

# Boston Retirement System

## Actuarial Valuation and Review

As of January 1, 2020



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 25, 2020

Retirement Board  
Boston Retirement System  
City Hall, Room 816  
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Dear Board Members:

We are pleased to submit this Actuarial Valuation and Review as of January 1, 2020. It summarizes the actuarial data used in the valuation, analyzes the preceding two years' experience, and establishes the funding requirements for fiscal 2021 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 Boston Retirement 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. Further, in her opinion, the assumptions as approved by the Board are reasonably related to the experience of and the expectations for the Boston Retirement System.

We look forward to reviewing this report with you and to answering any questions.

Sincerely,  
Segal

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

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

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

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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, 2020. 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, 2019, provided by the staff of the Retirement System;
- The assets of the System as of December 31, 2019, 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, 2019 for the Retirement System is provided in a separate report.

## Section 1: Actuarial Valuation Summary

### Valuation highlights

1. It is important to note that this actuarial valuation is based on plan assets as of December 31, 2019. Due to the COVID-19 pandemic, market conditions have changed significantly since the valuation date. The System's actuarial 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. While it is impossible to determine how the markets will perform over the next several months, and how that will affect the results of next year's valuation, Segal is available to prepare projections of potential outcomes upon request.
2. 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.
3. 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.
4. 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.
5. The funded ratio (the ratio of the actuarial value of assets to actuarial accrued liability) is 63.24% for the BRS as a whole, compared to the prior valuation funded ratio of 62.88%. 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 62.65%, compared to 63.86% 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.
6. The rate of return on the market value of assets for the BRS was -4.83% and 15.74% for the plan years ended December 31, 2018 and December 31, 2019, respectively. The rate of return on the actuarial value of assets (which gradually recognizes market fluctuations) was 5.30% and 7.21% for the plan years ended December 31, 2018 and December 31, 2019, respectively.
7. The actuarial value of assets for the BRS as of December 31, 2019 was \$7.477 billion, or 100.94% of the market value of assets of \$7.407 billion reported in the Annual Statement. As of December 31, 2017, the actuarial value of assets was 98.46% of the market value.

## Section 1: Actuarial Valuation Summary

8. The investment experience in the past years has only been partially recognized in the actuarial value of assets. As the deferred net loss of \$69.7 million is recognized in future years, the cost of the System is likely to increase unless the net loss 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 losses on the actuarial value of assets in the next few years. The deferred investment losses 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*.
9. The following actuarial assumptions were changed with this valuation:
  - For the BRS excluding Teachers:
    - The investment rate of return assumption was lowered from 7.50% to 7.05%.
    - The mortality for non-disabled participants was updated from the RP-2014 Blue Collar Employee and Healthy Annuitant Mortality Tables set forward 1 year for female participants projected generationally using Scale MP-2017 to the Pub-2010 General Employee, Healthy Retiree and Contingent Survivor Amount-Weighted Mortality Tables set forward one year projected generationally using Scale MP-2019 for Groups 1 and 2 and to the Pub-2010 Safety Employee, Healthy Retiree and Contingent Survivor Amount-Weighted Mortality Tables projected generationally using Scale MP-2019 for Group 4.
    - The mortality for disabled participants was updated from the RP-2014 Blue Collar Healthy Annuitant Mortality Table set forward 1 year projected generationally using Scale MP-2017 to the Pub-2010 General Healthy Retiree Amount-Weighted Mortality Tables set forward one year projected generationally using Scale MP-2019 for Groups 1 and 2 and to the Pub-2010 Disabled Retiree Amount-Weighted Mortality Tables projected generationally using Scale MP-2019.

Changing these assumptions increased the unfunded liability by approximately \$463.3 million and increased the normal cost by approximately \$19.7 million.

- For Teachers:
  - The investment rate of return assumption was lowered from 7.35% to 7.15%.
  - The mortality for non-disabled participants was updated from the RP-2014 White Collar Employee and Healthy Annuitant Mortality Tables projected generationally using Scale MP-2016 to the Pub-2010 Teacher Employee, Healthy Retiree and Contingent Survivor Headcount-Weighted Mortality Tables projected generationally using Scale MP-2019.
  - The mortality for disabled participants was updated from the RP-2014 Healthy Annuitant Mortality Tables set forward four years projected generationally using Scale BB2D to the Pub-2010 Teacher Healthy Retiree Headcount-Weighted Mortality Tables projected generationally using Scale MP-2019.

Changing these assumptions increased the unfunded liability by approximately \$98.4 million and increased the normal cost by approximately \$4.4 million.

## Section 1: Actuarial Valuation Summary

10. The unfunded liability was expected to decrease by \$226 million from \$3.933 billion as of January 1, 2018 to \$3.707 billion as of January 1, 2020. The actual unfunded liability as of January 1, 2020 is \$4.346 billion or \$639 million more than expected. The increase is primarily due to the assumption changes described above. Other sources of gains and losses are discussed in *Sections 2 and 3*.
11. The fiscal 2021 appropriation for the BRS excluding Teachers has been set equal to the previously budgeted amount of \$335,531,696. 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 fully funded the liabilities of the BRS excluding Teachers by June 30, 2025 with appropriations that increased 8.85% per year.
12. The Commonwealth appropriation for the Teachers is \$162,976,424 for fiscal 2021. The total Commonwealth appropriation is expected to increase by 9.63% through fiscal 2023 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.
13. *Section 2* shows participant and asset information, the experience analysis, liabilities and a funding schedule for the BRS excluding Teachers, with comparisons to 2018. *Section 3* shows the same information for the Teachers with comparisons to 2018. *Section 4* shows participant and asset information for all employees of the BRS.
14. 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

		2020	2018
<b>Contributions:</b>	• Actuarially Determined Contributions for fiscal year 2021 and 2019	\$335,531,696	\$283,189,199
	• Actuarially Determined Contributions for fiscal year 2022 and 2020	365,226,251	308,251,443
	• Actuarially Determined Contributions for fiscal year 2023 and 2021	397,548,774	335,531,696
<b>Actuarial accrued liability for plan year beginning January 1:</b>	• Retired participants and beneficiaries	\$3,827,382,780	\$3,340,337,893
	• Inactive vested participants	123,499,767	101,843,021
	• Inactive participants due a refund of employee contributions	51,081,790	37,968,525
	• Active participants	3,543,152,940	3,070,817,129
	• Total	7,545,117,277	6,550,966,568
<b>Assets for plan year beginning January 1:</b>	• Normal cost including administrative expenses for plan year beginning January 1	190,491,468	157,529,726
	• Market value of assets (MVA)	\$5,583,428,192	\$5,072,440,419
	• Actuarial value of assets (AVA)	5,703,899,970	5,038,741,926
<b>Funded status for plan year beginning January 1:</b>	• Actuarial value of assets as a percentage of market value of assets	102.16%	99.34%
	• Unfunded actuarial accrued liability on market value of assets	\$1,961,689,085	\$1,478,526,149
	• Funded percentage on MVA basis	74.00%	77.43%
<b>Key assumptions</b>	• Unfunded actuarial accrued liability on actuarial value of assets	\$1,841,217,307	\$1,512,224,642
	• Funded percentage on AVA basis	75.60%	76.92%
	• Net investment return	7.05%	7.50%
<b>Demographic data for plan year beginning January 1:</b>	• Long-term wage inflation rate	3.25%	3.25%
	• Number of retired participants and beneficiaries	9,779	9,721
	• Number of inactive vested participants	776	800
	• Number of inactive participants due a refund of employee contributions	8,907	7,500
	• Number of active participants	14,709	14,445
	• Total payroll <sup>1</sup>	\$1,063,526,175	\$978,059,711
	• Average payroll	72,304	67,709

<sup>1</sup> Payroll figures are for the prior year and reflect annualized salaries for participants hired during the year. Calendar year 2019 payroll figures were reduced for Fire Fighters to reflect retroactive payments made during the year. For participants hired in December 2017 or December 2019, salaries were set equal to \$35,000 for Group 1 and \$50,000 for Group 4.

## Section 1: Actuarial Valuation Summary

### Summary of key valuation results – Teachers

		2020	2018
<b>Actuarial accrued liability for plan year beginning January 1:</b>	<ul style="list-style-type: none"> <li>Retired participants and beneficiaries</li> <li>Inactive vested participants</li> <li>Inactive participants due a refund of employee contributions</li> <li>Active participants</li> <li>Total</li> <li>Normal cost including administrative expenses for plan year beginning January 1</li> </ul>	\$2,595,693,503 72,340,548 50,717,317 1,558,527,366 4,277,278,734 84,917,565	\$2,482,365,576 61,353,783 33,092,018 1,467,524,023 4,044,335,400 77,823,376
<b>Assets for plan year beginning January 1:</b>	<ul style="list-style-type: none"> <li>Market value of assets (MVA)</li> <li>Actuarial value of assets (AVA)</li> <li>Actuarial value of assets as a percentage of market value of assets</li> </ul>	\$1,823,646,734 1,772,897,935 97.22%	\$1,694,050,718 1,623,499,500 95.84%
<b>Funded status for plan year beginning January 1:</b>	<ul style="list-style-type: none"> <li>Unfunded actuarial accrued liability on market value of assets</li> <li>Funded percentage on MVA basis</li> <li>Unfunded actuarial accrued liability on actuarial value of assets</li> <li>Funded percentage on AVA basis</li> </ul>	\$2,453,632,000 42.64% \$2,504,380,799 41.45%	\$2,350,284,682 41.89% \$2,420,835,900 40.14%
<b>Key assumptions</b>	<ul style="list-style-type: none"> <li>Net investment return</li> <li>Long-term wage inflation rate</li> </ul>	7.15% 3.25%	7.35% 3.25%
<b>Demographic data for plan year beginning January 1:</b>	<ul style="list-style-type: none"> <li>Number of retired participants and beneficiaries</li> <li>Number of inactive vested participants</li> <li>Number of inactive participants due a refund of employee contributions</li> <li>Number of active participants</li> <li>Total payroll<sup>1</sup></li> <li>Average payroll</li> </ul>	4,780 371 2,624 6,147 \$583,380,055 94,905	4,727 309 2,014 6,550 \$562,185,195 85,830

<sup>1</sup> Payroll figures are for the prior year and reflect annualized salaries for participants hired during the year. Calendar year 2019 payroll figures were reduced to reflect retroactive payments made during the year. For participants hired in December 2017 or December 2019, salaries were set equal to \$50,000. Calendar year 2017 payroll figures were increased to reflect bargaining contracts that were settled in 2018.

## Section 1: Actuarial Valuation Summary

### Summary of key valuation results – All Boston Retirement System employees

		2020	2018
<b>Actuarial accrued liability for plan year beginning January 1:</b>	<ul style="list-style-type: none"> <li>Retired participants and beneficiaries</li> <li>Inactive vested participants</li> <li>Inactive participants due a refund of employee contributions</li> <li>Active participants</li> <li>Total</li> <li>Normal cost including administrative expenses for plan year beginning January 1</li> </ul>	<p>\$6,423,076,283</p> <p>195,840,315</p> <p>101,799,107</p> <p>5,101,680,306</p> <p>11,822,396,011</p> <p>275,409,033</p>	<p>\$5,822,703,469</p> <p>163,196,804</p> <p>71,060,543</p> <p>4,538,341,152</p> <p>10,595,301,968</p> <p>235,353,102</p>
<b>Assets for plan year beginning January 1:</b>	<ul style="list-style-type: none"> <li>Market value of assets (MVA)</li> <li>Actuarial value of assets (AVA)</li> <li>Actuarial value of assets as a percentage of market value of assets</li> </ul>	<p>\$7,407,074,926</p> <p>7,476,797,905</p> <p>100.94%</p>	<p>\$6,766,491,137</p> <p>6,662,241,426</p> <p>98.46%</p>
<b>Funded status for plan year beginning January 1:</b>	<ul style="list-style-type: none"> <li>Unfunded actuarial accrued liability on market value of assets</li> <li>Funded percentage on MVA basis</li> <li>Unfunded actuarial accrued liability on actuarial value of assets</li> <li>Funded percentage on AVA basis</li> </ul>	<p>\$4,415,321,085</p> <p>62.65%</p> <p>\$4,345,598,106</p> <p>63.24%</p>	<p>\$3,828,810,831</p> <p>63.86%</p> <p>\$3,933,060,542</p> <p>62.88%</p>
<b>Demographic data for plan year beginning January 1:</b>	<ul style="list-style-type: none"> <li>Number of retired participants and beneficiaries</li> <li>Number of inactive vested participants</li> <li>Number of inactive participants due a refund of employee contributions</li> <li>Number of active participants</li> <li>Total payroll<sup>1</sup></li> <li>Average payroll</li> </ul>	<p>14,559</p> <p>1,147</p> <p>11,531</p> <p>20,856</p> <p>\$1,646,906,229</p> <p>78,966</p>	<p>14,448</p> <p>1,109</p> <p>9,514</p> <p>20,995</p> <p>\$1,540,244,906</p> <p>73,362</p>

<sup>1</sup> Payroll figures are for the prior year and reflect annualized salaries for participants hired during the year. For BRS excluding Teachers, calendar year 2019 payroll figures were reduced for Fire Fighters to reflect retroactive payments made during the year. For Teachers, calendar year 2019 payroll figures were reduced to reflect retroactive payments made during the year and calendar year 2017 payroll figures were increased to reflect bargaining contracts that were settled in 2018. For participants hired in December 2017 or December 2019, salaries were set equal to \$35,000 for Group 1 and \$50,000 for Group 4 and Teachers.

