



City of Cambridge Contributory Retirement System

**Actuarial Valuation and Review as of
January 1, 2018**

This report has been prepared at the request of the City of Cambridge Retirement Board to assist in administering the City of Cambridge 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. The measurements shown in this actuarial valuation may not be applicable for other purposes.

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July 31, 2018

Retirement Board
City of Cambridge Contributory Retirement System
100 Cambridge Park Drive, Suite 101
Cambridge, MA 02140

Dear Board Members:

We are pleased to submit this Actuarial Valuation and Review as of January 1, 2018. It summarizes the actuarial data used in the valuation, analyzes the preceding two years' experience, and establishes the funding requirements for fiscal 2019 and later years.

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 City of Cambridge Retirement System. That assistance is gratefully acknowledged.

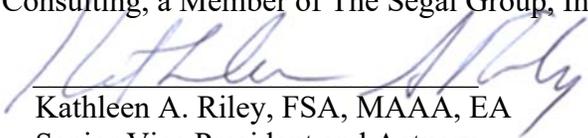
The actuarial calculations were directed under my supervision. I am a member of the American Academy of Actuaries and I meet the Qualification Standards of the American Academy of Actuaries to render the actuarial opinion herein. To the best of my knowledge, the information supplied in this actuarial valuation is complete and accurate. Further, in my opinion, the assumptions as approved by the Board are reasonably related to the experience of and the expectations for the City of Cambridge Retirement System.

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

Sincerely,

Segal Consulting, a Member of The Segal Group, Inc.

By:


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

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Section 1: Actuarial Valuation Summary

Purpose and Basis

This report was prepared by Segal Consulting to present a valuation of the City of Cambridge Retirement System as of January 1, 2018. 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.

Certain disclosure information required by GASB Statements No 67 and 68 as of December 31, 2017 for the City of Cambridge Retirement System is provided in a separate report.

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, 2017, provided by the staff of the Retirement System;
- The assets of the System as of December 31, 2017, 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.

Significant Issues

1. Segal Consulting (“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 City of Cambridge Contributory Retirement System meets this standard and funds the unfunded actuarial accrued liability of the plan by June 30, 2026.
2. The funded ratio (the ratio of the market value of assets to actuarial accrued liability) is 87.69%, compared to the prior valuation’s funded ratio of 81.09%. This ratio is one measure of funding status, and its history is a measure of funding progress. These measurements are not necessarily appropriate for assessing the sufficiency of assets to cover the estimated cost of settling the benefit obligation or the need for or the amount of future contributions.
3. During the plan years ending December 31, 2016 and December 31, 2017, the market value rates of return were 8.38% and 16.49%, respectively. With the prior valuation, the actuarial value of assets was set equal to the market value of assets. The market value of assets as of December 31, 2017 was \$1.34 billion. As of December 31, 2016, the market value of assets was \$1.08 billion.
4. The following actuarial assumptions were changed with this valuation:
 - The investment return assumption was decreased from 7.75% to 7.50%.
 - The mortality assumption for non-disabled participants was updated from the RP-2000 Employee and Healthy Annuitant Mortality Tables projected generationally from 2009 using Scale BB2D to the RP-2014 Blue Collar Employee and Healthy Annuitant Mortality Tables set forward 1 year for female participants projected generationally using Scale MP-2017.
 - The mortality assumption for disabled participants was updated from the RP-2000 Healthy Annuitant Mortality Table projected generationally from 2015 using Scale BB2D to the RP-2014 Blue Collar Healthy Annuitant Mortality Table set forward 1 year projected generationally using Scale MP-2017.
 - The administrative expense assumption was increased from \$1,150,000 for calendar year 2016 to \$1,300,000 for calendar year 2018.

Changing these assumptions increased the unfunded liability by approximately \$44.5 million and increased the employer normal cost by approximately \$2,068,000.

5. As permitted by Section 19 of Chapter 188 of the Acts of 2010, the Cost of Living Adjustment base was increased from \$14,000 to \$16,000 as of July 1, 2018.

6. The unfunded liability was expected to decrease by \$20.3 million from \$252.9 as of January 1, 2016 to \$232.6 million as of January 1, 2018. The actual unfunded liability of \$187.6 million is \$45.0 million less than expected, primarily due to the investment gain on a market value basis, offset by the assumption changes and plan change noted above. Sources of gains and losses are discussed in *Section 2*.
7. The funding schedule included in this report fully funds the System by June 30, 2026 with appropriations that increase 5.85% per year for two years and remain level thereafter. With the prior valuation, the Board approved a funding schedule that fully funded the System by June 30, 2026 with appropriations that increase 5.85% per year.
8. This actuarial report as of January 1, 2018 is based on financial and demographic data as of that date. Changes subsequent to that date are not reflected and will affect future actuarial costs of the plan.
9. 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 included a discussion of various risks that may affect the plan in *Section 2*.

Summary of Key Valuation Results

		2018	2016
Contributions for fiscal year beginning July 1:	• Actuarially Determined Contributions for fiscal year 2019 and 2017	\$43,173,090	\$40,047,891
	• Actuarially Determined Contributions for fiscal year 2020 and 2018	45,681,166	40,831,840
	• Actuarially Determined Contributions for fiscal year 2021 and 2019	48,335,964	43,173,090
Actuarial accrued liability for plan year beginning January 1:	• Retired participants and beneficiaries	\$775,483,148	\$648,130,146
	• Inactive vested participants	22,573,957	19,200,359
	• Inactive participants due a refund of employee contributions	8,608,905	9,219,935
	• Active participants	<u>716,468,259</u>	<u>660,855,043</u>
	• Total	\$1,523,134,269	\$1,337,405,483
	• Normal cost including administrative expenses for plan year beginning January 1	35,855,130	31,928,306
Assets for plan year beginning January 1:	• Market value of assets (MVA)	\$1,335,576,051	\$1,084,498,793
	• Actuarial value of assets (AVA)	1,335,576,051	1,084,498,793
	• Actuarial value of assets as a percentage of market value of assets	100.00%	100.00%
Funded status for plan year beginning January 1:	• Unfunded actuarial accrued liability on market value of assets	\$187,558,218	\$252,906,690
	• Funded percentage on MVA basis	87.69%	81.09%
Key assumptions:	• Net investment return	7.50%	7.75%
	• Long-term inflation rate	3.50%	3.50%
Demographic data for plan year beginning January 1:	• Number of retired participants and beneficiaries	2,149	2,019
	• Number of inactive vested participants	139	126
	• Number of inactive participants entitled to a refund of employee contributions	621	728
	• Number of active participants	2,991	3,019
	• Total payroll	\$222,022,885	\$211,726,778
	• Average payroll	74,230	70,131

Notes: Actuarially Determined Contributions include an additional payment of \$300,000.
 Actuarially Determined Contributions for fiscal years 2018 and 2019 include an adjustment for a change in the timing of employer payments.
 Payroll figures are for the prior calendar year.

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 Consulting (“Segal”) relies on a number of input items. These include:

Plan of benefits	Plan provisions define the rules that will be used to determine benefit payments, and those rules, or the interpretation of them, may change over time. Even where they appear precise, outside factors may change how they operate. It is important to keep Segal informed with respect to plan provisions and administrative procedures, and to review the plan summary included in our report to confirm that Segal has correctly interpreted the plan of benefits.
Participant data	An actuarial valuation for a plan is based on data provided to the actuary by the City of Cambridge Contributory Retirement System. Segal does not audit such data for completeness or accuracy, other than reviewing it for obvious inconsistencies compared to prior data and other information that appears unreasonable. It is important for Segal to receive the best possible data and to be informed about any known incomplete or inaccurate data.
Assets	The valuation is based on the market value of assets as of the valuation date, as provided by the City of Cambridge Contributory Retirement System. The City of Cambridge Contributory Retirement System uses an “actuarial value of assets” that differs from market value to gradually reflect year-to-year changes in the market value of assets in determining the contribution requirements.
Actuarial assumptions	In preparing an actuarial valuation, Segal projects the benefits to be paid to existing plan participants for the rest of their lives and the lives of their beneficiaries. This projection requires actuarial assumptions as to the probability of death, disability, withdrawal, and retirement of each participant for each year. In addition, the benefits projected to be paid for each of those events in each future year reflect actuarial assumptions as to salary increases and cost-of-living adjustments. The projected benefits are then discounted to a present value, based on the assumed rate of return that is expected to be achieved on the plan’s assets. There is a reasonable range for each assumption used in the projection and the results may vary materially based on which assumptions are selected. It is important for any user of an actuarial valuation to understand this concept. Actuarial assumptions are periodically reviewed to ensure that future valuations reflect emerging plan experience. While future changes in actuarial assumptions may have a significant impact on the reported results, that does not mean that the previous assumptions were unreasonable.

