

Boston Retirement System

Actuarial Valuation and Review as of January 1, 2022



This report has been prepared at the request of the Retirement Board to assist in administering the Boston Retirement System. This valuation report may not otherwise be copied or reproduced in any form without the consent of the Retirement Board and may only be provided to other parties in its entirety, unless expressly authorized by Segal. The measurements shown in this actuarial valuation may not be applicable for other purposes.

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August 1, 2022

Retirement Board
Boston Retirement System
City Hall, Room 816
Boston, MA 02201

Dear Board Members:

We are pleased to submit this Actuarial Valuation and Review as of January 1, 2022. It summarizes the actuarial data used in the valuation, analyzes the preceding two years' experience, and establishes the funding requirements for fiscal 2023 and later years.

The report shows the results for the valuation for the Boston Retirement System as a whole, and separately for the Teachers and the Boston Retirement System excluding Teachers.

This report was prepared in accordance with generally accepted actuarial principles and practices at the request of the Board to assist in administering the Retirement System. The census information and financial information on which our calculations were based was prepared by the staff of the System. That assistance is gratefully acknowledged.

The actuarial calculations were directed under the supervision of Kathleen A. Riley, FSA, MAAA, EA. She is a member of the American Academy of Actuaries and meets the Qualification Standards of the American Academy of Actuaries to render the actuarial opinion herein. To the best of her knowledge, the information supplied in this actuarial valuation is complete and accurate. The assumptions used in this actuarial valuation were selected by the Board based upon her analysis and recommendations. In her opinion, the assumptions are reasonable and take into account the experience of the Boston Retirement System and reasonable expectations.

We look forward to reviewing this report at your next meeting and to answering any questions.

Sincerely,
Segal

A handwritten signature in blue ink that reads "Kathleen A. Riley".

Kathleen A. Riley, FSA, MAAA, EA
Senior Vice President and Consultant

A handwritten signature in blue ink that reads "Bridget P. Orr".

Bridget P. Orr, FSA, MAAA, EA
Consulting Actuary

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Section 1: Actuarial Valuation Summary

Purpose and basis

This report was prepared by Segal to present a valuation of the Boston Retirement System as of January 1, 2022. The valuation was performed to determine whether the assets and contributions are sufficient to provide the prescribed benefits. The measurements shown in this actuarial valuation may not be applicable for other purposes. In particular, the measures herein are not necessarily appropriate for assessing the sufficiency of System assets to cover the estimated cost of settling the System's benefit obligations. Future actuarial measurements may differ significantly from the current measurements presented in this report due to such factors as the following: plan experience differing from that anticipated by the economic or demographic assumptions; changes in economic or demographic assumptions; increases or decreases expected as part of the natural operation of the methodology used for these measurements; and changes in plan provisions or applicable law.

The contribution requirements presented in this report are based on:

- The benefit provisions of Massachusetts General Law Chapter 32;
- The characteristics of covered active participants, inactive participants, and retired participants and beneficiaries as of December 31, 2021, provided by the staff of the Retirement System;
- The assets of the System as of December 31, 2021, provided by the staff of the Retirement System;
- Economic assumptions regarding future salary increases and investment earnings; and
- Other actuarial assumptions regarding employee terminations, retirement, death, etc.

Certain disclosure information required by GASB Statements No 67 and 68 as of December 31, 2021 for the Retirement System is provided in a separate report.

Section 1: Actuarial Valuation Summary

Valuation highlights

1. Segal strongly recommends an actuarial funding method that targets 100% funding of the actuarial accrued liability. Generally, this implies payments that are ultimately at least enough to cover normal cost, interest on the unfunded actuarial accrued liability and the principal balance. The funding policy adopted by the Boston Retirement System meets this standard and funds the unfunded actuarial accrued liability excluding Teachers by June 30, 2027. The funding policy for the Teachers is determined by the Commonwealth.
2. The report shows the results of the valuation for the Boston Retirement System (BRS) as a whole and separately for the Teachers and the BRS excluding Teachers.
3. In accordance with Chapter 112 of the Acts of 2010, the assets attributable to Teachers (27% of the market value of assets) were transferred to the PRIT Fund in 2010. The obligation to fund the liabilities of the Teachers and a share of the administrative cost of the BRS related to the Teachers remains an obligation of the Commonwealth. Beginning in December 2010, appropriations have been received by the BRS from the Commonwealth for the Teachers and have been transferred to the PRIT Fund. Transfers are made from the PRIT Fund on a monthly basis to cover the excess of benefit payments to the Teachers and a share of administrative expenses over the Teachers' employee contributions.
4. The funded ratio (the ratio of the actuarial value of assets to actuarial accrued liability) is 68.91% for the BRS as a whole, compared to the prior valuation funded ratio of 63.24%. This ratio is one measure of funding status, and its history is a measure of funding progress. Using the market value of assets, the funded ratio is 73.85%, compared to 62.65% as of the prior valuation date. These measurements are not necessarily appropriate for assessing the sufficiency of System assets to cover the estimated cost of settling the Boston Retirement System's benefit obligation or the need for or the amount of future contributions.
5. The rate of return on the market value of assets for the BRS was 11.68% and 13.85% for the plan years ended December 31, 2020 and December 31, 2021, respectively. The rate of return on the actuarial value of assets (which gradually recognizes market fluctuations) was 7.79% and 9.03% for the plan years ended December 31, 2020 and December 31, 2021, respectively.
6. The actuarial value of assets for the BRS as of December 31, 2021 was \$8.850 billion, or 93.31% of the market value of assets of \$9.484 billion reported in the Annual Statement. As of December 31, 2019, the actuarial value of assets was 100.94% of the market value.
7. The investment experience in the past years has only been partially recognized in the actuarial value of assets. As the deferred net gain of \$634.1 million is recognized in future years, the cost of the System is likely to decrease unless the net gain is offset by future experience. This implies that earning the assumed rate of investment return (net of expenses) on a market value basis will result in investment gains on the actuarial value of assets in the next few years. The deferred investment gains are not recognized in the projection of the unfunded actuarial accrued liability in the funding schedule for the BRS excluding Teachers shown in *Section 2*.

Section 1: Actuarial Valuation Summary

8. The following actuarial assumptions were changed with this valuation:

- For the BRS excluding Teachers:

- The investment rate of return assumption was lowered from 7.05% to 6.90%.
- The generational mortality improvement scale was updated from Scale MP-2019 to Scale MP-2021.
- The administrative expense assumption was lowered from \$7.70 million for calendar year 2020 to \$7.28 million for calendar year 2022.

Changing these assumptions increased the unfunded liability by approximately \$110.1 million and increased the normal cost by approximately \$6.5 million.

- For Teachers:

- The investment rate of return assumption was lowered from 7.15% to 7.00%.
- The generational mortality improvement scale was updated from Scale MP-2019 to Scale MP-2021.
- The administrative expense assumption was lowered from \$3.30 million for calendar year 2020 to \$3.12 million for calendar year 2022.

Changing these assumptions increased the unfunded liability by approximately \$61.0 million and increased the normal cost by approximately \$3.2 million.

9. The COLA base was increased from \$14,000 to \$15,000 on July 1, 2021. The change increased the unfunded liability for BRS excluding Teachers by approximately \$28.5 million and the unfunded liability for Teachers by approximately \$15.0 million.
10. The unfunded liability was expected to decrease by \$272 million from \$4.346 billion as of January 1, 2020 to \$4.073 billion as of January 1, 2022. The actual unfunded liability as of January 1, 2022 is \$3.993 billion or \$80 million less than expected. The decrease is primarily due to the investment gain on an actuarial basis partially offset by the assumption changes and the increase in the COLA base described above. Other sources of gains and losses are discussed in Sections 2 and 3.
11. The fiscal 2023 appropriation for the BRS excluding Teachers has been set equal to the previously budgeted amount of \$403,678,138. The funding schedule included in this report is projected to fully fund the System by June 30, 2027, if all assumptions are met and there are no changes in the plan of benefits or actuarial assumptions, with appropriations that increase 8.85% per year. The prior funding schedule also fully funded the liabilities of the BRS excluding Teachers by June 30, 2027 with appropriations that increased 8.85% per year.
12. The Commonwealth appropriation for the Teachers is \$196,832,959 for fiscal 2023. The total Commonwealth appropriation is expected to increase by 9.63% through fiscal 2035 and the Commonwealth's liabilities are expected to be fully funded in 2036. The allocation of the total Commonwealth appropriation in future fiscal years to the Teachers will be determined each year.

Section 1: Actuarial Valuation Summary

13. *Section 2* shows participant and asset information, the experience analysis, liabilities and a funding schedule for the BRS excluding Teachers, with comparisons to 2020. *Section 3* shows the same information for the Teachers with comparisons to 2020. *Section 4* shows participant and asset information for all employees of the BRS.
14. It is important to note that this actuarial valuation is based on plan assets as of December 31, 2021. The System's funded status does not reflect short-term fluctuations of the market, but rather is based on the market values on the last day of the plan year. Moreover, this actuarial valuation does not include any possible short-term or long-term impacts on mortality of the covered population that may emerge after December 31, 2021 due to the COVID-19 pandemic. Segal is available to prepare projections of potential outcomes of market conditions and other demographic experience upon request.
15. Since the actuarial valuation results are dependent on a given set of assumptions, there is a risk that emerging results may differ significantly as actual experience proves to be different from the assumptions. We have not been engaged to perform a detailed analysis of the potential range of the impact of risk relative to the System's future financial condition, but have included a brief discussion of some risks that may affect the BRS excluding Teachers in *Section 2* and the Teachers in *Section 3*. A more detailed assessment would provide the Board with a better understanding of the inherent risks.

Section 1: Actuarial Valuation Summary

Summary of key valuation results – BRS excluding Teachers

		2022	2020
Contributions	• Actuarially Determined Contributions for fiscal year 2023 and 2021	\$403,678,138 ¹	\$335,531,696
	• Actuarially Determined Contributions for fiscal year 2024 and 2022	439,403,653	365,226,251
	• Actuarially Determined Contributions for fiscal year 2025 and 2023	478,290,876	397,548,774
Actuarial accrued liability for plan year beginning January 1:	• Retired participants and beneficiaries	\$4,336,591,142	\$3,827,382,780
	• Inactive vested participants	147,244,535	123,499,767
	• Inactive participants due a refund of employee contributions	62,088,988	51,081,790
	• Active participants	3,671,793,401	3,543,152,940
	• Total	8,217,718,066	7,545,117,277
	• Normal cost including administrative expense assumption for plan year beginning January 1	208,299,348	190,491,468
Assets for plan year beginning January 1:	• Market value of assets (MVA)	\$7,130,505,146	\$5,583,428,192
	• Actuarial value of assets (AVA)	6,768,562,195	5,703,899,970
	• Actuarial value of assets as a percentage of market value of assets	94.92%	102.16%
Funded status for plan year beginning January 1:	• Unfunded actuarial accrued liability on market value of assets	\$1,087,212,920	\$1,961,689,085
	• Funded percentage on MVA basis	86.77%	74.00%
	• Unfunded actuarial accrued liability on actuarial value of assets	\$1,449,155,871	\$1,841,217,307
	• Funded percentage on AVA basis	82.37%	75.60%
Key assumptions	• Net investment return	6.90%	7.05%
	• Long-term wage inflation rate	3.25%	3.25%
Demographic data for plan year beginning January 1:	• Number of retired participants and beneficiaries	9,998	9,779
	• Number of inactive vested participants	856	776
	• Number of inactive participants due a refund of employee contributions	9,921	8,907
	• Number of active participants	14,581	14,709
	• Total payroll ²	\$1,130,019,040	\$1,063,526,175
	• Average payroll	77,499	72,304

¹ As a result of the adoption of a \$15,000 COLA base, the Actuarially Determined Contributions for fiscal years 2022 and 2023 were revised after the January 1, 2020 valuation, dated August 25, 2020, was completed.

² Payroll figures are for the prior year and reflect annualized salaries for participants hired during the year. Calendar year 2021 payroll figures were increased by 3% for Police, 1% for Fire Fighters, and 2.5% for Group 1 and Group 2 employees to estimate unsettled contracts. Calendar year 2019 payroll figures were reduced for Fire Fighters to reflect retroactive payments made during the year.

Section 1: Actuarial Valuation Summary

Summary of key valuation results – Teachers

		2022	2020
Actuarial accrued liability for plan year beginning January 1:	<ul style="list-style-type: none"> Retired participants and beneficiaries Inactive vested participants Inactive participants due a refund of employee contributions Active participants Total Normal cost including administrative expense assumption for plan year beginning January 1 	\$2,689,353,554 92,706,424 61,603,333 1,781,072,106 4,624,735,417 96,966,960	\$2,595,693,503 72,340,548 50,717,317 1,558,527,366 4,277,278,734 84,917,565
Assets for plan year beginning January 1:	<ul style="list-style-type: none"> Market value of assets (MVA) Actuarial value of assets (AVA) Actuarial value of assets as a percentage of market value of assets 	\$2,353,125,177 2,080,996,195 88.44%	\$1,823,646,734 1,772,897,935 97.22%
Funded status for plan year beginning January 1:	<ul style="list-style-type: none"> Unfunded actuarial accrued liability on market value of assets Funded percentage on MVA basis Unfunded actuarial accrued liability on actuarial value of assets Funded percentage on AVA basis 	\$2,271,610,240 50.88% \$2,543,739,222 45.00%	\$2,453,632,000 42.64% \$2,504,380,799 41.45%
Key assumptions	<ul style="list-style-type: none"> Net investment return Long-term wage inflation rate 	7.00% 3.25%	7.15% 3.25%
Demographic data for plan year beginning January 1:	<ul style="list-style-type: none"> Number of retired participants and beneficiaries Number of inactive vested participants Number of inactive participants due a refund of employee contributions Number of active participants Total payroll¹ Average payroll 	4,821 447 2,900 6,303 \$655,169,031 103,946	4,780 371 2,624 6,147 \$583,380,055 94,905

¹ Payroll figures are for the prior year and reflect annualized salaries for participants hired during the year. Calendar year 2021 payroll figures were increased by 1% to estimate unsettled contracts. Calendar year 2019 payroll figures were reduced to reflect retroactive payments made during the year.

Section 1: Actuarial Valuation Summary

Summary of key valuation results – All Boston Retirement System employees

		2022	2020
Actuarial accrued liability for plan year beginning January 1:	• Retired participants and beneficiaries	\$7,025,944,695	\$6,423,076,283
	• Inactive vested participants	239,950,960	195,840,315
	• Inactive participants due a refund of employee contributions	123,692,321	101,799,107
	• Active participants	5,452,865,507	5,101,680,306
	• Total	12,842,453,483	11,822,396,011
	• Normal cost including administrative expense assumption for plan year beginning January 1	305,266,308	275,409,033
Assets for plan year beginning January 1:	• Market value of assets (MVA)	\$9,483,630,323	\$7,407,074,926
	• Actuarial value of assets (AVA)	8,849,558,390	7,476,797,905
	• Actuarial value of assets as a percentage of market value of assets	93.31%	100.94%
Funded status for plan year beginning January 1:	• Unfunded actuarial accrued liability on market value of assets	\$3,358,823,160	\$4,415,321,085
	• Funded percentage on MVA basis	73.85%	62.65%
	• Unfunded actuarial accrued liability on actuarial value of assets	\$3,992,895,093	\$4,345,598,106
	• Funded percentage on AVA basis	68.91%	63.24%
Demographic data for plan year beginning January 1:	• Number of retired participants and beneficiaries	14,819	14,559
	• Number of inactive vested participants	1,303	1,147
	• Number of inactive participants due a refund of employee contributions	12,821	11,531
	• Number of active participants	20,884	20,856
	• Total payroll ¹	\$1,785,188,071	\$1,646,906,230
	• Average payroll	85,481	78,966

¹ Payroll figures are for the prior year and reflect annualized salaries for participants hired during the year. Calendar year 2021 payroll figures were increased by 3% for Police, 1% for Fire Fighters and Teachers, and 2.5% for Group 1 and Group 2 employees to estimate unsettled contracts. Calendar year 2019 payroll figures were reduced for Fire Fighters and Teachers to reflect retroactive payments made during the year.

Section 1: Actuarial Valuation Summary

Important information about actuarial valuations

An actuarial valuation is a budgeting tool with respect to the financing of future projected obligations of a pension plan. It is an estimated forecast – the actual long-term cost of the plan will be determined by the actual benefits and expenses paid and the actual investment experience of the plan.