## 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:

<b>Plan of benefits</b>	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.
<b>Participant data</b>	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.
<b>Assets</b>	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.
<b>Actuarial assumptions</b>	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.

## Section 1: Actuarial Valuation Summary

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

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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.

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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.

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

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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.

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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.

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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

The Actuarial Valuation and Review considers the number and demographic characteristics of covered participants, including active participants, inactive participants, retired participants and beneficiaries.

This section presents a summary of significant statistical data on these participant groups.

A detailed distribution of the active participants by age, service and average payroll can be found in *Section 4, Exhibit A*.

### Participant Population: 2007 – 2019

Year Ended December 31	Active Participants	Inactive Participants	Retired Participants and Beneficiaries	Total Non-Actives	Ratio of Non-Actives to Actives
2007	15,943	4,959	10,246	15,205	0.95
2009	14,449	6,189	10,044	16,233	1.12
2011	13,951	6,823	10,000	16,823	1.21
2013	14,235	6,751	9,925	16,676	1.17
2015	14,288	7,549	9,856	17,405	1.22
2017	14,445	8,300	9,721	18,021	1.25
2019	14,709	9,683	9,779	19,462	1.32

## Section 2: Actuarial Valuation Results – BRS excluding Teachers

### Table of Plan Coverage

Category	Year Ended December 31		Change From Prior Year
	2019	2017	
<b>Active participants in valuation:</b>			
• Number	14,709	14,445	1.8%
• Average age	46.3	46.4	-0.1
• Average years of service	12.9	13.7	-0.8
• Total payroll	\$1,063,526,175	\$978,059,711	8.7%
• Average payroll	72,304	67,709	6.8%
• Member contributions	1,072,727,239	1,013,349,734	5.9%
• Number with unknown age	85	2	N/A
<b>Inactive vested participants:</b>			
• Inactive participants due a refund of employee contributions	8,907	7,500	18.8%
• Inactive participants with a vested right to a deferred or immediate benefit	776	800	-3.0%
<b>Retired participants:</b>			
• Number in pay status	6,380	6,143	3.9%
• Average age	73.9	74.1	-0.2
• Average monthly benefit	\$3,227	\$2,966	8.8%
<b>Disabled participants:</b>			
• Number in pay status	1,612	1,674	-3.7%
• Average age	69.3	68.7	0.6
• Average monthly benefit	\$4,433	\$4,193	5.7%
<b>Beneficiaries:</b>			
• Number in pay status	1,787	1,904	-6.1%
• Average age	76.9	77.3	-0.4
• Average monthly benefit	\$2,041	\$1,815	12.5%

**Notes:**

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

Calendar year 2019 payroll figures were reduced for Fire Fighters to reflect retroactive payments made during the year.

For participants hired in December 2017 or December 2019, salaries were set equal to \$35,000 for Group 1 and \$50,000 for Group 4.

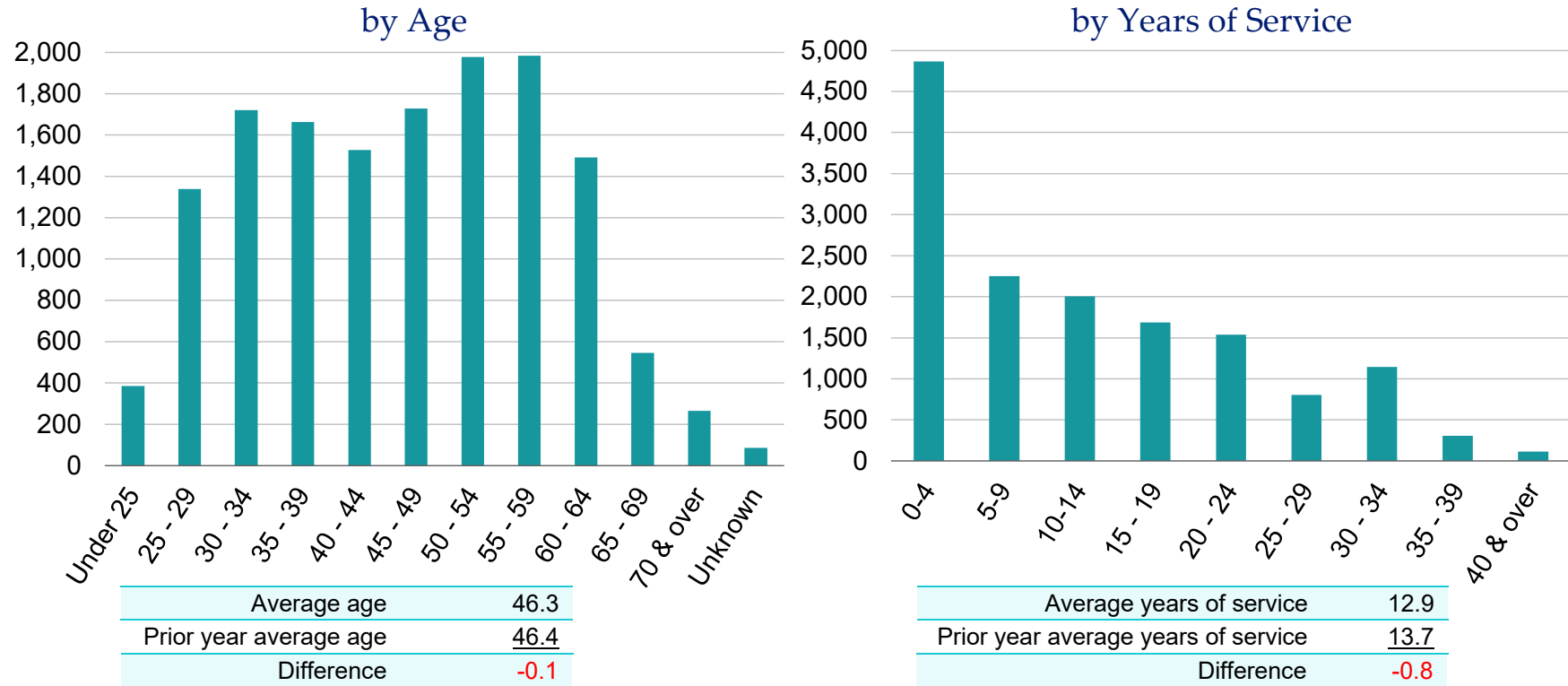
## Section 2: Actuarial Valuation Results – BRS excluding Teachers

### Active participants

Plan costs are affected by the age, years of service and payroll of active participants. In this year's valuation, there were 14,709 active participants with an average age of 46.3, average years of service of 12.9 years and average payroll of \$72,304. The 14,445 active participants in the prior valuation had an average age of 46.4, average service of 13.7 years and average payroll of \$67,709.

Among the active participants, there were 85 with unknown age and none with unknown service information. The actuarial calculations were adjusted for the missing information by assuming that it was the same as information provided for other active participants with similar known characteristics.

Distribution of Active Participants as of December 31, 2019



### Inactive participants

In this year's valuation, there were 776 participants with a vested right to a deferred or immediate vested benefit and 8,907 participants entitled to a return of their employee contributions.



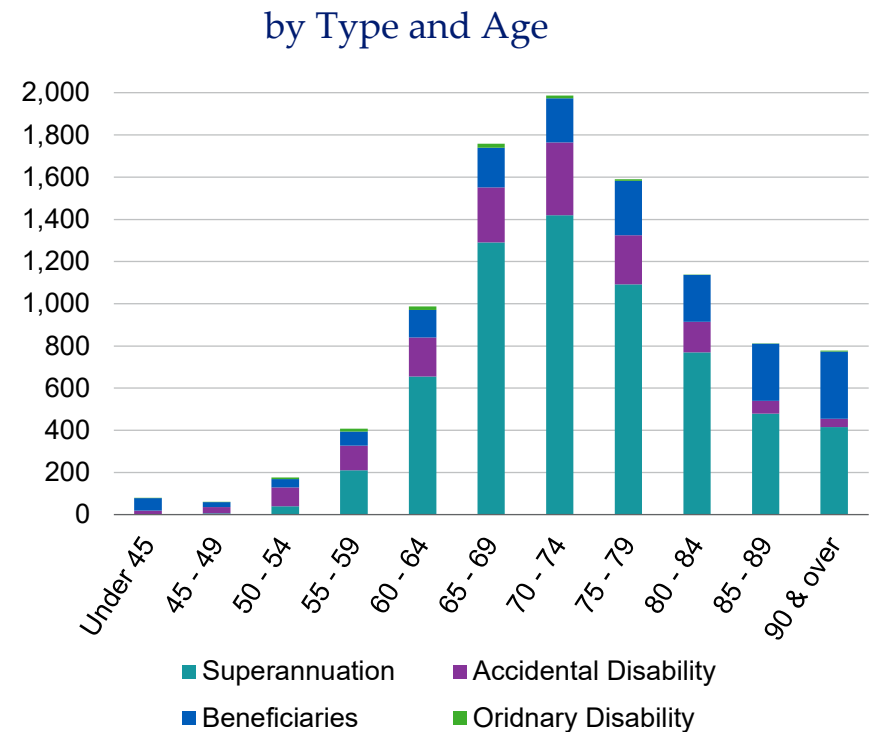
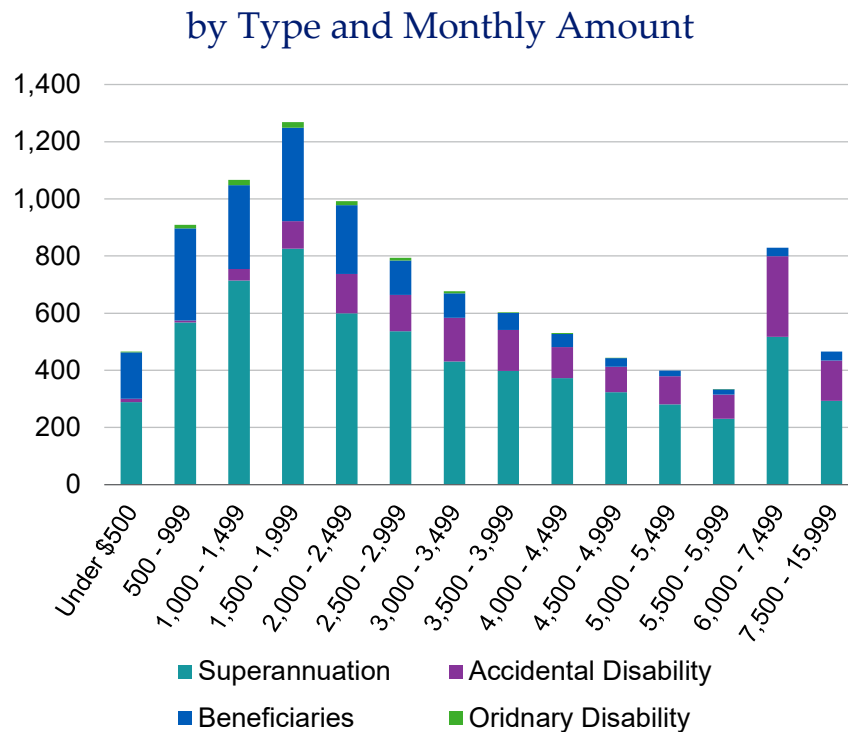
## Section 2: Actuarial Valuation Results – BRS excluding Teachers

### Retired participants and beneficiaries

As of December 31, 2019, 7,992 retired participants and 1,787 beneficiaries were receiving total monthly benefits of \$31,378,344, excluding COLAs reimbursed by the Commonwealth. For comparison, in the previous valuation, there were 7,817 retired participants and 1,904 beneficiaries were receiving total monthly benefits of \$28,697,014, excluding COLAs reimbursed by the Commonwealth.

As of December 31, 2019, the average monthly benefit for retired participants and beneficiaries is \$3,209, compared to \$2,952 in the previous valuation. The average age for retired participants and beneficiaries is 73.7 in the current valuation, compared with 73.8 in the prior valuation.