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

- The actuarial valuation is prepared at the request of the City of Cambridge Contributory Retirement System. Segal is not responsible for the use or misuse of its report, particularly by any other party.
- An actuarial valuation is a measurement of the plan's assets and liabilities at a specific date. Accordingly, except where otherwise noted, Segal did not perform an analysis of the potential range of future financial measures. The actual long-term cost of the plan will be determined by the actual benefits and expenses paid and the actual investment experience of the plan.
- Actuarial results in this report are not rounded, but that does not imply precision.
- If the City of Cambridge Contributory Retirement System is aware of any event or trend that was not considered in this valuation that may materially change the results of the valuation, Segal should be advised, so that we can evaluate it.
- Segal does not provide investment, legal, accounting, or tax advice. Segal's valuation is based on our understanding of applicable guidance in these areas and of the plan's provisions, but they may be subject to alternative interpretations. The City of Cambridge Contributory Retirement System should look to their other advisors for expertise in these areas.

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

Section 2: Actuarial Valuation Results

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.

More detailed information for this valuation year and the preceding valuation can be found in *Section 3, Exhibits A and B*.

PARTICIPANT POPULATION: 1999 – 2017

Year Ended December 31	Active Participants	Inactive Participants*	Retired Participants and Beneficiaries	Total Non-Actives	Ratio of Non-Actives to Actives
1999	3,655	392	1,629	2,021	0.55
2001	3,870	675	1,662	2,337	0.60
2003	3,825	822	1,746	2,568	0.67
2005	3,739	1,070	1,739	2,809	0.75
2007	4,119	918	1,756	2,674	0.65
2009	3,614	1,174	1,809	2,983	0.83
2011	3,332	1,154	1,893	3,047	0.91
2013	3,145	942	1,966	2,908	0.92
2015	3,019	854	2,019	2,873	0.95
2017	2,991	760	2,149	2,909	0.97

* Excludes terminated participants due a refund of employee contributions prior to 2001.

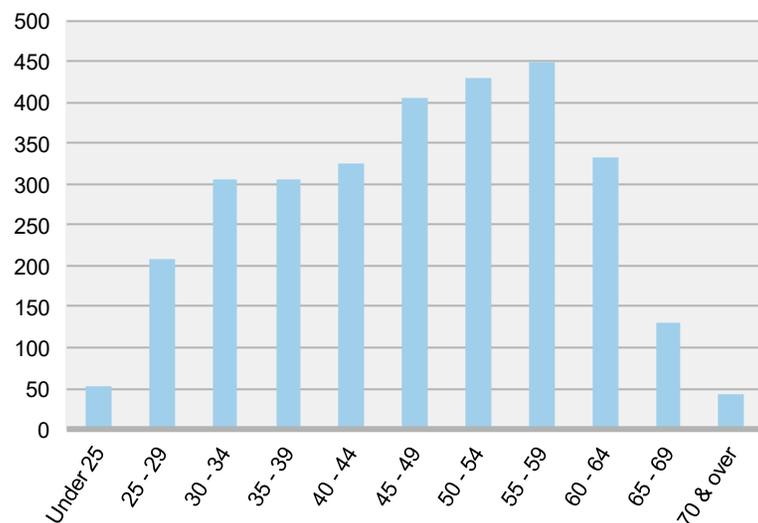
Active Participants

Plan costs are affected by the age, years of service and payroll of active participants. In this year’s valuation, there were 2,991 active participants with an average age of 47.7, average service of 14.4 years and average payroll of \$74,230. The 3,019 active participants in the prior valuation had an average age of 48.0, average service of 14.6 years and average payroll of \$70,131.

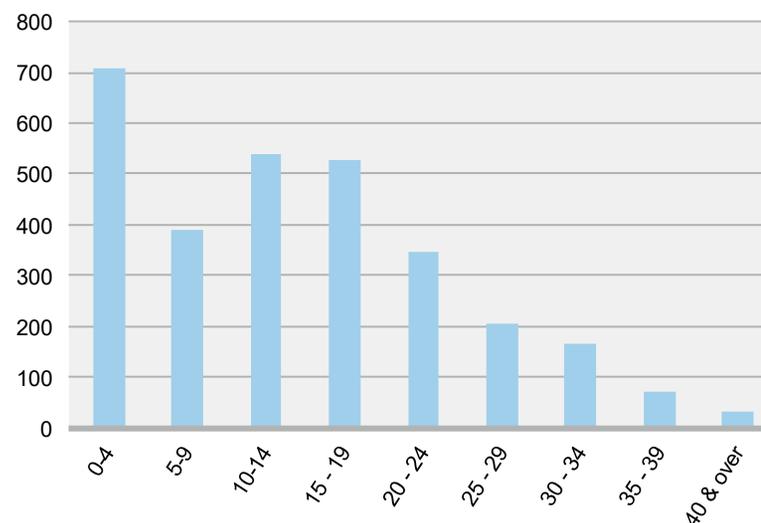
Among the active participants, there were none with unknown age and service information.

Distribution of Active Participants as of December 31, 2017

BY AGE



BY YEARS OF SERVICE



Inactive Participants

In this year’s valuation, there were 139 participants with a right to a deferred or immediate vested benefit and 621 participants entitled to a return of their employee contributions.

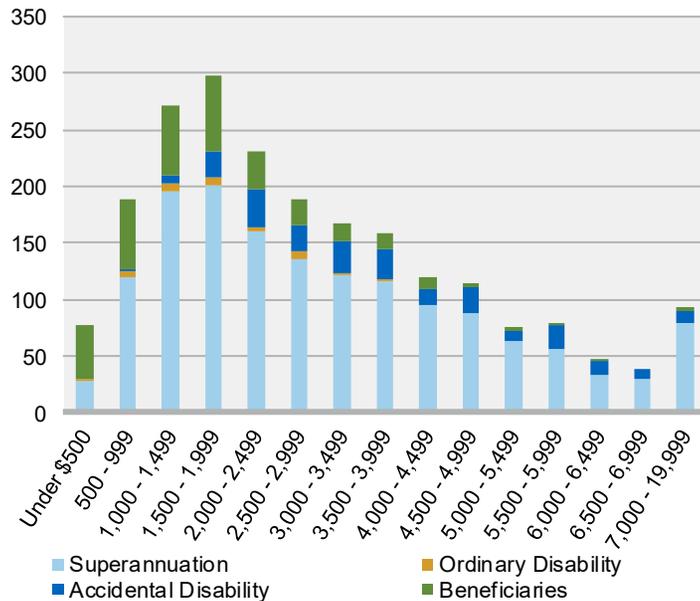
Retired Participants and Beneficiaries

As of December 31, 2017, 1,800 retired participants and 349 beneficiaries were receiving total monthly benefits of \$6,479,370, excluding COLAs reimbursed by the Commonwealth. For comparison, in the previous valuation, there were 1,657 retired participants and 362 beneficiaries receiving monthly benefits of \$5,582,111, excluding COLAs reimbursed by the Commonwealth.

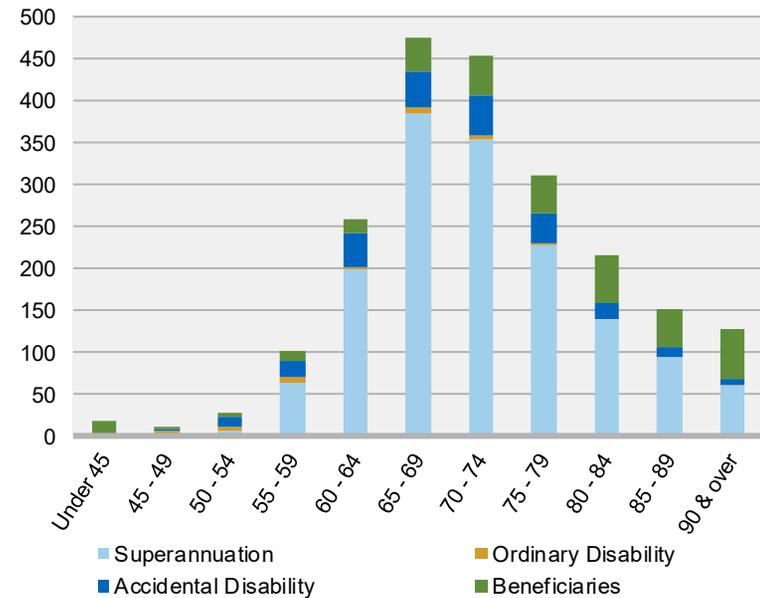
As of December 31, 2017, the average monthly benefit for retired participants and beneficiaries is \$3,016, compared to \$2,765 in the previous valuation. The average age for retired participants and beneficiaries is 72.2 in the current valuation, compared with 72.0 in the prior valuation.

