.958541	0.027642
70	0.030154	0.951342	0.028687
71	0.031562	0.945980	0.029857
72	0.033176	0.942428	0.031266
73	0.034970	0.940787	0.032899
74	0.036958	0.940740	0.034768
75	0.039229	0.942097	0.036958
76	0.041819	0.944337	0.039491
77	0.044710	0.947394	0.042358
78	0.048307	0.950699	0.045925
79	0.052303	0.954158	0.049905
80	0.056767	0.957723	0.054367
81	0.062062	0.961445	0.059669
82	0.068109	0.965131	0.065734
83	0.074894	0.968657	0.072547
84	0.082566	0.971974	0.080252
85	0.091216	0.975080	0.088943
86	0.100820	0.977875	0.098589
87	0.111356	0.980554	0.109191
88	0.123017	0.982918	0.120916
89	0.135400	0.984769	0.133338
90	0.149661	0.986054	0.147574
91	0.164311	0.986944	0.162166
92	0.182022	0.987266	0.179704
93	0.199471	0.987267	0.196931
94	0.218169	0.986302	0.215181
95	0.234947	0.984993	0.231421
96	0.258664	0.984795	0.254731
97	0.283145	0.984771	0.278833
98	0.307627	0.984894	0.302980
99	0.332109	0.985042	0.327141
100	0.356590	0.985660	0.351476
101	0.382602	0.986451	0.377418
102	0.410909	0.987341	0.405707
103	0.443041	0.988183	0.437805
104	0.480529	0.989074	0.475279
105	0.524902	0.990041	0.519674
106	0.579221	0.990909	0.573955
107	0.646546	0.991902	0.641310
108	0.732997	0.992796	0.727717
109	0.846989	0.993741	0.841688
110	1.000000	n/a	1.000000

TABLE 7: Police & Fire Retirement System Service Retiree Mortality
Effective 4/1/2023 (For Valuation Purposes Only)

Age	q_x	MP-2021 Factor	2023 Val q_x
0	0.000100	1.048505	0.000105
1	0.000100	1.048505	0.000105
2	0.000100	1.048505	0.000105
3	0.000100	1.048505	0.000105
4	0.000100	1.048505	0.000105
5	0.000100	1.048505	0.000105
6	0.000100	1.048505	0.000105
7	0.000100	1.048505	0.000105
8	0.000100	1.048505	0.000105
9	0.000100	1.048505	0.000105
10	0.000100	1.048505	0.000105
11	0.000100	1.048505	0.000105
12	0.000100	1.048505	0.000105
13	0.000100	1.048505	0.000105
14	0.000100	1.048505	0.000105
15	0.000100	1.048505	0.000105
16	0.000100	1.048505	0.000105
17	0.000110	1.048505	0.000115
18	0.000110	1.048505	0.000115
19	0.000120	1.048505	0.000126
20	0.000130	1.048505	0.000136
21	0.000140	1.049206	0.000147
22	0.000140	1.051962	0.000147
23	0.000150	1.057150	0.000159
24	0.000160	1.065218	0.000170
25	0.000170	1.075687	0.000183
26	0.000180	1.088136	0.000196
27	0.000190	1.102948	0.000210
28	0.000200	1.118720	0.000224
29	0.000210	1.135095	0.000238
30	0.000220	1.151504	0.000253
31	0.000240	1.167205	0.000280
32	0.000250	1.181824	0.000295
33	0.000260	1.195066	0.000311
34	0.000280	1.206186	0.000338
35	0.000290	1.214816	0.000352
36	0.000310	1.220207	0.000378
37	0.000330	1.222057	0.000403
38	0.000350	1.219646	0.000427
39	0.000370	1.213021	0.000449
40	0.000390	1.201915	0.000469
41	0.000536	1.186888	0.000636
42	0.000682	1.168456	0.000797
43	0.000828	1.147450	0.000950
44	0.000974	1.124406	0.001095
45	0.001353	1.100573	0.001489
46	0.001532	1.077149	0.001650
47	0.001695	1.054159	0.001787
48	0.001841	1.032904	0.001902
49	0.001970	1.014100	0.001998
50	0.002084	0.997996	0.002080
51	0.002186	0.985087	0.002153
52	0.002281	0.975619	0.002225
53	0.002374	0.969707	0.002302
54	0.002469	0.966980	0.002387
55	0.002572	0.967173	0.002488
56	0.002687	0.969897	0.002606
57	0.002821	0.974607	0.002749
58	0.002982	0.980638	0.002924
59	0.003183	0.987121	0.003142
60	0.003438	0.993814	0.003417
61	0.003762	0.999721	0.003761
62	0.004166	1.004630	0.004185
63	0.004664	1.008076	0.004702
64	0.005267	1.009541	0.005317
65	0.005991	1.009068	0.006045
66	0.006859	1.006608	0.006904
67	0.007899	1.002122	0.007916
68	0.009137	0.996154	0.009102
69	0.010593	0.989272	0.010479
70	0.012283	0.982008	0.012062
71	0.014217	0.974935	0.013861
72	0.016400	0.968342	0.015881
73	0.018842	0.962924	0.018143
74	0.021558	0.958738	0.020668
75	0.024579	0.955964	0.023497
76	0.027951	0.954303	0.026674
77	0.031733	0.953750	0.030265
78	0.035996	0.954255	0.034349
79	0.040820	0.955459	0.039002
80	0.046285	0.956929	0.044291
81	0.052472	0.959149	0.050328
82	0.059458	0.961471	0.057167
83	0.067314	0.963797	0.064877
84	0.076109	0.966323	0.073546
85	0.085898	0.968707	0.083210
86	0.096732	0.971048	0.093931
87	0.108654	0.973173	0.105739
88	0.121701	0.975107	0.118671
89	0.135910	0.976920	0.132773
90	0.151312	0.978221	0.148017
91	0.167932	0.979278	0.164452
92	0.185789	0.979819	0.182040
93	0.204895	0.979720	0.200740
94	0.225256	0.979180	0.220566
95	0.246879	0.977902	0.241424
96	0.270225	0.977902	0.264254
97	0.294325	0.978098	0.287879
98	0.318425	0.978442	0.311561
99	0.342525	0.979032	0.335343
100	0.366625	0.979942	0.359271
101	0.392231	0.981073	0.384807
102	0.420097	0.982255	0.412642
103	0.451728	0.983438	0.444247
104	0.488631	0.984845	0.481226
105	0.532312	0.985932	0.524823
106	0.585783	0.987242	0.578310
107	0.652058	0.988653	0.644659
108	0.737161	0.989842	0.729673
109	0.849376	0.991157	0.841865
110	1.000000	n/a	1.000000

TABLE 8: Police & Fire Retirement System Disability Retiree Mortality
Effective 4/1/2023 (For Valuation Purposes Only)