Distribution of Pensioners and Beneficiaries as of December 31, 2019



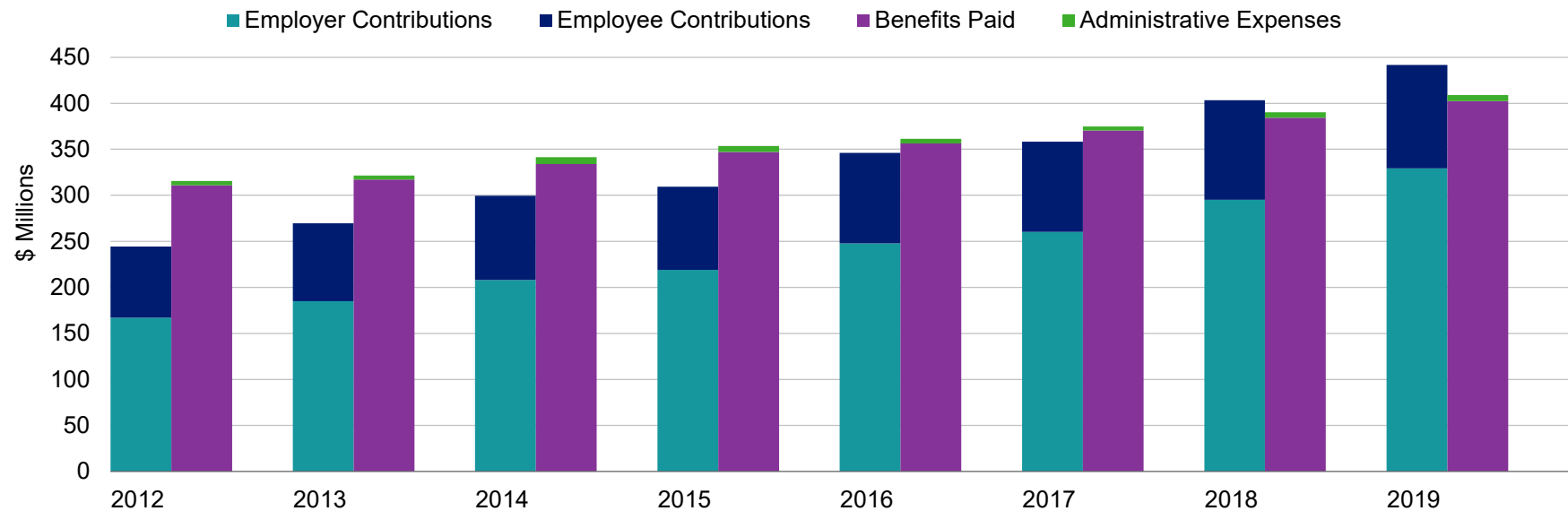
## Section 2: Actuarial Valuation Results – BRS excluding Teachers

### 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 B*.

Comparison of Contributions with Benefits and Expenses  
for Years Ended December 31, 2012 – 2019



## Section 2: Actuarial Valuation Results – BRS excluding 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.

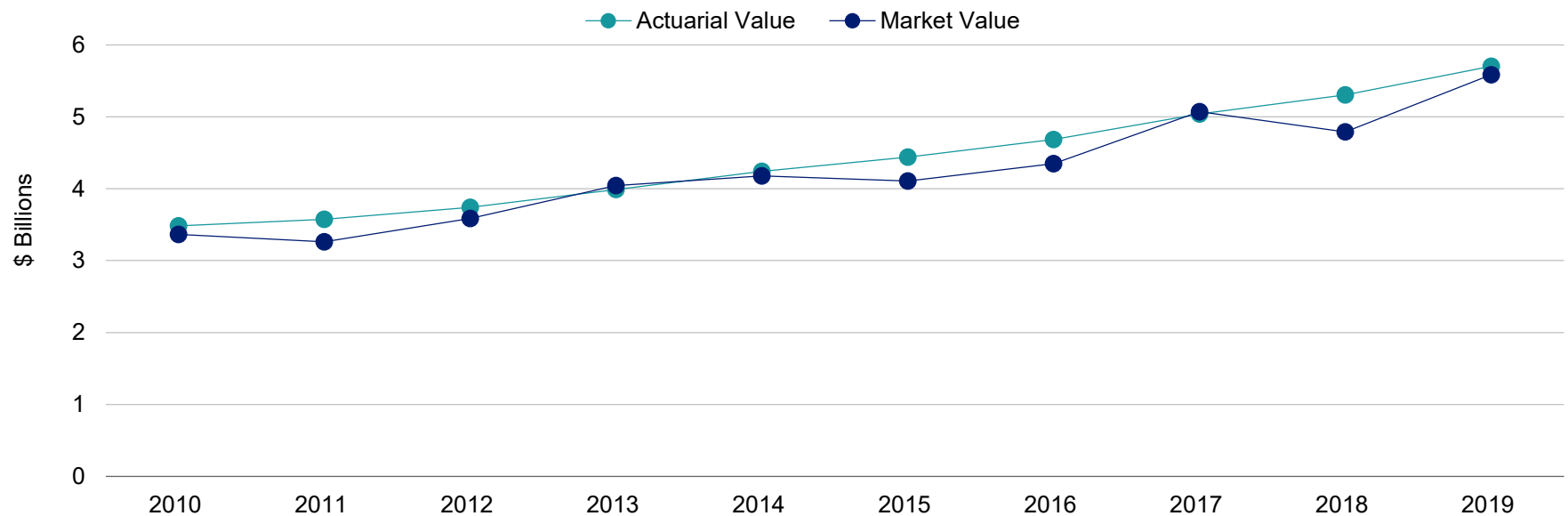
### Determination of Actuarial Value of Assets

		Year Ended	
		December 31, 2019	December 31, 2018
<b>1</b>	Actuarial value of assets at the beginning of the year	\$5,302,554,256	\$5,038,741,926
<b>2</b>	Contributions, less benefit payments and expense during the year	32,551,412	13,062,022
<b>3</b>	Average actuarial value: <b>(1) + [50% of (2)]</b>	5,318,829,962	5,045,272,937
<b>4</b>	Expected investment income: <b>7.50% x (3)</b>	398,912,247	378,395,470
<b>5</b>	Preliminary actuarial value of assets at the end of the year: <b>(1) + (2) + (4)</b>	5,734,017,915	5,430,199,418
<b>6</b>	Market value of assets at the end of the year	5,583,428,192	4,791,973,610
<b>7</b>	Adjustment toward market value: <b>20% of [(6) – (5)]</b>	<b>-30,117,945</b>	<b>-127,645,162</b>
<b>8</b>	Adjustment to be within 20% corridor	0	0
<b>9</b>	Final actuarial value of assets at the end of the year: <b>(5) + (7) + (8)</b>	5,703,899,970	5,302,554,256
<b>10</b>	Actuarial value as a percentage of market value: <b>(9) ÷ (6)</b>	102.16%	110.65%

## Section 2: Actuarial Valuation Results – BRS excluding 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.

Actuarial Value of Assets vs. Market Value of Assets as of December 31, 2010 – 2019



## Section 2: Actuarial Valuation Results – BRS excluding 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.

The net experience loss over the two-year period is \$181,463,294, which includes \$157,763,107 from investment losses and \$23,700,187 in losses from all other sources. The net experience variation from individual sources other than investments was 0.3% of the actuarial accrued liability. A discussion of the major components of the actuarial experience is on the following pages.

#### Actuarial Experience for Two-Year Period Ended December 31, 2019

<b>1</b>	Net loss from investments	<b>-\$157,763,107</b>
<b>2</b>	Gain from administrative expenses	3,149,318
<b>3</b>	Net loss from other experience	<b>-26,849,505</b>
<b>4</b>	Net experience loss: <b>1 + 2 + 3</b>	<b>-\$181,463,294</b>

## Section 2: Actuarial Valuation Results – BRS excluding 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 System's investment policy. The rate of return on the market value of assets for the 2019 and 2018 plan years was 15.78% and -5.78%, respectively.

For valuation purposes, the assumed rate of return on the actuarial value of assets was 7.50% for the 2019 and 2018 plan years. The actual rate of return on an actuarial basis for the 2019 and 2018 plan years was 6.93% and 4.97%, respectively. Since the actual return for the year was less than the assumed return, the System experienced an actuarial loss during the two-year period ending December 31, 2019 with regard to its investments.

#### Investment Experience

	Year Ended December 31, 2019		Year Ended December 31, 2018	
	Market Value	Actuarial Value	Market Value	Actuarial Value
<b>1</b> Net investment income	\$758,903,170	\$368,794,302	-\$293,528,832	\$250,750,308
<b>2</b> Average value of assets	4,808,249,316	5,318,829,962	5,078,971,430	5,045,272,937
<b>3</b> Rate of return: <b>1 + 2</b>	15.78%	6.93%	-5.78%	4.97%
<b>4</b> Assumed rate of return	7.50%	7.50%	7.50%	7.50%
<b>5</b> Expected investment income: <b>2 x 4</b>	\$360,618,699	\$398,912,247	\$380,922,857	\$378,395,470
<b>6</b> Actuarial gain/(loss): <b>1 – 5</b>	\$398,284,471	-\$30,117,945	-\$674,451,689	-\$127,645,162

## Section 2: Actuarial Valuation Results – BRS excluding 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 10 years, including averages over select time periods.

Based on this experience and future expectations, we have lowered the assumed rate of return from 7.50% to 7.05%.

### Investment Return – Actuarial Value vs. Market Value: 2010 - 2019

Year Ended December 31	Actuarial Value Investment Return		Market Value Investment Return	
	Amount	Percent	Amount	Percent
2010	\$227,907,602	7.08%	\$331,718,631	11.07%
2011	195,775,161	5.71%	-843,146	-0.03%
2012	236,215,344	6.67%	398,647,225	12.36%
2013	301,559,400	8.12%	508,811,061	14.28%
2014	292,523,874	7.37%	177,462,844	4.41%
2015	244,055,385	5.79%	-27,167,667	-0.65%
2016	259,306,839	5.85%	253,867,742	6.19%
2017	370,823,776	7.93%	741,446,031	17.09%
2018	250,750,308	4.97%	-293,528,832	-5.78%
2019	368,794,302	6.93%	758,903,170	15.78%
	Most recent five-year average return	6.30%		6.38%
	Ten-year average return	6.61%		7.19%

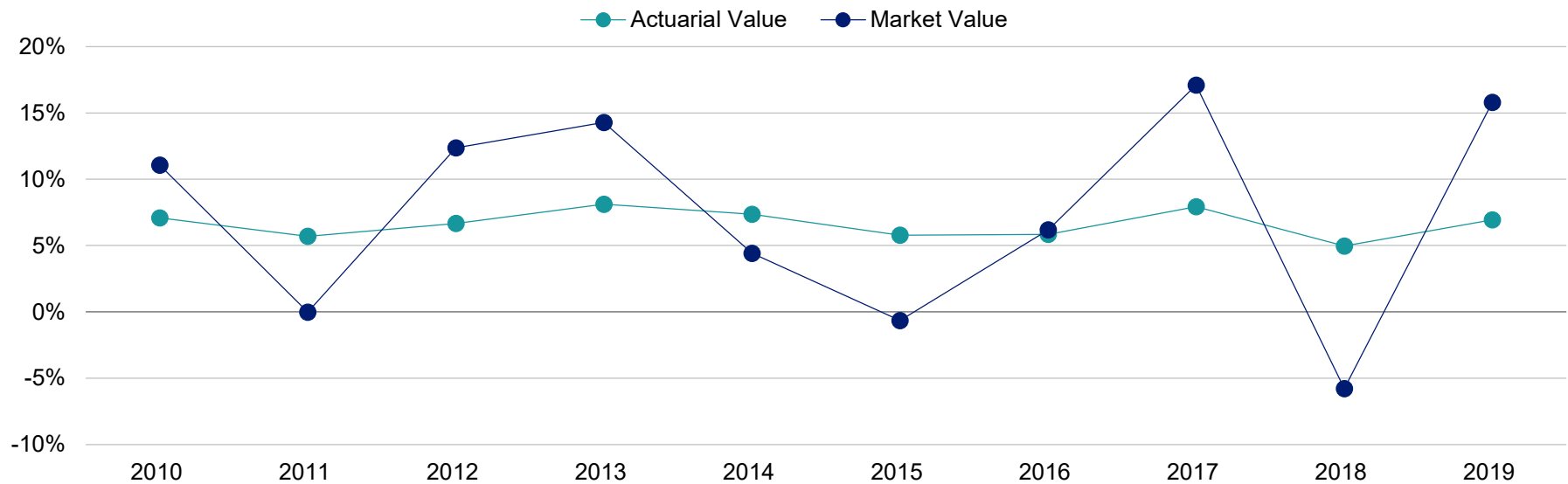
Note:

Each year's yield is weighted by the average asset value in that year.