Distribution of Pensioners and Beneficiaries as of December 31, 2017

BY TYPE AND MONTHLY AMOUNT



BY TYPE AND AGE

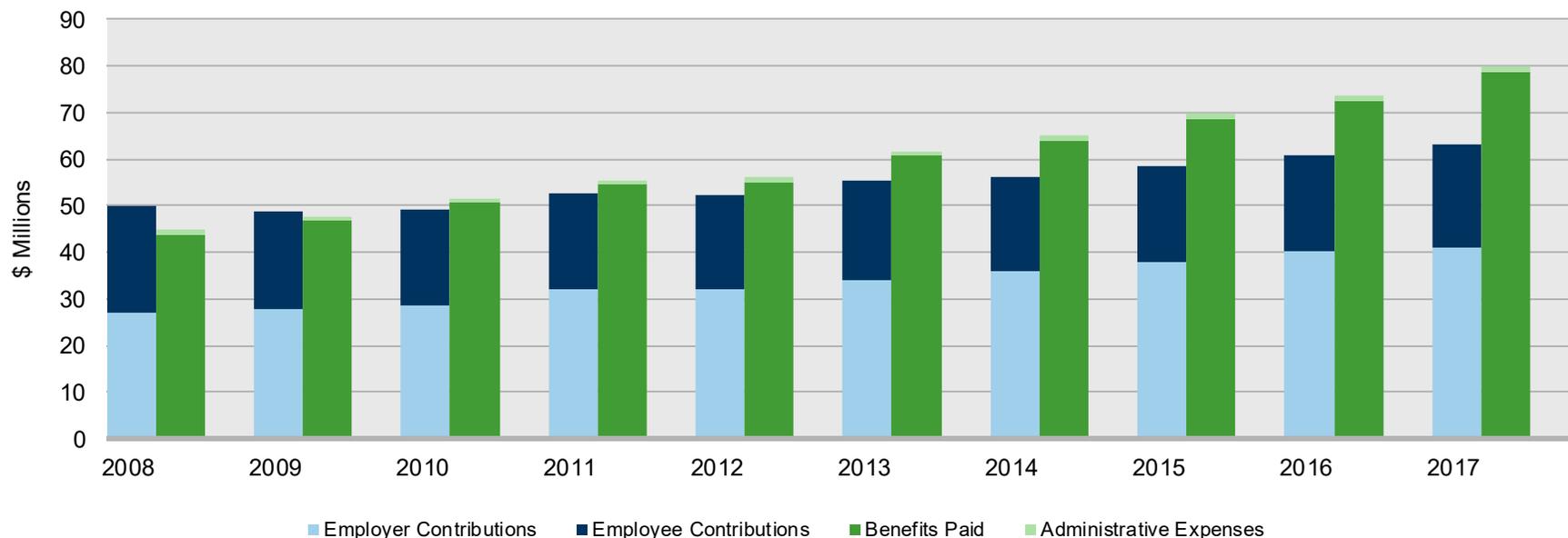


Financial Information

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 3, Exhibits C and D*.

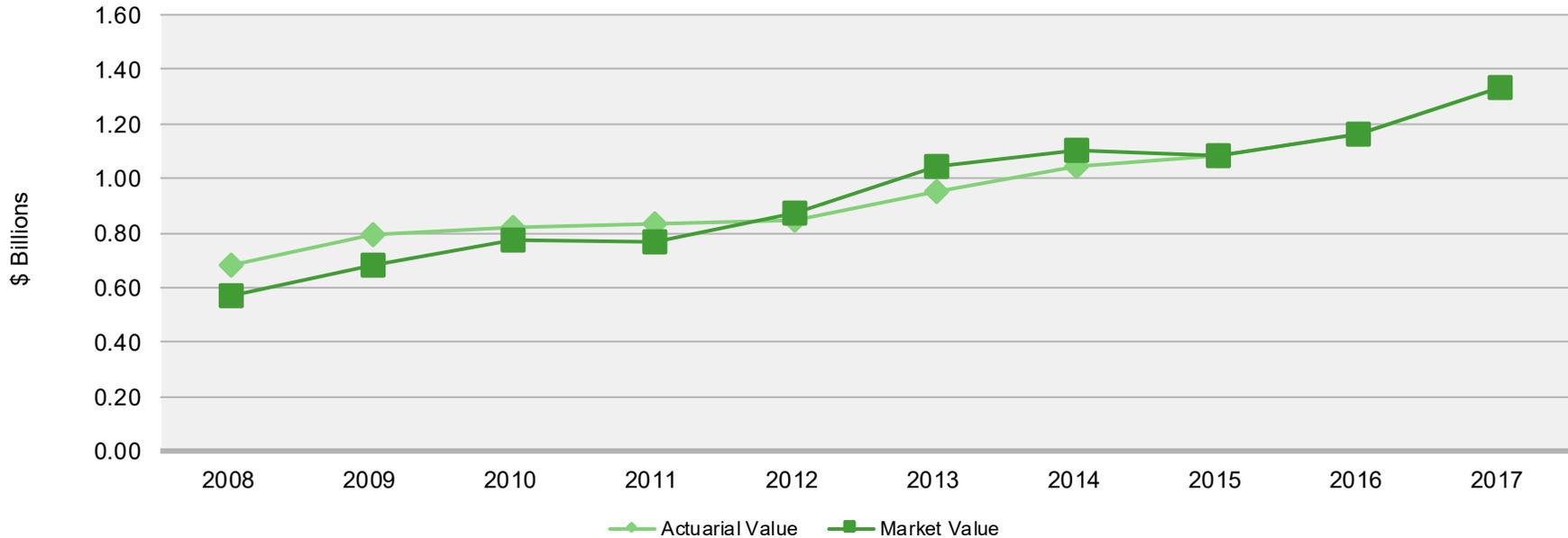
COMPARISON OF CONTRIBUTIONS WITH BENEFITS AND EXPENSES FOR YEARS ENDED DECEMBER 31, 2008 – 2017



The actuarial value (equal to the market value of assets) is a representation of the City of Cambridge Retirement System's financial status. The actuarial asset value is significant because the City of Cambridge Retirement 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.

With the prior valuation, the Board set the actuarial value of assets equal to the market value of assets.

ACTUARIAL VALUE OF ASSETS VS. MARKET VALUE OF ASSETS AS OF DECEMBER 31, 2008 – 2017



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 \$99,999,075, which includes a gain of \$107,575,808 from investments and a net loss of \$7,576,733 from all other sources. The net experience variation from individual sources other than investments was 0.5% 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, 2017

1	Net gain from investments	\$107,575,808
2	Net gain from administrative expenses	196,677
3	Net loss from other experience	<u>-7,773,410</u>
4	Net experience gain: 1 + 2 + 3	\$99,999,075

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 City of Cambridge Retirement System’s investment policy. The rate of return on the market value of assets for the 2017 and 2016 plan years was 16.49% and 8.38%, respectively.

For valuation purposes, the assumed rate of return on the actuarial value of assets was 7.75% for 2017 and 2016. The City of Cambridge Retirement System experienced an actuarial gain during the two-year period ending December 31, 2017 with regard to its investments.

INVESTMENT EXPERIENCE

	Year Ended December 31, 2017	Year Ended December 31, 2016
1 Net investment income	\$190,247,348	\$90,299,489
2 Average value of assets	1,153,724,473	1,078,159,773
3 Rate of return: 1 ÷ 2	16.49%	8.38%
4 Assumed rate of return	7.75%	7.75%
5 Expected investment income: 2 × 4	\$89,413,647	\$83,557,382
6 Actuarial gain/(loss): 1 – 5	\$100,833,701	\$6,742,107

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 for the last 12 years, including averages over select time periods.

Based on this experience and future expectations, we have lowered the assumed rate of return from 7.75% to 7.50%.

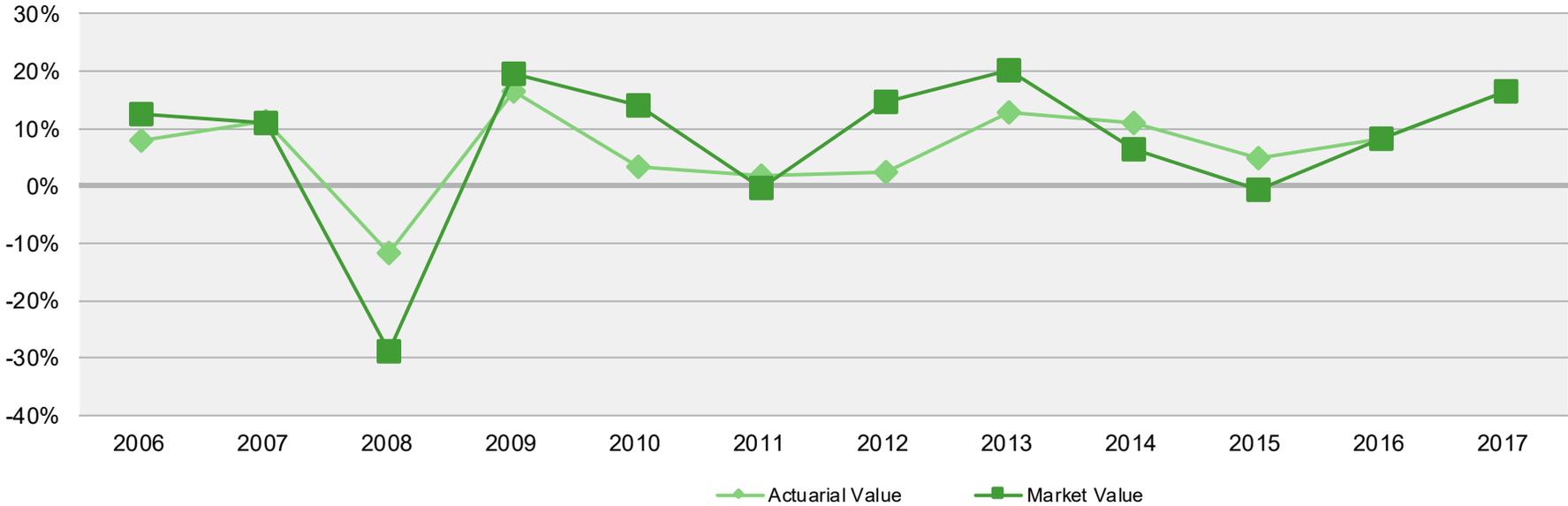
INVESTMENT RETURN – ACTUARIAL VALUE OF ASSETS VS. MARKET VALUE OF ASSETS: 2006 - 2017