Age	q_x	MP-2021 Factor	2023 Val q_x
0	0.000400	1.048505	0.000419
1	0.000400	1.048505	0.000419
2	0.000400	1.048505	0.000419
3	0.000400	1.048505	0.000419
4	0.000400	1.048505	0.000419
5	0.000400	1.048505	0.000419
6	0.000400	1.048505	0.000419
7	0.000400	1.048505	0.000419
8	0.000400	1.048505	0.000419
9	0.000400	1.048505	0.000419
10	0.000400	1.048505	0.000419
11	0.000400	1.048505	0.000419
12	0.000400	1.048505	0.000419
13	0.000400	1.048505	0.000419
14	0.000400	1.048505	0.000419
15	0.000400	1.048505	0.000419
16	0.000400	1.048505	0.000419
17	0.000440	1.048505	0.000461
18	0.000440	1.048505	0.000461
19	0.000480	1.048505	0.000503
20	0.000520	1.048505	0.000545
21	0.000560	1.049206	0.000588
22	0.000560	1.051962	0.000589
23	0.000600	1.057150	0.000634
24	0.000640	1.065218	0.000682
25	0.000680	1.075687	0.000731
26	0.000720	1.088136	0.000783
27	0.000760	1.102948	0.000838
28	0.000800	1.118720	0.000895
29	0.000840	1.135095	0.000953
30	0.000880	1.151504	0.001013
31	0.000960	1.167205	0.001121
32	0.001000	1.181824	0.001182
33	0.001040	1.195066	0.001243
34	0.001120	1.206186	0.001351
35	0.001160	1.214816	0.001409
36	0.001399	1.220207	0.001707
37	0.001639	1.222057	0.002003
38	0.001878	1.219646	0.002290
39	0.002118	1.213021	0.002569
40	0.002357	1.201915	0.002833
41	0.002597	1.186888	0.003082
42	0.002836	1.168456	0.003314
43	0.003075	1.147450	0.003528
44	0.003315	1.124406	0.003727
45	0.003554	1.100573	0.003911
46	0.003794	1.077149	0.004087
47	0.004033	1.054159	0.004251
48	0.004273	1.032904	0.004414
49	0.004289	1.014100	0.004349
50	0.004371	0.997996	0.004362
51	0.004514	0.985087	0.004447
52	0.004713	0.975619	0.004598
53	0.004957	0.969707	0.004807
54	0.005240	0.966980	0.005067
55	0.005554	0.967173	0.005372
56	0.005894	0.969897	0.005717
57	0.006256	0.974607	0.006097
58	0.006641	0.980638	0.006512
59	0.007047	0.987121	0.006956
60	0.007480	0.993814	0.007434
61	0.007944	0.999721	0.007942
62	0.008448	1.004630	0.008487
63	0.009005	1.008076	0.009078
64	0.009630	1.009541	0.009722
65	0.010343	1.009068	0.010437
66	0.011168	1.006608	0.011242
67	0.012130	1.002122	0.012156
68	0.013256	0.996154	0.013205
69	0.014581	0.989272	0.014425
70	0.016140	0.982008	0.015850
71	0.017975	0.974935	0.017524
72	0.020131	0.968342	0.019494
73	0.022648	0.962924	0.021808
74	0.025568	0.958738	0.024513
75	0.028924	0.955964	0.027650
76	0.032745	0.954303	0.031249
77	0.037050	0.953750	0.035336
78	0.041856	0.954255	0.039941
79	0.047172	0.955459	0.045071
80	0.053002	0.956929	0.050719
81	0.059347	0.959149	0.056923
82	0.066204	0.961471	0.063653
83	0.073570	0.963797	0.070907
84	0.081442	0.966323	0.078699
85	0.089816	0.968707	0.087005
86	0.098689	0.971048	0.095832
87	0.108654	0.973173	0.105739
88	0.121701	0.975107	0.118671
89	0.135910	0.976920	0.132773
90	0.151312	0.978221	0.148017
91	0.167932	0.979278	0.164452
92	0.185789	0.979819	0.182040
93	0.204895	0.979720	0.200740
94	0.225256	0.979180	0.220566
95	0.246879	0.977902	0.241424
96	0.270225	0.977902	0.264254
97	0.294325	0.978098	0.287879
98	0.318425	0.978442	0.311561
99	0.342525	0.979032	0.335343
100	0.366625	0.979942	0.359271
101	0.392231	0.981073	0.384807
102	0.420097	0.982255	0.412642
103	0.451728	0.983438	0.444247
104	0.488631	0.984845	0.481226
105	0.532312	0.985932	0.524823
106	0.585783	0.987242	0.578310
107	0.652058	0.988653	0.644659
108	0.737161	0.989842	0.729673
109	0.849376	0.991157	0.841865
110	1.000000	n/a	1.000000

TABLE 9: Retirement System Male Beneficiary Mortality
Effective 4/1/2023 (For Valuation Purposes Only)

Age	q_x	MP-2021 Factor	2023 Val q_x
0	0.000190	1.048505	0.000199
1	0.000190	1.048505	0.000199
2	0.000190	1.048505	0.000199
3	0.000190	1.048505	0.000199
4	0.000190	1.048505	0.000199
5	0.000190	1.048505	0.000199
6	0.000190	1.048505	0.000199
7	0.000190	1.048505	0.000199
8	0.000190	1.048505	0.000199
9	0.000190	1.048505	0.000199
10	0.000190	1.048505	0.000199
11	0.000190	1.048505	0.000199
12	0.000190	1.048505	0.000199
13	0.000190	1.048505	0.000199
14	0.000190	1.048505	0.000199
15	0.000190	1.048505	0.000199
16	0.000200	1.048505	0.000210
17	0.000220	1.048505	0.000231
18	0.000230	1.048505	0.000241
19	0.000240	1.048505	0.000252
20	0.000260	1.048505	0.000273
21	0.000270	1.049206	0.000283
22	0.000290	1.051962	0.000305
23	0.000300	1.057150	0.000317
24	0.000320	1.065218	0.000341
25	0.000340	1.075687	0.000366
26	0.000360	1.088136	0.000392
27	0.000380	1.102948	0.000419
28	0.000400	1.118720	0.000447
29	0.000420	1.135095	0.000477
30	0.000450	1.151504	0.000518
31	0.000470	1.167205	0.000549
32	0.000500	1.181824	0.000591
33	0.000530	1.195066	0.000633
34	0.000560	1.206186	0.000675
35	0.000590	1.214816	0.000717
36	0.000620	1.220207	0.000757
37	0.000660	1.222057	0.000807
38	0.000690	1.219646	0.000842
39	0.000730	1.213021	0.000886
40	0.000780	1.201915	0.000937
41	0.000820	1.186888	0.000973
42	0.000870	1.168456	0.001017
43	0.000920	1.147450	0.001056
44	0.000970	1.124406	0.001091
45	0.001020	1.100573	0.001123
46	0.001080	1.077149	0.001163
47	0.001140	1.054159	0.001202
48	0.001210	1.032904	0.001250
49	0.001280	1.014100	0.001298
50	0.001350	0.997996	0.001347
51	0.002175	0.985087	0.002143
52	0.003001	0.975619	0.002928
53	0.003826	0.969707	0.003710
54	0.004652	0.966980	0.004498
55	0.005477	0.967173	0.005297
56	0.006302	0.969897	0.006112
57	0.007128	0.974607	0.006947
58	0.007953	0.980638	0.007799
59	0.008779	0.987121	0.008666
60	0.009604	0.993814	0.009545
61	0.009737	0.999721	0.009734
62	0.009976	1.004630	0.010022
63	0.010343	1.008076	0.010427
64	0.010864	1.009541	0.010968
65	0.011561	1.009068	0.011666
66	0.012454	1.006608	0.012536
67	0.013552	1.002122	0.013581
68	0.014860	0.996154	0.014803
69	0.016383	0.989272	0.016207
70	0.018123	0.982008	0.017797
71	0.020087	0.974935	0.019584
72	0.022287	0.968342	0.021581
73	0.024747	0.962924	0.023829
74	0.027496	0.958738	0.026361
75	0.030575	0.955964	0.029229
76	0.034031	0.954303	0.032476
77	0.037919	0.953750	0.036165
78	0.042302	0.954255	0.040367
79	0.047244	0.955459	0.045140
80	0.052814	0.956929	0.050539
81	0.059084	0.959149	0.056670
82	0.066124	0.961471	0.063576
83	0.074005	0.963797	0.071326
84	0.082792	0.966323	0.080004
85	0.092533	0.968707	0.089637
86	0.103254	0.971048	0.100265
87	0.114959	0.973173	0.111875
88	0.127626	0.975107	0.124449
89	0.141213	0.976920	0.137954
90	0.155657	0.978221	0.152267
91	0.170886	0.979278	0.167345
92	0.186820	0.979819	0.183050
93	0.203383	0.979720	0.199258
94	0.220506	0.979180	0.215915
95	0.238128	0.977902	0.232866
96	0.261746	0.977902	0.255962
97	0.286126	0.978098	0.279859
98	0.310506	0.978442	0.303812
99	0.334885	0.979032	0.327863
100	0.359265	0.979942	0.352059
101	0.385169	0.981073	0.377879
102	0.413358	0.982255	0.406023
103	0.445357	0.983438	0.437981
104	0.482689	0.984845	0.475374
105	0.526877	0.985932	0.519465
106	0.580970	0.987242	0.573558
107	0.648015	0.988653	0.640662
108	0.734107	0.989842	0.726650
109	0.847626	0.991157	0.840131
110	1.000000	n/a	1.000000