In order to prepare a valuation, Segal relies on a number of input items. These include:

Plan of benefits	Plan provisions define the rules that will be used to determine benefit payments, and those rules, or the interpretation of them, may change over time. Even where they appear precise, outside factors may change how they operate. It is important to keep Segal informed with respect to plan provisions and administrative procedures, and to review the plan summary included in our report to confirm that Segal has correctly interpreted the plan of benefits.
Participant data	An actuarial valuation for a plan is based on data provided to the actuary by the Retirement System. Segal does not audit such data for completeness or accuracy, other than reviewing it for obvious inconsistencies compared to prior data and other information that appears unreasonable. It is important for Segal to receive the best possible data and to be informed about any known incomplete or inaccurate data.
Assets	The valuation is based on the market value of assets as of the valuation date, as provided by the Retirement System. The Retirement System uses an “actuarial value of assets” that differs from market value to gradually reflect year-to-year changes in the market value of assets in determining the contribution requirements.
Actuarial assumptions	In preparing an actuarial valuation, Segal projects the benefits to be paid to existing plan participants for the rest of their lives and the lives of their beneficiaries. This projection requires actuarial assumptions as to the probability of death, disability, withdrawal, and retirement of each participant for each year. In addition, the benefits projected to be paid for each of those events in each future year reflect actuarial assumptions as to salary increases and cost-of-living adjustments. The projected benefits are then discounted to a present value, based on the assumed rate of return that is expected to be achieved on the plan’s assets. There is a reasonable range for each assumption used in the projection and the results may vary materially based on which assumptions are selected. It is important for any user of an actuarial valuation to understand this concept. Actuarial assumptions are periodically reviewed to ensure that future valuations reflect emerging plan experience. While future changes in actuarial assumptions may have a significant impact on the reported results that does not mean that the previous assumptions were unreasonable.
Models	Segal valuation results are based on proprietary actuarial modeling software. The actuarial valuation models generate a comprehensive set of liability and cost calculations that are presented to meet regulatory, legislative and client requirements. Deterministic cost projections are based on a proprietary forecasting model. Our Actuarial Technology and Systems unit, comprised of both actuaries and programmers, is responsible for the initial development and maintenance of these models. The models have a modular structure that allows for a high degree of accuracy, flexibility and user control. The client team programs the assumptions and the plan provisions, validates the models, and reviews test lives and results, under the supervision of the responsible actuary.

Section 1: Actuarial Valuation Summary

The user of Segal's actuarial valuation (or other actuarial calculations) should keep the following in mind:

The actuarial valuation is prepared at the request of the Retirement Board. Segal is not responsible for the use or misuse of its report, particularly by any other party.

An actuarial valuation is a measurement of the Plan's assets and liabilities at a specific date. Accordingly, except where otherwise noted, Segal did not perform an analysis of the potential range of future financial measures. The actual long-term cost of the Plan will be determined by the actual benefits and expenses paid and the actual investment experience of the Plan.

Actuarial results in this report are not rounded, but that does not imply precision.

If the Retirement Board is aware of any event or trend that was not considered in this valuation that may materially change the results of the valuation, Segal should be advised, so that we can evaluate it.

Segal does not provide investment, legal, accounting, or tax advice. Segal's valuation is based on our understanding of applicable guidance in these areas and of the Plan's provisions, but they may be subject to alternative interpretations. The Retirement Board should look to their other advisors for expertise in these areas.

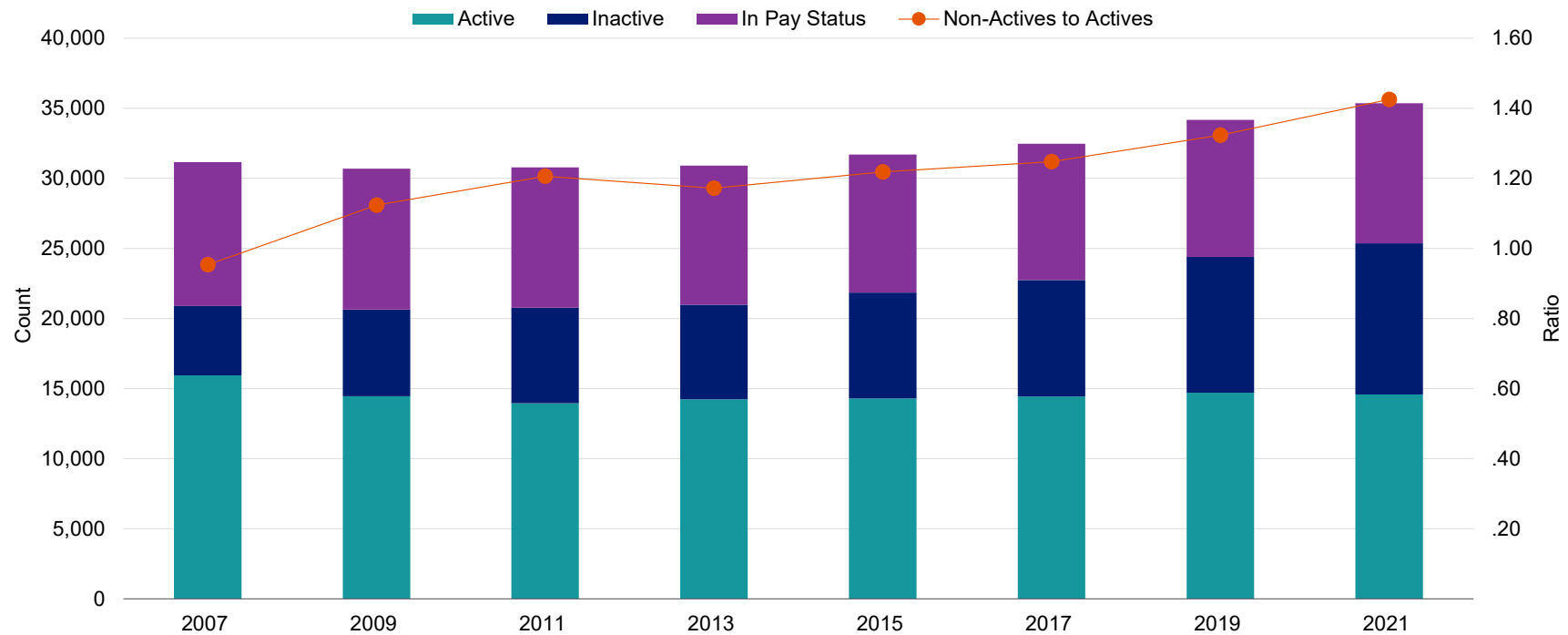
As Segal has no discretionary authority with respect to the management or assets of the System, it is not a fiduciary in its capacity as actuaries and consultants with respect to the System.

Section 2: Actuarial Valuation Results – Boston Retirement System excluding Teachers

Participant data

This section presents a summary of significant statistical data on covered participants.

Participant Population: 2007 – 2021



In Pay Status	10,246	10,044	10,000	9,925	9,856	9,721	9,779	9,998
Inactive ¹	4,959	6,189	6,823	6,751	7,549	8,300	9,683	10,777
Active	15,943	14,449	13,951	14,235	14,288	14,445	14,709	14,581
Ratio	0.95	1.12	1.21	1.17	1.22	1.25	1.32	1.42

More detailed information for this valuation year and the preceding valuation can be found in *Section 4, Exhibit A*.

¹ Includes terminated participants due a refund of employee contributions.

Section 2: Actuarial Valuation Results

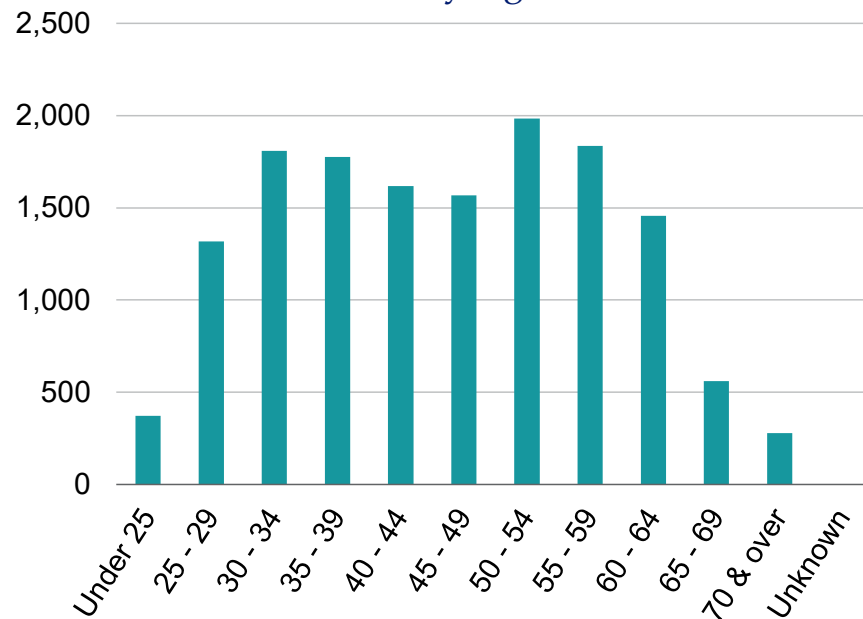
Active participants

As of December 31,	2021	2019	Change
Active participants	14,581	14,709	-0.9%
Average age	46.1	46.3	-0.2
Average years of service	12.6	12.9	-0.3
Average compensation	77,499	72,304	7.2%

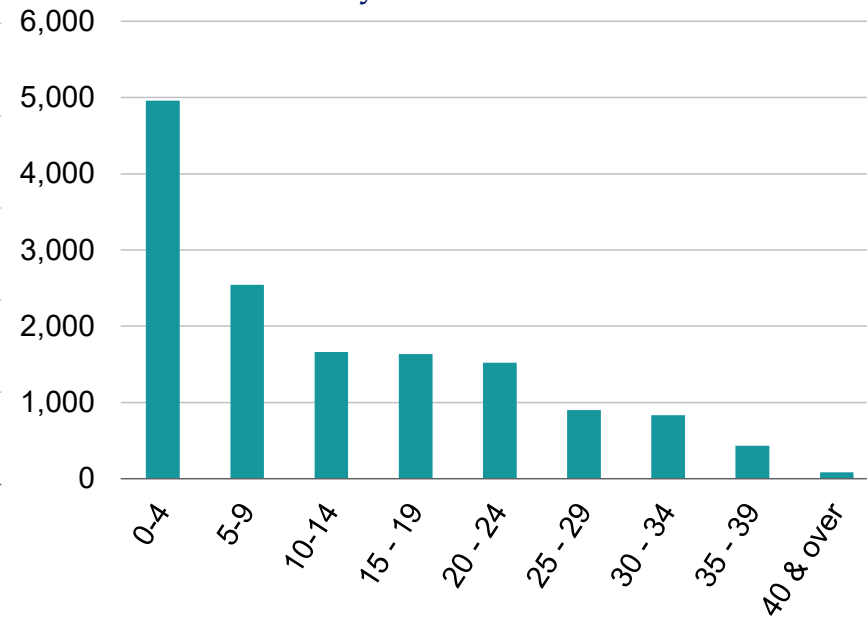
Among the active participants, there was one participant with unknown age information in the current valuation and 85 in the prior valuation.

Distribution of Active Participants as of December 31, 2021

by Age



by Years of Service



Inactive participants

In this year's valuation, there were 856 participants with a vested right to a deferred or immediate vested benefit.

In addition, there were 9,921 participants entitled to a return of their employee contributions.

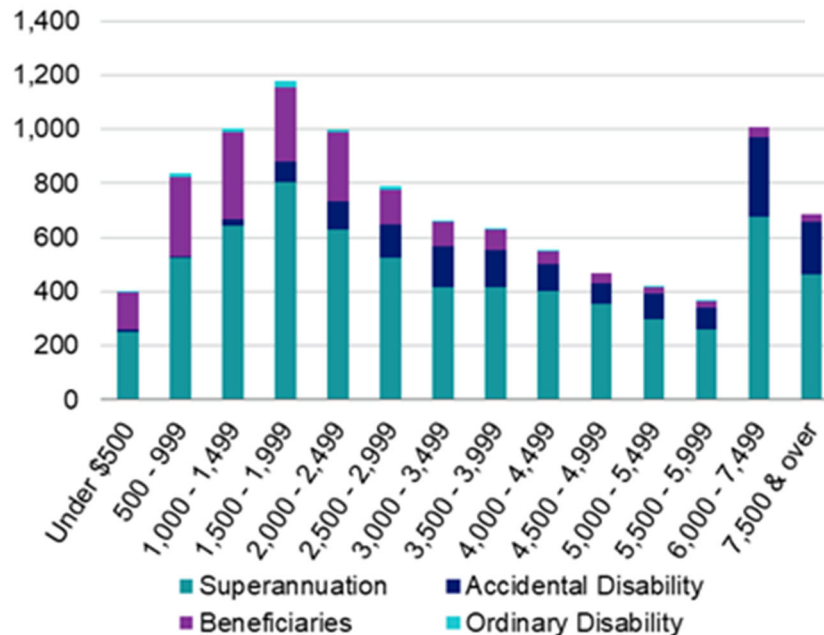
Section 2: Actuarial Valuation Results

Retired participants and beneficiaries

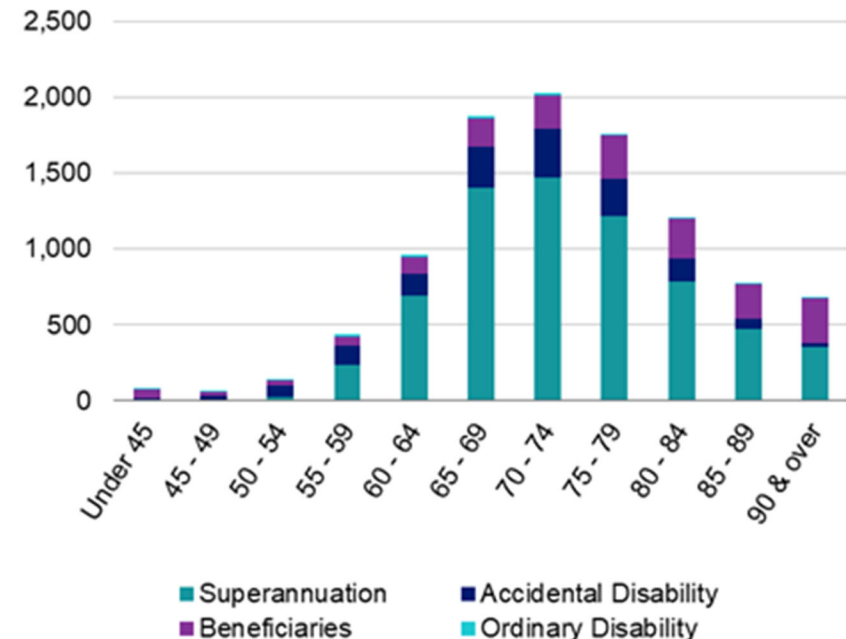
As of December 31,	2021	2019	Change
Retirees	8,216	7,992	2.8%
Beneficiaries	1,782	1,787	-0.3%
Average age	72.8	73.7	-0.9
Average amount	\$3,490	\$3,209	8.8%
Total monthly amount ¹	\$34,890,416	\$31,378,344	11.2%

Distribution of Retired Participants and Beneficiaries as of December 31, 2021

by Type and Monthly Amount



by Type and Age



¹ Excludes COLAs reimbursed by the Commonwealth.

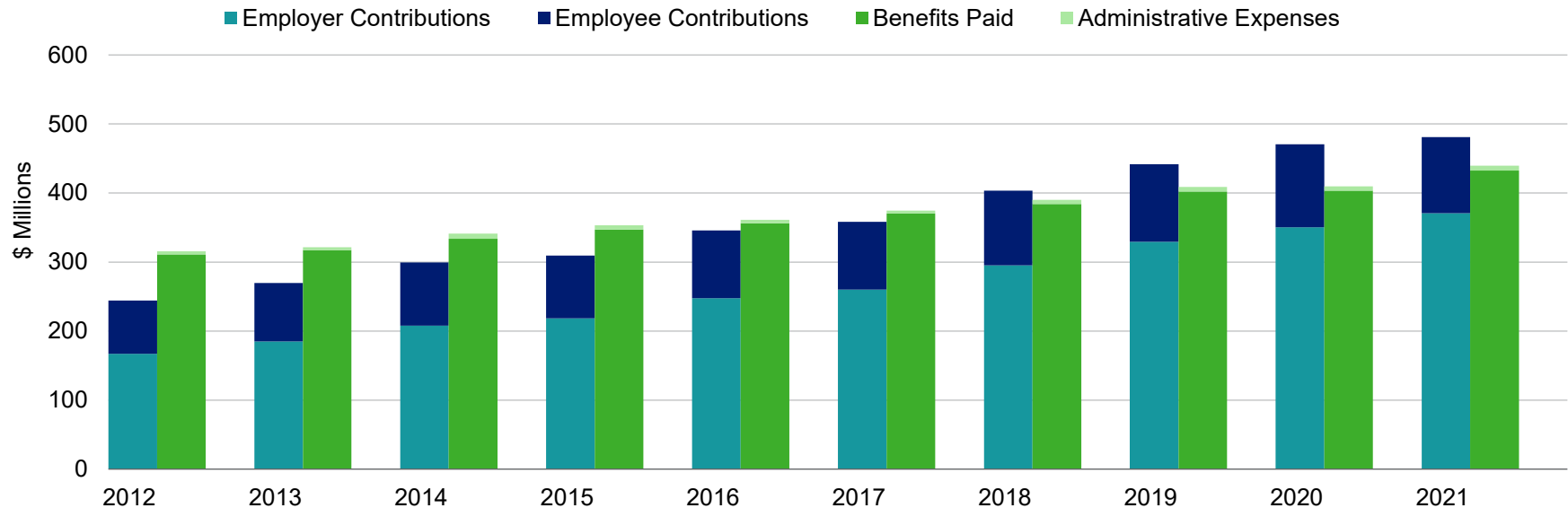
Section 2: Actuarial Valuation Results

Financial information

Retirement plan funding anticipates that, over the long term, both contributions (less administrative expenses) and investment earnings (less investment fees) will be needed to cover benefit payments. Retirement plan assets change as a result of the net impact of these income and expense components.