## Section 2: Actuarial Valuation Results – BRS excluding Teachers

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 - 2019





## Section 2: Actuarial Valuation Results – BRS excluding Teachers

### Non-investment experience

#### Administrative expenses

Administrative expenses for the years ended December 31, 2018 and 2019 totaled \$6,131,839 and \$6,588,813, respectively, as compared to the assumption of \$7,700,000 for calendar year 2018 and \$7,950,250 for calendar year 2019. This resulted in a gain of \$3,149,318 for the two-year period, including an adjustment for interest. Based on information on expenses provided by the Retirement System, we have reset the assumption to \$11,000,000 for the Boston Retirement System for calendar year 2020, with 70% or \$7,700,000 assigned to the BRS excluding Teachers.

#### Demographic 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, 2019 amounted to \$26,849,505.

#### Liability Changes Due to Demographic Experience for Two-Year Period Ended December 31, 2019

Gain due to mortality experience	\$12,341,744
Loss due to salaries increasing more than expected	-57,700,777
Gain due to service corrections	46,345,877
Miscellaneous experience loss	-27,836,349
Total	-\$26,849,505

## Section 2: Actuarial Valuation Results – BRS excluding Teachers

### Actuarial assumptions

The assumption changes reflected in this report are:

- The investment rate of return assumption was lowered from 7.50% to 7.05%.
- The mortality for non-disabled participants was updated from the RP-2014 Blue Collar Employee and Healthy Annuitant Mortality Tables set forward 1 year for female participants projected generationally using Scale MP-2017 to the Pub-2010 General Employee, Healthy Retiree and Contingent Survivor Amount-Weighted Mortality Tables set forward one year projected generationally using Scale MP-2019 for Groups 1 and 2 and to the Pub-2010 Safety Employee, Healthy Retiree and Contingent Survivor Amount-Weighted Mortality Tables projected generationally using Scale MP-2019 for Group 4.
- The mortality for disabled participants was updated from the RP-2014 Blue Collar Healthy Annuitant Mortality Table set forward 1 year projected generationally using Scale MP-2017 to the Pub-2010 General Healthy Retiree Amount-Weighted Mortality Tables set forward one year projected generationally using Scale MP-2019 for Groups 1 and 2 and to the Pub-2010 Disabled Retiree Amount-Weighted Mortality Tables projected generationally using Scale MP-2019.

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

### Plan provisions

There were no changes in plan provisions since the prior valuation.

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

## Section 2: Actuarial Valuation Results – BRS excluding Teachers

### Development of unfunded actuarial accrued liability

	Year Ended	
	December 31, 2019	December 31, 2018
<b>1</b> Unfunded actuarial accrued liability at beginning of year	\$1,376,453,557	\$1,512,224,642
<b>2</b> Normal cost at beginning of year	162,649,442	157,529,726
<b>3</b> Total contributions	-441,553,332	-403,404,713
<b>4</b> Interest		
• For whole year on <b>1 + 2</b>	\$115,432,725	\$125,231,578
• For half year on <b>3</b>	<u>-16,558,250</u>	<u>-15,127,676</u>
Total interest	<u>98,874,475</u>	<u>110,103,902</u>
<b>5</b> Expected unfunded actuarial accrued liability	\$1,196,424,142	\$1,376,453,557
<b>6</b> Changes due to:		
• Investment loss	\$157,763,107	-
• Other experience loss	23,700,187	-
• Assumptions	<u>463,329,871</u>	-
Total changes	<u>644,793,165</u>	-
<b>7</b> Unfunded actuarial accrued liability at end of year	\$1,841,217,307	-

## Section 2: Actuarial Valuation Results – BRS excluding 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. For fiscal 2021, the actuarially determined contribution has been set equal to the previously budgeted amount of \$335,531,696. 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 2022 appropriation is \$365,226,251.

The prior funding schedule fully funded the liabilities of the BRS excluding Teachers by June 30, 2025 with appropriations that increased 8.85% per year.

#### Actuarially Determined Contribution for Year Beginning July 1

	2020		2018	
	Amount	% of Projected Payroll	Amount	% of Projected Payroll
1. Total normal cost	\$182,791,468	16.53%	\$149,829,726	14.73%
2. Administrative expenses	7,700,000	0.70%	7,700,000	0.76%
3. Expected employee contributions	<u>-109,467,514</u>	<u>-9.90%</u>	<u>-99,385,035</u>	<u>-9.77%</u>
4. Employer normal cost: (1) + (2) + (3)	\$81,023,954	7.33%	\$58,144,691	5.71%
5. Actuarial accrued liability	7,545,117,277		6,550,966,568	
6. Actuarial value of assets	<u>5,703,899,970</u>		<u>5,038,741,926</u>	
7. Unfunded actuarial accrued liability: (5) - (6)	\$1,841,217,307		\$1,512,224,642	
8. Employer normal cost projected to July 1, 2020 and 2018	82,330,066	7.33%	59,081,988	5.71%
9. Projected unfunded actuarial accrued liability	1,905,014,933		1,567,907,880	
10. Payment on projected unfunded actuarial accrued liability	<u>253,201,630</u>	<u>22.53%</u>	<u>224,107,211</u>	<u>21.68%</u>
11. Budgeted appropriation for fiscal 2021 and 2019: (8) + (10)	\$335,531,696	29.86%	\$283,189,199	27.39%
12. Projected payroll as of July 1	\$1,123,772,995		\$1,033,868,562	

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 – BRS excluding Teachers

### 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
2021	\$82,330,066	\$2,898,233	\$250,303,397	\$335,531,696	\$1,905,014,933	8.85%
2022	85,293,455	2,898,233	277,034,563	365,226,251	1,768,266,140	8.85%
2023	88,362,949	2,898,233	306,287,592	397,548,774	1,593,260,845	8.85%
2024	91,542,329	2,898,233	338,291,278	432,731,840	1,374,602,309	8.85%
2025	94,835,512	2,898,233	373,294,863	471,028,608	1,106,268,400	8.85%
2026	98,246,553	2,898,233	411,569,854	512,714,640	781,545,613	8.85%
2027	101,779,650	2,898,233	390,058,261	494,736,144	392,956,492	-3.51%
2028	105,439,153	0	0	105,439,153	0	-78.69%
2029	109,229,564	0	0	109,229,564	0	3.59%
2030	113,155,544	0	0	113,155,544	0	3.59%

Notes:

Fiscal 2021 Actuarially Determined Contribution set to budgeted amount.

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

Item (2) reflects 3.25% growth in payroll as well as a 0.15% adjustment to the total normal cost to reflect the effects of mortality 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 deferred investment gains and losses.

## Section 2: Actuarial Valuation Results – BRS excluding 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 ten 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 seven 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 Retirement System'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.  
Over the past six valuations, the non-investment gain/(loss) has ranged from a loss of \$57.6 million to a gain of \$189.6 million.

## Section 2: Actuarial Valuation Results – BRS excluding Teachers

Since 2008, 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 77.4% 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 Retirement System's asset allocation is aligned to meet emerging pension liabilities.

In 2019, contributions exceeded benefits and expenses by \$32.6 million. In future years, cash may be needed from the investment portfolio to meet benefit payments.

# Section 3: Actuarial Valuation Results – Teachers

## Participant data

The Actuarial Valuation and Review considers the number and demographic characteristics of covered participants, including active participants, inactive participants, retired participants and beneficiaries.

This section presents a summary of significant statistical data on these participant groups for the Teachers of the Boston Retirement System.

A detailed distribution of the active participants by age, service and average payroll can be found in *Section 4, Exhibit C*.

### Participant Population: 2007 – 2019

Year Ended December 31	Active Participants	Inactive Participants	Retired Participants and Beneficiaries	Total Non-Actives	Ratio of Non-Actives to Actives
2007	5,805	1,281	3,693	4,974	0.86
2009	5,566	1,424	3,914	5,338	0.96
2011	5,448	1,964	4,189	6,153	1.13
2013	6,043	2,040	4,416	6,456	1.07
2015	6,210	2,191	4,629	6,820	1.10
2017	6,550	2,323	4,727	7,050	1.08
2019	6,147	2,995	4,780	7,775	1.26



## Section 3: Actuarial Valuation Results – Teachers

Table of Plan Coverage

Category	Year Ended December 31		Change From Prior Year
	2019	2017	
<b>Active participants in valuation:</b>			
• Number	6,147	6,550	-6.2%
• Average age	42.4	42.3	0.1
• Average years of service	11.3	11.4	-0.1
• Total payroll	\$583,380,055	\$562,185,195	3.8%
• Average payroll	94,905	85,830	10.6%
• Member contributions	564,358,025	540,654,068	4.4%
<b>Inactive vested participants:</b>			
• Inactive participants due a refund of employee contributions	2,624	2,014	30.3%
• Inactive participants with a vested right to a deferred or immediate benefit	371	309	20.1%
<b>Retired participants:</b>			
• Number in pay status	4,349	4,299	1.2%
• Average age	73.4	72.6	0.8
• Average monthly benefit	\$4,689	\$4,517	3.8%
<b>Disabled participants:</b>			
• Number in pay status	118	121	-2.5%
• Average age	70.7	70.6	0.1
• Average monthly benefit	\$3,459	\$3,134	10.4%
<b>Beneficiaries:</b>			
• Number in pay status	313	307	2.0%
• Average age	75.0	74.6	0.4
• Average monthly benefit	\$2,088	\$1,963	6.4%

**Notes:**

Payroll figures are for the prior calendar year and reflect annualized salaries for participants hired during the year. Calendar year 2019 payroll figures were reduced to reflect retroactive payments made during the year. For participants hired in December 2017 or December 2019, salaries were set equal to \$50,000. Calendar year 2017 payroll figures were increased to reflect bargaining contracts that were settled in 2018.

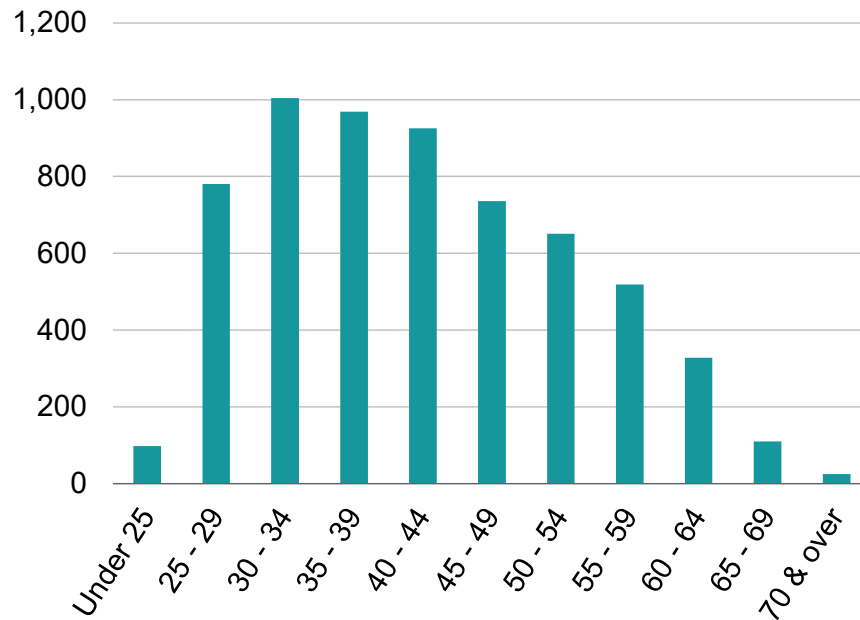
## Section 3: Actuarial Valuation Results – Teachers

### Active participants

Plan costs are affected by the age, years of service and payroll of active participants. In this year's valuation, there were 6,147 active participants with an average age of 42.4, average years of service of 11.3 years and average payroll of \$94,905. The 6,550 active participants in the prior valuation had an average age of 42.3, average service of 11.4 years and average payroll of \$85,830.