TABLE 10: Retirement System Female Beneficiary Mortality
Effective 4/1/2023 (For Valuation Purposes Only)

Age	q_x	MP-2021 Factor	2023 Val q_x
0	0.000190	1.060483	0.000201
1	0.000190	1.060483	0.000201
2	0.000190	1.060483	0.000201
3	0.000190	1.060483	0.000201
4	0.000190	1.060483	0.000201
5	0.000190	1.060483	0.000201
6	0.000190	1.060483	0.000201
7	0.000190	1.060483	0.000201
8	0.000190	1.060483	0.000201
9	0.000190	1.060483	0.000201
10	0.000190	1.060483	0.000201
11	0.000190	1.060483	0.000201
12	0.000190	1.060483	0.000201
13	0.000190	1.060483	0.000201
14	0.000190	1.060483	0.000201
15	0.000190	1.060483	0.000201
16	0.000200	1.060483	0.000212
17	0.000220	1.060483	0.000233
18	0.000230	1.060483	0.000244
19	0.000240	1.060483	0.000255
20	0.000260	1.060483	0.000276
21	0.000270	1.063263	0.000287
22	0.000290	1.067310	0.000310
23	0.000300	1.072689	0.000322
24	0.000320	1.079204	0.000345
25	0.000340	1.087542	0.000370
26	0.000360	1.096959	0.000395
27	0.000380	1.107691	0.000421
28	0.000400	1.119331	0.000448
29	0.000420	1.130960	0.000475
30	0.000450	1.142272	0.000514
31	0.000470	1.152671	0.000542
32	0.000500	1.161260	0.000581
33	0.000530	1.167186	0.000619
34	0.000560	1.169788	0.000655
35	0.000590	1.168932	0.000690
36	0.000620	1.163884	0.000722
37	0.000660	1.154998	0.000762
38	0.000690	1.142535	0.000788
39	0.000730	1.127168	0.000823
40	0.000780	1.109187	0.000865
41	0.000820	1.089584	0.000893
42	0.000870	1.069308	0.000930
43	0.000920	1.048716	0.000965
44	0.000970	1.028984	0.000998
45	0.001020	1.010313	0.001031
46	0.001080	0.993236	0.001073
47	0.001140	0.977968	0.001115
48	0.001210	0.965125	0.001168
49	0.001280	0.955067	0.001222
50	0.001350	0.947605	0.001279
51	0.001913	0.943405	0.001805
52	0.002477	0.942215	0.002334
53	0.003040	0.944360	0.002871
54	0.003603	0.949378	0.003421
55	0.004166	0.956895	0.003986
56	0.004377	0.966232	0.004229
57	0.004599	0.976377	0.004490
58	0.004837	0.986982	0.004774
59	0.005101	0.996536	0.005083
60	0.005400	1.004190	0.005423
61	0.005742	1.008795	0.005792
62	0.006139	1.010291	0.006202
63	0.006601	1.008463	0.006657
64	0.007136	1.003497	0.007161
65	0.007754	0.996129	0.007724
66	0.008462	0.986993	0.008352
67	0.009268	0.976943	0.009054
68	0.010178	0.967389	0.009846
69	0.011203	0.958541	0.010739
70	0.012353	0.951342	0.011752
71	0.013643	0.945980	0.012906
72	0.015090	0.942428	0.014221
73	0.016717	0.940787	0.015727
74	0.018551	0.940740	0.017452
75	0.020625	0.942097	0.019431
76	0.022977	0.944337	0.021698
77	0.025651	0.947394	0.024302
78	0.028695	0.950699	0.027280
79	0.032163	0.954158	0.030689
80	0.036116	0.957723	0.034589
81	0.040616	0.961445	0.039050
82	0.045731	0.965131	0.044136
83	0.051526	0.968657	0.049911
84	0.058068	0.971974	0.056441
85	0.065416	0.975080	0.063786
86	0.073622	0.977875	0.071993
87	0.082729	0.980554	0.081120
88	0.092771	0.982918	0.091186
89	0.103772	0.984769	0.102191
90	0.115743	0.986054	0.114129
91	0.128689	0.986944	0.127009
92	0.142603	0.987266	0.140787
93	0.157474	0.987267	0.155469
94	0.173285	0.986302	0.170911
95	0.190016	0.984993	0.187164
96	0.215125	0.984795	0.211854
97	0.241045	0.984771	0.237374
98	0.266964	0.984894	0.262931
99	0.292884	0.985042	0.288503
100	0.318803	0.985660	0.314231
101	0.346343	0.986451	0.341650
102	0.376312	0.987341	0.371548
103	0.410332	0.988183	0.405483
104	0.450021	0.989074	0.445104
105	0.497000	0.990041	0.492050
106	0.554509	0.990909	0.549468
107	0.625787	0.991902	0.620719
108	0.717316	0.992796	0.712149
109	0.838003	0.993741	0.832758
110	1.000000	n/a	1.000000

TABLE 11: Employees' Retirement System Death and Disability Central Rates of Decrement
Effective 4/1/2020