Year Ended December 31	Actuarial Value Investment Return		Market Value Investment Return	
	Amount	Percent	Amount	Percent
2006	\$50,222,320	7.93%	\$79,521,825	12.66%
2007	77,029,038	11.21	78,925,558	11.10
2008	-89,051,384	-11.59	-229,027,048	-28.81
2009	112,693,653	16.51	111,691,775	19.63
2010	26,347,460	3.32	96,012,756	14.12
2011	15,318,166	1.87	-3,728,564	-0.48
2012	19,226,418	2.32	111,822,865	14.59
2013	108,280,094	12.82	175,813,466	20.14
2014	104,503,946	11.05	65,611,478	6.30
2015	50,453,604	4.85	-6,716,067	-0.61
2016	90,299,489	8.38	90,299,489	8.38
2017	<u>190,247,348</u>	16.49	<u>190,247,348</u>	16.49
Total	\$755,570,152		\$760,474,881	
Most recent five-year average return		10.74%		9.83%
Most recent ten-year average return		7.02%		6.82%
Most recent 12-year average return		7.35%		7.48%

Notes: Each year's yield is weighted by the average asset value in that year.
Actuarial value investment return for 2015 includes the change in asset method.

The following chart shows the actuarial value of assets rate of return and the market value of assets rate of return over the past twelve years.

MARKET AND ACTUARIAL RATES OF RETURN FOR YEARS ENDED DECEMBER 31, 2006 - 2017



Administrative Expenses

Administrative expenses for the years ended December 31, 2016 and December 31, 2017 were \$1,112,054 and \$1,127,717, respectively, compared to the assumption of \$1,150,000 for calendar 2016 and \$1,190,250 for calendar 2017. This resulted in a gain of \$196,677 for the two-year period, including an adjustment for interest. Based on information on expenses provided by the Retirement System, we have increased the assumption to \$1,300,000 for calendar year 2018.

Other Experience

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

- the extent of turnover among participants,
- retirement experience (earlier or later than projected),
- mortality (more or fewer deaths 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, 2017 amounted to \$7,773,410.

LIABILITY CHANGES DUE TO DEMOGRAPHIC EXPERIENCE FOR TWO-YEAR PERIOD ENDED DECEMBER 31, 2017

Salary increases greater than expected for continuing actives	-\$3,054,435
Loss due to fewer deaths than expected among retired members and beneficiaries	-8,318,297
Miscellaneous gain	<u>3,599,322</u>
Total	-\$7,773,410

Changes in the Actuarial Accrued Liability

The actuarial accrued liability as of January 1, 2018 is \$1,523,134,269, an increase of \$185,728,786, or 13.9%, from the actuarial accrued liability as of the prior valuation date. The liability is expected to grow each year with normal cost and interest, and to decline due to benefit payments made. Additional fluctuations can occur due to actual experience that differs from expected (as discussed in the previous subsection) and changes in assumptions and plan provisions (as noted below).

Actuarial Assumptions

The following actuarial assumptions were changed with this valuation:

- The investment return assumption was decreased from 7.75% to 7.50%.
- The mortality assumption for non-disabled participants was updated from the RP-2000 Employee and Healthy Annuitant Mortality Tables projected generationally from 2009 using Scale BB2D to the RP-2014 Blue Collar Employee and Healthy Annuitant Mortality Tables set forward 1 year for female participants projected generationally using Scale MP-2017.
- The mortality assumption for disabled participants was updated from the RP-2000 Healthy Annuitant Mortality Table projected generationally from 2015 using Scale BB2D to the RP-2014 Blue Collar Healthy Annuitant Mortality Table set forward 1 year projected generationally using Scale MP-2017.
- The administrative expense assumption was increased from \$1,150,000 for calendar year 2016 to \$1,300,000 for calendar year 2018.

Changing these assumptions increased the unfunded liability by approximately \$44.5 million and increased the employer normal cost by approximately \$2,068,000.

Details on actuarial assumptions and methods are in *Section 4, Exhibit I*.

Plan Provisions

As permitted by Section 19 of Chapter 188 of the Acts of 2010, the Cost of Living Adjustment base was increased from \$14,000 to \$16,000 as of July 1, 2018.

A summary of plan provisions is in *Section 4, Exhibit II*.

Development of Unfunded Actuarial Accrued Liability

	Year ended	
	December 31, 2017	December 31, 2016
1 Unfunded actuarial accrued liability at beginning of year	\$243,548,448	\$252,906,690
2 Normal cost at beginning of year	33,045,797	31,928,306
3 Total contributions	-62,978,769	-60,997,603
4 Interest		
• For whole year on 1 + 2	\$21,436,054	\$22,074,712
• For half year on 3	<u>-2,440,427</u>	<u>-2,363,657</u>
Total interest	<u>18,995,627</u>	<u>19,711,055</u>
5 Expected unfunded actuarial accrued liability	\$232,611,103	\$243,548,448
6 Changes due to:		
• Net gain from investments	-\$107,575,808	--
• Net loss from other experience	7,576,733	--
• Changes in assumptions	43,394,752	--
• Change in COLA base	<u>11,551,438</u>	--
Total changes	<u>-45,052,885</u>	--
7 Unfunded actuarial accrued liability at end of year	\$187,558,218	--

Actuarially Determined Contribution

The actuarially determined contribution is equal to the employer normal cost payment and a payment on the unfunded actuarial accrued liability. As of January 1, 2019, the actuarially determined contribution has been set equal to the previously budgeted amount of \$42,873,090 determined with the prior valuation (and adjusted to a July 1 payment date) plus an additional contribution of \$300,000.

The funding schedule included in this report fully funds the System by June 30, 2026 with appropriations that increase 5.85% per year for two years and remain level thereafter. With the prior valuation, the Board approved a funding schedule that fully funded the System by June 30, 2026 with appropriations that increase 5.85% per year.

ACTUARIALLY DETERMINED CONTRIBUTION FOR YEAR BEGINNING JANUARY 1

	2018		2016	
	Amount	% of Projected Payroll	Amount	% of Projected Payroll
1 Total normal cost	\$34,555,130	14.92%	\$30,778,306	13.93%
2 Administrative expenses	1,300,000	0.56%	1,150,000	0.52%
3 Expected employee contributions	<u>-22,801,904</u>	<u>-9.85%</u>	<u>-21,450,503</u>	<u>-9.71%</u>
4 Employer normal cost: (1) + (2) - (3)	\$13,053,226	5.64%	\$10,477,803	4.74%
5 Actuarial accrued liability	1,523,134,269		1,337,405,483	
6 Actuarial value of assets	<u>1,335,576,051</u>		<u>1,084,498,793</u>	
7 Unfunded actuarial accrued liability: (5) - (6)	\$187,558,218		\$252,906,690	
8 Employer normal cost projected to July 1, 2018 and 2016, adjusted for timing for fiscal 2017 only	13,279,693	5.64%	11,089,317	4.93%
9 Projected unfunded actuarial accrued liability	194,464,500		262,523,966	
10 Payment on unfunded actuarial accrued liability including additional \$300,000, adjusted for timing for fiscal 2017 only	29,893,397	12.69%	28,958,574	12.88%
11 Actuarially Determined Contribution: (8) + (10)	\$43,173,090	18.33%	\$40,047,891	17.82%
12 Projected payroll as of July 1	\$235,586,114		\$224,796,824	

Notes: Actuarially Determined Contribution for 2019 is assumed to be paid on July 1.
 Actuarially Determined Contribution for 2017 is assumed to be paid in the middle of the fiscal year.
 Actuarially Determined Contributions are set equal to the budgeted amounts determined with the prior valuation.

Funding Schedule

(1) Fiscal Year Ended June 30	(2) Employer Normal Cost	(3) Amortization of Unfunded Liability	(4) Actuarially Determined Contribution Before Additional Payment: (2) + (3)	(5) Additional Payment	(6) Actuarially Determined Contribution With Additional Payment: (4) + (5)	(7) Total Unfunded Accrued Liability	(8) Increase Over Prior Year
2019	\$13,279,693	\$29,593,397	\$42,873,090	\$300,000	\$43,173,090	\$194,464,500	--
2020	13,799,060	31,582,106	45,381,166	300,000	45,681,166	176,913,935	5.8500%
2021	14,338,599	33,697,365	48,035,964	300,000	48,335,964	155,909,217	5.8500%
2022	14,899,091	33,136,873	48,035,964	300,000	48,335,964	131,055,240	0.0000%
2023	15,481,343	32,554,621	48,035,964	300,000	48,335,964	104,939,745	0.0000%
2024	16,086,195	31,949,769	48,035,964	300,000	48,335,964	77,491,508	0.0000%
2025	16,714,521	31,321,443	48,035,964	300,000	48,335,964	48,634,870	0.0000%
2026	17,367,225	17,989,434	35,356,659	300,000	35,656,659	18,289,434	-26.3954%
2027	18,045,248	0	18,045,248	0	18,045,248	0	-48.9622%

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

Actuarially Determined Contribution for fiscal year 2019 is set equal to the budgeted amount determined in the prior valuation.