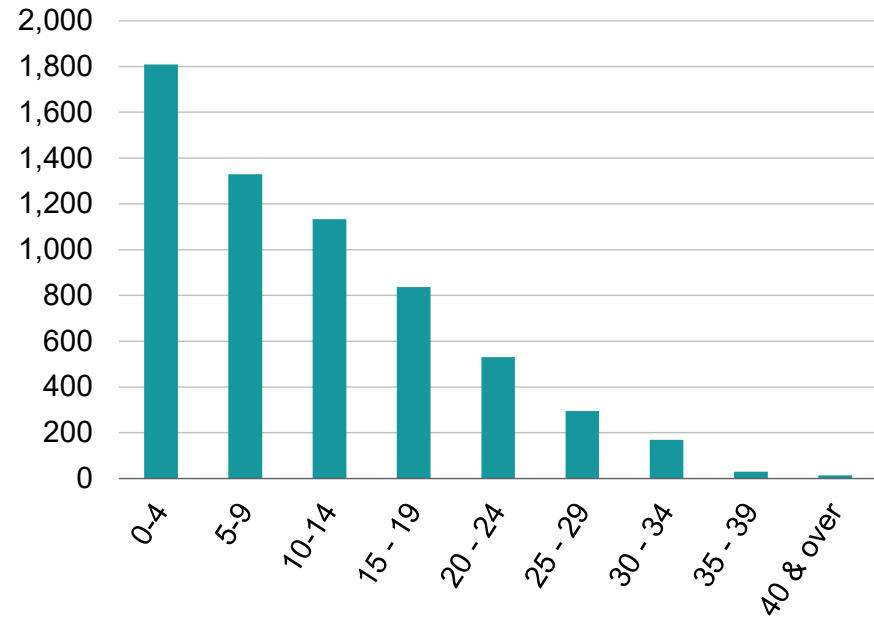
Among the active participants, there were none with unknown age.

Distribution of Active Participants as of December 31, 2019  
by Age



Average age	42.4
Prior year average age	<u>42.3</u>
Difference	0.1

by Years of Service



Average years of service	11.3
Prior year average years of service	<u>11.4</u>
Difference	-0.1

### Inactive participants

In this year's valuation, there were 371 participants with a vested right to a deferred or immediate vested benefit and 2,624 participants entitled to a return of their employee contributions.

## Section 3: Actuarial Valuation Results – Teachers

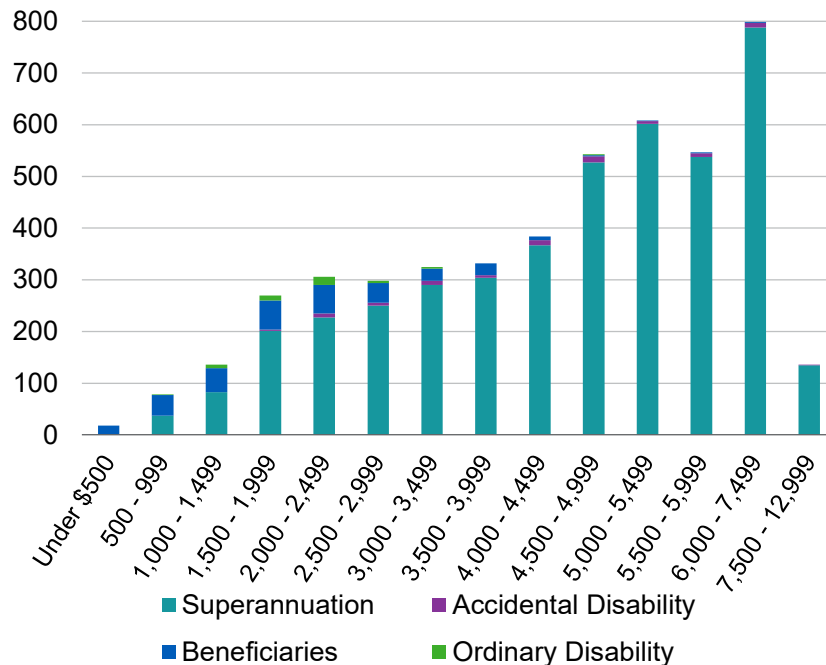
### Retired participants and beneficiaries

As of December 31, 2019, 4,467 retired participants and 313 beneficiaries were receiving total monthly benefits of \$21,453,082. For comparison, in the previous valuation, there were 4,420 retired participants and 307 beneficiaries were receiving total monthly benefits of \$20,399,691.

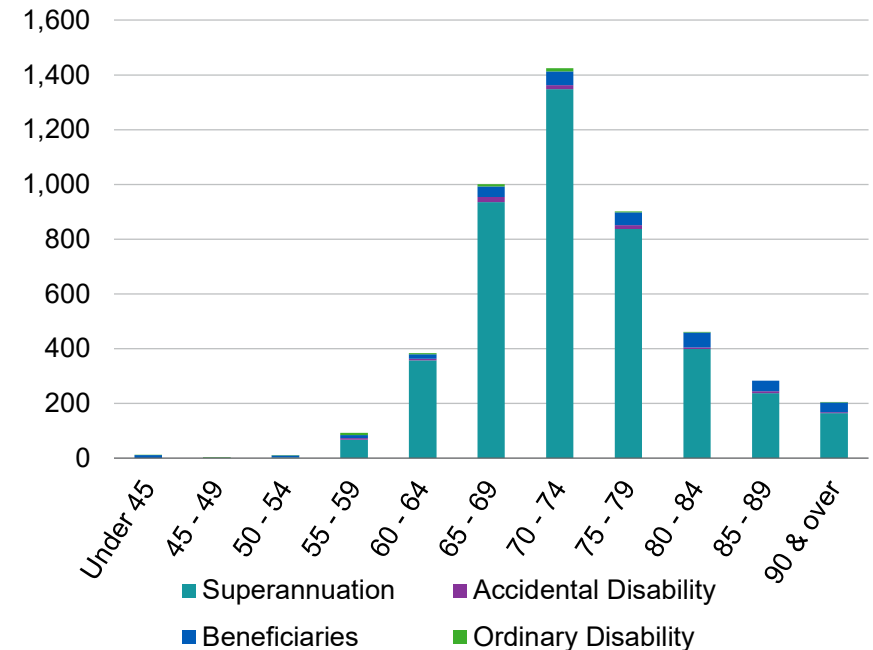
As of December 31, 2019, the average monthly benefit for retired participants and beneficiaries is \$4,488, compared to \$4,316 in the previous valuation. The average age for retired participants and beneficiaries is 73.4 in the current valuation, compared with 72.7 in the prior valuation.

#### Distribution of Pensioners and Beneficiaries as of December 31, 2019

by Type and Monthly Amount



by Type and Age



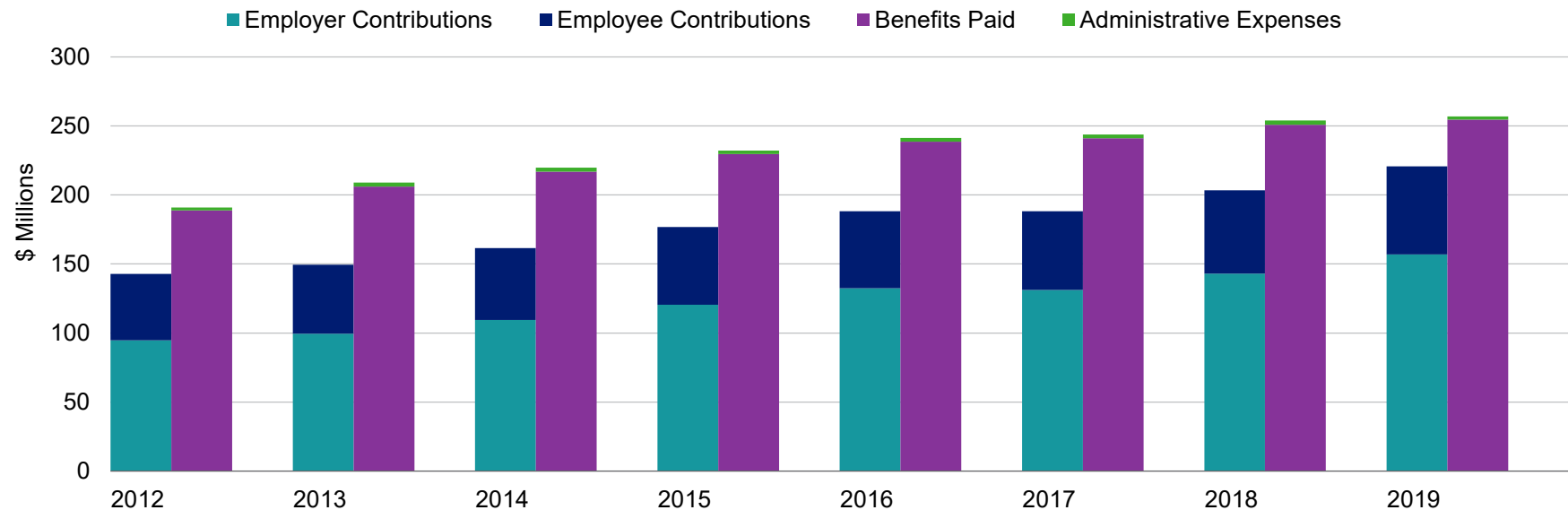
## Section 3: Actuarial Valuation Results – Teachers

### 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 – 2019



## 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.

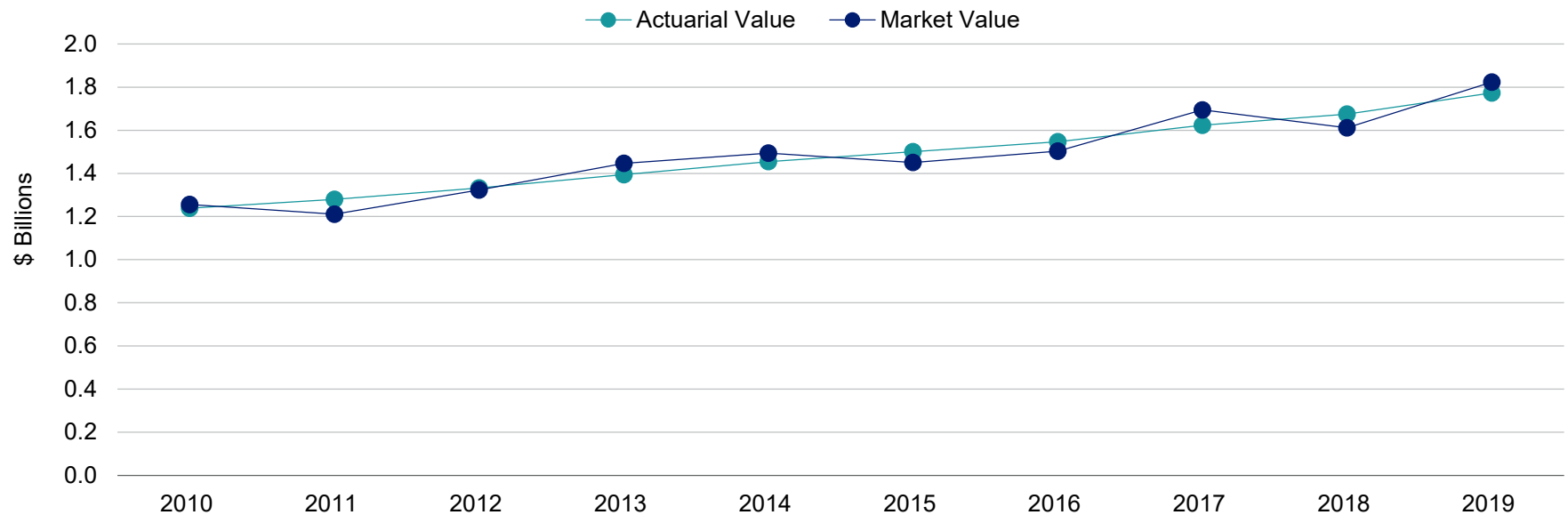
### Determination of Actuarial Value of Assets

		Year Ended	
		December 31, 2019	December 31, 2018
<b>1</b>	Actuarial value of assets at the beginning of the year	\$1,674,554,722	\$1,623,499,500
<b>2</b>	Contributions, less benefit payments and expense during the year	-36,097,188	-50,521,729
<b>3</b>	Average actuarial value: <b>(1) + [50% of (2)]</b>	1,656,506,128	1,598,238,635
<b>4</b>	Expected investment income: <b>7.35% x (3)</b>	121,753,200	117,470,540
<b>5</b>	Preliminary actuarial value of assets at the end of the year: <b>(1) + (2) + (4)</b>	1,760,210,735	1,690,448,310
<b>6</b>	Market value of assets at the end of the year	1,823,646,734	1,610,980,371
<b>7</b>	Adjustment toward market value: <b>20% of [(6) – (5)]</b>	12,687,200	-15,893,588
<b>8</b>	Adjustment to be within 20% corridor	0	0
<b>9</b>	Final actuarial value of assets at the end of the year: <b>(5) + (7) + (8)</b>	1,772,897,935	1,674,554,722
<b>10</b>	Actuarial value as a percentage of market value: <b>(9) ÷ (6)</b>	97.22%	103.95%

## 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.

Actuarial Value of Assets vs. Market Value of Assets as of December 31, 2010 – 2019



## 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.

The net experience gain over the two-year period is \$104,516,600, which includes \$3,206,388 from investment losses and \$107,722,988 in gains from all other sources. The net experience variation from individual sources other than investments was 2.5% of the actuarial accrued liability. A discussion of the major components of the actuarial experience is on the following pages.