Age	Ordinary Death	Accidental Death	Ordinary Disability	Accidental Disability Tiers 1, 2	Accidental Disability Tiers 3, 4, 5, 6
15	0.00019	0.00001	0.00006	0.00020	0.00001
16	0.00020	0.00001	0.00006	0.00020	0.00001
17	0.00022	0.00001	0.00007	0.00020	0.00001
18	0.00023	0.00001	0.00008	0.00020	0.00001
19	0.00024	0.00001	0.00009	0.00020	0.00001
20	0.00026	0.00001	0.00010	0.00020	0.00001
21	0.00027	0.00001	0.00011	0.00020	0.00001
22	0.00029	0.00001	0.00012	0.00020	0.00001
23	0.00030	0.00001	0.00014	0.00020	0.00001
24	0.00032	0.00001	0.00015	0.00020	0.00001
25	0.00034	0.00001	0.00017	0.00020	0.00001
26	0.00036	0.00001	0.00019	0.00020	0.00001
27	0.00038	0.00001	0.00021	0.00020	0.00001
28	0.00040	0.00001	0.00023	0.00020	0.00001
29	0.00042	0.00001	0.00025	0.00020	0.00001
30	0.00045	0.00001	0.00028	0.00020	0.00001
31	0.00047	0.00001	0.00031	0.00020	0.00001
32	0.00050	0.00001	0.00035	0.00020	0.00001
33	0.00053	0.00001	0.00039	0.00020	0.00001
34	0.00056	0.00001	0.00043	0.00020	0.00001
35	0.00059	0.00001	0.00048	0.00020	0.00001
36	0.00062	0.00001	0.00053	0.00020	0.00001
37	0.00066	0.00001	0.00059	0.00020	0.00001
38	0.00069	0.00001	0.00066	0.00020	0.00001
39	0.00073	0.00001	0.00073	0.00020	0.00001
40	0.00078	0.00001	0.00081	0.00020	0.00001
41	0.00082	0.00001	0.00090	0.00020	0.00001
42	0.00087	0.00001	0.00100	0.00020	0.00001
43	0.00092	0.00001	0.00111	0.00020	0.00004
44	0.00097	0.00001	0.00124	0.00020	0.00004
45	0.00102	0.00001	0.00137	0.00020	0.00004
46	0.00108	0.00001	0.00153	0.00020	0.00004
47	0.00114	0.00001	0.00170	0.00020	0.00004
48	0.00121	0.00001	0.00189	0.00020	0.00004
49	0.00128	0.00001	0.00210	0.00020	0.00004
50	0.00135	0.00001	0.00233	0.00020	0.00004
51	0.00143	0.00001	0.00259	0.00020	0.00004
52	0.00151	0.00001	0.00288	0.00020	0.00004
53	0.00160	0.00001	0.00320	0.00020	0.00004
54	0.00169	0.00001	0.00355	0.00020	0.00004
55	0.00178	0.00001	0.00395	0.00015	0.00004
56	0.00189	0.00001	0.00438	0.00015	0.00004
57	0.00199	0.00001	0.00487	0.00015	0.00004
58	0.00211	0.00001	0.00541	0.00015	0.00004
59	0.00223	0.00001	0.00602	0.00015	0.00004
60	0.00236	0.00001	0.00668	0.00015	0.00004
61	0.00249	0.00001	0.00743	0.00015	0.00004
62	0.00263	0.00001	0.00825	0.00015	0.00004
63	0.00278	0.00001	0.00917	0.00015	0.00004
64	0.00294	0.00001	0.01019	0.00015	0.00004
65	0.00324	0.00001	0.01121	0.00015	0.00004
66	0.00356	0.00001	0.01233	0.00015	0.00004
67	0.00392	0.00001	0.01356	0.00015	0.00004
68	0.00431	0.00001	0.01492	0.00015	0.00004
69	0.00474	0.00001	0.01641	0.00015	0.00004
70	0.00000	0.00000	0.00000	0.00000	0.00000

TABLE 12: Employees' Retirement System Withdrawal Central Rates of Decrement blended over all tiers - Effective 4/1/2020

Age	0 ≤ Service < 2	2 ≤ Service < 3	3 ≤ Service < 4	4 ≤ Service < 5	5 ≤ Service < 10	10 ≤ Service
15	0.19800	0.12105	0.08625	0.06565	0.05530	0.02160
16	0.19800	0.12105	0.08625	0.06565	0.05530	0.02160
17	0.19800	0.12105	0.08625	0.06565	0.05530	0.02160
18	0.23699	0.12105	0.08625	0.06565	0.05530	0.02160
19	0.25824	0.12105	0.08625	0.06565	0.05530	0.02160
20	0.26455	0.12105	0.08625	0.06565	0.05530	0.02160
21	0.26061	0.12105	0.08625	0.06565	0.05530	0.02160
22	0.25065	0.12105	0.08625	0.06565	0.05530	0.02160
23	0.23716	0.12105	0.08625	0.06565	0.05530	0.02160
24	0.22128	0.13032	0.09636	0.07120	0.05587	0.02160
25	0.20403	0.13556	0.10074	0.07480	0.05598	0.02160
26	0.18697	0.13799	0.10186	0.07686	0.05561	0.02160
27	0.17211	0.13796	0.10159	0.07820	0.05482	0.02160
28	0.16086	0.13539	0.10077	0.07949	0.05379	0.02160
29	0.15327	0.13034	0.09957	0.08098	0.05274	0.02155
30	0.14830	0.12340	0.09792	0.08243	0.05186	0.02147
31	0.14471	0.11562	0.09574	0.08331	0.05124	0.02133
32	0.14175	0.10824	0.09300	0.08305	0.05087	0.02115
33	0.13924	0.10222	0.08972	0.08131	0.05069	0.02094
34	0.13728	0.09780	0.08598	0.07814	0.05059	0.02072
35	0.13595	0.09459	0.08202	0.07401	0.05047	0.02052
36	0.13506	0.09198	0.07824	0.06962	0.05021	0.02035
37	0.13432	0.08950	0.07511	0.06567	0.04975	0.02020
38	0.13346	0.08700	0.07295	0.06259	0.04901	0.02003
39	0.13237	0.08456	0.07174	0.06044	0.04802	0.01983
40	0.13114	0.08239	0.07112	0.05897	0.04685	0.01961
41	0.12986	0.08066	0.07054	0.05786	0.04562	0.01941
42	0.12861	0.07946	0.06955	0.05687	0.04445	0.01927
43	0.12745	0.07878	0.06796	0.05592	0.04345	0.01921
44	0.12641	0.07850	0.06593	0.05506	0.04261	0.01915
45	0.12556	0.07846	0.06379	0.05430	0.04187	0.01896
46	0.12502	0.07850	0.06189	0.05360	0.04112	0.01845
47	0.12487	0.07846	0.06044	0.05290	0.04027	0.01758
48	0.12516	0.07827	0.05950	0.05214	0.03930	0.01644
49	0.12583	0.07794	0.05897	0.05134	0.03830	0.01527
50	0.12675	0.07746	0.05871	0.05060	0.03737	0.01428
51	0.12775	0.07684	0.05857	0.05007	0.03658	0.01359
52	0.12864	0.07603	0.05844	0.04987	0.03583	0.01316
53	0.12935	0.07502	0.05828	0.05005	0.03490	0.01292
54	0.12990	0.07387	0.05814	0.05063	0.03346	0.01280
55	0.13047	0.07277	0.05818	0.05166	0.03138	0.01274
56	0.13139	0.07204	0.05864	0.05322	0.02888	0.01273
57	0.13308	0.07204	0.05978	0.05550	0.02670	0.01274
58	0.13597	0.07310	0.06183	0.05865	0.02568	0.01279
59	0.14039	0.07542	0.06486	0.06276	0.02633	0.01285
60	0.14640	0.07900	0.06887	0.06781	0.02856	0.01292
61	0.15365	0.08365	0.07372	0.07366	0.03185	0.01300
62	0.16121	0.08885	0.07915	0.07994	0.03563	0.01307
63	0.16746	0.09364	0.08469	0.08600	0.03964	0.01312
64	0.16746	0.09364	0.08469	0.08600	0.03964	0.01312
65	0.16746	0.09364	0.08469	0.08600	0.03964	0.01312
66	0.16746	0.09364	0.08469	0.08600	0.03964	0.01312
67	0.16746	0.09364	0.08469	0.08600	0.03964	0.01312
68	0.16746	0.09364	0.08469	0.08600	0.03964	0.01312
69	0.16746	0.09364	0.08469	0.08600	0.03964	0.01312
70	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Note: Vesting Schedule Adjustment factors apply to these blended withdrawal rates. See the first page of Appendix B for details.