Additional financial information, including a summary of transactions for the valuation year, is presented in *Section 4, Exhibit B*.

Comparison of Contributions with Benefits and Expenses
for Years Ended December 31, 2012 – 2021



Section 2: Actuarial Valuation Results

It is desirable to have level and predictable plan costs from one year to the next. For this reason, the Board has approved an asset valuation method that gradually adjusts to market value. Under this valuation method, the full value of market fluctuations is not recognized in a single year and, as a result, the asset value and the plan costs are more stable. The amount of the adjustment to recognize market value is treated as income, which may be positive or negative. Realized and unrealized gains and losses are treated equally and, therefore, the sale of assets has no immediate effect on the actuarial value.

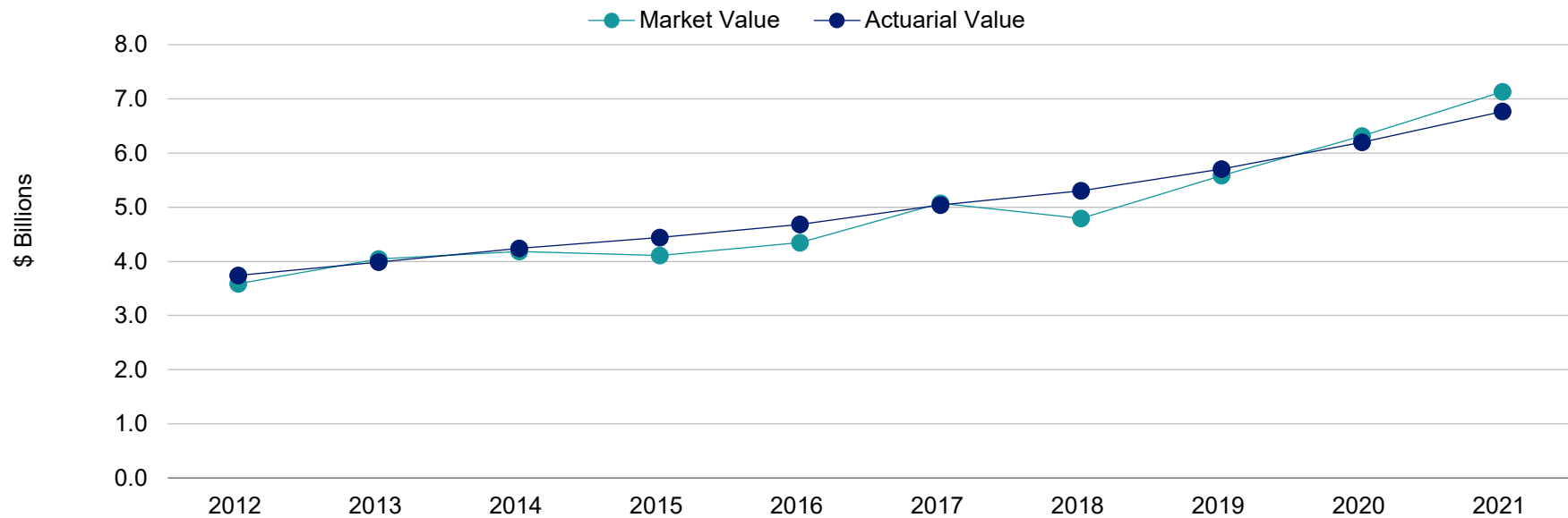
Determination of Actuarial Value of Assets

		Year Ended	
		December 31, 2021	December 31, 2020
1	Actuarial value of assets at the beginning of the year	\$6,198,346,579	\$5,703,899,970
2	Contributions, less benefit payments and expense during the year	41,290,938	61,011,857
3	Average actuarial value: (1) + [50% of (2)]	6,218,992,048	5,734,405,899
4	Expected investment income: 7.05% x (3)	438,438,939	404,275,616
5	Preliminary actuarial value of assets at the end of the year: (1) + (2) + (4)	6,678,076,457	6,169,187,443
6	Market value of assets at the end of the year	7,130,505,146	6,314,983,122
7	Adjustment toward market value: 20% of [(6) – (5)]	90,485,738	29,159,136
8	Adjustment to be within 20% corridor	0	0
9	Final actuarial value of assets at the end of the year: (5) + (7) + (8)	6,768,562,195	6,198,346,579
10	Actuarial value as a percentage of market value: (9) ÷ (6)	94.92%	98.15%

Section 2: Actuarial Valuation Results

Both the actuarial value and market value of assets are representations of the System's financial status. As investment gains and losses are gradually taken into account, the actuarial value of assets tracks the market value of assets. The actuarial asset value is significant because the System's liabilities are compared to these assets to determine what portion, if any, remains unfunded. Amortization of the unfunded actuarial accrued liability is an important element in determining the contribution requirement.

Market Value of Assets vs. Actuarial Value of Assets



Market Value ¹	\$3.59	\$4.04	\$4.18	\$4.11	\$4.35	\$5.07	\$4.79	\$5.58	\$6.31	\$7.13
Actuarial Value ¹	3.74	3.99	4.24	4.44	4.68	5.04	5.30	5.70	6.20	6.77

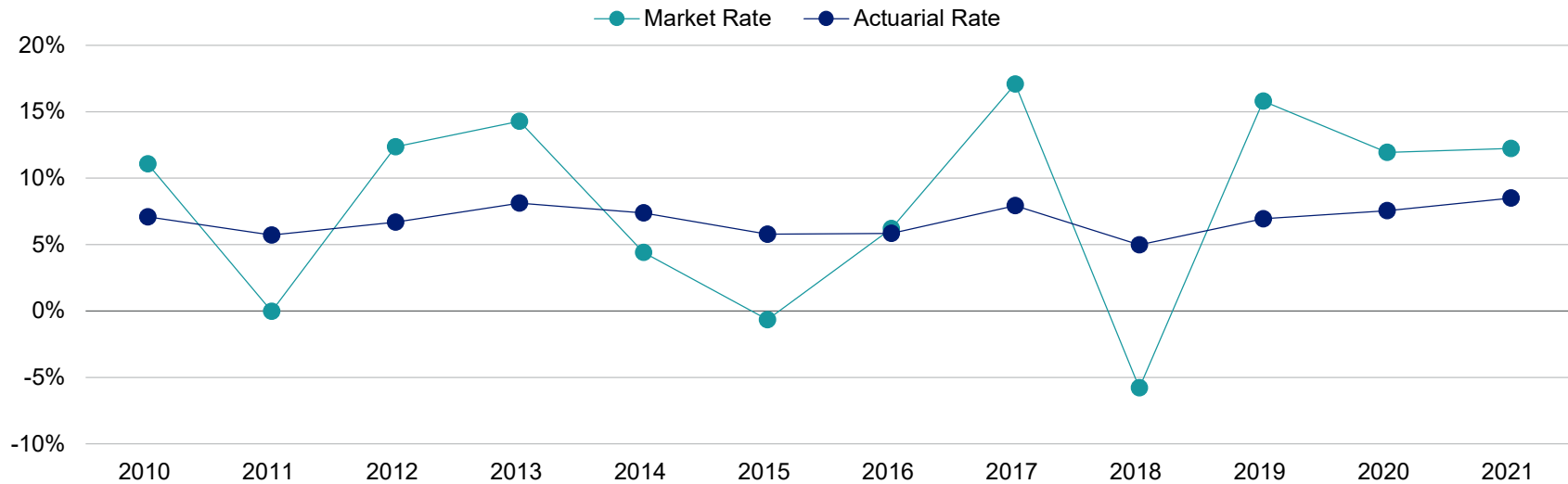
¹ In \$ billions

Section 2: Actuarial Valuation Results

Because actuarial planning is long term, it is useful to see how the assumed investment rate of return has followed actual experience over time. The chart below shows the rate of return on an actuarial basis compared to the actual market value investment return for the last 12 years, including averages over select time periods.

As described earlier in this section, the actuarial asset valuation method gradually recognizes fluctuations in the market value rate of return. The goal of this is to stabilize the actuarial rate of return and to produce more level pension plan costs.

Market and Actuarial Rates of Return for Years Ended December 31, 2010 - 2021



Market rate	11.07%	-0.03%	12.36%	14.28%	4.41%	-0.65%	6.19%	17.09%	-5.78%	15.78%	11.94%	12.22%
Actuarial rate	7.08%	5.71%	6.67%	8.12%	7.37%	5.79%	5.85%	7.93%	4.97%	6.93%	7.56%	8.50%
Assumed rate	8.00%	8.00%	7.75%	7.75%	7.75%	7.75%	7.75%	7.75%	7.50%	7.50%	7.05%	7.05%

Average Rates of Return	Actuarial Value	Market Value
Most recent five-year average return:	7.23%	10.13%
Most recent ten-year average return:	7.01%	8.76%
12-year average return:	6.93%	8.33%

Section 2: Actuarial Valuation Results

Actuarial experience

To calculate any actuarially determined contribution, assumptions are made about future events that affect the amount and timing of benefits to be paid and assets to be accumulated. Each year actual experience is measured against the assumptions. If overall experience is more favorable than anticipated (an actuarial gain), any contribution requirement will decrease from the previous year. On the other hand, any contribution requirement will increase if overall actuarial experience is less favorable than expected (an actuarial loss).

Taking account of experience gains or losses in one year without making a change in assumptions reflects the belief that the single year's experience was a short-term development and that, over the long term, experience will return to the original assumptions. For contribution requirements to remain stable, assumptions should approximate experience. If assumptions are changed, the contribution requirement is adjusted to take into account a change in experience anticipated for all future years.

Actuarial Experience for Two-Year Period Ended December 31, 2021

1	Net gain from investments ¹	\$119,644,874
2	Net gain from administrative expenses	2,371,035
3	Net gain from other experience	<u>58,204,629</u>
4	Net experience gain: 1 + 2 + 3	\$180,220,538

¹ Details on next page

Section 2: Actuarial Valuation Results

Investment experience

A major component of projected asset growth is the assumed rate of return. The assumed return should represent the expected long-term rate of return, based on the System's investment policy. The rate of return on the market value of assets was 12.22% and 11.94% for the years ended December 31, 2021 and December 31, 2020, respectively.

For valuation purposes, the assumed rate of return on the actuarial value of assets was 7.05% for the years ended December 31, 2021 and December 31, 2020. The actual rate of return on an actuarial basis was 8.50% and 7.56% for the years ended December 31, 2021 and December 31, 2020, respectively. Since the actual return for the year was greater than the assumed return, the System experienced an actuarial gain during the two-year period ending December 31, 2021 with regard to its investments.

Based on this experience and future expectations, we have lowered the assumed rate of return from 7.05% to 6.90%.

Investment Experience

	Year Ended December 31, 2021		Year Ended December 31, 2020	
	Market Value	Actuarial Value	Market Value	Actuarial Value
1 Net investment income	\$774,231,086	\$528,924,677	\$670,543,077	\$433,434,752
2 Average value of assets	6,335,628,591	6,218,992,048	5,613,934,121	5,734,405,899
3 Rate of return: 1 ÷ 2	12.22%	8.50%	11.94%	7.56%
4 Assumed rate of return	7.05%	7.05%	7.05%	7.05%
5 Expected investment income: 2 x 4	\$446,661,816	\$438,438,939	\$395,782,355	\$404,275,616
6 Actuarial gain/(loss): 1 - 5	327,569,270	90,485,738	274,760,722	29,159,136

Section 2: Actuarial Valuation Results

Non-investment experience

Administrative expenses

Administrative expenses for the years ended December 31, 2020 and 2021 totaled \$6,233,481 and \$7,305,273, respectively, as compared to the assumption of \$7,700,000 for calendar year 2020 and \$7,950,250 for calendar year 2021. This resulted in a gain of \$2,371,035 for the two-year period, including an adjustment for interest. Based on information on expenses provided by the Retirement System, we have lowered the assumption from \$11,000,000 to \$10,400,000 for the Boston Retirement System for calendar year 2022, with 70% or \$7,280,000 assigned to the BRS excluding Teachers.

Other experience

There are other differences between the expected and the actual experience that appear when the new valuation is compared with the projections from the previous valuation. These include:

- mortality (more or fewer deaths than projected),
- the extent of turnover among participants,
- retirement experience (earlier or later than projected),
- the number of disability retirements (more or fewer than projected), and
- salary increases (greater or smaller than projected).

The net gain from this other experience for the two-year period ending December 31, 2021 amounted to \$58,204,629.

Liability Changes Due to Demographic Experience for Two-Year Period Ended December 31, 2021

Loss due to salaries increasing more than expected	-\$6,952,906
Gain due to mortality experience	33,564,998
Gain to due transfers to Teachers	20,110,703
Loss due to increase in COLA base to \$15,000	-28,477,880
Miscellaneous experience gain	<u>39,959,714</u>
Total	\$58,204,629

Section 2: Actuarial Valuation Results

Actuarial assumptions

The assumption changes reflected in this report are:

- The investment rate of return assumption was lowered from 7.05% to 6.90%.
- The generational mortality improvement scale was updated from Scale MP-2019 to Scale MP-2021.
- The administrative expense assumption was lowered from \$7.70 million for calendar year 2020 to \$7.28 million for calendar year 2022.

Details on actuarial assumptions and methods are in *Section 5, Exhibit I*.

Plan provisions

The COLA base was increased from \$14,000 to \$15,000 on July 1, 2021.

A summary of plan provisions is in *Section 5, Exhibit II*.

Section 2: Actuarial Valuation Results

Development of Unfunded Actuarial Accrued Liability

	Year Ended	
	December 31, 2021	December 31, 2020
1 Unfunded actuarial accrued liability at beginning of year	\$1,687,780,108	\$1,841,217,307
2 Normal cost at beginning of year	196,682,441	190,491,468
3 Total contributions	<u>-481,070,483</u>	<u>-470,576,320</u>
4 Interest on 1, 2 & 3	<u>115,896,875</u>	<u>126,647,653</u>
5 Expected unfunded actuarial accrued liability	\$1,519,288,941	\$1,687,780,108
6 Changes due to:		
(a) Experience gain, net of change in COLA base	<u>-\$180,220,538</u>	-
(b) Assumptions	<u>110,087,468</u>	-
Total changes	<u>-\$70,133,070</u>	-
7 Unfunded actuarial accrued liability at end of year	\$1,449,155,871	-

Section 2: Actuarial Valuation Results

Actuarially determined contribution

The Actuarially Determined Contribution is equal to the employer normal cost payment and a payment on the unfunded actuarial accrued liability. For fiscal 2023, the actuarially determined contribution has been set equal to the previously budgeted amount of \$403,678,138. The detail of the Actuarially Determined Contribution is shown below.

The funding schedule included in this report fully funds the liabilities of the BRS excluding Teachers by June 30, 2027 with appropriations that increase 8.85% per year. The fiscal 2024 appropriation is \$439,403,653.

The prior funding schedule also fully funded the liabilities of the BRS excluding Teachers by June 30, 2027 with appropriations that increased 8.85% per year.