#### Actuarial Experience for Two-Year Period Ended December 31, 2019

<b>1</b>	Net loss from investments	<b>-\$3,206,388</b>
<b>2</b>	Gain from administrative expenses	1,672,324
<b>3</b>	Net gain from other experience	<u>106,050,664</u>
<b>4</b>	Net experience gain: <b>1 + 2 + 3</b>	<b>\$104,516,600</b>

## 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 System’s investment policy. The rate of return on the market value of assets for the 2019 and 2018 plan years was 15.62% and -1.95%, respectively.

For valuation purposes, the assumed rate of return on the actuarial value of assets was 7.35% for the 2019 and 2018 plan years. The actual rate of return on an actuarial basis for the 2019 and 2018 plan years was 8.12% and 6.36%, respectively. Since the actual return for the year was less than the assumed return, the System experienced an actuarial loss during the two-year period ending December 31, 2019 with regard to its investments.

#### Investment Experience

	Year Ended December 31, 2019		Year Ended December 31, 2018	
	Market Value	Actuarial Value	Market Value	Actuarial Value
<b>1</b> Net investment income	\$248,763,551	\$134,440,400	-\$32,548,617	\$101,576,952
<b>2</b> Average value of assets	1,592,931,777	1,656,506,128	1,668,789,854	1,598,238,635
<b>3</b> Rate of return: <b>1 + 2</b>	15.62%	8.12%	-1.95%	6.36%
<b>4</b> Assumed rate of return	7.35%	7.35%	7.35%	7.35%
<b>5</b> Expected investment income: <b>2 x 4</b>	\$117,080,486	\$121,753,200	\$122,656,054	\$117,470,540
<b>6</b> Actuarial gain/(loss): <b>1 - 5</b>	\$131,683,065	\$12,687,200	-\$155,204,671	-\$15,893,588



## 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 10 years, including averages over select time periods.

Based on this experience and future expectations, we have lowered the assumed rate of return from 7.35% to 7.15%.

### Investment Return – Actuarial Value vs. Market Value: 2010 - 2019

Year Ended December 31	Actuarial Value Investment Return		Market Value Investment Return	
	Amount	Percent	Amount	Percent
2010	\$95,270,615	8.64%	\$154,709,657	14.59%
2011	83,285,518	6.84%	-2,647,747	-0.21%
2012	101,068,635	8.05%	159,649,908	13.45%
2013	120,630,899	9.26%	183,271,929	14.17%
2014	119,024,449	8.72%	105,879,526	7.47%
2015	101,510,620	7.11%	11,543,574	0.79%
2016	99,633,968	6.76%	106,465,538	7.48%
2017	131,613,393	8.66%	245,938,652	16.66%
2018	101,576,952	6.36%	-32,548,617	-1.95%
2019	134,440,400	8.12%	248,763,551	15.62%
Most recent five-year average return		7.41%		7.61%
Ten-year average return		7.82%		8.55%

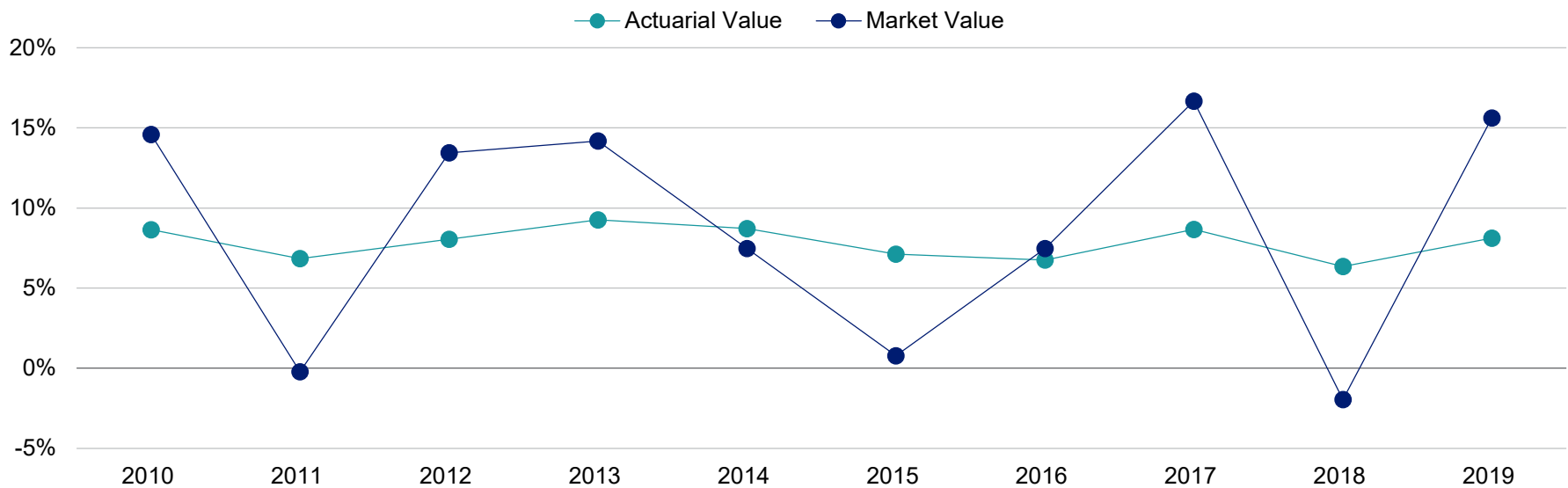
Note:

Each year's yield is weighted by the average asset value in that year.

## Section 3: Actuarial Valuation Results – Teachers

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 - 2019



## Section 3: Actuarial Valuation Results – Teachers

### Non-investment experience

#### Administrative expenses

Administrative expenses for the years ended December 31, 2018 and 2019 totaled \$3,103,964 and \$2,231,348, respectively, as compared to the assumption of \$3,300,000 for calendar year 2018 and \$3,407,250 for calendar year 2019. This resulted in a gain of \$1,672,324 for the two-year period, including an adjustment for interest. Based on information on expenses provided by the Retirement System, we have reset the assumption to \$11,000,000 for calendar year 2020, with 70%, or \$7,700,000 assigned to the BRS excluding Teachers, and 30%, or \$3,300,000, assigned to the Teachers.

#### Demographic 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, 2019 amounted to \$106,050,664.

#### Liability Changes Due to Demographic Experience for Two-Year Period Ended December 31, 2019

Loss due to mortality experience	-\$2,487,435
Loss due to salaries increasing more than expected	-2,525,751
Gain due to service corrections	9,711,906
Miscellaneous experience gain	<u>101,351,944</u>
Total	\$106,050,664

## 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 7.35% to 7.15%.
- The mortality for non-disabled participants was updated from the RP-2014 White Collar Employee and Healthy Annuitant Mortality Tables projected generationally using Scale MP-2016 to the Pub-2010 Teacher Employee, Healthy Retiree and Contingent Survivor Headcount-Weighted Mortality Tables projected generationally using Scale MP-2019.
- The mortality for disabled participants was updated from the RP-2014 Healthy Annuitant Mortality Tables set forward four years projected generationally using Scale BB2D to the Pub-2010 Teacher Healthy Retiree Headcount-Weighted Mortality Tables projected generationally using Scale MP-2019.

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

### Plan provisions

There were no changes in plan provisions since the prior valuation.

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, 2019	December 31, 2018
<b>1</b> Unfunded actuarial accrued liability at beginning of year	\$2,471,482,183	\$2,420,835,900
<b>2</b> Normal cost at beginning of year	80,352,636	77,823,376
<b>3</b> Total contributions	-220,798,725	-203,355,245
<b>4</b> Interest		
• For whole year on <b>1 + 2</b>	187,559,859	\$183,651,457
• For half year on <b>3</b>	<u>-8,114,353</u>	<u>-7,473,305</u>
Total interest	<u>179,445,506</u>	<u>176,178,152</u>
<b>5</b> Expected unfunded actuarial accrued liability	\$2,510,481,600	\$2,471,482,183
<b>6</b> Changes due to:		
• Investment loss	\$3,206,388	-
• Other experience gain	-107,722,988	-
• Assumptions	<u>98,415,800</u>	-
Total changes	<u>-6,100,800</u>	-
<b>7</b> Unfunded actuarial accrued liability at end of year	\$2,504,380,799	-

## 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 \$162,976,424 for fiscal 2021. The total Commonwealth appropriation is expected to increase by 9.63% through fiscal 2023 and the Commonwealth's liabilities are expected to be fully funded in 2036. The detail of the Actuarially Determined Contribution is shown below.

The budgeted appropriation for fiscal 2021 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. However, with 9.63% increases in the appropriation, 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

	2020		2018	
	Amount	% of Projected Payroll	Amount	% of Projected Payroll
1. Total normal cost	\$81,617,565	13.30%	\$74,523,376	12.61%
2. Administrative expenses	3,300,000	0.54%	3,300,000	0.56%
3. Expected employee contributions	<u>-66,288,930</u>	<u>-10.80%</u>	<u>-63,410,670</u>	<u>-10.73%</u>
4. Employer normal cost: (1) + (2) + (3)	\$18,628,635	3.03%	\$14,412,706	2.44%
5. Actuarial accrued liability	4,277,278,734		4,044,335,400	
6. Actuarial value of assets	<u>1,772,897,935</u>		<u>1,623,499,500</u>	
7. Unfunded actuarial accrued liability: (5) - (6)	\$2,504,380,799		\$2,420,835,900	
8. Employer normal cost projected to July 1, 2020 and 2018, adjusted for timing	19,593,957	3.14%	15,173,703	2.53%
9. Projected unfunded actuarial accrued liability	2,634,155,952		2,508,224,326	
10. Payment on projected unfunded actuarial accrued liability, adjusted for timing	<u>143,382,467</u>	<u>22.99%</u>	<u>127,971,860</u>	<u>21.31%</u>
11. Budgeted appropriation for fiscal 2021 and 2019: (8) + (10)	\$162,976,424	26.13%	\$143,145,563	23.83%
12. Projected payroll as of July 1	\$623,781,750		\$600,605,514	

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 ten years has ranged from a low of -1.95% to a high of 16.66%.

- 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 16 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 Retirement System'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 \$135.2 million.

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

## Section 3: Actuarial Valuation Results – Teachers

Since 2008, 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 Retirement System's asset allocation is aligned to meet emerging pension liabilities.

In 2019, benefits and expenses exceeded contributions by \$36.1 million. 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, 2019 – 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	384	382	2	--	--	--	--	--	--	--
	\$40,046	\$39,976	\$53,461	--	--	--	--	--	--	--
25 - 29	1,339	1,203	133	3	--	--	--	--	--	--
	\$54,447	\$52,746	\$69,547	\$66,957	--	--	--	--	--	--
30 - 34	1,720	1,000	581	134	5	--	--	--	--	--
	\$66,551	\$57,665	\$79,842	\$75,688	\$54,623	--	--	--	--	--
35 - 39	1,663	592	454	510	101	6	--	--	--	--
	\$76,272	\$53,114	\$85,178	\$94,178	\$82,001	\$68,750	--	--	--	--
40 - 44	1,527	398	271	397	341	112	8	--	--	--
	\$76,976	\$45,903	\$67,887	\$91,335	\$95,712	\$101,201	\$80,328	--	--	--
45 - 49	1,729	369	212	244	339	433	106	26	--	--
	\$79,085	\$44,531	\$53,689	\$76,327	\$86,282	\$107,950	\$109,168	\$105,276	--	--
50 - 54	1,977	329	219	218	291	352	263	289	16	--
	\$79,673	\$39,354	\$55,799	\$54,714	\$73,587	\$101,288	\$108,059	\$115,761	\$92,237	--
55 - 59	1,984	260	169	199	248	274	202	492	129	11
	\$82,031	\$40,061	\$53,255	\$51,866	\$62,326	\$86,947	\$99,097	\$118,001	\$109,424	\$140,134
60 - 64	1,491	138	134	182	218	222	141	264	137	55
	\$76,214	\$41,021	\$51,083	\$50,569	\$52,831	\$73,414	\$85,870	\$112,539	\$113,396	\$122,848
65 - 69	546	63	53	87	96	96	58	49	15	29
	\$57,268	\$30,995	\$43,470	\$48,943	\$58,169	\$58,142	\$62,369	\$79,237	\$81,541	\$98,789
70 & over	264	46	22	31	47	43	24	25	7	19
	\$46,239	\$25,352	\$33,461	\$36,527	\$45,871	\$52,563	\$55,304	\$62,829	\$68,463	\$72,583
Unknown	85	85	--	--	--	--	--	--	--	--
	\$26,866	\$26,866	--	--	--	--	--	--	--	--
Total	14,709	4,865	2,250	2,005	1,686	1,538	802	1,145	304	114
	\$72,304	\$48,707	\$69,023	\$74,863	\$75,071	\$92,397	\$96,888	\$113,024	\$107,991	\$110,018

**Notes:**

Payroll figures are for the prior calendar year and reflect annualized salaries for participants hired during the year. Calendar year payroll figures were reduced for Fire Fighters to reflect retroactive payments made during the year. For participants hired in December 2019, salaries were set equal to \$35,000 for Group 1 and \$50,000 for Group 4.