TABLE 13: Employees' Retirement System Age-Based Plans Retirement Central Rates of Decrement Effective 4/1/2020

Age	Tier 1			Tiers 2, 3, 4		
	Service < 20	20 ≤ Srv < 30	30 ≤ Service	Service < 20	20 ≤ Srv < 30	30 ≤ Service
55	0.16985	0.34977	0.77499	0.05895	0.08590	0.47092
56	0.09286	0.13929	0.26808	0.03780	0.04952	0.18857
57	0.07541	0.11619	0.23320	0.03780	0.05216	0.17845
58	0.09055	0.12956	0.21587	0.03960	0.05491	0.17183
59	0.10371	0.15469	0.21164	0.04386	0.06162	0.18384
60	0.10331	0.17394	0.21365	0.04829	0.07343	0.19365
61	0.13785	0.21229	0.24184	0.07578	0.16592	0.23334
62	0.19152	0.34528	0.35390	0.13825	0.35571	0.29639
63	0.15155	0.25017	0.23024	0.10753	0.22081	0.21538
64	0.17236	0.29052	0.23115	0.11760	0.21617	0.20854
65	0.22845	0.29262	0.26254	0.16671	0.28793	0.24495
66	0.23898	0.31788	0.26292	0.19340	0.31970	0.29280
67	0.19844	0.28362	0.22238	0.16763	0.27857	0.24846
68	0.15865	0.31095	0.20547	0.15500	0.25117	0.21412
69	0.19512	0.26244	0.18605	0.16490	0.26427	0.21208
70	2.00000	2.00000	2.00000	2.00000	2.00000	2.00000

Age	Tier 5			Tiers 6		
	Service < 20	20 ≤ Srv < 30	30 ≤ Service	Service < 20	20 ≤ Srv < 30	30 ≤ Service
55	0.04716	0.06872	0.08590	0.04716	0.06872	0.08590
56	0.03024	0.03962	0.04952	0.03024	0.03962	0.04952
57	0.03024	0.04173	0.05216	0.03024	0.04173	0.05216
58	0.03168	0.04393	0.05491	0.03168	0.04393	0.05491
59	0.03509	0.04930	0.06162	0.03509	0.04930	0.06162
60	0.03863	0.05874	0.07343	0.03863	0.05874	0.07343
61	0.06062	0.13274	0.16592	0.06062	0.13274	0.16592
62	0.18825	0.45571	1.09639	0.08825	0.15571	0.25571
63	0.10753	0.22081	0.21538	0.20753	0.52081	1.11538
64	0.11760	0.21617	0.20854	0.11760	0.21617	0.20854
65	0.16671	0.28793	0.24495	0.16671	0.28793	0.24495
66	0.19340	0.31970	0.29280	0.19340	0.31970	0.29280
67	0.16763	0.27857	0.24846	0.16763	0.27857	0.24846
68	0.15500	0.25117	0.21412	0.15500	0.25117	0.21412
69	0.16490	0.26427	0.21208	0.16490	0.26427	0.21208
70	2.00000	2.00000	2.00000	2.00000	2.00000	2.00000

The Tier 5 rates and Tier 6 rates listed above are defined using adjustments to the Tiers 2, 3, 4 rates, as described below.

Age	Tier 5		
	Service < 20	20 ≤ Srv < 30	30 ≤ Service*
<62	Service < 20 rate * 0.80	20 ≤ Srv < 30 rate * 0.80	20 ≤ Srv < 30 rate "as is"
=62	Service < 20 rate + 0.05	20 ≤ Srv < 30 rate + 0.10	30 ≤ Service rate + 0.8
>62	Service < 20 rate "as is"	20 ≤ Srv < 30 rate "as is"	30 ≤ Service rate "as is"

* except that Tier 5 Unified Court Peace Officers with 30 ≤ Service use the Tiers 2, 3, 4 30 ≤ Service rate "as is" at all ages.

Age	Tier 6		
	Service < 20	20 ≤ Srv < 30	30 ≤ Service
<62	Service < 20 rate * 0.80	20 ≤ Srv < 30 rate * 0.80	20 ≤ Srv < 30 rate "as is"
=62	Service < 20 rate – 0.05	20 ≤ Srv < 30 rate – 0.20	20 ≤ Srv < 30 rate – 0.10
=63	Service < 20 rate + 0.10	20 ≤ Srv < 30 rate + 0.30	30 ≤ Service rate + 0.90
>63	Service < 20 rate "as is"	20 ≤ Srv < 30 rate as is	30 ≤ Service rate "as is"

TABLE 14: Employees' Retirement System Service-Based Plans Retirement Central Rates of Decrement Effective 4/1/2020

Service	State Corrections Officers 25 Year Plan Tiers 1, 2	State Corrections Officers 25 Year Plan Tiers 3, 5, 6	County Corrections Officers 25 Year Plan All Tiers
25	0.20915	0.35143	0.39788
26	0.22135	0.20590	0.13927
27	0.22418	0.17710	0.12715
28	0.21834	0.17526	0.06190
29	0.20314	0.18232	0.12518
30	0.18023	0.25008	0.31048
31	0.15638	0.24101	0.22222
32	0.15787	0.22845	0.22744
33	0.18173	0.19237	0.29032
34	0.20559	0.21389	0.41606
35	0.23067	0.23796	0.39785
36	0.27093	0.29235	0.39785
37	0.33205	0.33040	0.39785
38	0.38247	0.33040	0.39785
39	0.39053	0.33040	0.39785
40	0.39053	0.33040	0.39785
41	0.39053	0.33040	0.39785
42	0.39053	0.33040	0.39785
43	0.39053	0.33040	0.39785
44	0.39053	0.33040	0.39785
45	0.39053	0.33040	0.39785
46	0.39053	0.33040	0.39785
47	0.39053	0.33040	0.39785
48	0.39053	0.33040	0.39785
49	0.39053	0.33040	0.39785
50	0.39053	0.33040	0.39785
51	0.39053	0.33040	0.39785
52	0.39053	0.33040	0.39785
53	0.39053	0.33040	0.39785
54	0.39053	0.33040	0.39785
55	2.00000	2.00000	2.00000

TABLE 15: Police & Fire Retirement System Death and Disability Central Rates of Decrement
Effective 4/1/2020

Age	Ordinary Death	Accidental Death	Ordinary Disability	Performance of Duty Disability	Accidental Disability
15	0.00010	0.00001	0.00001	0.00020	0.00020
16	0.00010	0.00001	0.00001	0.00020	0.00020
17	0.00011	0.00001	0.00001	0.00020	0.00020
18	0.00011	0.00001	0.00002	0.00020	0.00020
19	0.00012	0.00001	0.00002	0.00020	0.00020
20	0.00013	0.00001	0.00002	0.00020	0.00020
21	0.00014	0.00001	0.00002	0.00020	0.00020
22	0.00014	0.00001	0.00002	0.00020	0.00020
23	0.00015	0.00001	0.00003	0.00020	0.00020
24	0.00016	0.00001	0.00003	0.00020	0.00020
25	0.00017	0.00001	0.00003	0.00020	0.00020
26	0.00018	0.00001	0.00004	0.00020	0.00020
27	0.00019	0.00001	0.00004	0.00020	0.00020
28	0.00020	0.00001	0.00005	0.00020	0.00020
29	0.00021	0.00001	0.00005	0.00020	0.00020
30	0.00022	0.00001	0.00006	0.00020	0.00020
31	0.00024	0.00001	0.00006	0.00020	0.00020
32	0.00025	0.00001	0.00007	0.00020	0.00020
33	0.00026	0.00001	0.00008	0.00020	0.00020
34	0.00028	0.00001	0.00009	0.00020	0.00020
35	0.00029	0.00001	0.00010	0.00020	0.00020
36	0.00031	0.00001	0.00011	0.00050	0.00050
37	0.00033	0.00001	0.00012	0.00080	0.00080
38	0.00035	0.00001	0.00013	0.00110	0.00110
39	0.00037	0.00001	0.00015	0.00140	0.00140
40	0.00039	0.00001	0.00016	0.00170	0.00170
41	0.00041	0.00001	0.00018	0.00200	0.00200
42	0.00043	0.00001	0.00020	0.00230	0.00230
43	0.00046	0.00004	0.00022	0.00260	0.00260
44	0.00048	0.00004	0.00025	0.00290	0.00290
45	0.00051	0.00004	0.00027	0.00320	0.00320
46	0.00054	0.00004	0.00031	0.00320	0.00320
47	0.00057	0.00004	0.00034	0.00320	0.00320
48	0.00060	0.00004	0.00038	0.00320	0.00320
49	0.00064	0.00004	0.00042	0.00320	0.00320
50	0.00068	0.00004	0.00047	0.00320	0.00320
51	0.00071	0.00004	0.00052	0.00320	0.00320
52	0.00076	0.00004	0.00058	0.00320	0.00320
53	0.00080	0.00004	0.00064	0.00320	0.00320
54	0.00084	0.00004	0.00071	0.00320	0.00320
55	0.00089	0.00004	0.00079	0.00320	0.00320
56	0.00094	0.00004	0.00088	0.00320	0.00320
57	0.00100	0.00004	0.00097	0.00320	0.00320
58	0.00105	0.00004	0.00108	0.00320	0.00320
59	0.00111	0.00004	0.00120	0.00320	0.00320
60	0.00118	0.00004	0.00134	0.00320	0.00320
61	0.00125	0.00004	0.00149	0.00320	0.00320
62	0.00132	0.00004	0.00165	0.00320	0.00320
63	0.00139	0.00004	0.00183	0.00320	0.00320
64	0.00147	0.00004	0.00204	0.00320	0.00320
65	0.00162	0.00004	0.00224	0.00320	0.00320
66	0.00178	0.00004	0.00247	0.00320	0.00320
67	0.00196	0.00004	0.00271	0.00320	0.00320
68	0.00215	0.00004	0.00298	0.00320	0.00320
69	0.00237	0.00004	0.00328	0.00320	0.00320
70	0.00000	0.00000	0.00000	0.00000	0.00000