Actuarially Determined Contribution for Year Beginning July 1

	2022		2020	
	Amount	% of Projected Payroll	Amount	% of Projected Payroll
1 Total normal cost	\$201,019,348	17.11%	\$182,791,468	16.53%
2 Administrative expenses	7,280,000	0.62%	7,700,000	0.70%
3 Expected employee contributions	<u>-117,816,039</u>	<u>-10.03%</u>	<u>-109,467,514</u>	<u>-9.90%</u>
4 Employer normal cost: (1) + (2) + (3)	\$90,483,309	7.70%	\$81,023,954	7.33%
5 Actuarial accrued liability	8,217,718,066		7,545,117,277	
6 Actuarial value of assets	<u>6,768,562,195</u>		<u>5,703,899,970</u>	
7 Unfunded actuarial accrued liability: (5) - (6)	\$1,449,155,871		\$1,841,217,307	
8 Employer normal cost projected to July 1, 2022 and 2020	91,941,906	7.70%	82,330,066	7.33%
9 Projected unfunded actuarial accrued liability	1,498,317,850		1,905,014,933	
10 Payment on projected unfunded actuarial accrued liability	<u>311,736,232</u>	<u>26.11%</u>	<u>253,201,630</u>	<u>22.53%</u>
11 Actuarially determined contribution: (8) + (10)	\$403,678,138	33.81%	\$335,531,696	29.86%
12 Projected payroll	\$1,193,858,301		\$1,123,772,995	

Notes:

Actuarially Determined Contributions are assumed to be paid on July 1.

Actuarially Determined Contributions are set equal to the budgeted amounts determined with the prior valuation.

Section 2: Actuarial Valuation Results

Funding schedule

(1) Fiscal Year Ended June 30	(2) Employer Normal Cost	(3) Amortization of Unfunded Inactive Sheriff Liability	(4) Amortization of Remaining Unfunded Liability	(5) Actuarially Determined Contribution (ADC): (2) + (3) + (4)	(6) Unfunded Actuarial Accrued Liability at Beginning of Fiscal Year	(7) Percent Increase in ADC over Prior Year
2023	\$91,941,906	\$2,888,636	\$308,847,596	\$403,678,138	\$1,498,317,850	- -
2024	95,246,366	2,888,636	341,268,651	439,403,653	1,268,455,750	8.85%
2025	98,668,993	2,888,636	376,733,247	478,290,876	988,075,057	8.85%
2026	102,213,992	2,888,636	415,516,991	520,619,619	650,436,443	8.85%
2027	105,885,721	2,888,636	245,152,306	353,926,663	248,040,942	-32.02%
2028	109,688,690	0	0	109,688,690	0	-69.01%
2029	113,627,571	0	0	113,627,571	0	3.59%
2030	117,707,200	0	0	117,707,200	0	3.59%

Notes:

Actuarially determined contribution for fiscal year 2023 is set equal to the amount determined with the prior valuation.

Actuarially determined contributions are assumed to be paid on July 1.

Item (2) reflects 3.25% growth in payroll and a 0.15% adjustment to total normal cost to reflect the effect of morality improvements due to the generational mortality assumption.

Projected normal cost does not reflect the future impact of pension reform for new hires.

Projected unfunded actuarial accrued liability does not reflect the recognition of deferred investment gains or losses.

Section 2: Actuarial Valuation Results

Risk

Since the actuarial valuation results are dependent on a given set of assumptions and data as of a specific date, there is a risk that emerging results may differ significantly as actual experience differs from the assumptions.

This report does not contain a detailed analysis of the potential range of future measurements, but does include a brief discussion of some risks that may affect the Retirement System. We recommend a more detailed assessment to provide the Board with a better understanding of the risks inherent in the Retirement System. This assessment may include scenario testing, sensitivity testing, stress testing and stochastic modeling.

- Investment Risk (the risk that returns will be different than expected)

The market value rate of return over the last 12 years has ranged from a low of -5.78% to a high of 17.09%.

- Longevity Risk (the risk that mortality experience will be different than expected)

The actuarial valuation includes an expectation of future improvement in life expectancy. Emerging plan experience that does not match these expectations will result in either an increase or decrease in the actuarially determined contribution.

- Contribution Risk (the risk that actual contributions will be different from actuarially determined contribution)

Massachusetts General Law Chapter 32 requires payment of the actuarially determined contribution. If future experience matches current assumptions, we project the unfunded actuarial accrued liability will be paid off in five years.

- Demographic Risk (the risk that participant experience will be different than assumed)

Examples of this risk include:

- Actual retirements occurring earlier or later than assumed.
- More or less active participant turnover than assumed.
- Disability experience greater or less than expected.
- Salary increases greater or less than projected.

- Actual Experience and Implications for the Future

Past experience can help demonstrate the sensitivity of key results to the Plan's actual experience.

Over the last ten years, the investment gain/(loss) on the market value of assets for a year has ranged from a loss of \$647.5 million to a gain of \$405.2 million

Section 2: Actuarial Valuation Results

Over the past seven valuations, the non-investment gain(loss) for a year has ranged from a loss of \$57.6 million to a gain of \$189.6 million.

The funded percentage on the actuarial value of assets has ranged from a low of 69.9% as of January 1, 2010 to a high of 82.4% as of January 1, 2022.

- Maturity Measures

As pension plans mature, the cash need to fulfill benefit obligations will increase over time. Therefore, cash flow projections and analysis should be performed to assure that the Retirement System's asset allocation is aligned to meet emerging pension liabilities.

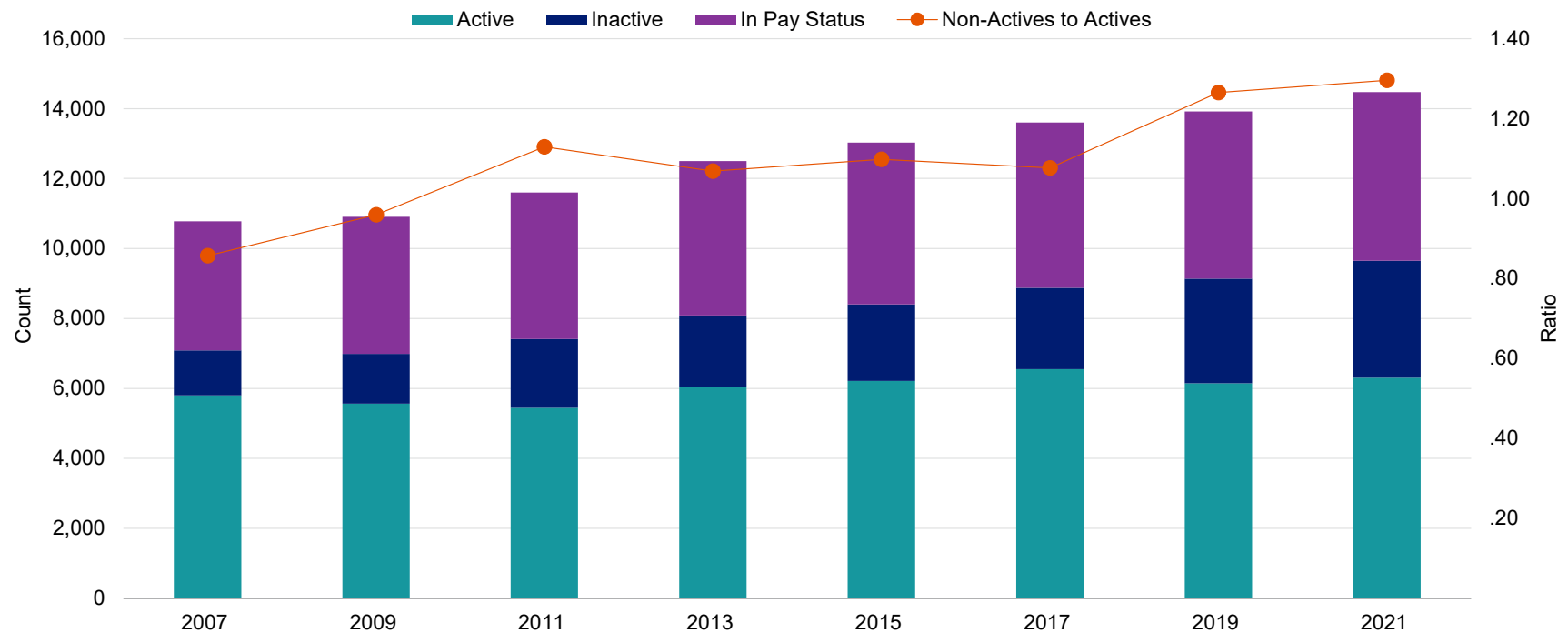
In 2021, contributions exceeded benefits and expenses by \$41.3 million. In future years, cash may be needed from the investment portfolio to meet benefit payments.

Section 3: Actuarial Valuation Results – Teachers

Participant data

This section presents a summary of significant statistical data on covered participants.

Participant Population: 2007 – 2021



In Pay Status	3,693	3,914	4,189	4,416	4,629	4,727	4,780	4,821
Inactive ¹	1,281	1,424	1,964	2,040	2,191	2,323	2,995	3,347
Active	5,805	5,566	5,448	6,043	6,210	6,550	6,147	6,303
Ratio	0.86	0.96	1.13	1.07	1.10	1.08	1.26	1.30

More detailed information for this valuation year and the preceding valuation can be found in *Section 4, Exhibit C*.

¹ Includes terminated participants due a refund of employee contributions.

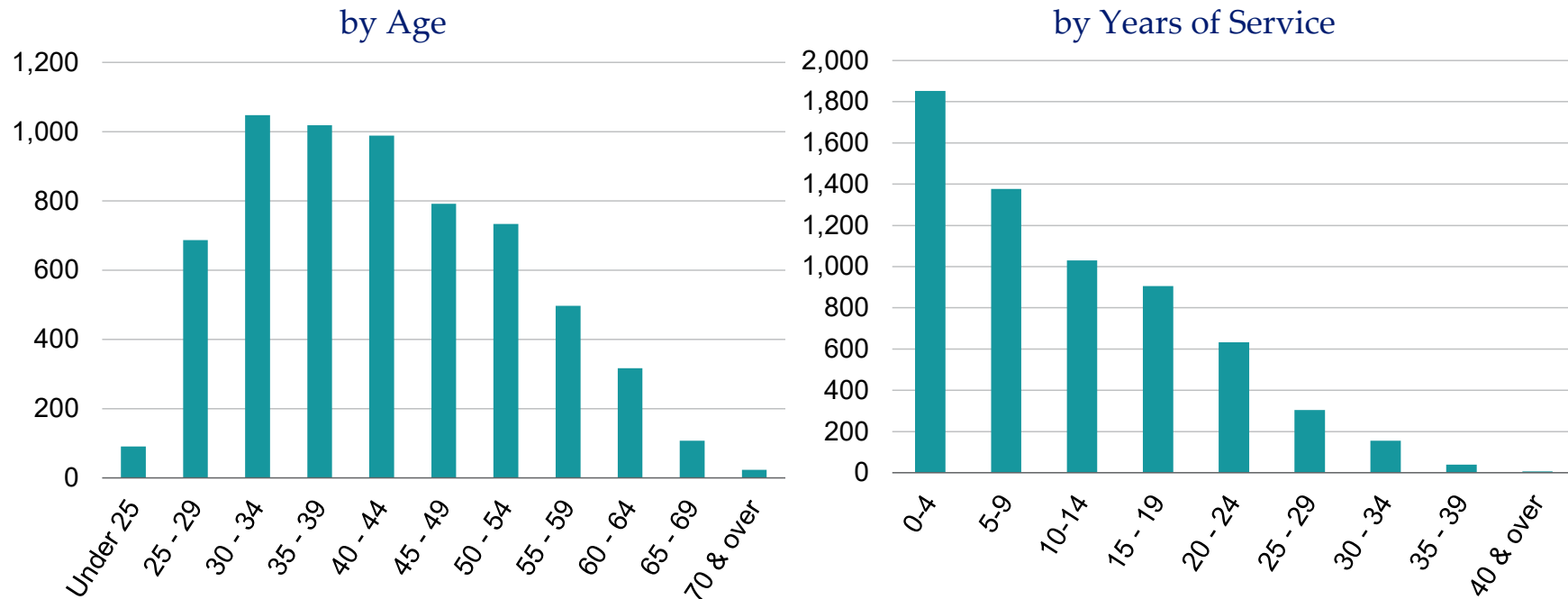
Section 3: Actuarial Valuation Results – Teachers

Active participants

As of December 31,	2021	2019	Change
Active participants	6,303	6,147	2.5%
Average age	42.6	42.4	0.2
Average years of service	11.4	11.3	0.1
Average compensation	103,946	94,905	9.5%

Among the active participants, there were none with unknown age information.

Distribution of Active Participants as of December 31, 2021



Inactive participants

In this year's valuation, there were 447 participants with a vested right to a deferred or immediate vested benefit.

In addition, there were 2,900 participants entitled to a return of their employee contributions.

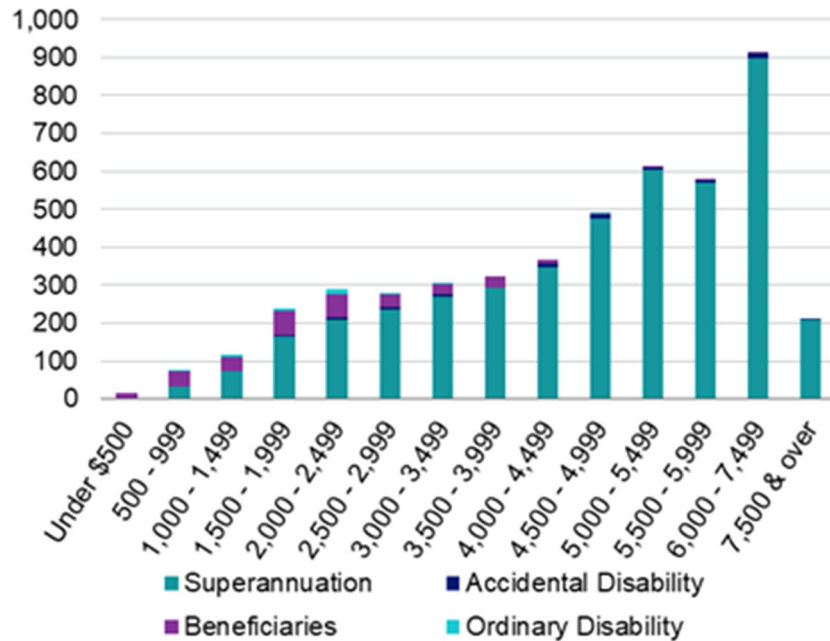
Section 3: Actuarial Valuation Results – Teachers

Retired participants and beneficiaries

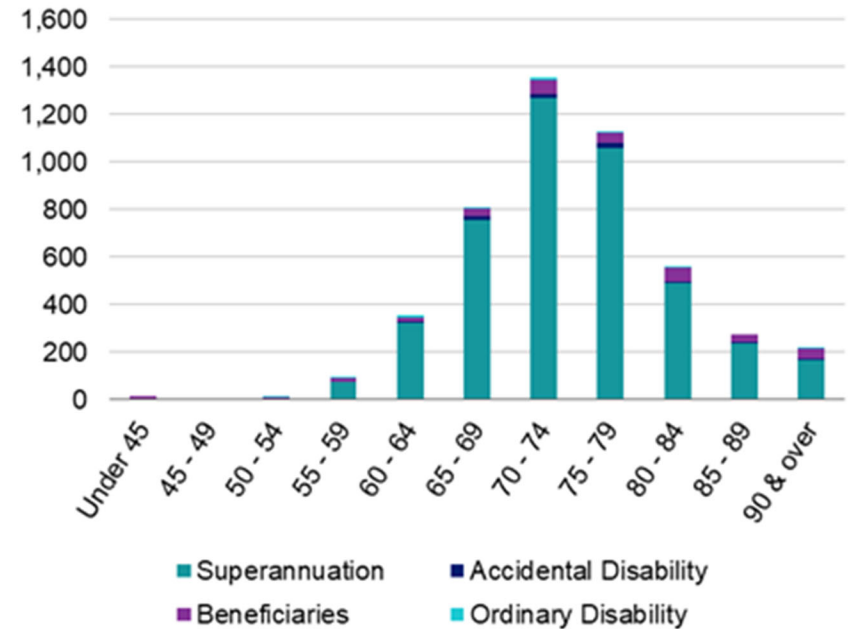
As of December 31,	2021	2019	Change
Retirees	4,495	4,467	0.6%
Beneficiaries	326	313	4.2%
Average age	74.1	73.4	0.7
Average amount	\$4,655	\$4,488	3.7%
Total monthly amount ¹	\$22,442,351	\$21,453,082	4.6%

Distribution of Retired Participants and Beneficiaries as of December 31, 2021

by Type and Monthly Amount



by Type and Age



¹ Excludes COLAs reimbursed by the Commonwealth.