Item (2) reflects 3.5% growth in payroll and a 0.15% adjustment to total normal cost to reflect the effect of mortality improvements due to the generational mortality assumption.

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

Risk

The actuarial valuation results depend on a single set of assumptions; however, there is a risk that emerging results may differ significantly as actual experience proves to be different from the current 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 of the risks that may affect the System. This discussion is focused on funding-related risks, but similar concerns may apply to risks regarding the level of expense and liabilities reported for System accounting purposes as well.

We recommend a more detailed assessment of the risks to provide the Board with a better understanding of the risks inherent in the System. This assessment may include scenario testing, sensitivity testing, and/or stochastic modeling.

A detailed risk assessment is important for your System because relatively small changes in investment performance can produce large increases in the contribution requirements since the funding schedule is relatively short.

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

The market value rate of return over the last 12 years has ranged from a low of -28.81% to a high of 20.14%.

- 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 requires payment of the actuarially determined contribution. If future experience matches the current assumptions, we project the unfunded actuarial accrued liability will be paid off in 8 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 in Recent Years and Implications for the Future

Past experience can help demonstrate the sensitivity of key results to the Plan's actual experience. Over the past ten years:

- The investment gain(loss) has ranged from a loss of \$296,592,305 to a gain of \$105,973,263.
- The non-investment gain(loss) has ranged from a loss of \$7,576,733 to a gain of \$28,336,832.
- Since 2008, the funded percentage on the actuarial value of assets has ranged from a low of 77.8% as of January 1, 2012 to a high of 92.0% as of January 1, 2008.

➤ Maturity Measures

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

Section 3: Supplemental Information

EXHIBIT A – TABLE OF PLAN COVERAGE

Category	Year Ended December 31		Change From Prior Year
	2017	2015	
Active participants in valuation:			
• Number	2,991	3,019	-0.9%
• Average age	47.7	48.0	-0.3
• Average years of service	14.4	14.6	-0.2
• Total payroll for prior year	\$222,022,885	\$211,726,778	4.9%
• Average payroll	74,230	70,131	5.8%
• Member contributions	24,928,107	23,947,610	4.1%
Inactive participants due a refund of employee contributions	621	728	-14.7%
Inactive participants with a vested right to a deferred or immediate benefit	139	126	10.3%
Retired participants:			
• Number in pay status	1,524	1,387	9.9%
• Average age	72.1	72.0	0.1
• Average monthly benefit	\$3,182	\$2,936	8.4%
Disabled participants:			
• Number in pay status	275	270	1.9%
• Average age	68.5	68.2	0.3
• Average monthly benefit	\$3,656	\$3,399	7.6%
Beneficiaries:			
• Number in pay status	349	362	-3.6%
• Average age	75.9	72.5	0.7
• Average monthly benefit	\$1,785	\$1,636	9.1%

Note: Payroll figures are for the prior calendar year.

**EXHIBIT B – PARTICIPANTS IN ACTIVE SERVICE AS OF DECEMBER 31, 2017
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	53	53	--	--	--	--	--	--	--	--
	\$39,580	\$39,580	--	--	--	--	--	--	--	--
25 - 29	209	180	29	--	--	--	--	--	--	--
	\$52,371	\$50,225	\$65,689	--	--	--	--	--	--	--
30 - 34	305	167	94	42	2	--	--	--	--	--
	\$64,214	\$55,550	\$71,768	\$81,251	\$74,758	--	--	--	--	--
35 - 39	306	84	73	99	49	1	--	--	--	--
	\$71,995	\$54,320	\$70,097	\$83,242	\$81,722	\$105,246	--	--	--	--
40 - 44	325	65	43	91	103	22	1	--	--	--
	\$76,307	\$56,088	\$73,720	\$74,559	\$86,765	\$97,161	\$124,761	--	--	--
45 - 49	406	56	49	74	112	87	26	2	--	--
	\$78,828	\$57,400	\$63,299	\$71,249	\$82,001	\$96,704	\$102,346	\$78,594	--	--
50 - 54	431	38	40	74	87	100	47	43	2	--
	\$82,555	\$51,723	\$70,772	\$70,075	\$79,282	\$100,067	\$95,662	\$92,689	\$106,719	--
55 - 59	449	37	27	83	83	66	63	53	31	6
	\$77,105	\$59,620	\$52,471	\$70,248	\$70,777	\$79,157	\$90,621	\$102,289	\$80,383	\$74,294
60 - 64	333	19	26	48	61	49	47	46	29	8
	\$82,374	\$56,967	\$71,751	\$75,403	\$80,128	\$82,357	\$79,182	\$89,237	\$106,194	\$129,247
65 - 69	131	7	9	22	22	16	18	17	6	14
	\$77,905	\$51,870	\$83,315	\$68,554	\$78,272	\$66,637	\$69,518	\$103,196	\$79,679	\$93,751
70 & over	43	2	2	5	8	5	4	7	4	6
	\$63,315	\$71,695	\$26,275	\$63,771	\$59,837	\$68,290	\$61,153	\$63,174	\$63,091	\$74,735
Total	2,991	708	392	538	527	346	206	168	72	34
	\$74,230	\$55,402	\$68,764	\$74,672	\$79,953	\$90,550	\$88,391	\$94,438	\$90,491	\$95,314

EXHIBIT C – SUMMARY STATEMENT OF INCOME AND EXPENSES ON A MARKET VALUE BASIS

	Year Ended December 31, 2017	Year Ended December 31, 2016
Net assets at market value at the beginning of the year	\$1,162,120,243	\$1,084,498,793
Contribution income:		
• Employer contributions	\$40,831,840	\$40,047,891
• Employee contributions	22,146,929	20,949,712
• Less administrative expenses	<u>-1,127,717</u>	<u>-1,112,054</u>
Net contribution income	61,851,052	59,885,549
Net investment income	<u>190,247,348</u>	<u>90,299,489</u>
Total income available for benefits	\$252,098,400	\$150,185,038
Less benefit payments:		
• Pensions, annuities, refunds and net transfers	-\$78,885,526	-\$72,860,769
• Net 3(8)(c) reimbursements	<u>242,934</u>	<u>297,181</u>
Net benefit payments	-\$78,642,592	-\$72,563,588
Change in reserve for future benefits	\$173,455,808	\$77,621,450
Net assets at market value at the end of the year	\$1,335,576,051	\$1,162,120,243

EXHIBIT D – DEVELOPMENT OF THE FUND THROUGH DECEMBER 31, 2017

Year Ended December 31	Employer Contributions	Employee Contributions	Other Contributions	Net Investment Return*	Administrative Expenses	Benefit Payments	Market Value of Assets at Year-End	Actuarial Value of Assets at Year-End	Actuarial Value as a Percent of Market Value
2008	\$26,891,503	\$22,966,497	\$4,430	-\$229,027,048	\$859,128	\$43,876,275	\$568,421,838	\$682,106,205	120.0%
2009	27,727,711	21,199,168	0	111,691,775	805,680	46,905,287	681,329,524	796,015,770	116.8%
2010	28,553,542	20,501,312	0	96,012,756	891,447	50,743,313	774,762,374	819,783,324	105.8%
2011	32,212,987	20,322,105	0	-3,728,564	859,734	54,480,133	768,229,036	832,296,715	108.3%
2012	31,962,897	20,145,293	0	111,822,865	1,001,639	55,073,657	876,084,795	847,556,027	96.7%
2013	33,815,176	21,640,855	0	175,813,466	986,283	60,634,265	1,045,733,743	949,671,604	90.8%
2014	35,775,814	20,572,796	0	65,611,478	1,031,915	64,034,766	1,102,627,150	1,045,457,479	94.8%
2015	37,851,149	20,478,977	0	-6,716,067	1,076,459	68,665,956	1,084,498,793	1,084,498,793	100.0%
2016	40,047,891	20,949,712	0	90,299,489	1,112,054	72,563,588	1,162,120,243	1,162,120,243	100.0%
2017	40,831,840	22,146,929	0	190,247,348	1,127,717	78,642,592	1,335,576,051	1,335,576,051	100.0%

Notes: Net Investment Return is on a market basis, net of investment fees.
Reflects change in asset method in 2015.