TABLE 16: Police & Fire Retirement System Withdrawal Central Rates of Decrement
Effective 4/1/2020

Service	Withdrawal
0	0.07328
1	0.04003
2	0.02114
3	0.01340
4	0.01142
5	0.01133
6	0.01112
7	0.01043
8	0.00937
9	0.00811
10	0.00673
11	0.00544
12	0.00432
13	0.00351
14	0.00300
15	0.00268
16	0.00230
17	0.00186
18	0.00160
19	0.00160
20	0.00160
21	0.00160
22	0.00160
23	0.00160
24	0.00160
25	0.00160
26	0.00160
27	0.00160
28	0.00160
29	0.00160
30	0.00160
31	0.00160
32	0.00160
33	0.00160
34	0.00160
35	0.00160
36	0.00160
37	0.00160
38	0.00160
39	0.00160
40	0.00160
41	0.00160
42	0.00160
43	0.00160
44	0.00160
45	0.00160
46	0.00160
47	0.00160
48	0.00160
49	0.00160
50	0.00160
51	0.00160
52	0.00160
53	0.00160
54	0.00160
55	0.00000

TABLE 17: Police & Fire Retirement System Age-Based Plans Retirement Central Rates of Decrement Effective 4/1/2020

Age	Tier 1			Tiers 2, 5		
	Service < 20	20 ≤ Srv < 30	30 ≤ Service	Service < 20	20 ≤ Srv < 30	30 ≤ Service
55	0.16985	0.34977	0.77499	0.05895	0.08590	0.08590
56	0.09286	0.13929	0.26808	0.03780	0.04952	0.04952
57	0.07541	0.11619	0.23320	0.03780	0.05216	0.05216
58	0.09055	0.12956	0.21587	0.03960	0.05491	0.05491
59	0.10371	0.15469	0.21164	0.04386	0.06162	0.06162
60	0.10331	0.17394	0.21365	0.04829	0.07343	0.07343
61	0.13785	0.21229	0.24184	0.07578	0.16592	0.16592
62	0.19152	0.34528	0.35390	0.13825	0.35571	0.35571
63	0.15155	0.25017	0.23024	0.10753	0.22081	0.22081
64	0.17236	0.29052	0.23115	0.11760	0.21617	0.21617
65	0.22845	0.29262	0.26254	0.16671	0.28793	0.28793
66	0.23898	0.31788	0.26292	0.19340	0.31970	0.31970
67	0.19844	0.28362	0.22238	0.16763	0.27857	0.27857
68	0.15865	0.31095	0.20547	0.15500	0.25117	0.25117
69	0.19512	0.26244	0.18605	0.16490	0.26427	0.26427
70	2.00000	2.00000	2.00000	2.00000	2.00000	2.00000

Age				Tiers 6		
				Service < 20	20 ≤ Srv < 30	30 ≤ Service
55				0.04716	0.06872	0.08590
56				0.03024	0.03962	0.04952
57				0.03024	0.04173	0.05216
58				0.03168	0.04393	0.05491
59				0.03509	0.04930	0.06162
60				0.03863	0.05874	0.07343
61				0.06062	0.13274	0.16592
62				0.08825	0.15571	0.25571
63				0.35753	0.52081	1.11538
64				0.11760	0.21617	0.20854
65				0.16671	0.28793	0.24495
66				0.19340	0.31970	0.29280
67				0.16763	0.27857	0.24846
68				0.15500	0.25117	0.21412
69				0.16490	0.26427	0.21208
70				2.00000	2.00000	2.00000

Age-Based retirement plans make up less than 1% of all PFRS by salary. Therefore, the PFRS service retirement rates are selected to correspond with the ERS assumption reflecting the same early age reduction factors, as described below.

PFRS Tier 1 rates above are identical to ERS Tier 1 across all service groupings.

PFRS Tier 2, 5 rates above use the ERS Tier 2, 3, 4 rates as follows

PFRS Tiers 2, 5 Service < 20	uses	ERS Tier 2, 3, 4 Service < 20
PFRS Tiers 2, 5 20 ≤ Srv < 30	uses	ERS Tier 2, 3, 4 20 ≤ Srv < 30
PFRS Tiers 2, 5 30 ≤ Service	uses	ERS Tier 2, 3, 4 20 ≤ Srv < 30

PFRS Tier 6 rates above are identical to ERS Tier 6 across all service groupings.

TABLE 18: Police & Fire Retirement System Service-Based Plans Retirement Central Rates of Decrement Effective 4/1/2020

Service	20 Year Plan (no additional 60ths beyond 20 years)	20 Year Plan (plus additional 60ths beyond 20 years)	State Police 20 Year Plan	Article 14 20 Year Plan
20	0.31492	0.10607	0.10032	0.02000
21	0.14905	0.06366	0.07433	0.02000
22	0.12749	0.05857	0.07743	0.02000
23	0.13002	0.06826	0.06716	0.02000
24	0.10300	0.08483	0.09944	0.02000
25	0.10031	0.09264	0.12625	0.80000
26	0.07680	0.08322	0.11564	0.50000
27	0.11734	0.09188	0.13445	0.50000
28	0.09717	0.12632	0.12134	0.50000
29	0.08140	0.12838	0.14570	0.50000
30	0.07559	0.17748	0.21896	0.50000
31	0.12715	0.27831	0.40367	0.50000
32	0.15484	0.38048	0.53202	0.50000
33	0.12245	0.28649	0.48511	0.50000
34	0.12376	0.27901	0.30769	0.50000
35	0.15385	0.25410	0.32558	0.50000
36	0.14063	0.33438	0.32558	0.50000
37	0.13853	0.29008	0.32558	0.50000
38	0.13853	0.29008	0.32558	0.50000
39	0.13853	0.29008	0.32558	0.50000
40	0.13853	0.29008	0.32558	0.50000
41	0.13853	0.29008	0.32558	0.50000
42	0.13853	0.29008	0.32558	0.50000
43	0.13853	0.29008	0.32558	0.50000
44	0.13853	0.29008	0.32558	0.50000
45	0.13853	0.29008	0.32558	0.50000
46	0.13853	0.29008	0.32558	0.50000
47	0.13853	0.29008	0.32558	0.50000
48	0.13853	0.29008	0.32558	0.50000
49	0.13853	0.29008	0.32558	0.50000
50	0.13853	0.29008	0.32558	0.50000
51	0.13853	0.29008	0.32558	0.50000
52	0.13853	0.29008	0.32558	0.50000
53	0.13853	0.29008	0.32558	0.50000
54	0.13853	0.29008	0.32558	0.50000
55	2.00000	2.00000	2.00000	2.00000