## Section 4: Supplemental Information

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

	Year Ended December 31, 2019	Year Ended December 31, 2018
Net assets at market value at the beginning of the year	\$4,791,973,610	\$5,072,440,419
<b>Contribution income:</b>		
• Employer contributions	\$329,251,443	\$295,189,207
• Employee contributions	112,301,889	108,215,506
• Less administrative expenses	<u>-6,588,813</u>	<u>-6,131,839</u>
Net contribution income	434,964,519	397,272,874
Net investment income	<u>758,903,170</u>	<u>-293,528,832</u>
<b>Total income available for benefits</b>	<b>\$1,193,867,689</b>	<b>\$103,744,042</b>
<b>Less benefit payments</b>	<b>-\$402,413,107</b>	<b>-\$384,210,852</b>
<b>Change in reserve for future benefits</b>	<b>\$791,454,582</b>	<b>-\$280,466,810</b>
<b>Net assets at market value at the end of the year</b>	<b>\$5,583,428,192</b>	<b>\$4,791,973,610</b>

## Section 4: Supplemental Information

### Exhibit C: Participants in Active Service as of December 31, 2019 – 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	98	98	--	--	--	--	--	--	--	--
	\$55,582	\$55,582	--	--	--	--	--	--	--	--
25 - 29	781	677	104	--	--	--	--	--	--	--
	\$71,503	\$69,623	\$83,742	--	--	--	--	--	--	--
30 - 34	1,004	486	454	64	--	--	--	--	--	--
	\$85,617	\$75,353	\$93,809	\$105,449	--	--	--	--	--	--
35 - 39	969	215	328	391	35	--	--	--	--	--
	\$96,815	\$78,184	\$97,231	\$105,335	\$112,176	--	--	--	--	--
40 - 44	926	113	179	306	292	35	1	--	--	--
	\$101,444	\$74,989	\$96,674	\$104,156	\$110,289	\$113,402	\$113,797	--	--	--
45 - 49	736	87	108	136	199	169	35	2	--	--
	\$102,803	\$74,120	\$94,288	\$103,073	\$109,902	\$111,894	\$114,753	\$108,063	--	--
50 - 54	651	59	67	97	129	148	114	35	2	--
	\$106,265	\$80,077	\$97,862	\$98,885	\$110,357	\$113,461	\$113,753	\$116,721	\$112,139	--
55 - 59	519	50	49	71	97	86	80	79	6	1
	\$105,493	\$74,706	\$92,084	\$102,790	\$110,215	\$111,021	\$112,864	\$115,691	\$113,709	\$115,523
60 - 64	328	21	28	44	62	59	52	44	16	2
	\$105,386	\$71,096	\$84,559	\$101,695	\$103,672	\$112,706	\$112,411	\$118,699	\$115,435	\$119,368
65 - 69	110	3	7	20	20	30	11	6	5	8
	\$106,188	\$73,400	\$98,034	\$98,656	\$109,664	\$111,196	\$112,783	\$102,227	\$108,739	\$109,282
70 & over	25	--	5	4	3	3	2	4	1	3
	\$101,595	--	\$82,262	\$72,026	\$109,981	\$113,314	\$120,467	\$117,632	\$115,936	\$114,391
<b>Total</b>	<b>6,147</b>	<b>1,809</b>	<b>1,329</b>	<b>1,133</b>	<b>837</b>	<b>530</b>	<b>295</b>	<b>170</b>	<b>30</b>	<b>14</b>
	<b>\$94,905</b>	<b>\$72,475</b>	<b>\$94,215</b>	<b>\$103,663</b>	<b>\$109,772</b>	<b>\$112,349</b>	<b>\$113,403</b>	<b>\$116,163</b>	<b>\$113,771</b>	<b>\$112,263</b>

**Notes:**

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

Calendar year payroll figures were reduced to reflect retroactive payments made during the year.

For participants hired in December 2019, salaries were set equal to \$50,000.

## Section 4: Supplemental Information

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

	Year Ended December 31, 2019	Year Ended December 31, 2018
Net assets at market value at the beginning of the year	\$1,610,980,371	\$1,694,050,718
<b>Contribution income:</b>		
• Employer contributions	\$157,040,605	\$143,145,563
• Employee contributions	63,758,120	60,209,682
• Less administrative expenses	<u>-2,231,348</u>	<u>-3,103,964</u>
Net contribution income	218,567,377	200,251,281
Net investment income	<u>248,763,551</u>	<u>-32,548,617</u>
<b>Total income available for benefits</b>	<b>\$467,330,928</b>	<b>\$167,702,664</b>
<b>Less benefit payments</b>	<b>-\$254,664,565</b>	<b>-\$250,773,010</b>
<b>Change in reserve for future benefits</b>	<b>\$212,666,363</b>	<b>-\$83,070,346</b>
<b>Net assets at market value at the end of the year</b>	<b>\$1,823,646,734</b>	<b>\$1,610,980,371</b>

## Section 4: Supplemental Information

### Exhibit E: Participant Population – All Employees: 2001 – 2019

Year Ended December 31	Active Participants	Inactive Participants	Retired Participants and Beneficiaries	Total Non-Actives	Ratio of Non-Actives to Actives
2001	22,003	3,560	13,144	16,704	0.76
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

## Section 4: Supplemental Information

### Exhibit F: Table of Plan Coverage – All Employees

Category	Year Ended December 31		Change From Prior Year
	2019	2017	
<b>Active participants in valuation:</b>			
• Number	20,856	20,995	-0.7%
• Average age	45.2	45.1	0.1
• Average years of service	12.4	13.0	-0.6
• Total payroll <sup>1</sup>	\$1,646,906,229	\$1,540,244,906	6.9%
• Average payroll	78,966	73,362	7.6%
• Account balances	1,637,085,263	1,554,003,803	5.3%
• Number with unknown age	85	2	N/A
<b>Inactive participants in valuation:</b>			
Inactive participants with a vested right to a deferred or immediate benefit	1,147	1,109	3.4%
Inactive participants due a refund of employee contributions	11,531	9,514	21.2%
<b>Retired participants:</b>			
• Number in pay status	10,729	10,442	2.7%
• Average age	73.7	73.5	0.2
• Average monthly benefit	\$3,819	\$3,605	5.9%
<b>Disabled participants:</b>			
• Number in pay status	1,730	1,795	-3.6%
• Average age	69.4	68.9	0.5
• Average monthly benefit	\$4,366	\$4,121	5.9%
<b>Beneficiaries:</b>			
• Number in pay status	2,100	2,211	-5.0%
• Average age	76.6	76.9	-0.3
• Average monthly benefit	\$2,048	\$1,836	11.5%

<sup>1</sup> Payroll figures are for the prior year and reflect annualized salaries for participants hired during the year. For Boston Retirement System excluding Teachers, calendar year 2019 payroll figures were reduced for Fire Fighters to reflect retroactive payments made during the year. For Teachers, calendar year 2019 payroll figures were reduced to reflect retroactive payments made during the year, and calendar year 2017 payroll figures were increased to reflect bargaining contracts that were settled in 2018. For participants hired in December 2017 or December 2019, salaries were set equal to \$35,000 for Group 1 and \$50,000 for Group 4 and Teachers.

## Section 4: Supplemental Information

### Exhibit G: Investment Return – Actuarial Value vs. Market Value – All Assets: 2006-2019

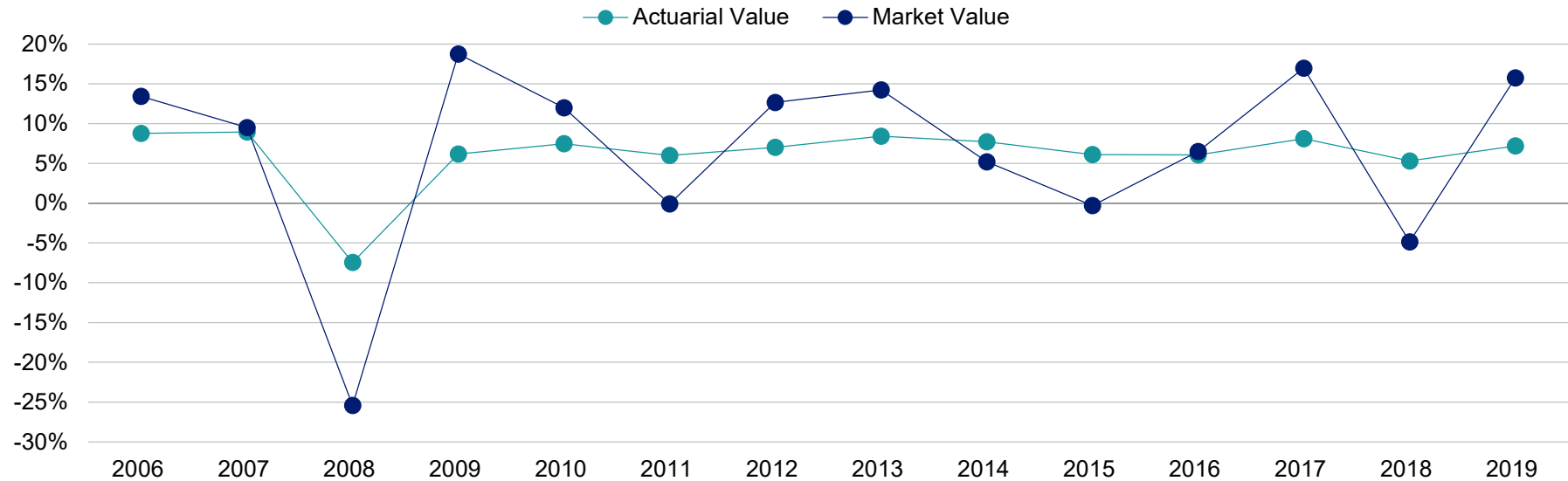
Year Ended December 31	Actuarial Value Investment Return		Market Value Investment Return	
	Amount	Percent	Amount	Percent
2006	\$335,622,622	8.79%	\$506,115,642	13.43%
2007	368,013,791	8.95%	403,369,820	9.53%
2008	-330,344,896	-7.44%	-1,167,563,433	-25.41%
2009	251,082,864	6.17%	635,296,107	18.76%
2010	323,178,217	7.48%	486,428,288	11.99%
2011	279,060,679	6.00%	-3,490,893	-0.08%
2012	337,283,979	7.03%	558,297,133	12.65%
2013	422,190,300	8.41%	692,082,990	14.26%
2014	411,548,325	7.72%	283,342,371	5.21%
2015	345,566,005	6.12%	-15,624,093	-0.28%
2016	358,940,806	6.08%	360,333,280	6.52%
2017	502,437,169	8.11%	987,384,683	16.98%
2018	352,327,261	5.30%	-326,077,448	-4.83%
2019	503,234,703	7.21%	1,007,666,721	15.74%
Most recent five-year average return		6.57%		6.69%
Most recent ten-year average return		6.91%		7.54%
14-year average return		6.20%		6.35%

**Note:**

Each year's yield is weighted by the average asset value in that year.

## Section 4: Supplemental Information

### Exhibit H: Market and Actuarial Rates of Return for Years Ended December 31, 2006 – 2019 – All Assets





## Section 4: Supplemental Information

### Exhibit I: Definition of Pension Terms

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

<b>Actuarial Accrued Liability for Actives:</b>	The equivalent of the accumulated normal costs allocated to the years before the valuation date.
<b>Actuarial Accrued Liability for Pensioners and Beneficiaries:</b>	The single-sum value of lifetime benefits to existing pensioners 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.
<b>Actuarial Cost Method:</b>	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.
<b>Actuarial Gain or Loss:</b>	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. Through the actuarial assumptions, rates of decrements, rates of salary increases, and rates of fund earnings have been forecasted. 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 in actuarial liabilities that are larger than projected. Actuarial gains will shorten the time required for funding of the actuarial balance sheet deficiency while actuarial losses will lengthen the funding period.
<b>Actuarially Equivalent:</b>	Of equal actuarial present value, determined as of a given date and based on a given set of Actuarial Assumptions.
<b>Actuarial Present Value (APV):</b>	<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>

## Section 4: Supplemental Information

<b>Actuarial Present Value of Future Plan Benefits:</b>	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 Plan Benefits includes the liabilities for active members, retired members, beneficiaries receiving benefits, and inactive members entitled to either a refund 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.
<b>Actuarial Valuation:</b>	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. An Actuarial Valuation for a governmental retirement system typically also includes calculations of items needed for compliance with GASB, such as the Actuarially Determined Contribution (ADC) and the Net Pension Liability (NPL).
<b>Actuarial Value of Assets (AVA):</b>	The value of the Fund'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 ADC.
<b>Actuarially Determined:</b>	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 law.
<b>Actuarially Determined Contribution (ADC):</b>	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.
<b>Amortization Method:</b>	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 UAAL. 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 UAAL. 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.
<b>Amortization Payment:</b>	The portion of the pension plan contribution, or ADC, that is designed to pay interest on and to amortize the Unfunded Actuarial Accrued Liability.