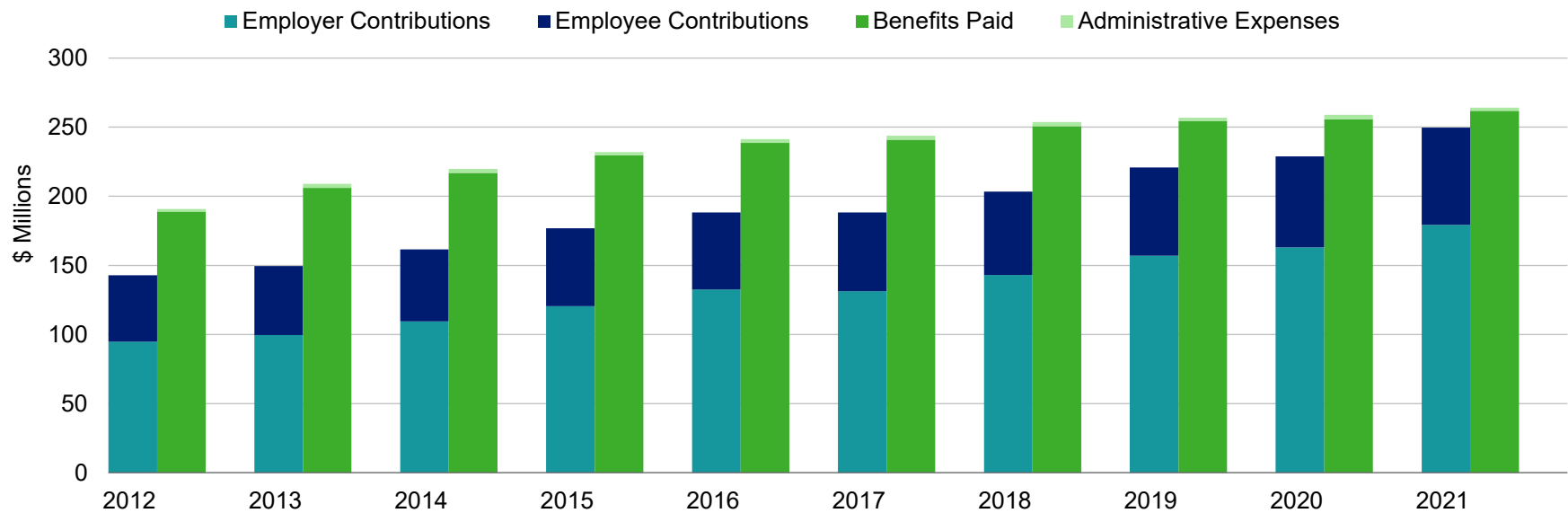
Section 3: Actuarial Valuation Results – Teachers

Financial information

Retirement plan funding anticipates that, over the long term, both contributions (less administrative expenses) and investment earnings (less investment fees) will be needed to cover benefit payments. Retirement plan assets change as a result of the net impact of these income and expense components.

Additional financial information, including a summary of transactions for the valuation year, is presented in *Section 4, Exhibit D*.

Comparison of Contributions with Benefits and Expenses
for Years Ended December 31, 2012 – 2021



Section 3: Actuarial Valuation Results – Teachers

It is desirable to have level and predictable plan costs from one year to the next. For this reason, the Board has approved an asset valuation method that gradually adjusts to market value. Under this valuation method, the full value of market fluctuations is not recognized in a single year and, as a result, the asset value and the plan costs are more stable. The amount of the adjustment to recognize market value is treated as income, which may be positive or negative. Realized and unrealized gains and losses are treated equally and, therefore, the sale of assets has no immediate effect on the actuarial value.

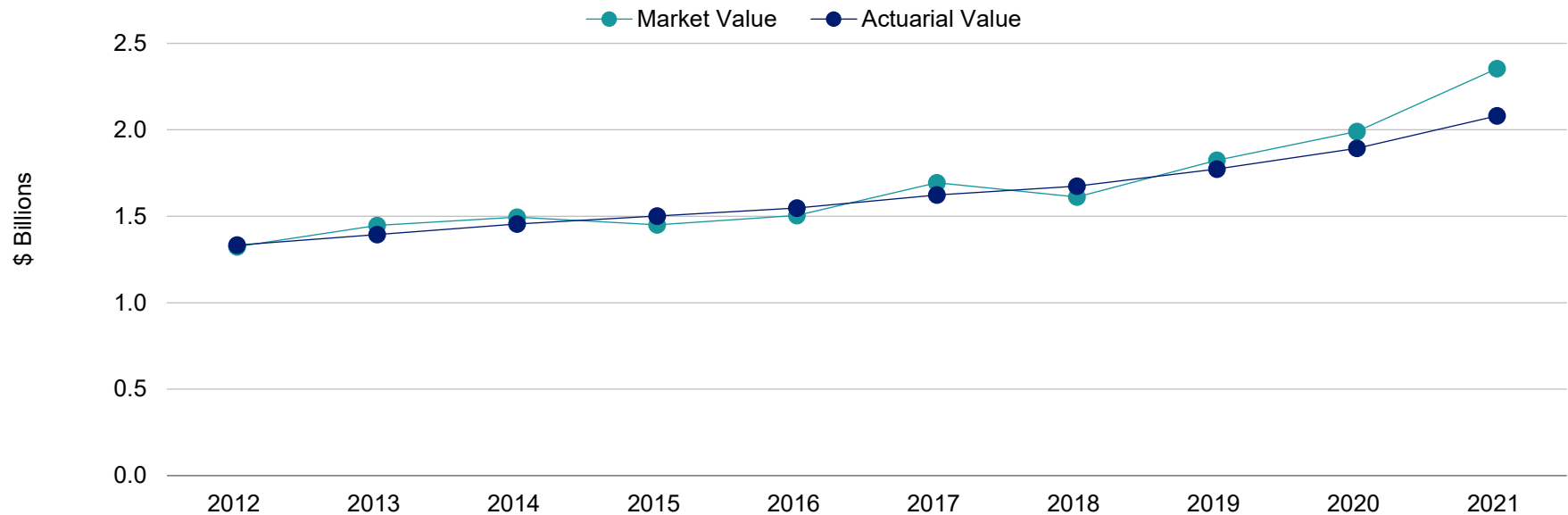
Determination of Actuarial Value of Assets

		Year Ended	
		December 31, 2021	December 31, 2020
1	Actuarial value of assets at the beginning of the year	\$1,892,695,890	\$1,772,897,935
2	Contributions, less benefit payments and expense during the year	-14,539,895	-30,184,047
3	Average actuarial value: (1) + [50% of (2)]	1,885,425,943	1,757,805,911
4	Expected investment income: 7.15% x (3)	134,807,955	125,683,123
5	Preliminary actuarial value of assets at the end of the year: (1) + (2) + (4)	2,012,963,950	1,868,397,010
6	Market value of assets at the end of the year	2,353,125,177	1,989,891,411
7	Adjustment toward market value: 20% of [(6) – (5)]	68,032,245	24,298,880
8	Adjustment to be within 20% corridor	0	0
9	Final actuarial value of assets at the end of the year: (5) + (7) + (8)	2,080,996,195	1,892,695,890
10	Actuarial value as a percentage of market value: (9) ÷ (6)	88.44%	95.12%

Section 3: Actuarial Valuation Results – Teachers

Both the actuarial value and market value of assets are representations of the System’s financial status. As investment gains and losses are gradually taken into account, the actuarial value of assets tracks the market value of assets. The actuarial asset value is significant because the System’s liabilities are compared to these assets to determine what portion, if any, remains unfunded. Amortization of the unfunded actuarial accrued liability is an important element in determining the contribution requirement.

Market Value of Assets vs. Actuarial Value of Assets



Market Value ¹	\$1.32	\$1.45	\$1.49	\$1.45	\$1.50	\$1.69	\$1.61	\$1.82	\$1.99	\$2.35
Actuarial Value ¹	1.33	1.39	1.45	1.50	1.55	1.62	1.67	1.77	1.89	2.08

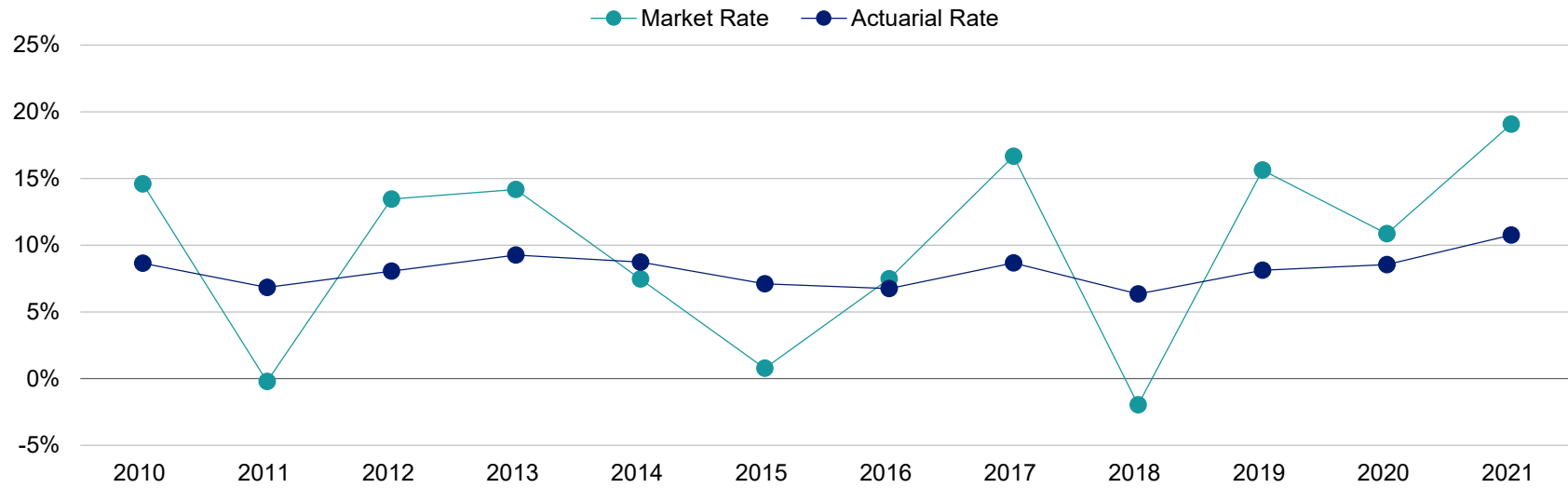
¹ In \$ billions

Section 3: Actuarial Valuation Results – Teachers

Because actuarial planning is long term, it is useful to see how the assumed investment rate of return has followed actual experience over time. The chart below shows the rate of return on an actuarial basis compared to the actual market value investment return for the last 12 years, including averages over select time periods.

As described earlier in this section, the actuarial asset valuation method gradually recognizes fluctuations in the market value rate of return. The goal of this is to stabilize the actuarial rate of return and to produce more level pension plan costs.

Market and Actuarial Rates of Return for Years Ended December 31, 2010 - 2021



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Market rate	14.59%	-0.21%	13.45%	14.17%	7.47%	0.79%	7.48%	16.66%	-1.95%	15.62%	10.86%	19.05%
Actuarial rate	8.64%	6.84%	8.05%	9.26%	8.72%	7.11%	6.76%	8.66%	6.36%	8.12%	8.53%	10.76%
Assumed rate	8.25%	8.25%	8.25%	8.25%	8.0%	8.0%	7.5%	7.5%	7.35%	7.35%	7.15%	7.15%

Average Rates of Return	Actuarial Value	Market Value
Most recent five-year average return:	8.56%	12.15%
Most recent ten-year average return:	8.28%	10.47%
12-year average return:	8.20%	9.97%

Section 3: Actuarial Valuation Results – Teachers

Actuarial experience

To calculate any actuarially determined contribution, assumptions are made about future events that affect the amount and timing of benefits to be paid and assets to be accumulated. Each year actual experience is measured against the assumptions. If overall experience is more favorable than anticipated (an actuarial gain), any contribution requirement will decrease from the previous year. On the other hand, any contribution requirement will increase if overall actuarial experience is less favorable than expected (an actuarial loss).

Taking account of experience gains or losses in one year without making a change in assumptions reflects the belief that the single year's experience was a short-term development and that, over the long term, experience will return to the original assumptions. For contribution requirements to remain stable, assumptions should approximate experience. If assumptions are changed, the contribution requirement is adjusted to take into account a change in experience anticipated for all future years.

Actuarial Experience for Two-Year Period Ended December 31, 2021

1	Net gain from investments ¹	\$92,331,125
2	Net gain from administrative expenses	1,175,237
3	Net loss from other experience	<u>-22,012,903</u>
4	Net experience gain: 1 + 2 + 3	\$71,493,459

¹ Details on next page

Section 3: Actuarial Valuation Results – Teachers

Investment experience

A major component of projected asset growth is the assumed rate of return. The assumed return should represent the expected long-term rate of return, based on the Plan’s investment policy. The rate of return on the market value of assets was 19.05% and 10.86% for the years ended December 31, 2021 and December 31, 2020, respectively.

For valuation purposes, the assumed rate of return on the actuarial value of assets was 7.15% for the years ended December 31, 2021 and December 31, 2020. The actual rate of return on an actuarial basis was 10.76% and 8.53% for the years ended December 31, 2021 and December 31, 2020, respectively. Since the actual return for the year was greater than the assumed return, the System experienced an actuarial gain during the two-year period ending December 31, 2021 with regard to its investments.

Investment Experience

	Year Ended December 31, 2021		Year Ended December 31, 2020	
	Market Value	Actuarial Value	Market Value	Actuarial Value
1 Net investment income	\$377,773,661	\$202,840,200	\$196,428,724	\$149,982,003
2 Average value of assets	1,982,621,464	1,885,425,943	1,808,554,711	1,757,805,911
3 Rate of return: 1 ÷ 2	19.05%	10.76%	10.86%	8.53%
4 Assumed rate of return	7.15%	7.15%	7.15%	7.15%
5 Expected investment income: 2 x 4	\$141,757,435	\$134,807,955	\$129,311,662	\$125,683,123
6 Actuarial gain/(loss): 1 - 5	236,016,226	8,032,245	67,117,062	24,298,880

Section 3: Actuarial Valuation Results – Teachers

Non-investment experience

Administrative expenses

Administrative expenses for the years ended December 31, 2020 and 2021 totaled \$3,226,512 and \$2,389,178, respectively, as compared to the assumption of \$3,300,000 for calendar year 2020 and \$3,407,250 for calendar year 2021. This resulted in a gain of \$1,175,237 for the two-year period, including an adjustment for interest. Based on information on expenses provided by the Retirement System, we have lowered the assumption from \$11,000,000 to \$10,400,000 for the Boston Retirement System for calendar year 2022, with 30% or \$3,120,000 assigned to the Teachers.

Other experience

There are other differences between the expected and the actual experience that appear when the new valuation is compared with the projections from the previous valuation. These include:

- mortality (more or fewer deaths than projected),
- the extent of turnover among participants,
- retirement experience (earlier or later than projected),
- the number of disability retirements (more or fewer than projected), and
- salary increases (greater or smaller than projected).

The net loss from this other experience for the two-year period ending December 31, 2021 amounted to \$22,012,903.

Liability Changes Due to Demographic Experience for Two-Year Period Ended December 31, 2021

Loss due to salaries increasing more than expected	-\$11,239,946
Gain due to mortality experience	15,432,481
Loss to due transfers to Teachers	-20,110,703
Loss due to increase in COLA base to \$15,000	-14,965,675
Miscellaneous experience gain	8,870,940
Total	-\$22,012,903

Section 3: Actuarial Valuation Results – Teachers

Actuarial assumptions

The assumption changes reflected in this report are:

- The investment rate of return assumption was lowered from 7.15% to 7.00%.
- The generational mortality improvement scale was updated from Scale MP-2019 to Scale MP-2021.
- The administrative expense assumption was lowered from \$3.30 million for calendar year 2020 to \$3.12 million for calendar year 2022.

Details on actuarial assumptions and methods are in *Section 5, Exhibit I*.

Plan provisions

The COLA base was increased from \$14,000 to \$15,000 on July 1, 2021.

A summary of plan provisions is in *Section 5, Exhibit II*.

Section 3: Actuarial Valuation Results – Teachers

Development of Unfunded Actuarial Accrued Liability

	Year Ended December 31,	
	2021	2020
1 Unfunded actuarial accrued liability at beginning of year	\$2,537,405,766	\$2,504,380,799
2 Normal cost at beginning of year	87,677,386	84,917,565
3 Total contributions	-249,649,694	-228,846,180
4 Interest on 1, 2 & 3	<u>178,768,468</u>	<u>176,953,582</u>
5 Expected unfunded actuarial accrued liability	\$2,554,201,926	\$2,537,405,766
6 Changes due to:		
(a) Experience gain, including change in COLA base	-\$71,493,459	-
(b) Assumptions	<u>61,030,754</u>	-
Total changes	<u>-\$10,462,705</u>	-
7 Unfunded actuarial accrued liability at end of year	\$2,543,739,222	-

Section 3: Actuarial Valuation Results – Teachers

Actuarially determined contribution

The Actuarially Determined Contribution is equal to the employer normal cost payment and a payment on the unfunded actuarial accrued liability. The Commonwealth appropriation for the Teachers is \$196,832,959 for fiscal 2023. The total Commonwealth appropriation is expected to increase by 9.63% through fiscal 2035 and the Commonwealth's liabilities are expected to be fully funded in 2036. The allocation of the total Commonwealth appropriation in future fiscal years to the Teachers will be determined each year. The detail of the Actuarially Determined Contribution is shown below.