TABLE 19: Employees' Retirement System Salary Scale
Effective 4/1/2018

Service	Increase
0	1.0880
1	1.0880
2	1.0770
3	1.0660
4	1.0550
5	1.0495
6	1.0462
7	1.0451
8	1.0440
9	1.0429
10	1.0418
11	1.0407
12	1.0396
13	1.0385
14	1.0374
15	1.0363
16	1.0352
17	1.0341
18	1.0330
19	1.0330
20	1.0330
21	1.0330
22	1.0330
23	1.0330
24	1.0330
25	1.0330
26	1.0330
27	1.0330
28	1.0330
29	1.0330
30	1.0330
31	1.0330
32	1.0330
33	1.0330
34	1.0330
35	1.0330
36	1.0330
37	1.0330
38	1.0330
39	1.0330
40	1.0330
41	1.0330
42	1.0330
43	1.0330
44	1.0330
45	1.0330
46	1.0330
47	1.0330
48	1.0330
49	1.0330
50	1.0330
51	1.0330
52	1.0330
53	1.0330
54	1.0330
55	1.0330

TABLE 20: Police & Fire Retirement System Salary Scale
Effective 4/1/2021

Service	Increase
0	1.2800
1	1.2800
2	1.1800
3	1.1300
4	1.1100
5	1.0800
6	1.0600
7	1.0500
8	1.0400
9	1.0400
10	1.0400
11	1.0400
12	1.0400
13	1.0400
14	1.0400
15	1.0400
16	1.0400
17	1.0400
18	1.0400
19	1.0400
20	1.0400
21	1.0400
22	1.0400
23	1.0400
24	1.0400
25	1.0400
26	1.0300
27	1.0300
28	1.0300
29	1.0300
30	1.0300
31	1.0300
32	1.0300
33	1.0300
34	1.0300
35	1.0300
36	1.0300
37	1.0300
38	1.0300
39	1.0300
40	1.0300
41	1.0300
42	1.0300
43	1.0300
44	1.0300
45	1.0300
46	1.0300
47	1.0300
48	1.0300
49	1.0300
50	1.0300
51	1.0300
52	1.0300
53	1.0300
54	1.0300
55	1.0300

Appendix C:
Additional Considerations in Setting the Investment Rate of Return Assumption

While the primary consideration is the Asset Allocation (AA) Policy, other considerations may include alternative capital market assumptions and the perspectives of stakeholders, including credit rating agencies.

The AA Policy analysis is heavily reliant upon the asset class return assumptions developed by investment consultant RVK. While the target asset allocation has not changed since the January 2020 Asset Allocation Report, the forecasted asset class return assumptions are updated annually. Generally, the annual update of capital market assumptions is less scrutinized than those used to set the Asset Allocation Policy. A shift in expectations may reflect a divergence from the risk/reward balance preferred by the Trustee, which would be corrected with the next quinquennial review of the AA Policy. Therefore, while informative and deserving mention, the annual updates do not necessarily change the long-term expectation.

For the fiscal year ending March 31, 2023, the new capital market assumptions result in an expected arithmetic return of 6.97% with a standard deviation of 10.97%, for a geometric return of 6.41%.

We can compare the new RVK assumptions to the capital market assumptions used by other investment professionals. The table below summarizes different forecasters' median return expectations for different portfolio compositions, as presented in the 2023 Enrolled Actuaries Conference. The composition of the Common Retirement Fund is best described as 80/20, meaning 80% volatile investments and 20% fixed return assets.

Investment Firms Capital Market Assumption Sets (CMAs)*	60/40	65/35	70/30	75/25	80/20	85/15	90/10
1	3.41%	3.59%	4.04%	4.46%	4.55%	4.89%	5.19%
2	3.48%	3.64%	4.28%	4.63%	4.87%	5.24%	5.41%
3	3.59%	3.74%	4.32%	5.15%	5.30%	5.58%	5.84%
4	3.90%	4.10%	4.67%	5.19%	5.35%	5.59%	5.84%
5	3.99%	4.16%	4.68%	5.20%	5.37%	5.64%	5.88%
6	3.99%	4.17%	4.72%	5.23%	5.52%	5.86%	6.08%
7	4.00%	4.22%	4.80%	5.42%	5.55%	5.90%	6.15%
8	4.05%	4.28%	4.84%	5.47%	5.57%	5.96%	6.24%
9	4.43%	4.63%	5.16%	5.63%	5.83%	6.17%	6.39%
10	4.47%	3.65%	5.64%	5.91%	6.00%	6.22%	6.47%
11	4.97%	5.16%	5.69%	6.46%	6.43%	6.77%	7.07%
12	5.16%	5.35%	5.93%	6.57%	6.86%	7.67%	7.99%
2022 Consensus Average	**4.12%**	**4.31%**	**4.90%**	**5.44%**	**5.60%**	**5.96%**	**6.21%**

*Investment Firms' CMAs published for 2022. Investment Firms do not rank the same across all asset allocations. Some rank a little higher in some asset allocations than they do in others. Nevertheless, they are listed here from 1 through 12.

The newest estimates from RVK are higher than most estimates provided by other investment firms.

Beyond the AA Policy and the capital market assumptions, consideration may be given to the position of stakeholders, such as credit rating agencies.

Credit rating agencies (such as S&P Global Ratings) review the financial health of public entities, including states and municipalities. Like an individual's credit score, a credit rating agency's analysis of a public entity will affect the cost of issuing debt and may limit the ability to borrow altogether (for example, the interest rate paid on municipal bonds). This can have serious consequences that impact the financial health of the public entity for a prolonged period.

One consideration of S&P Global Ratings is the assumed investment rate of return used to discount pension plan liabilities. The guidance issued by S&P Global Ratings expects the assumption:

- to not exceed 6.0% based on current market conditions for a typical public pension plan,
- to reflect realistic performance of the target investment portfolio, and
- to be cognizant of the level of budgetary stress the participating employers can withstand.

The recommended assumption is below 6.0% and reflects reasonable return expectations of the target asset allocation. The Risk Disclosure section includes details regarding volatility in employer billing rates.

We close this appendix with two sidebar discussions that aim to illuminate technical information and situational context.

Sidebar: Understanding the difference between Arithmetic Return and Geometric Return

A full discussion comparing the arithmetic return and the geometric return is beyond the scope of this report. But the geometric return is generally regarded as the appropriate target for the assumed investment rate of return to be consistent with the application of compound interest.