EXHIBIT E – DEPARTMENT STATISTICS AS OF DECEMBER 31, 2017

Category	Fire	Police	Water	Sewer	Housing	Redevel.	School	Other	Total City	PHC	All Department Total
Active participants in valuation											
• Number	266	275	46	207	182	5	522	814	2,317	674	2,991
• Average age	44.9	44.5	49.1	51.1	47.8	42.3	46.3	46.1	46.4	52	47.7
• Average service	17.2	18.2	17.2	13.4	11.6	5.6	11.3	12.7	13.6	17.1	14.4
• Total payroll	\$29,199,896	\$29,695,565	\$3,458,800	\$12,931,998	\$12,544,737	\$393,239	\$24,450,085	\$55,720,756	\$168,395,076	\$53,627,809	\$222,022,885
• Average payroll	109,774	107,984	75,191	62,473	68,927	78,648	46,839	68,453	72,678	79,566	74,230
Inactive participants entitled to a return of their employee contributions											
	0	3	4	14	37	0	257	109	424	197	621
Inactive participants with a vested right to a deferred or immediate benefit											
	1	2	1	6	11	0	17	29	67	72	139
Retired participants and beneficiaries in pay status											
• Retired participants	116	141	21	83	55	7	251	286	960	565	1,525
• Disabled participants	95	52	9	30	16	0	29	15	246	29	275
• Beneficiaries	54	72	15	49	19	3	46	45	303	46	349
• Total number in pay status	265	265	45	162	90	10	326	346	1,509	640	2,149
• Total monthly benefits	\$1,188,062	\$1,101,983	\$116,416	\$357,513	\$233,444	\$22,792	\$627,304	\$962,399	\$4,609,913	\$1,869,457	\$6,479,370
• Average monthly benefit	4,483	4,158	2,587	2,207	2,594	2,279	1,924	2,782	3,055	2,921	3,015

EXHIBIT F – DEPARTMENT RESULTS AS OF JANUARY 1, 2018
ALLOCATION OF 2019 – 2021 APPROPRIATION BY ACTUARIAL COST AND PAYROLL ALLOCATION

Category	Fire	Police	Water	Sewer	Housing	Re devel.	School	Other	Total City	PHC	Total
1 Total normal cost	\$6,565,121	\$6,467,195	\$423,155	\$1,919,107	\$1,780,939	\$55,418	\$3,360,311	\$7,023,190	\$27,594,436	\$6,960,694	\$34,555,130
2 Administrative expenses	246,986	243,303	15,920	72,199	67,001	2,085	126,418	264,220	1,038,132	261,868	1,300,000
3 Expected employee contribution	<u>-3,044,939</u>	<u>-3,097,830</u>	<u>-350,932</u>	<u>-1,303,148</u>	<u>-1,293,046</u>	<u>-41,937</u>	<u>-2,416,016</u>	<u>-5,682,737</u>	<u>-17,230,585</u>	<u>-5,571,319</u>	<u>-22,801,904</u>
4 Employer normal cost: (1) + (2) + (3)	\$3,767,168	\$3,612,668	\$88,143	\$688,158	\$554,894	\$15,566	\$1,070,713	\$1,604,673	\$11,401,983	\$1,651,243	\$13,053,226
5 Employer normal cost as a percent of payroll	12.36%	11.65%	2.44%	5.11%	4.25%	3.81%	4.21%	2.76%	6.50%	2.95%	5.64%
6 Actuarial accrued liability	\$252,901,407	\$249,180,959	\$25,869,279	\$80,150,350	\$59,425,464	\$2,903,163	\$140,759,382	\$268,102,000	\$1,079,292,004	\$443,842,265	\$1,523,134,269
7 Actuarial value of assets	<u>221,759,217</u>	<u>218,496,903</u>	<u>22,683,745</u>	<u>70,280,664</u>	<u>52,107,833</u>	<u>2,545,669</u>	<u>123,426,321</u>	<u>235,088,014</u>	<u>946,388,366</u>	<u>389,187,685</u>	<u>1,335,576,051</u>
8 Unfunded actuarial accrued liability: (6) – (7)	\$31,142,190	\$30,684,057	\$3,185,534	\$9,869,686	\$7,317,631	\$357,494	\$17,333,061	\$33,013,985	\$132,903,638	\$54,654,580	\$187,558,218
9 Employer normal cost, projected to July 1, 2018	3,832,526	3,675,346	89,672	700,097	564,521	15,836	1,089,290	1,632,514	11,599,802	1,679,891	13,279,693
10 Projected unfunded accrued liability	32,288,910	31,813,907	3,302,832	10,233,108	7,587,081	370,658	17,971,300	34,229,628	137,797,424	56,667,075	194,464,499
11 Payment on remaining unfunded accrued liability	4,913,691	4,841,406	502,621	1,557,263	1,154,594	56,406	2,734,853	5,209,028	20,969,863	8,623,534	29,593,397
12 Fiscal 2019 Actuarially Determined Contribution: (10) + (11)	8,746,217	8,516,752	592,293	2,257,360	1,719,115	72,242	3,824,143	6,841,542	32,569,665	10,303,425	42,873,090
13 Fiscal 2020 Actuarially Determined Contribution	9,220,931	8,980,952	629,877	2,389,545	1,819,276	76,675	4,051,360	7,259,824	34,428,440	10,952,726	45,381,166
14 Fiscal 2021 Actuarially Determined Contribution	9,722,093	9,471,087	669,768	2,529,463	1,925,267	81,374	4,291,987	7,703,176	36,394,215	11,641,749	48,035,964
15 Projected calendar year payroll	30,485,444	31,007,509	3,612,293	13,476,968	13,049,162	408,520	25,443,694	58,057,986	175,541,576	56,026,941	231,568,517
16 Approximate payroll allocation of fiscal 2019 Actuarially Determined Contribution	5,644,140	5,740,796	668,788	2,495,155	2,415,950	75,634	4,710,700	10,748,980	32,500,142	10,372,948	42,873,090
17 Approximate payroll allocation of fiscal 2020 Actuarially Determined Contribution	5,974,322	6,076,633	707,912	2,641,121	2,557,283	80,059	4,986,276	11,377,795	34,401,401	10,979,765	45,381,166
18 Approximate payroll allocation of fiscal 2021 Actuarially Determined Contribution	6,323,820	6,432,116	749,325	2,795,627	2,706,884	84,742	5,277,973	12,043,396	36,413,883	11,622,081	48,035,964

Notes: Actuarial value of assets allocated in proportion to the actuarial accrued liability.
Actuarially Determined Contributions are assumed to be paid on July 1.
Actuarially Determined Contributions do not reflect the additional payment.

EXHIBIT G – UNIT RESULTS AS OF JANUARY 1, 2018

Category	Housing	Revel.	Other	Total City	PHC	Total
1 Total normal cost	\$1,780,939	\$55,418	\$25,758,079	\$27,594,436	\$6,960,694	\$34,555,130
2 Administrative expenses	67,001	2,085	969,046	1,038,132	261,868	1,300,000
3 Expected employee contributions	<u>-1,293,046</u>	<u>-41,937</u>	<u>-15,895,602</u>	<u>-17,230,585</u>	<u>-5,571,319</u>	<u>-22,801,904</u>
4 Employer normal cost: (1) + (2) + (3)	\$554,894	\$15,566	\$10,831,523	\$11,401,983	\$1,651,243	\$13,053,226
5 Employer normal cost as a percent of payroll	4.25%	3.81%	6.68%	6.50%	2.95%	5.64%
6 Actuarial accrued liability	\$59,425,464	\$2,903,163	\$1,016,963,377	\$1,079,292,004	\$443,842,265	\$1,523,134,269
7 Actuarial value of assets	<u>52,107,833</u>	<u>2,545,669</u>	<u>891,734,864</u>	<u>946,388,366</u>	<u>389,187,685</u>	<u>1,335,576,051</u>
8 Unfunded actuarial accrued liability: (6) – (7)	\$7,317,631	\$357,494	\$125,228,513	\$132,903,638	\$54,654,580	\$187,558,218
9 Actuarial allocation - fiscal 2019 Actuarially Determined Contribution	1,719,115	72,242	30,778,308	32,569,665	10,303,425	42,873,090
10 Actuarial allocation - fiscal 2020 Actuarially Determined Contribution	1,819,276	76,675	32,532,489	34,428,440	10,952,726	45,381,166
11 Actuarial allocation - fiscal 2021 Actuarially Determined Contribution	1,925,267	81,374	34,387,574	36,394,215	11,641,749	48,035,964
12 Projected calendar year payroll	13,049,162	408,520	162,083,894	175,541,576	56,026,941	231,568,517
13 Payroll allocation - fiscal 2019 Actuarially Determined Contribution	2,415,950	75,634	30,008,558	32,500,142	10,372,948	42,873,090
14 Payroll allocation - fiscal 2020 Actuarially Determined Contribution	2,557,283	80,059	31,764,059	34,401,401	10,979,765	45,381,166
15 Payroll allocation - fiscal 2021 Actuarially Determined Contribution	2,706,884	84,742	33,622,257	36,413,883	11,622,081	48,035,964

Notes: Actuarial value of assets allocated in proportion to the actuarial accrued liability.
 Actuarially Determined Contributions are assumed to be paid on July 1.
 Actuarially Determined Contributions do not reflect the additional payment.