The budgeted appropriation for fiscal 2023 covers the employer normal cost and a portion of the interest on the unfunded liability. Therefore, the unfunded liability is expected to increase for a number of years. If the allocation of the Commonwealth appropriation for the Teachers increases 9.63%, the unfunded liability is projected to be fully funded by the target date of June 30, 2036, if all assumptions are met and there are no future changes in assumptions or the plan of benefits.

Actuarially Determined Contribution for Year Beginning July 1

	2022		2020	
	Amount	% of Projected Payroll	Amount	% of Projected Payroll
1 Total normal cost	\$93,846,960	13.62%	\$81,617,565	13.30%
2 Administrative expenses	3,120,000	0.45%	3,300,000	0.54%
3 Expected employee contributions	<u>-74,760,210</u>	<u>-10.85%</u>	<u>-66,288,930</u>	<u>-10.80%</u>
4 Employer normal cost (1) + (2) + (3)	\$22,206,750	3.22%	\$18,628,635	3.03%
5 Actuarial accrued liability	4,624,735,417		4,277,278,734	
6 Actuarial value of assets	<u>2,080,996,195</u>		<u>1,772,897,935</u>	
7 Unfunded actuarial accrued liability: (5) - (6)	\$2,543,739,222		\$2,504,380,799	
8 Employer normal cost projected to July 1, 2022 and 2020, adjusted for timing	23,341,132	3.33%	19,593,957	3.14%
9 Projected unfunded actuarial accrued liability	2,631,264,311		2,592,366,813	
10 Payment on projected unfunded actuarial accrued liability, adjusted for timing	<u>173,491,827</u>	<u>24.78%</u>	<u>143,382,467</u>	<u>22.99%</u>
11 Actuarially determined contribution: (8) + (10)	\$196,832,959	28.11%	\$162,976,424	26.13%
12 Projected payroll	\$700,162,530		\$623,781,750	

Note:

Actuarially Determined Contributions are assumed to be paid on December 31.

Section 3: Actuarial Valuation Results – Teachers

Risk

Since the actuarial valuation results are dependent on a given set of assumptions and data as of a specific date, there is a risk that emerging results may differ significantly as actual experience differs from the assumptions.

This report does not contain a detailed analysis of the potential range of future measurements, but does include a brief discussion of some risks that may affect the Retirement System. We recommend a more detailed assessment to provide the Board with a better understanding of the risks inherent in the Retirement System. This assessment may include scenario testing, sensitivity testing, stress testing and stochastic modeling.

- Investment Risk (the risk that returns will be different than expected)

The market value rate of return over the last 12 years has ranged from a low of -1.95% to a high of 19.05%.

- Longevity Risk (the risk that mortality experience will be different than expected)

The actuarial valuation includes an expectation of future improvement in life expectancy. Emerging plan experience that does not match these expectations will result in either an increase or decrease in the actuarially determined contribution.

- Contribution Risk (the risk that actual contributions will be different from actuarially determined contribution)

If future experience matches current assumptions, we project the unfunded actuarial accrued liability will be paid off in 14 years.

- Demographic Risk (the risk that participant experience will be different than assumed)

Examples of this risk include:

- Actual retirements occurring earlier or later than assumed.
- More or less active participant turnover than assumed.
- Disability experience greater or less than expected.
- Salary increases greater or less than projected.

- Actual Experience and Implications for the Future

Past experience can help demonstrate the sensitivity of key results to the Plan's actual experience.

Over the last ten years, the investment gain/(loss) on the market value of assets for a year has ranged from a loss of \$155.2 million to a gain of \$236.0 million.

Section 3: Actuarial Valuation Results – Teachers

Over the past seven valuations, the non-investment gain(loss) for a year has ranged from a loss of \$159.1 million to a gain of \$122.7 million.

The funded percentage on the actuarial value of assets has ranged from a low of 40.1% as of January 1, 2018 to a high of 50.4% as of January 1, 2008.

- Maturity Measures

As pension plans mature, the cash need to fulfill benefit obligations will increase over time. Therefore, cash flow projections and analysis should be performed to assure that the Plan's asset allocation is aligned to meet emerging pension liabilities.

For the prior year benefits and expenses were \$14.5 million more than contributions received. In future years, more cash may be needed from the investment portfolio to meet benefit payments.

Section 4: Supplemental Information

Exhibit A: Participants in Active Service as of December 31, 2021 – BRS excluding Teachers by Age, Years of Service, and Average Payroll

Age	Years of Service									
	Total	0-4	5-9	10-14	15 - 19	20 - 24	25 - 29	30 - 34	35 - 39	40 & over
Under 25	372	370	2	--	--	--	--	--	--	--
	\$50,107	\$50,062	\$58,546	--	--	--	--	--	--	--
25 - 29	1,319	1,197	122	--	--	--	--	--	--	--
	\$60,988	\$60,039	\$70,300	--	--	--	--	--	--	--
30 - 34	1,810	1,072	628	105	5	--	--	--	--	--
	\$72,131	\$62,634	\$85,687	\$88,166	\$68,722	--	--	--	--	--
35 - 39	1,776	656	528	439	150	3	--	--	--	--
	\$81,029	\$58,203	\$89,401	\$100,859	\$93,453	\$75,521	--	--	--	--
40 - 44	1,619	424	325	313	440	114	3	--	--	--
	\$82,687	\$47,124	\$75,631	\$92,985	\$110,983	\$98,064	\$64,796	--	--	--
45 - 49	1,568	337	234	213	298	361	119	6	--	--
	\$83,329	\$49,823	\$58,330	\$78,355	\$100,710	\$107,464	\$118,792	\$98,039	--	--
50 - 54	1,984	362	244	185	231	399	327	202	34	--
	\$86,176	\$47,035	\$62,286	\$65,507	\$78,714	\$101,670	\$120,126	\$121,152	\$121,352	--
55 - 59	1,837	256	215	164	214	273	203	329	177	6
	\$83,606	\$43,850	\$55,066	\$57,988	\$66,052	\$84,389	\$111,385	\$122,550	\$114,621	\$102,867
60 - 64	1,457	167	145	138	169	213	166	228	190	41
	\$82,338	\$45,623	\$59,098	\$57,123	\$54,976	\$71,420	\$96,120	\$113,048	\$128,528	\$127,816
65 - 69	560	62	74	68	91	112	64	47	24	18
	\$60,119	\$36,416	\$46,355	\$56,594	\$52,778	\$67,187	\$64,702	\$83,377	\$83,379	\$96,752
70 & over	278	55	27	39	35	48	20	23	10	21
	\$49,434	\$25,428	\$36,538	\$42,522	\$47,426	\$53,881	\$76,929	\$61,101	\$68,684	\$86,779
Unknown	1	1	--	--	--	--	--	--	--	--
	\$10,899	\$10,899	--	--	--	--	--	--	--	--
Total	14,581	4,959	2,544	1,664	1,633	1,523	902	835	435	86
	\$77,499	\$54,855	\$73,884	\$80,737	\$86,514	\$91,352	\$108,490	\$115,543	\$118,442	\$109,553

Notes:

Payroll figures are for the prior calendar year and reflect annualized salaries for participants hired during the year.

Calendar year 2021 payroll figures were increased by 3% for Police, 1% for Fire Fighters, and 2.5% for Group 1 and Group 2 employees to estimate unsettled contracts.

Section 4: Supplemental Information

Exhibit B: Summary Statement of Income and Expenses on a Market Value Basis – BRS excluding Teachers

	Year Ended December 31, 2021	Year Ended December 31, 2020
Net assets at market value at the beginning of the year	\$6,314,983,122	\$5,583,428,192
Contribution income:		
• Employer contributions	\$370,857,270	\$350,531,696
• Employee contributions	110,213,215	120,044,624
• Less administrative expenses	<u>-7,305,273</u>	<u>-6,233,481</u>
Net contribution income	\$473,765,212	\$464,342,839
Net investment income	<u>\$774,231,084</u>	<u>\$670,543,073</u>
Total income available for benefits	\$1,247,996,296	\$1,134,885,912
Less benefit payments	-\$432,474,272	-\$403,330,982
Change in reserve for future benefits	\$815,522,024	\$731,554,930
Net assets at market value at the end of the year	\$7,130,505,146	\$6,314,983,122

Section 4: Supplemental Information

Exhibit C: Participants in Active Service as of December 31, 2021 – Teachers by Age, Years of Service, and Average Payroll

Age	Years of Service									
	Total	0-4	5-9	10-14	15 - 19	20 - 24	25 - 29	30 - 34	35 – 39	40 & over
Under 25	90	90	--	--	--	--	--	--	--	--
	\$73,126	\$73,126	--	--	--	--	--	--	--	--
25 - 29	687	595	92	--	--	--	--	--	--	--
	\$80,717	\$78,901	\$92,459	--	--	--	--	--	--	--
30 - 34	1,048	515	487	46	--	--	--	--	--	--
	\$93,583	\$83,621	\$102,202	\$113,851	--	--	--	--	--	--
35 - 39	1,019	255	356	349	59	--	--	--	--	--
	\$104,793	\$87,769	\$105,303	\$114,622	\$117,157	--	--	--	--	--
40 - 44	989	152	174	292	325	46	--	--	--	--
	\$109,724	\$84,604	\$106,305	\$112,808	\$118,739	\$122,382	--	--	--	--
45 - 49	792	88	104	139	217	220	21	3	--	--
	\$113,362	\$86,059	\$108,854	\$111,327	\$118,122	\$122,074	\$123,107	\$113,368	--	--
50 - 54	734	80	77	93	143	173	136	25	7	--
	\$113,191	\$91,137	\$103,910	\$104,022	\$114,875	\$120,821	\$123,633	\$125,845	\$118,119	--
55 - 59	497	48	46	53	77	101	78	79	15	--
	\$115,208	\$79,187	\$111,005	\$103,688	\$121,259	\$120,164	\$121,820	\$128,082	\$117,437	--
60 - 64	317	22	31	39	69	57	48	41	10	--
	\$110,076	\$68,913	\$85,827	\$99,781	\$112,202	\$121,695	\$121,045	\$124,161	\$124,675	--
65 - 69	107	6	9	15	13	29	18	8	5	4
	\$112,295	\$53,941	\$112,991	\$110,163	\$107,584	\$116,150	\$119,967	\$124,682	\$118,589	\$126,441
70 & over	23	1	1	3	3	6	3	--	3	3
	\$118,560	\$22,631	\$118,363	\$91,687	\$131,648	\$133,114	\$125,633	--	\$122,334	\$124,434
Total	6,303	1,852	1,377	1,029	906	632	304	156	40	7
	\$103,946	\$82,268	\$103,477	\$111,412	\$117,477	\$121,247	\$122,525	\$126,236	\$119,877	\$125,581

Note:

Payroll figures are for the prior year and reflect annualized salaries for participants hired during the year. Calendar year 2021 payroll figures were increased by 1% to estimate unsettled contracts.

Section 4: Supplemental Information

Exhibit D: Summary Statement of Income and Expenses on a Market Value Basis – Teachers

	Year Ended December 31, 2021	Year Ended December 31, 2020
Net assets at market value at the beginning of the year	\$1,989,891,411	\$1,823,646,734
Contribution income:		
• Employer contributions	\$179,368,660	\$162,976,424
• Employee contributions	70,281,034	65,869,756
• Less administrative expenses	<u>-2,389,178</u>	<u>-3,226,512</u>
Net contribution income	\$247,260,516	\$225,619,668
Net investment income	<u>\$377,773,661</u>	<u>\$196,428,724</u>
Total income available for benefits	\$625,034,177	\$422,048,392
Less benefit payments	-\$261,800,411	-\$255,803,715
Change in reserve for future benefits	\$363,233,766	\$166,244,677
Net assets at market value at the end of the year	\$2,353,125,177	\$1,989,891,411

Section 4: Supplemental Information

Exhibit E: Participant Population – All Employees: 2003 – 2021

Participant Data Statistics: 2003 – 2021

Year Ended December 31	Active Participants	Inactive Participants	Retired Participants and Beneficiaries	Total Non-Actives	Ratio of Non-Actives to Actives
2003	20,456	5,294	14,034	19,328	0.94
2005	20,917	6,178	13,783	19,961	0.95
2007	21,748	6,240	13,939	20,179	0.93
2009	20,015	7,613	13,958	21,571	1.08
2011	19,399	8,787	14,189	22,976	1.18
2013	20,278	8,791	14,341	23,132	1.14
2015	20,498	9,740	14,485	24,225	1.18
2017	20,995	10,623	14,448	25,071	1.19
2019	20,856	12,678	14,559	27,237	1.31
2021	20,884	14,124	14,819	28,943	1.39

Section 4: Supplemental Information

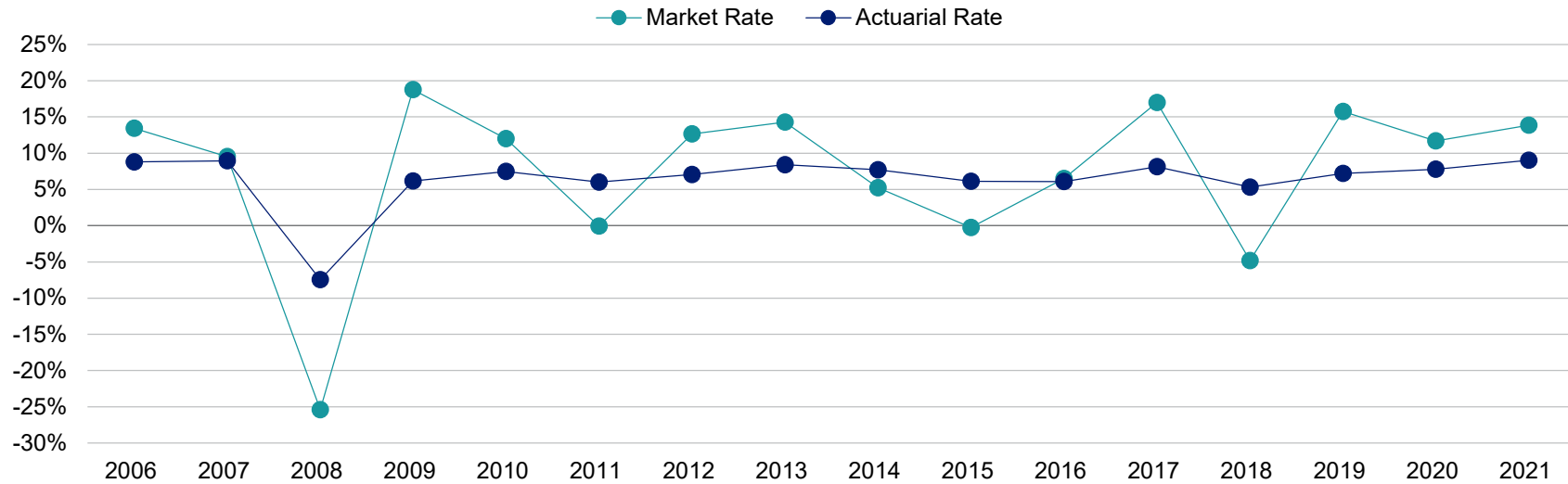
Exhibit F: Table of Plan Coverage – All Employees

Category	Year Ended December 31		Change From Prior Year
	2021	2019	
Active participants in valuation:			
• Number	20,884	20,856	0.1%
• Average age	45.1	45.2	-0.1
• Average years of service	12.2	12.4	-0.2
• Total payroll ¹	\$1,785,188,071	\$1,646,906,229	8.4%
• Average payroll	85,481	78,966	8.3%
• Account balances	1,744,573,853	1,637,085,263	6.6%
• Number with unknown age	1	85	-98.8%
Inactive participants with a vested right to a deferred or immediate benefit	1,303	1,147	13.6%
Inactive participants due a refund of employee contributions	12,821	11,531	11.2%
Retired participants:			
• Number in pay status	11,034	10,729	2.8%
• Average age	73.8	73.7	0.1
• Average monthly benefit	\$4,074	\$3,819	6.7%
Disabled participants:			
• Number in pay status	1,677	1,730	-3.1%
• Average age	69.9	69.4	0.5
• Average monthly benefit	\$4,674	\$4,366	7.1%
Beneficiaries:			
• Number in pay status	2,108	2,100	0.4%
• Average age	76.5	76.6	-0.1
• Average monthly benefit	\$2,155	\$2,048	5.2%

¹ Payroll figures are for the prior year and reflect annualized salaries for participants hired during the year. Calendar year 2021 payroll figures were increased by 3% for Police, 1% for Fire Fighters and Teachers, and 2.5% for Group 1 and Group 2 employees to estimate unsettled contracts. Calendar year 2019 payroll figures were reduced for Fire Fighters and Teachers to reflect retroactive payments made during the year.