## Section 4: Supplemental Information

<b>Assumptions or Actuarial Assumptions:</b>	<p>The estimates upon which the cost of the Fund is calculated, including:</p> <p><u>Investment return</u> - the rate of investment yield that the Fund will earn over the long-term future;</p> <p><u>Mortality rates</u> - the death rates of employees and pensioners; life expectancy is based on these rates;</p> <p><u>Retirement rates</u> - the rate or probability of retirement at a given age or service;</p> <p><u>Disability rates</u> - the probability of disability retirement at a given age;</p> <p><u>Withdrawal rates</u> - the rates at which employees of various ages are expected to leave employment for reasons other than death, disability, or retirement;</p> <p><u>Salary increase rates</u> - the rates of salary increase due to inflation and productivity growth.</p>
<b>Closed Amortization Period:</b>	<p>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 30 years, it is 29 years at the end of one year, 28 years at the end of two years, etc. See Open Amortization Period.</p>
<b>Decrements:</b>	<p>Those causes/events due to which a member's status (active-inactive-retiree-beneficiary) changes, that is: death, retirement, disability, or withdrawal.</p>
<b>Defined Benefit Plan:</b>	<p>A retirement plan in which benefits are defined by a formula applied to the member's compensation and/or years of service.</p>
<b>Defined Contribution Plan:</b>	<p>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.</p>
<b>Employer Normal Cost:</b>	<p>The portion of the Normal Cost to be paid by the employer. This is equal to the Normal Cost less expected member contributions.</p>
<b>Experience Study:</b>	<p>A periodic review and analysis of the actual experience of the Fund 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 as deemed appropriate by the Actuary.</p>
<b>Funded Ratio:</b>	<p>The ratio of the actuarial value of assets (AVA) to the actuarial accrued liability (AAL). Plans sometimes calculate a market funded ratio, using the market value of assets (MVA), rather than the AVA.</p>

## Section 4: Supplemental Information

<b>GASB 67 and GASB 68:</b>	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.
<b>Investment Return:</b>	The rate of earnings of the Fund 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.
<b>Net Pension Liability (NPL):</b>	The Net Pension Liability is equal to the Total Pension Liability minus the Plan Fiduciary Net Position.
<b>Normal Cost:</b>	That portion of the Actuarial Present Value of pension plan benefits and expenses allocated to a valuation year by the Actuarial Cost Method. Any payment in respect of an Unfunded Actuarial Accrued Liability is not part of Normal Cost (see Amortization Payment). For pension plan benefits that are provided in part by employee contributions, Normal Cost refers to the total of employee contributions and employer Normal Cost unless otherwise specifically stated.
<b>Open Amortization Period:</b>	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 determining the Amortization Period each year. In theory, if an Open Amortization Period with level percentage of payroll is used to amortize the Unfunded Actuarial Accrued Liability, the UAAL will never decrease, but will become smaller each year, in relation to covered payroll, if the actuarial assumptions are realized.
<b>Plan Fiduciary Net Position:</b>	Market value of assets.
<b>Total Pension Liability (TPL):</b>	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.
<b>Unfunded Actuarial Accrued Liability:</b>	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.
<b>Valuation Date or Actuarial Valuation Date:</b>	The date as of which the value of assets is determined and as of which the Actuarial Present Value of Future Plan 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 and Actuarial Cost Method

<b>Rationale for Demographic and Noneconomic Assumptions for Teachers:</b>	The assumptions for the Teachers are based on guidance from the actuary of the Massachusetts Teachers' Retirement System. These assumptions were used because there is a larger experience base to rely on and because the liabilities of the Boston Teachers are funded by the Commonwealth of Massachusetts. We have reviewed these demographic assumptions and have no reason to doubt their reasonableness.
<b>Net Investment Return:</b>	7.05% for BRS excluding Teachers and 7.15% for Teachers (previously, 7.50% for BRS excluding Teachers and 7.35% for Teachers)  The net investment return assumption for BRS excluding Teachers 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.

## Section 5: Actuarial Valuation Basis

### 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%.

The salary scale assumption for BRS excluding Teachers is a long-term estimate derived from historical data, current and recent market expectations, and professional judgment.

### Interest on Employee Contributions:

3.5%

## Section 5: Actuarial Valuation Basis

<b>Administrative Expenses:</b>	<p>\$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. (Previously, \$11,000,000 for calendar year 2018, 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>
<b>Mortality Rates:</b>	<p><u>BRS excluding Teachers</u></p> <p><b>Groups 1 and 2</b></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-2019 (previously, RP-2014 Blue Collar Employee and Healthy Annuitant Mortality Tables set forward one year for female participants projected generationally using Scale MP-2017)</p> <p><i>Disabled:</i> Pub-2010 General Healthy Retiree Amount-Weighted Mortality Tables set forward one year projected generationally using Scale MP-2019 (previously, RP-2014 Blue Collar Healthy Annuitant Mortality Table set forward one year projected generationally using Scale MP-2017)</p> <p><b>Group 4</b></p> <p><i>Healthy:</i> Pub-2010 Safety Employee, Healthy Retiree and Contingent Survivor Amount-Weighted Mortality Tables projected generationally using Scale MP-2019 (previously, RP-2014 Blue Collar Employee and Healthy Annuitant Mortality Tables set forward one year for female participants projected generationally using Scale MP-2017)</p> <p><i>Disabled:</i> Pub-2010 Disabled Retiree Amount-Weighted Mortality Tables projected generationally using Scale MP-2019 (previously, RP-2014 Blue Collar Healthy Annuitant Mortality Table set forward one year projected generationally using Scale MP-2017)</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-2019 to reflect future mortality improvement.</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-2019 (previously, RP-2014 White Collar Employee and Healthy Annuitant Mortality Tables projected generationally with Scale MP-2016)</p> <p><i>Disabled:</i> Pub-2010 Teacher Healthy Retiree Headcount-Weighted Mortality Tables projected generationally using Scale MP-2019 (previously, RP-2014 Healthy Annuitant Mortality Table set forward four years projected generationally with Scale BB2D from 2014)</p>

## Section 5: Actuarial Valuation Basis

### Termination Rates before Retirement:

Age	Groups 1 and 2 Rate (%) – BRS excluding Teachers						Disability	Withdrawal
	Mortality							
	Current		Previous					
	Male	Female	Male	Female				
20	0.04	0.01	0.05	0.02	0.03	6.58		
25	0.03	0.01	0.06	0.02	0.04	5.27		
30	0.04	0.02	0.06	0.03	0.06	4.83		
35	0.05	0.03	0.07	0.03	0.07	4.47		
40	0.07	0.04	0.08	0.05	0.11	3.84		
45	0.11	0.06	0.13	0.08	0.18	3.21		
50	0.16	0.09	0.22	0.14	0.30	1.52		
55	0.24	0.13	0.36	0.20	0.50	0.33		
60	0.34	0.20	0.61	0.30	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	Current		Previous		Disability	Withdrawal	
	Male	Female	Male	Female			
20	0.04	0.02	0.05	0.02	0.15	0.00	
25	0.04	0.02	0.06	0.02	0.21	0.00	
30	0.04	0.03	0.06	0.03	0.28	0.00	
35	0.05	0.04	0.07	0.03	0.37	0.00	
40	0.06	0.05	0.08	0.05	0.55	0.00	
45	0.08	0.07	0.13	0.08	0.90	0.00	
50	0.12	0.09	0.22	0.14	1.51	0.00	
55	0.18	0.12	0.36	0.20	2.52	0.00	
60	0.26	0.17	0.61	0.30	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.

The termination rates and disability rates for the BRS excluding Teachers 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

Rate (%) – Teachers						
Mortality						
Age	Current		Previous		Disability	
	Male	Female	Male	Female		
20	0.04	0.01	0.03	0.01	0.04	
25	0.02	0.01	0.03	0.01	0.05	
30	0.03	0.02	0.03	0.02	0.06	
35	0.04	0.02	0.04	0.02	0.06	
40	0.05	0.03	0.04	0.03	0.10	
45	0.08	0.05	0.07	0.06	0.30	
50	0.13	0.08	0.12	0.09	0.50	
55	0.19	0.12	0.20	0.14	0.70	
60	0.29	0.18	0.33	0.21	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:

		Rate (%) – Teachers									
		Years of Service									
		0 – 1		2		3		4		5	
Age		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

		Rate (%) – Teachers									
		Years of Service									
		6		7		8		9		10+	
Age		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

## 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

The retirement rates for the BRS excluding Teachers 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

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

## Section 5: Actuarial Valuation Basis

<b>Retirement Rates for Inactive Vested Participants:</b>	<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>
<b>Inactive Vested Participants:</b>	<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>
<b>Loading:</b>	<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>
<b>Unknown Data for Participants:</b>	<p>Same as those exhibited by participants with similar known characteristics.</p>
<b>Family Composition:</b>	<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>
<b>Benefit Election:</b>	<p>All participants are assumed to elect Option A. The benefit election reflects the fact that all benefit options are actuarially equivalent.</p>
<b>2019 Salary:</b>	<p>2019 salary equal to salaries provided in the data, except salaries for new hires were annualized.</p> <p>Calendar year 2019 payroll figures were reduced for Fire Fighters to reflect retroactive payments made during the year and were reduced for Teachers to reflect retroactive payments made during the year. For participants hired in December 2019, salaries were set equal to \$35,000 for Group 1 and \$50,000 for Group 4 and Teachers.</p>
<b>Total Service:</b>	<p>Total creditable service reported in the data.</p>
<b>Net 3(8)(c) Liability:</b>	<p>No liability is valued for benefits paid to or received from other municipal retirement systems.</p>
<b>Actuarial Value of Assets:</b>	<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>
<b>Actuarial Cost Method:</b>	<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

### **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, 2020:

- The investment return assumption was lowered from 7.50% to 7.05%.
- The mortality for non-disabled participants was updated from the RP-2014 Blue Collar Employee and Healthy Annuitant Mortality Tables set forward 1 year for female participants projected generationally using Scale MP-2017 to the Pub-2010 General Employee, Healthy Retiree and Contingent Survivor Amount-Weighted Mortality Tables set forward one year projected generationally using Scale MP-2019 for Groups 1 and 2 and to the Pub-2010 Safety Employee, Healthy Retiree and Contingent Survivor Amount-Weighted Mortality Tables projected generationally using Scale MP-2019 for Group 4.
- The mortality for disabled participants was updated from the RP-2014 Blue Collar Healthy Annuitant Mortality Table set forward 1 year projected generationally using Scale MP-2017 to the Pub-2010 General Healthy Retiree Amount-Weighted Mortality Tables set forward one year projected generationally using Scale MP-2019 for Groups 1 and 2 and to the Pub-2010 Disabled Retiree Amount-Weighted Mortality Tables projected generationally using Scale MP-2019.
- The administrative expense assumption was reset from \$11,000,000 for calendar year 2018, 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, to \$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.

The following changes in actuarial assumptions were made based on guidance from the actuary of the Massachusetts Teachers' Retirement System as of January 1, 2020:

- The investment rate of return assumption was lowered from 7.35% to 7.15%.
- The mortality for non-disabled participants was updated from the RP-2014 White Collar Employee and Healthy Annuitant Mortality Tables projected generationally using Scale MP-2016 to the Pub-2010 Teacher Employee, Healthy Retiree and Contingent Survivor Headcount-Weighted Mortality Tables projected generationally using Scale MP-2019.
- The mortality for disabled participants was updated from the RP-2014 Healthy Annuitant Mortality Tables set forward four years projected generationally using Scale BB2D to the Pub-2010 Teacher Healthy Retiree Headcount-Weighted Mortality Tables projected generationally using Scale MP-2019.



## 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

<b>Ordinary Disability Benefit:</b>	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.
<b>Accidental Disability Benefit:</b>	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.
<b>Death Benefits:</b>	<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>
<b>"Heart And Lung Law" And Cancer Presumption:</b>	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.
<b>Options:</b>	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

<b>Post-Retirement Benefits:</b>	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 \$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.
<b>Changes in Plan Provisions:</b>	None.