EXHIBIT H – DEFINITIONS OF PENSION TERMS

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

Actuarial Accrued Liability for Actives:	The equivalent of the accumulated normal costs allocated to the years before the valuation date.
Actuarial Accrued Liability for Pensioners and Beneficiaries:	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.
Actuarial Cost Method:	A procedure allocating the Actuarial Present Value of Future Benefits to various time periods; a method used to determine the Normal Cost and the Actuarial Accrued Liability that are used to determine the actuarially determined contribution.
Actuarial Gain or Loss:	A measure of the difference between actual experience and that expected based upon a set of Actuarial Assumptions, during the period between two Actuarial Valuation dates. 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.
Actuarially Equivalent:	Of equal actuarial present value, determined as of a given date and based on a given set of Actuarial Assumptions.
Actuarial Present Value (APV):	<p>The value of an amount or series of amounts payable or receivable at various times, determined as of a given date by the application of a particular set of Actuarial Assumptions. Each such amount or series of amounts is:</p> <p>Adjusted for the probable financial effect of certain intervening events (such as changes in compensation levels, marital status, etc.)</p> <p>Multiplied by the probability of the occurrence of an event (such as survival, death, disability, withdrawal, etc.) on which the payment is conditioned, and</p> <p>Discounted according to an assumed rate (or rates) of return to reflect the time value of money.</p>

Actuarial Present Value of Future Plan Benefits:	The Actuarial Present Value of benefit amounts expected to be paid at various future times under a particular set of Actuarial Assumptions, taking into account such items as the effect of advancement in age, anticipated future compensation, and future service credits. The Actuarial Present Value of Future 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.
Actuarial Valuation:	The determination, as of a valuation date, of the Normal Cost, Actuarial Accrued Liability, Actuarial Value of Assets, and related Actuarial Present Values for a plan. 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).
Actuarial Value of Assets (AVA):	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.
Actuarially Determined:	Values that have been determined utilizing the principles of actuarial science. An actuarially determined value is derived by application of the appropriate actuarial assumptions to specified values determined by provisions of the law.
Actuarially Determined Contribution (ADC):	The employer's periodic required contributions, expressed as a dollar amount or a percentage of covered plan compensation, determined under the Plan's funding policy. The ADC consists of the Employer Normal Cost and the Amortization Payment.
Amortization Method:	A method for determining the Amortization Payment. The most common methods used are level dollar and level percentage of payroll. Under the Level Dollar method, the Amortization Payment is one of a stream of payments, all equal, whose Actuarial Present Value is equal to the 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.
Amortization Payment:	The portion of the pension plan contribution, or ADC, that is designed to pay interest on and to amortize the Unfunded Actuarial Accrued Liability.

Assumptions or Actuarial Assumptions:	The estimates upon which the cost of the Fund is calculated, including: Investment return - the rate of investment yield that the Fund will earn over the long-term future; Mortality rates - the death rates of employees and pensioners; life expectancy is based on these rates; Retirement rates - the rate or probability of retirement at a given age or service; Disability rates – the probability of disability retirement at a given age; Withdrawal rates - the rates at which employees of various ages are expected to leave employment for reasons other than death, disability, or retirement; Salary increase rates - the rates of salary increase due to inflation and productivity growth.
Closed Amortization Period:	A specific number of years that is counted down by one each year, and therefore declines to zero with the passage of time. For example, if the amortization period is initially set at 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.
Decrements:	Those causes/events due to which a member’s status (active-inactive-retiree-beneficiary) changes, that is: death, retirement, disability, or withdrawal.
Defined Benefit Plan:	A retirement plan in which benefits are defined by a formula applied to the member’s compensation and/or years of service.
Defined Contribution Plan:	A retirement plan, such as a 401(k) plan, a 403(b) plan, or a 457 plan, in which the contributions to the plan are assigned to an account for each member, the plan’s earnings are allocated to each account, and each member’s benefits are a direct function of the account balance.
Employer Normal Cost:	The portion of the Normal Cost to be paid by the employer. This is equal to the Normal Cost less expected member contributions.
Experience Study:	A periodic review and analysis of the actual experience of the 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.
Funded Ratio:	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.
GASB 67 and GASB 68:	Governmental Accounting Standards Board (GASB) Statements No. 67 and No. 68. These are the governmental accounting standards that set the accounting rules for public retirement systems and the employers that sponsor or contribute to them. Statement No. 68 sets the accounting rules for the employers that sponsor or contribute to public retirement systems, while Statement No. 67 sets the rules for the systems themselves.

Investment Return:	The rate of earnings of the 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.
Net Pension Liability (NPL):	The Net Pension Liability is equal to the Total Pension Liability minus the Plan Fiduciary Net Position.
Normal Cost:	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.
Open Amortization Period:	An open amortization period is one which is used to determine the Amortization Payment but which does not change over time. If the initial period is set as 30 years, the same 30-year period is used in 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.
Plan Fiduciary Net Position:	Market value of assets.
Total Pension Liability (TPL):	The actuarial accrued liability under the entry age normal cost method and based on the blended discount rate as described in GASB 67 and 68.
Unfunded Actuarial Accrued Liability:	The excess of the Actuarial Accrued Liability over the Actuarial Value of Assets. This value may be negative, in which case it may be expressed as a negative Unfunded Actuarial Accrued Liability, also called the Funding Surplus.
Valuation Date or Actuarial Valuation Date:	The date as of which the value of assets is determined and as of which the Actuarial Present Value of Future Plan Benefits is determined. The expected benefits to be paid in the future are discounted to this date.



Section 4: Actuarial Valuation Basis

EXHIBIT I – ACTUARIAL ASSUMPTIONS AND ACTUARIAL COST METHOD

Net Investment Return:	<p>7.50%.(previously, 7.75%)</p> <p>The net investment return assumption is a long-term estimate derived from historical data, current and recent market expectations, and professional judgment. As part of the analysis, a building block approach was used that reflects inflation expectations and anticipated risk premiums for each of the portfolio’s asset classes, as well as the Plan’s target asset allocation.</p>
Salary Increases:	<p>4.50%</p> <p>Includes an allowance for inflation of 3.5%.</p> <p>The salary scale assumption is a long-term estimate derived from historical data, current and recent market expectations, and professional judgment.</p>
Interest on Employee Contributions:	<p>3.5%</p>
Administrative Expenses:	<p>\$1,300,000 for calendar 2018, increasing 3.50% per year (previously, \$1,150,000 for calendar 2016).</p> <p>The administrative expense assumption is based on information on expenses provided by the Retirement System.</p>
Mortality Rates:	<p><i>Pre-Retirement:</i> RP-2014 Blue Collar Employee Mortality Table set forward 1 year for female participants projected generationally using Scale MP-2017 (previously, RP-2000 Employee Mortality Table projected generationally using Scale BB2D from 2009)</p> <p><i>Healthy Retiree:</i> RP-2014 Blue Collar Healthy Annuitant Mortality Table set forward 1 year for female participants projected generationally using Scale MP-2017 (previously, RP-2000 Healthy Annuitant Mortality Table projected generationally using Scale BB2D from 2009)</p> <p><i>Disabled Retiree:</i> RP-2014 Blue Collar Healthy Annuitant Mortality Table set forward 1 year projected generationally using Scale MP-2017 (previously, RP-2000 Healthy Annuitant Mortality Table projected generationally using Scale BB2D from 2015)</p> <p>The underlying tables with generational projection to the ages of the participants as of the measurement date 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 four most recent valuations. The mortality tables were then adjusted to future years using a generational projection under Scale MP-2017 to reflect future mortality improvement.</p>

Termination Rates before Retirement:	Groups 1 and 2 – Rate (%)							
	Mortality						Withdrawal	
	Age	Current		Previous		Disability	PHC	All Other Departments
		Male	Female	Male	Female			
20	0.05	0.02	0.03	0.02	0.02	9.94	7.94	
25	0.06	0.02	0.04	0.02	0.04	9.67	7.72	
30	0.06	0.03	0.04	0.03	0.06	9.30	7.22	
35	0.07	0.03	0.08	0.05	0.11	8.71	6.28	
40	0.08	0.05	0.11	0.07	0.20	7.75	5.15	
45	0.13	0.08	0.15	0.11	0.29	6.35	3.98	
50	0.22	0.14	0.21	0.17	0.38	4.22	2.56	
55	0.36	0.20	0.30	0.25	0.48	1.55	0.00	
60	0.61	0.30	0.49	0.39	0.56	0.15	0.00	

Notes: 50% of the disability rates shown represent accidental disability.
20% of the accidental disabilities will die from the same cause as the disability.
50% of the death rates shown represent accidental death.
Mortality rates do not reflect generational projection.

Age	Group 4 – Rate (%)					
	Mortality				Disability	Withdrawal
	Current		Previous			
	Male	Female	Male	Female		
20	0.05	0.02	0.03	0.02	0.20	0.00
25	0.06	0.02	0.04	0.02	0.40	0.00
30	0.06	0.03	0.04	0.03	0.60	0.00
35	0.07	0.03	0.08	0.05	0.60	0.00
40	0.08	0.05	0.11	0.07	0.60	0.00
45	0.13	0.08	0.15	0.11	2.00	0.00
50	0.22	0.14	0.21	0.17	2.50	0.00
55	0.36	0.20	0.30	0.25	2.40	0.00
60	0.61	0.30	0.49	0.39	1.70	0.00

Notes: 90% of the disability rates shown represent accidental disability.
60% of the accidental disabilities will die from the same cause as the disability.
90% of the death rates shown represent accidental death.
Mortality rates do not reflect generational projection.