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Exhibit G: Market and Actuarial Rates of Return – All Assets: Years Ended December 31, 2006 – 2021



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Market rate	13.43%	9.53%	-25.41%	18.76%	11.99%	-0.08%	12.65%	14.26%	5.21%	-0.28%	6.52%	16.98%	-4.83%	15.74%	11.68%	13.85%
Actuarial rate	8.79%	8.95%	-7.44%	6.17%	7.48%	6.00%	7.03%	8.41%	7.72%	6.12%	6.08%	8.11%	5.30%	7.21%	7.79%	9.03%

Average Rates of Return	Actuarial Value	Market Value
Most recent five-year average return:	7.55%	10.63%
Most recent ten-year average return:	7.32%	9.19%
Most recent 15-year average return:	6.50%	7.27%
16-year average return:	6.60%	7.55%

Section 4: Supplemental Information

Exhibit H: Definition of Pension Terms

The following list defines certain technical terms for the convenience of the reader:

Actuarial Accrued Liability for Actives:	The equivalent of the accumulated normal costs allocated to the years before the valuation date.
Actuarial Accrued Liability for Retirees and Beneficiaries:	Actuarial Present Value of lifetime benefits to existing retirees and beneficiaries. This sum takes account of life expectancies appropriate to the ages of the annuitants and the interest that the sum is expected to earn before it is entirely paid out in benefits.
Actuarial Cost Method:	A procedure allocating the Actuarial Present Value of Future Benefits to various time periods; a method used to determine the Normal Cost and the Actuarial Accrued Liability that are used to determine the actuarially determined contribution.
Actuarial Gain or Loss:	A measure of the difference between actual experience and that expected based upon a set of Actuarial Assumptions, during the period between two Actuarial Valuation dates. To the extent that actual experience differs from that assumed, Actuarial Accrued Liabilities emerge which may be the same as forecasted, or may be larger or smaller than projected. Actuarial gains are due to favorable experience, e.g., assets earn more than projected, salary increases are less than assumed, members retire later than assumed, etc. Favorable experience means actual results produce actuarial liabilities not as large as projected by the actuarial assumptions. On the other hand, actuarial losses are the result of unfavorable experience, i.e., actual results yield actuarial liabilities that are larger than projected.
Actuarially Equivalent:	Of equal Actuarial Present Value, determined as of a given date and based on a given set of Actuarial Assumptions.
Actuarial Present Value (APV):	<p>The value of an amount or series of amounts payable or receivable at various times, determined as of a given date by the application of a particular set of Actuarial Assumptions. Each such amount or series of amounts is:</p> <p>Adjusted for the probable financial effect of certain intervening events (such as changes in compensation levels, marital status, etc.)</p> <p>Multiplied by the probability of the occurrence of an event (such as survival, death, disability, withdrawal, etc.) on which the payment is conditioned, and</p> <p>Discounted according to an assumed rate (or rates) of return to reflect the time value of money.</p>
Actuarial Present Value of Future Benefits:	The Actuarial Present Value of benefit amounts expected to be paid at various future times under a particular set of Actuarial Assumptions, taking into account such items as the effect of advancement in age, anticipated future compensation, and future service credits. The Actuarial Present Value of Future Benefits includes the liabilities for active members, retired members, beneficiaries receiving benefits, and inactive members entitled to either a refund of member contributions or a future retirement benefit. Expressed another way, it is the value that would have to be invested on the valuation date so that the amount invested plus investment earnings would provide sufficient assets to pay all projected benefits and expenses when due.

Section 4: Supplemental Information

Actuarial Valuation:	The determination, as of a valuation date, of the Normal Cost, Actuarial Accrued Liability, Actuarial Value of Assets, and related Actuarial Present Values for a plan, as well as Actuarially Determined Contributions.
Actuarial Value of Assets (AVA):	The value of the Plan's assets as of a given date, used by the actuary for valuation purposes. This may be the market or fair value of plan assets, but commonly plans use a smoothed value in order to reduce the year-to-year volatility of calculated results, such as the funded ratio and the Actuarially Determined Contribution.
Actuarially Determined:	Values that have been determined utilizing the principles of actuarial science. An actuarially determined value is derived by application of the appropriate actuarial assumptions to specified values determined by provisions of the Plan.
Actuarially Determined Contribution (ADC):	The employer's periodic required contributions, expressed as a dollar amount or a percentage of covered plan compensation, determined under the Plan's funding policy. The ADC consists of the Employer Normal Cost and the Amortization Payment.
Amortization Method:	A method for determining the Amortization Payment. The most common methods used are level dollar and level percentage of payroll. Under the Level Dollar method, the Amortization Payment is one of a stream of payments, all equal, whose Actuarial Present Value is equal to the Unfunded Actuarial Accrued Liability. Under the Level Percentage of Pay method, the Amortization Payment is one of a stream of increasing payments, whose Actuarial Present Value is equal to the Unfunded Actuarial Accrued Liability. Under the Level Percentage of Pay method, the stream of payments increases at the assumed rate at which total covered payroll of all active members will increase.
Amortization Payment:	The portion of the pension plan contribution, or ADC, that is intended to pay off the Unfunded Actuarial Accrued Liability.
Assumptions or Actuarial Assumptions:	The estimates upon which the cost of the Plan is calculated, including: <u>Investment return</u> - the rate of investment yield that the Plan will earn over the long-term future; <u>Mortality rates</u> - the rate or probability of death at a given age for employees and retirees; <u>Retirement rates</u> - the rate or probability of retirement at a given age or service; <u>Disability rates</u> - the rate or probability of disability retirement at a given age; <u>Withdrawal rates</u> - the rate or probability at which employees of various ages are expected to leave employment for reasons other than death, disability, or retirement; <u>Salary increase rates</u> - the rates of salary increase due to inflation, real wage growth and merit and promotion increases.
Closed Amortization Period:	A specific number of years that is counted down by one each year, and therefore declines to zero with the passage of time. For example, if the amortization period is initially set at 20 years, it is 19 years at the end of one year, 18 years at the end of two years, etc. See Open Amortization Period.
Decrements:	Those causes/events due to which a member's status (active-inactive-retiree-beneficiary) changes, that is: death, retirement, disability, or withdrawal.

Section 4: Supplemental Information

Defined Benefit Plan:	A retirement plan in which benefits are defined by a formula based on the member's compensation, age and/or years of service.
Defined Contribution Plan:	A retirement plan, such as a 401(k) plan, a 403(b) plan, or a 457 plan, in which the contributions to the plan are assigned to an account for each member, the plan's earnings are allocated to each account, and each member's benefits are a direct function of the account balance.
Employer Normal Cost:	The portion of the Normal Cost to be paid by the employer. This is equal to the Normal Cost less expected member contributions.
Experience Study:	A periodic review and analysis of the actual experience of the Plan that may lead to a revision of one or more actuarial assumptions. Actual rates of decrement and salary increases are compared to the actuarially assumed values and modified based on recommendations from the Actuary.
Funded Ratio:	The ratio of the Actuarial Value of Assets (AVA) to the Actuarial Accrued Liability (AAL). Plans sometimes also calculate a market funded ratio, using the Market Value of Assets (MVA), rather than the AVA.
GASB 67 and GASB 68:	Governmental Accounting Standards Board (GASB) Statements No. 67 and No. 68. These are the governmental accounting standards that set the accounting rules for public retirement systems and the employers that sponsor or contribute to them. Statement No. 68 sets the accounting rules for the employers that sponsor or contribute to public retirement systems, while Statement No. 67 sets the rules for the systems themselves.
Investment Return:	The rate of earnings of the Plan from its investments, including interest, dividends and capital gain and loss adjustments, computed as a percentage of the average value of the fund. For actuarial purposes, the investment return often reflects a smoothing of the capital gains and losses to avoid significant swings in the value of assets from one year to the next.
Net Pension Liability (NPL):	The Net Pension Liability is equal to the Total Pension Liability minus the Plan Fiduciary Net Position.
Normal Cost:	The portion of the Actuarial Present Value of Future Benefits and expenses allocated to a valuation year by the Actuarial Cost Method. Any payment with respect to an Unfunded Actuarial Accrued Liability is not part of the Normal Cost (see Amortization Payment). For pension plan benefits that are provided in part by employee contributions, Normal Cost refers to the total of member contributions and employer Normal Cost unless otherwise specifically stated.
Open Amortization Period:	An open amortization period is one which is used to determine the Amortization Payment but which does not change over time. If the initial period is set as 30 years, the same 30-year period is used in each future year in determining the Amortization Period.
Plan Fiduciary Net Position:	Market value of assets.
Total Pension Liability (TPL):	The actuarial accrued liability under the entry age normal cost method and based on the blended discount rate as described in GASB 67 and 68.

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Unfunded Actuarial Accrued Liability:	The excess of the Actuarial Accrued Liability over the Actuarial Value of Assets. This value may be negative, in which case it may be expressed as a negative Unfunded Actuarial Accrued Liability, also called the Funding Surplus or an Overfunded Actuarial Accrued Liability.
Valuation Date or Actuarial Valuation Date:	The date as of which the value of assets is determined and as of which the Actuarial Present Value of Future Benefits is determined. The expected benefits to be paid in the future are discounted to this date.

Section 5: Actuarial Valuation Basis

Exhibit I: Actuarial Assumptions, Methods and Models

Net Investment Return: 6.90% for BRS excluding Teachers and 7.00% for Teachers (previously, 7.05% for BRS excluding Teachers and 7.15% for Teachers)

The net investment return assumption is a long-term estimate derived from historical data, current and recent market expectations, and professional judgment. As part of the analysis, a building block approach was used that reflects inflation expectations and anticipated risk premiums for each of the portfolio's asset classes, as well as the Plan's target asset allocation.

Salary Increases:

Years of Service	Teachers	BRS excluding Teachers		
		Group 1	Group 2	Group 4
0	7.50%	4.00%	4.25%	4.50%
1	7.10%	4.00%	4.25%	4.50%
2	7.00%	4.00%	4.25%	4.50%
3	6.90%	4.00%	4.25%	4.50%
4	6.80%	4.00%	4.25%	4.50%
5	6.70%	4.00%	4.25%	4.50%
6	6.60%	4.00%	4.25%	4.50%
7	6.50%	4.00%	4.25%	4.50%
8	6.30%	4.00%	4.25%	4.50%
9	6.10%	4.00%	4.25%	4.50%
10	5.90%	4.00%	4.25%	4.50%
11	5.70%	4.00%	4.25%	4.50%
12	5.20%	4.00%	4.25%	4.50%
13	4.70%	4.00%	4.25%	4.50%
14	4.35%	4.00%	4.25%	4.50%
15 – 16	4.20%	4.00%	4.25%	4.50%
17 - 19	4.10%	4.00%	4.25%	4.50%
20 & later	4.00%	4.00%	4.25%	4.50%

Includes an allowance for wage inflation of 3.25%.

Section 5: Actuarial Valuation Basis

	The salary scale assumption is a long-term estimate derived from historical data, current and recent market expectations, and professional judgment.
Interest on Employee Contributions:	3.5%
Administrative Expenses:	<p>\$10,400,000 for calendar year 2022, increasing 3.25% per year, with 70%, or \$7,280,000 assigned to the BRS excluding Teachers and 30%, or \$3,120,000, assigned to the Teachers. (Previously, \$11,000,000 for calendar year 2020, increasing 3.25% per year, with 70%, or \$7,700,000 assigned to the BRS excluding Teachers, and 30%, or \$3,300,000, assigned to the Teachers.)</p> <p>The administrative expense assumption is based on information on expenses provided by the Retirement System.</p>
Mortality Rates:	<p><u>BRS excluding Teachers</u></p> <p>Groups 1 and 2</p> <p><i>Healthy:</i> Pub-2010 General Employee, Healthy Retiree and Contingent Survivor Amount-Weighted Mortality Tables set forward one year projected generationally using Scale MP-2021 (previously, Scale MP-2019)</p> <p><i>Disabled:</i> Pub-2010 General Healthy Retiree Amount-Weighted Mortality Tables set forward one year projected generationally using Scale MP-2021 (previously, Scale MP-2019)</p> <p>Group 4</p> <p><i>Healthy:</i> Pub-2010 Safety Employee, Healthy Retiree and Contingent Survivor Amount-Weighted Mortality Tables projected generationally using Scale MP-2021 (previously, Scale MP-2019)</p> <p><i>Disabled:</i> Pub-2010 Disabled Retiree Amount-Weighted Mortality Tables projected generationally using Scale MP-2021 (previously, Scale MP-2019)</p> <p><u>Teachers</u></p> <p><i>Healthy:</i> Pub-2010 Teacher Employee, Healthy Retiree and Contingent Survivor Headcount-Weighted Mortality Tables projected generationally using Scale MP-2021 (previously, Scale MP-2019)</p> <p><i>Disabled:</i> Pub-2010 Teacher Healthy Retiree Headcount-Weighted Mortality Tables projected generationally using Scale MP-2021 (previously, Scale MP-2019)</p> <p>The underlying tables with generational projection to the ages of the participants as of the measurement date reasonably reflect the projected mortality experience of the Plan as of the measurement date based on historical and current demographic data. As part of the analysis, a comparison was made between the actual number of retiree deaths and the projected number based on the prior years' assumptions over the five most recent valuations. The mortality tables were then adjusted to future years using a generational projection under Scale MP-2021 to reflect future mortality improvement.</p>

Section 5: Actuarial Valuation Basis

Termination Rates before Retirement:

Age	Groups 1 and 2 Rate (%) – BRS excluding Teachers			
	Mortality			
	Male	Female	Disability	Withdrawal
20	0.04	0.01	0.03	6.58
25	0.03	0.01	0.04	5.27
30	0.04	0.02	0.06	4.83
35	0.05	0.03	0.07	4.47
40	0.07	0.04	0.11	3.84
45	0.11	0.06	0.18	3.21
50	0.16	0.09	0.30	1.52
55	0.24	0.13	0.50	0.33
60	0.34	0.20	0.81	0.00

Notes:

Mortality rates do not reflect generational projection.

50% of the disability rates shown represent accidental disability.

20% of the accidental disabilities will die from the same cause as the disability.

20% of the death rates shown represent accidental death.

Section 5: Actuarial Valuation Basis

Group 4 Rate (%) – BRS excluding Teachers				
Mortality				
Age	Male	Female	Disability	Withdrawal
20	0.04	0.02	0.15	0.00
25	0.04	0.02	0.21	0.00
30	0.04	0.03	0.28	0.00
35	0.05	0.04	0.37	0.00
40	0.06	0.05	0.55	0.00
45	0.08	0.07	0.90	0.00
50	0.12	0.09	1.51	0.00
55	0.18	0.12	2.52	0.00
60	0.26	0.17	0.00	0.00

Notes:

Mortality rates do not reflect generational projection.

90% of the disability rates shown represent accidental disability.

60% of the accidental disabilities will die from the same cause as the disability.

50% of the death rates shown represent accidental death.

Section 5: Actuarial Valuation Basis

Rate (%) – Teachers			
Mortality			
Age	Male	Female	Disability
20	0.04	0.01	0.04
25	0.02	0.01	0.05
30	0.03	0.02	0.06
35	0.04	0.02	0.06
40	0.05	0.03	0.10
45	0.08	0.05	0.30
50	0.13	0.08	0.50
55	0.19	0.12	0.70
60	0.29	0.18	0.70

Notes:

Mortality rates do not reflect generational projection.

35% of the disability rates shown represent accidental disability.

40% of the accidental disabilities will die from the same cause as the disability.

75% of the death rates shown represent accidental death.

Section 5: Actuarial Valuation Basis

Withdrawal Rates:

Age	Rate (%) – Teachers									
	Years of Service									
	0 – 1		2		3		4		5	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
20	13.0	10.0	11.5	10.5	8.3	7.5	6.6	7.3	5.5	7.0
30	15.0	15.0	11.0	11.5	8.9	10.0	7.0	10.0	5.4	8.8
40	13.3	10.5	13.0	8.5	7.1	6.6	7.5	5.2	5.2	5.0
50	16.2	9.8	12.2	12.0	8.8	7.0	9.0	6.6	7.0	5.0

Age	Rate (%) – Teachers									
	Years of Service									
	6		7		8		9		10+	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
20	4.0	5.0	4.0	6.0	3.3	7.0	1.5	7.0	1.5	5.0
30	4.5	7.3	4.0	6.0	3.3	7.0	1.5	6.0	1.5	4.5
40	5.5	5.0	3.0	4.5	3.4	3.5	2.5	3.0	1.7	2.2
50	6.5	3.0	5.0	4.0	2.2	2.4	2.5	3.0	2.3	2.0

The termination rates and disability rates were based on historical and current demographic data, adjusted to reflect economic conditions of the area and estimated future experience and professional judgment. As part of the analysis, a comparison was made between the actual number of terminations and disability retirements and the projected number based on the prior years' assumptions over the five most recent valuations.