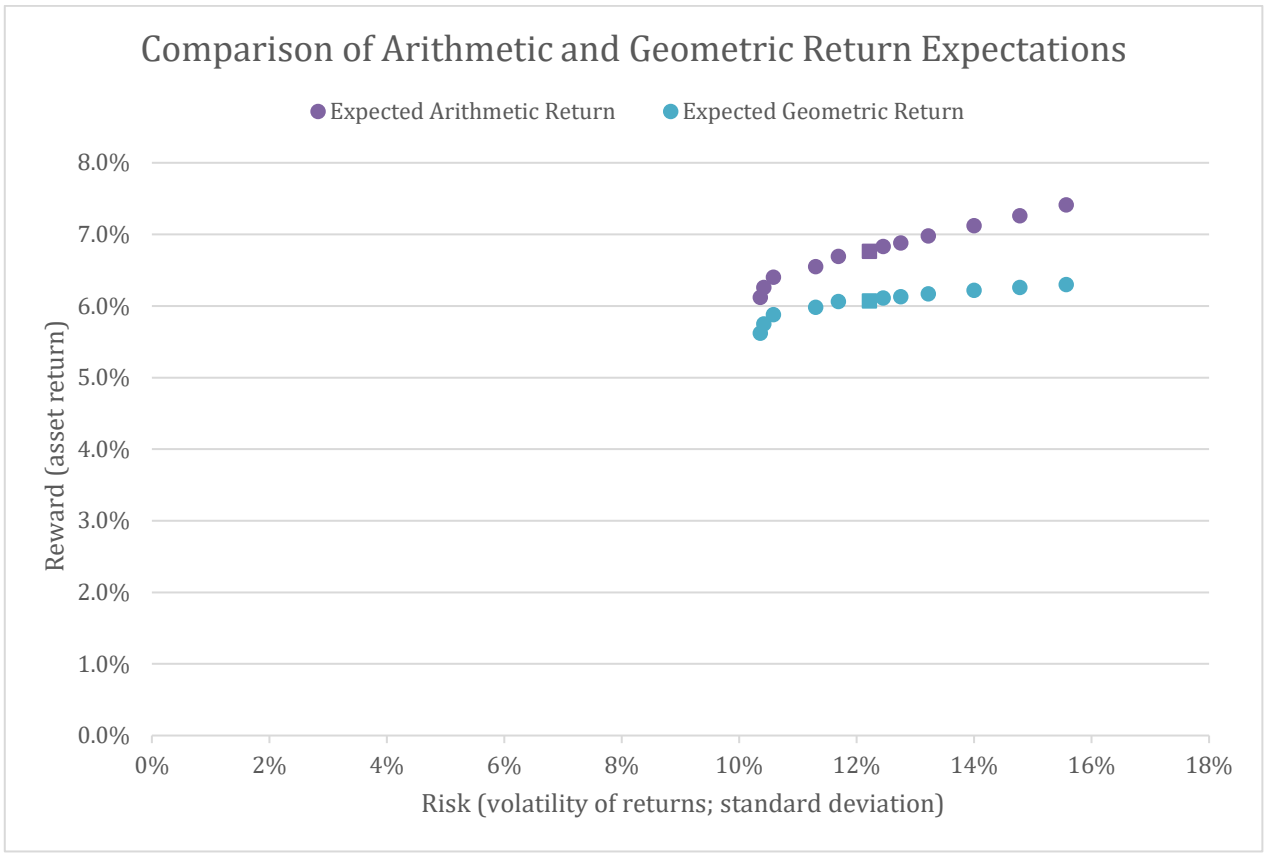
Arithmetic Return (AR) is the average of each year's annual return over a number of years.

Geometric Return (GR) is the annualized compound return expected over a number of years.

The different meaning of AR versus GR is best illustrated by example. In FY 2009, the NYSLRS investment return was -26.4%. In the year that followed it was 25.9%. The arithmetic average of these two years is approximately 0%. This does not mean however, that FY 2010 recouped all the FY 2009 losses. The GR for the two years was (1 – 26.4%) * (1 + 25.9%) – 1 = -7.3%, or -3.7% annually. This better characterizes the change in asset value over the two years.

The geometric return is always less than the arithmetic return. The more volatile the annual returns, the greater the difference. Said differently, the arithmetic return "rewards" risk-taking more than the geometric return. To visualize this, the graph below plots both returns for 10 asset allocations presented in the 2020 AA Report. The square marker represents the trustee-approved Asset Allocation Policy.

Notice how the geometric return is flatter than the arithmetic return as the risk increases.

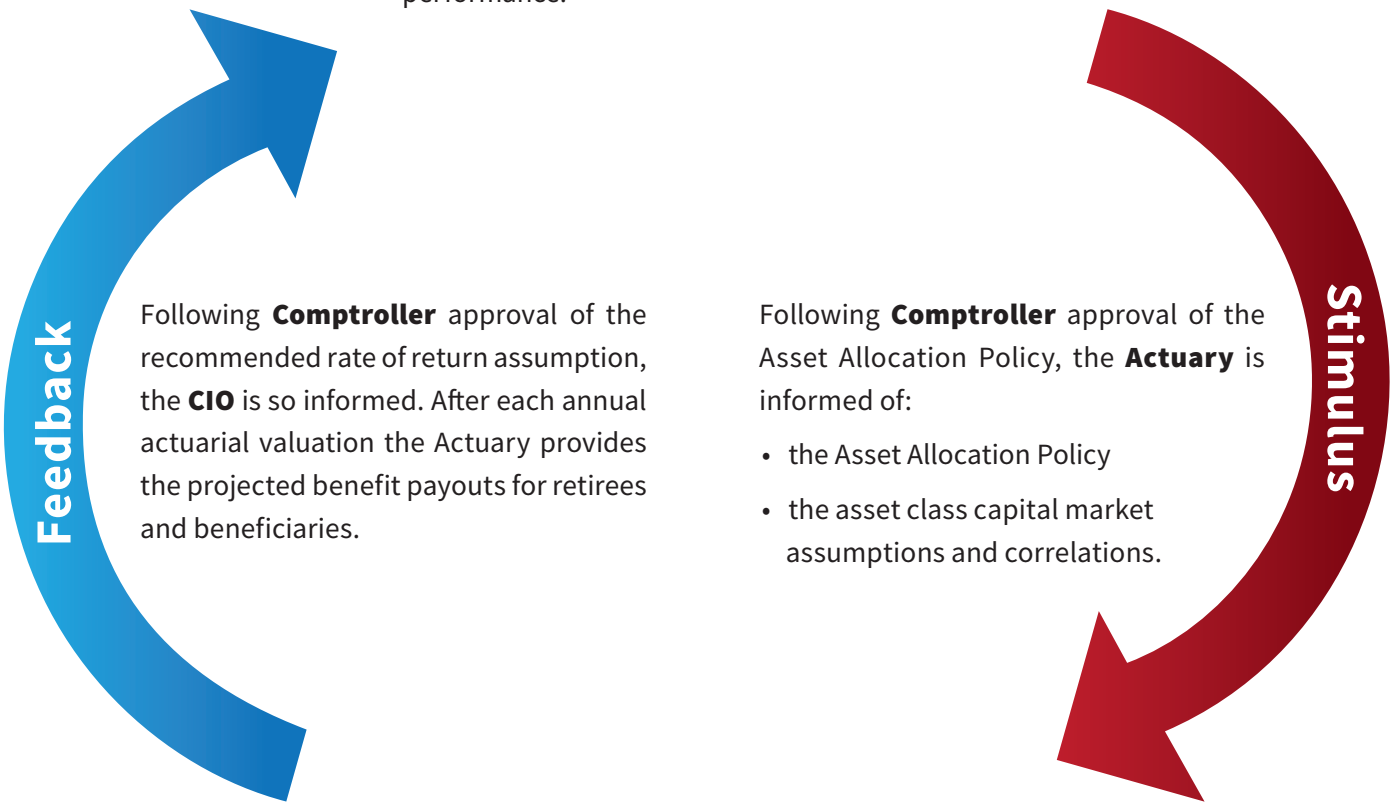


Sidebar: Understanding how the Assumed Rate of Return is Developed

CHIEF INVESTMENT OFFICER (CIO)

Periodically analyzes the investment landscape to determine the optimal asset allocation:

- guided by internal staff, external consultants, and the Investment Advisory Committee
- mindful of projected benefit payouts and the sensitivity of employer contributions to investment performance.



ACTUARY

Using stochastic modeling, determines/confirms the expected rate of return of the Asset Allocation Policy given the asset class capital market assumptions and correlations and recommends a rate of return assumption:

- guided by internal staff, an external consultant, and the Actuarial Advisory Committee
- mindful of the impact on employer contributions and the objective of smooth contribution rates.

Office of the New York State Comptroller
Thomas P. DiNapoli

NYSLRS
New York State and Local Retirement System