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

Retirement Rates:	Groups 1 and 2		Group 4	
	Age	Rate (%)	Age	Rate (%)
	55	5.0	50	5.0
	56	2.0	51	2.0
	57	2.0	52	2.0
	58	2.0	53	2.0
	59	2.0	54	2.0
	60	5.0	55	25.0
	61	2.0	56	2.0
	62	25.0	57	2.0
	63	5.0	58	2.0
	64	5.0	59	2.0
	65	10.0	60	25.0
	66	10.0	61	10.0
	67	100.0	62	10.0
	68	100.0	63	10.0
	69	100.0	64	10.0
	70	100.0	65	100.0
	<p>The retirement rates were based on historical and current demographic data, adjusted to reflect economic conditions of the area and estimated future experience and professional judgment. As part of the analysis, a comparison was made between the actual number of retirements by age and the projected number based on the prior years' assumptions over the four most recent valuations.</p>			
Retirement Age for Inactive Vested Participants:	<p>For participants hired prior to April 2, 2012, 60 for Groups 1 and 2 and 55 for Group 4. For participants hired April 2, 2012 or later, 60 for Group 1, 55 for Group 2, and 50 for Group 4.</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>			
Unknown Data for Participants:	<p>Same as those exhibited by participants with similar known characteristics.</p>			
Family Composition:	<p>75% of participants are assumed to be married. None are assumed to have dependent children. Females are assumed to be three years younger than their male spouses.</p>			

Benefit Election:	All participants are assumed to elect Option A. Benefit elections reflect the fact that all benefit options are actuarially equivalent.
Total Service:	Total creditable service reported in the data.
2017 Salary:	2017 salaries are equal to salaries provided in the data except for new hires where salaries were annualized based on date of hire.
Net 3(8)(c) Liability:	No liability is valued for benefits paid to or received from other municipal retirement systems.
Actuarial Value of Assets:	Market value of assets as reported in the System's Annual Statement.
Actuarial Cost Method:	Entry Age Normal Actuarial Cost Method. Entry Age is the attained age of the participant minus total creditable service. Normal Cost and Actuarial Accrued Liability are calculated on an individual basis and are allocated by salary. Normal Cost is determined using the plan of benefits applicable to each participant.
Justification for Change in Actuarial Assumptions:	<p>Based on past experience and future expectations, the following actuarial assumptions were changed with this valuation:</p> <ul style="list-style-type: none"> • The investment return assumption was decreased from 7.75% to 7.50%. • The mortality assumption for non-disabled participants was updated from the RP-2000 Employee and Healthy Annuitant Mortality Tables projected generationally using Scale BB2D from 2009 to the RP-2014 Blue Collar Employee and Healthy Annuitant Mortality Tables set forward 1 year for female participants projected generationally using Scale MP-2017. • The mortality assumption for disabled participants was updated from the RP-2000 Healthy Annuitant Mortality Table projected generationally using Scale BB2D from 2015 to the RP-2014 Blue Collar Healthy Annuitant Mortality Table set forward 1 year projected generationally using Scale MP-2017. • The administrative expense assumption was increased from \$1,150,000 for calendar year 2016 to \$1,300,000 for calendar year 2018.

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:	<p>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.)</p> <p>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:</p> <table border="1" style="width: 100%; border-collapse: collapse; margin: 10px 0;"> <thead> <tr style="background-color: #0070C0; color: white;"> <th colspan="4" style="text-align: center;">Age Last Birthday at Date of Retirement</th> </tr> <tr style="background-color: #0070C0; color: white;"> <th style="text-align: center;">Percent</th> <th style="text-align: center;">Group 1</th> <th style="text-align: center;">Group 2</th> <th style="text-align: center;">Group 4</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">2.5</td> <td style="text-align: center;">65 or over</td> <td style="text-align: center;">60 or over</td> <td style="text-align: center;">55 or over</td> </tr> <tr> <td style="text-align: center;">2.4</td> <td style="text-align: center;">64</td> <td style="text-align: center;">59</td> <td style="text-align: center;">54</td> </tr> <tr> <td style="text-align: center;">2.3</td> <td style="text-align: center;">63</td> <td style="text-align: center;">58</td> <td style="text-align: center;">53</td> </tr> <tr> <td style="text-align: center;">2.2</td> <td style="text-align: center;">62</td> <td style="text-align: center;">57</td> <td style="text-align: center;">52</td> </tr> <tr> <td style="text-align: center;">2.1</td> <td style="text-align: center;">61</td> <td style="text-align: center;">56</td> <td style="text-align: center;">51</td> </tr> <tr> <td style="text-align: center;">2.0</td> <td style="text-align: center;">60</td> <td style="text-align: center;">55</td> <td style="text-align: center;">50</td> </tr> <tr> <td style="text-align: center;">1.9</td> <td style="text-align: center;">59</td> <td style="text-align: center;">--</td> <td style="text-align: center;">49</td> </tr> <tr> <td style="text-align: center;">1.8</td> <td style="text-align: center;">58</td> <td style="text-align: center;">--</td> <td style="text-align: center;">48</td> </tr> <tr> <td style="text-align: center;">1.7</td> <td style="text-align: center;">57</td> <td style="text-align: center;">--</td> <td style="text-align: center;">47</td> </tr> <tr> <td style="text-align: center;">1.6</td> <td style="text-align: center;">56</td> <td style="text-align: center;">--</td> <td style="text-align: center;">46</td> </tr> <tr> <td style="text-align: center;">1.5</td> <td style="text-align: center;">55</td> <td style="text-align: center;">--</td> <td style="text-align: center;">45</td> </tr> </tbody> </table> <p>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.</p>	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
Age Last Birthday at Date of Retirement																																																					
Percent	Group 1	Group 2	Group 4																																																		
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1.7	57	--	47																																																		
1.6	56	--	46																																																		
1.5	55	--	45																																																		

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

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.

Ordinary Disability Benefit:

A member who is unable to perform his or her job due to a non-occupational disability will receive a retirement allowance if he or she has ten or more years of creditable service and has not reached age 55. The annual amount of such allowance shall be determined as if the member retired for superannuation at age 55 (age 60 for Group 1 members hired on or after April 2, 2012), based on the amount of creditable service at the date of disability. For veterans, there is a minimum benefit of 50 percent of the member’s most recent year’s pay plus an annuity based on his or her own contributions.

Accidental Disability Benefit:	For a job-connected disability, the benefit is 72 percent of the member's most recent annual pay plus an annuity based on his or her own contributions, plus additional amounts for surviving children. Benefits are capped at 75 percent of annual rate of regular compensation for employees who become members after January 1, 1988.
Death Benefits:	<p>In general, the beneficiary of an employee who dies in active service will receive a refund of the employee's own contributions. Alternatively, if the employee were eligible to retire on the date of death, a spouse's benefit will be paid equal to the amount the employee would have received under Option C. The surviving spouse of a member who dies with two or more years of credited service has the option of a refund of the employee's contributions or a monthly benefit regardless of eligibility to retire, if they were married for at least one year. There is also a minimum widow's pension of \$500 per month, and there are additional amounts for surviving children.</p> <p>If an employee's death is job-connected, the spouse will receive 72 percent of the member's most recent annual pay, in addition to a refund of the member's accumulated deductions, plus additional amounts for surviving children. However, in accordance with Section 100 of Chapter 32, the surviving spouse of a police officer, firefighter or corrections officer is killed in the line of duty will be eligible to receive an annual benefit equal to the maximum salary held by the member at the time of death.</p> <p>Upon the death of a job-connected disability retiree who retired prior to November 7, 1996 and could not elect an Option C benefit, a surviving spouse will receive an allowance of \$12,000 per year if the member dies for a reason unrelated to cause of disability.</p>
"Heart And Lung Law" And Cancer Presumption:	Any case of hypertension or heart disease resulting in total or partial disability or death to a uniformed fireman, permanent member of a police department, or certain employees of a county correctional facility is presumed to have been suffered in the line of duty, unless the contrary is shown by competent evidence. Any case of disease of the lungs or respiratory tract resulting in total disability or death to a uniformed fireman is presumed to have been suffered in the line of duty, unless the contrary is shown by competent evidence. There is an additional presumption for uniformed firemen that certain types of cancer are job-related if onset occurs while actively employed or within five years of retirement.
Options:	Members may elect to receive a full retirement allowance payable for life under Option A. Under Option B a member may elect to receive a lower monthly allowance in exchange for a guarantee that at the time of death any contributions not expended for annuity payments will be refunded to the beneficiary. Option C allows the member to take a lesser retirement allowance in exchange for providing a survivor with two-thirds of the lesser amount. Option C pensioners will have benefits converted from a reduced to a full retirement if the beneficiary predeceases the retiree.
Post-Retirement Benefits:	The Board has adopted the provisions of Section 51 of Chapter 127 of the Acts of 1999, which provide that the Retirement Board may approve an annual COLA in excess of the Consumer Price Index but not to exceed a 3% COLA on the first \$16,000 (previously, \$14,000) of a retirement allowance. Cost-of-living increases granted prior to July 1, 1998 are reimbursed by the Commonwealth and not reflected in this report.
Changes in Plan Provisions:	As permitted by Section 19 of Chapter 188 of the Acts of 2010, the Cost of Living Adjustment base was increased from \$14,000 to \$16,000 as of July 1, 2018.