Section 5: Actuarial Valuation Basis

Retirement Rates:

Rate (%) – BRS excluding Teachers			
Age	Groups 1 & 2	Age	Group 4
55	3.0	50	1.0
56	3.0	51	1.0
57	3.0	52	1.0
58	3.0	53	1.0
59	3.0	54	1.0
60	8.0	55	10.0
61	8.0	56	5.0
62	15.0	57	5.0
63	10.0	58	5.0
64	10.0	59	5.0
65	35.0	60	10.0
66	20.0	61	15.0
67	20.0	62	15.0
68	20.0	63	15.0
69	20.0	64	25.0
70	100.0	65	100.0

Section 5: Actuarial Valuation Basis

Age	Rate (%) – Non-TARP Teachers			
	Years of Service			
	Less than 20		20 or more	
	Male	Female	Male	Female
50	0.0	0.0	2.0	1.0
51	0.0	0.0	2.0	1.0
52	0.0	0.0	2.0	1.5
53	0.0	0.0	2.0	2.0
54	0.0	0.0	3.0	2.0
55	3.5	3.5	3.0	4.0
56	3.5	3.5	3.5	4.0
57	5.0	3.5	4.0	4.0
58	5.5	5.0	5.0	6.0
59	6.0	6.5	6.0	8.0
60	7.5	8.5	15.0	15.0
61	12.0	10.0	25.0	20.0
62	14.0	12.0	30.0	20.0
63	14.0	12.0	30.0	25.0
64	14.0	20.0	30.0	30.0
65	30.0	30.0	30.0	40.0
66	30.0	30.0	25.0	30.0
67	30.0	30.0	25.0	30.0
68	30.0	30.0	25.0	30.0
69	30.0	30.0	25.0	30.0
70	100.0	100.0	100.0	100.0

Section 5: Actuarial Valuation Basis

Age	Rate (%) – Non-TARP Teachers					
	Years of Service					
	Less than 20		20 – 29		30 or more	
	Male	Female	Male	Female	Male	Female
50	0.0	0.0	1.0	1.0	2.0	1.5
51	0.0	0.0	1.0	1.0	2.0	1.5
52	0.0	0.0	1.0	1.0	2.0	1.5
53	0.0	0.0	1.5	1.0	2.0	1.5
54	0.0	0.0	2.5	1.0	2.0	2.0
55	5.0	3.0	3.0	3.0	6.0	5.0
56	5.0	3.0	6.0	5.0	20.0	15.0
57	5.0	4.0	10.0	8.0	40.0	35.0
58	5.0	8.0	15.0	10.0	50.0	35.0
59	10.0	8.0	20.0	15.0	50.0	35.0
60	10.0	10.0	25.0	20.0	40.0	35.0
61	20.0	12.0	30.0	25.0	40.0	35.0
62	20.0	12.0	35.0	30.0	35.0	35.0
63	25.0	15.0	40.0	30.0	35.0	35.0
64	25.0	20.0	40.0	30.0	35.0	35.0
65	25.0	25.0	40.0	40.0	35.0	35.0
66	30.0	25.0	30.0	30.0	40.0	35.0
67	30.0	30.0	30.0	30.0	40.0	30.0
68	30.0	30.0	30.0	30.0	40.0	30.0
69	30.0	30.0	30.0	30.0	40.0	30.0
70	100.0	100.0	100.0	100.0	100.0	100.0

The retirement rates were based on historical and current demographic data, adjusted to reflect economic conditions of the area and estimated future experience and professional judgment. As part of the analysis, a comparison was made between the actual number of retirements by age and the projected number based on the prior years' assumptions over the five most recent valuations.

Section 5: Actuarial Valuation Basis

Retirement Rates for Inactive Vested Participants:	<p>Age 60 for Group 1 and Group 2 members and age 55 for Group 4 members hired prior to April 2, 2012. For members hired April 2, 2012 or later, age 60 for Group 1 members, age 55 for Group 2 members and age 50 for Group 4 members.</p> <p>The retirement age for inactive vested participants was based on historical and current demographic data, adjusted to reflect economic conditions of the area and estimated future experience and professional judgment.</p>
Inactive Vested Participants:	<p>Inactive vested participants whose present value of future benefits is less than their member contributions balance, including those for whom no final average salary information has been reported, are assumed to elect to receive an immediate refund of their member contributions.</p>
Loading:	<p>For the Teachers, the total normal cost was increased by 2% and the actuarial accrued liability of active members by 1% to account for buybacks at retirement and other unvalued benefits.</p>
Unknown Data for Participants:	<p>Same as those exhibited by participants with similar known characteristics.</p>
Family Composition:	<p>75% of participants are assumed to be married for BRS excluding Teachers, 80% for Teachers. None are assumed to have dependent children. Females are assumed to be three years younger than their male spouses.</p>
Benefit Election:	<p>All participants are assumed to elect Option A. The benefit election reflects the fact that all benefit options are actuarially equivalent.</p>
2021 Salary:	<p>2021 salary equal to salaries provided in the data, except salaries for new hires were annualized.</p> <p>Calendar year 2021 payroll figures were increased by 3% for Police, 1% for Fire Fighters, and 2.5% for Group 1 and Group 2 employees to estimate unsettled contracts. For participants hired in December 2021, salaries were set equal to \$35,000 for Group 1 and \$80,000 for Group 4.</p> <p>For Teachers, calendar year 2021 payroll figures were increased by 1% to estimate unsettled contracts. For participants hired in December 2021, 2021 salaries were set equal to \$80,000.</p>
Total Service:	<p>Total creditable service reported in the data.</p>
Net 3(8)(c) Liability:	<p>No liability is valued for benefits paid to or received from other municipal retirement systems.</p>
Actuarial Value of Assets:	<p>A preliminary actuarial value is first determined by taking the actuarial value of assets at the beginning of the year and adding assumed investment earnings (at the assumed actuarial rate of return) and the net new money during the year (contributions less benefit payments and administrative expenses). Twenty percent of the difference between the market value of assets and the preliminary actuarial value of assets is added to the preliminary actuarial value. In order that the actuarial value not differ too significantly from the market value of assets, the final actuarial value of assets must be within 20% of the market value of assets.</p>
Actuarial Cost Method:	<p>Entry Age Normal Actuarial Cost Method. Entry Age is the age of the participant less total creditable service. Normal Cost and Actuarial Accrued Liability are calculated on an individual basis and are allocated by salary. Normal Cost is determined by using the plan of benefits applicable to each participant.</p>

Section 5: Actuarial Valuation Basis

Actuarial Models:

Segal valuation results are based on proprietary actuarial modeling software. The actuarial valuation models generate a comprehensive set of liability and cost calculations that are presented to meet regulatory, legislative and client requirements. Our Actuarial Technology and Systems unit, comprised of both actuaries and programmers, is responsible for the initial development and maintenance of these models. The models have a modular structure that allows for a high degree of accuracy, flexibility and user control. The client team programs the assumptions and the plan provisions, validates the models, and reviews test lives and results, under the supervision of the responsible actuary.

Justification for Change in Actuarial Assumptions:

Based on past experience and future expectations, the following actuarial assumption were changed for BRS excluding Teachers as of January 1, 2022:

- The investment rate of return assumption was lowered from 7.05% to 6.90%.
- The generational mortality improvement scale was updated from Scale MP-2019 to Scale MP-2021.
- The administrative expense assumption was lowered from \$7.70 million for calendar year 2020 to \$7.28 million for calendar year 2022.

The following changes in actuarial assumptions were made based on guidance from the actuary of the Massachusetts Teachers' Retirement System as of January 1, 2022:

- The investment rate of return assumption was lowered from 7.15% to 7.00%.
- The generational mortality improvement scale was updated from Scale MP-2019 to Scale MP-2021.
- The administrative expense assumption was lowered from \$3.30 million for calendar year 2020 to \$3.12 million for calendar year 2022.

Section 5: Actuarial Valuation Basis

Exhibit II: Summary of Plan Provisions

This exhibit summarizes the major provisions of the Plan included in the valuation. It is not intended to be, nor should it be interpreted as, a complete statement of all plan provisions.

Plan Year: January 1 through December 31

Plan Status: Ongoing

Retirement Benefits: Employees covered by the Contributory Retirement Law are classified into one of four groups depending on job classification. Group 1 comprises most positions in state and local government. It is the general category of public employees. Group 4 comprises mainly police and firefighters. Group 2 is for other specified hazardous occupations. (Officers and inspectors of the State Police are classified as Group 3.)

For employees hired prior to April 2, 2012, the annual amount of the retirement allowance is based on the member's final three-year average salary multiplied by the number of years and full months of creditable service at the time of retirement and multiplied by a percentage according to the following table based on the age of the member at retirement:

Age Last Birthday at Date of Retirement			
Percent	Group 1	Group 2	Group 4
2.5	65 or over	60 or over	55 or over
2.4	64	59	54
2.3	63	58	53
2.2	62	57	52
2.1	61	56	51
2.0	60	55	50
1.9	59	--	49
1.8	58	--	48
1.7	57	--	47
1.6	56	--	46
1.5	55	--	45

TARP – Chapter 114 of the Acts of 2000 provides enhanced retirement benefits to teachers who elect to participate in the program and to all teachers hired on or after July 1, 2001. The retirement allowance of a participating teacher with 30 or more years of service is increased by an additional 2 percent for each full year of creditable service in excess of 24 years, up to the statutory maximum of 80 percent of the member's three-year salary average.

Section 5: Actuarial Valuation Basis

A member's final three-year average salary is defined as the greater of the highest consecutive three-year average annual rate of regular compensation and the average annual rate of regular compensation received during the last three years of creditable service prior to retirement.

For employees hired on April 2, 2012 or later, the annual amount of the retirement allowance is based on the member's final five-year average salary multiplied by the number of years and full months of creditable service at the time of retirement and multiplied by a percentage according to the following tables based on the age and years of creditable service of the member at retirement:

**For members with less than 30 years of creditable service:
Age Last Birthday at Date of Retirement**

Percent	Group 1	Group 2	Group 4
2.50	67 or over	62 or over	57 or over
2.35	66	61	56
2.20	65	60	55
2.05	64	59	54
1.90	63	58	53
1.75	62	57	52
1.60	61	56	51
1.45	60	55	50

**For members with 30 years of creditable service or greater:
Age Last Birthday at Date of Retirement**

Percent	Group 1	Group 2	Group 4
2.500	67 or over	62 or over	57 or over
2.375	66	61	56
2.250	65	60	55
2.125	64	59	54
2.000	63	58	53
1.875	62	57	52
1.750	61	56	51
1.625	60	55	50

Section 5: Actuarial Valuation Basis

A member's final five-year average salary is defined as the greater of the highest consecutive five-year average annual rate of regular compensation and the average annual rate of regular compensation received during the last five years of creditable service prior to retirement.

For employees who became members after January 1, 2011, regular compensation is limited to 64% of the federal limit found in 26 U.S.C. 401(a)(17). In addition, regular compensation for members who retire after April 2, 2012 will be limited to prohibit "spiking" of a member's salary to increase the retirement benefit.

For all employees, the maximum annual amount of the retirement allowance is 80 percent of the member's final average salary. Any member who is a veteran also receives an additional yearly retirement allowance of \$15 per year of creditable service, not exceeding \$300. The veteran allowance is paid in addition to the 80 percent maximum.

Employee Contributions:

Date of Hire	Contribution Rate
Prior to January 1, 1975	5%
January 1, 1975 – December 31, 1983	7%
January 1, 1984 – June 30, 1996	8%
July 1, 1996 onward	9%

In addition, employees hired after December 31, 1978 contribute an additional 2 percent of salary in excess of \$30,000.

Employees hired after 1983 who voluntarily withdraw their contributions with less than 10 ten years of credited service receive 3% interest on their contributions.

Employees in Group 1 hired on or after April 2, 2012 with 30 years of creditable service or greater will pay a base contribution rate of 6%.

Retirement Benefits (Superannuation):

Members of Group 1, 2 or 4 hired prior to April 2, 2012 may retire upon the attainment of age 55. For retirement at ages below 55, twenty years of creditable service is required.

Members hired prior to April 2, 2012 who terminate before age 55 with ten or more years of creditable service are eligible for a retirement allowance upon the attainment of age 55 (provided they have not withdrawn their accumulated deductions from the Annuity Savings Fund of the System).

Members of Group 1 hired April 2, 2012 or later may retire upon the attainment of age 60. Members of Group 2 or 4 hired April 2, 2012 or later may retire upon the attainment of age 55. Members of Group 4 may retire upon attainment of age 50 with ten years of creditable service.

Members hired April 2, 2012 or later who terminate before age 55 (60 for members of Group 1) with ten or more years of creditable service are eligible for a retirement allowance upon the attainment of age 55 (60 for members of Group 1) provided they have not withdrawn their accumulated deductions from the Annuity Savings Fund of the System.

Section 5: Actuarial Valuation Basis

Ordinary Disability Benefit:	A member who is unable to perform his or her job due to a non-occupational disability will receive a retirement allowance if he or she has ten or more years of creditable service and has not reached age 55. The annual amount of such allowance shall be determined as if the member retired for superannuation at age 55 (age 60 for Group 1 members hired on or after April 2, 2012), based on the amount of creditable service at the date of disability. For veterans, there is a minimum benefit of 50 percent of the member's most recent year's pay plus an annuity based on his or her own contributions.
Accidental Disability Benefit:	For a job-connected disability, the benefit is 72 percent of the member's most recent annual pay plus an annuity based on his or her own contributions, plus additional amounts for surviving children. Benefits are capped at 75 percent of annual rate of regular compensation for employees who become members after January 1, 1988.
Death Benefits:	<p>In general, the beneficiary of an employee who dies in active service will receive a refund of the employee's own contributions. Alternatively, if the employee were eligible to retire on the date of death, a spouse's benefit will be paid equal to the amount the employee would have received under Option C. The surviving spouse of a member who dies with two or more years of credited service has the option of a refund of the employee's contributions or a monthly benefit regardless of eligibility to retire, if they were married for at least one year. There is also a minimum widow's pension of \$500 per month, and there are additional amounts for surviving children.</p> <p>If an employee's death is job-connected, the spouse will receive 72 percent of the member's most recent annual pay, in addition to a refund of the member's accumulated deductions, plus additional amounts for surviving children. However, in accordance with Section 100 of Chapter 32, the surviving spouse of a police officer, firefighter or corrections officer is killed in the line of duty will be eligible to receive an annual benefit equal to the maximum salary held by the member at the time of death.</p> <p>Upon the death of a job-connected disability retiree who retired prior to November 7, 1996 and could not elect an Option C benefit, a surviving spouse will receive an allowance of \$12,000 per year if the member dies for a reason unrelated to cause of disability.</p>
"Heart And Lung Law" And Cancer Presumption:	Any case of hypertension or heart disease resulting in total or partial disability or death to a uniformed fireman, permanent member of a police department, or certain employees of a county correctional facility is presumed to have been suffered in the line of duty, unless the contrary is shown by competent evidence. Any case of disease of the lungs or respiratory tract resulting in total disability or death to a uniformed fireman is presumed to have been suffered in the line of duty, unless the contrary is shown by competent evidence. There is an additional presumption for uniformed firemen that certain types of cancer are job-related if onset occurs while actively employed or within five years of retirement.
Options:	Members may elect to receive a full retirement allowance payable for life under Option A. Under Option B a member may elect to receive a lower monthly allowance in exchange for a guarantee that at the time of death any contributions not expended for annuity payments will be refunded to the beneficiary. Option C allows the member to take a lesser retirement allowance in exchange for providing a survivor with two-thirds of the lesser amount. Option C pensioners will have benefits converted from a reduced to a full retirement if the beneficiary predeceases the retiree.

Section 5: Actuarial Valuation Basis

Post-Retirement Benefits:	The Board has adopted the provisions of Section 51 of Chapter 127 of the Acts of 1999, which provide that the Retirement Board may approve an annual COLA in excess of the Consumer Price Index but not to exceed a 3% COLA on the first \$15,000 (previously, \$14,000) of a retirement allowance. Cost-of-living increases granted prior to July 1, 1998 are reimbursed by the Commonwealth and not reflected in this report.
Changes in Plan Provisions:	As permitted by Section 19 of Chapter 188 of the Acts of 2010, the Cost of Living Adjustment base was increased from \$14,000 to \$15,000 on July 1, 2021.