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Teachers' and State Employees' Retirement System
Principal Results of Actuarial Valuation as of December 31, 2018

October 31, 2019 Board of Trustees Meeting

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Purpose of the Annual Actuarial Valuation

- As of the end of each calendar year:
  - An annual actuarial valuation is performed on TSERS
  - The actuary determines the amount of employer contributions to be made to TSERS during each member's career that, when combined with investment return and member contributions, are expected to be sufficient to pay for retirement benefits.
- • In addition, the annual actuarial valuation is performed to:
  - Determine the progress on funding TSERS
  - Explore why the results of the current valuation differ from the results of the valuation of the previous year
  - Satisfy regulatory and accounting requirements

The Valuation Process

- The diagram to the right summarizes the inputs and results of the actuarial valuation process.
- A detailed summary of the valuation process and a glossary of actuarial terms are provided in Appendix A of the actuarial report.
- This diagram will appear throughout the presentation to designate where we are in the process.

Inputs

Member Data
Asset Data
Benefit Provisions
Assumptions
Funding Methodology

↓

Results

Actuarial Value of Assets
Actuarial Accrued Liability
Net Actuarial Gain or Loss
Funded Ratio
Benefit Enhancement
Additional Disclosures
Projections

Member Data

The table below provides a summary of the membership data used in this valuation compared to the prior valuation.

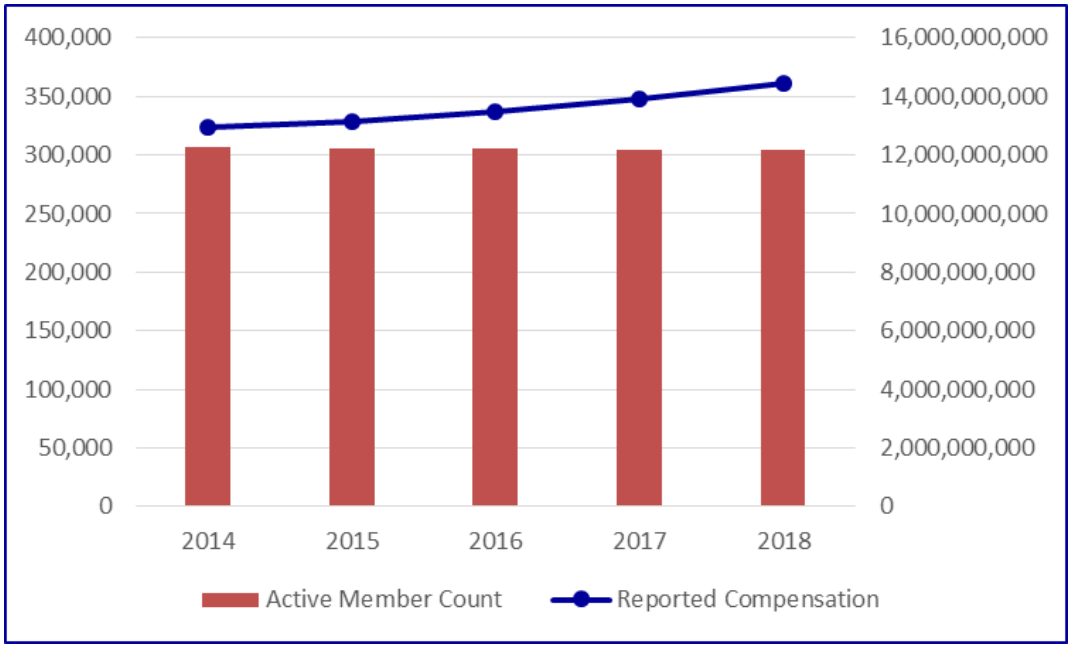
Number as of	12/31/2018	12/31/2017
Active Members	304,575	304,554
Members currently receiving Disability Income Plan benefits	6,190	6,680
Terminated members and survivors of deceased members entitled to benefits but not yet receiving benefits	168,755	160,087
Retired members and survivors of deceased members currently receiving benefits	222,084	215,008
Total	701,604	686,329

The number of active members increased by only 21 members from the previous valuation date. The number of TSERS members receiving benefits from the Disability Income Plan decreased by 7.3%. The number of retired members and survivors of deceased members currently receiving benefits increased by 3.3% from the previous valuation. The increase in retiree population is consistent with expectations.

A detailed summary of the membership data used in this valuation is provided in Section 3 and Appendix B.

Active Members

The graph below provides a history of the number of active members and reported compensation over the past five years.

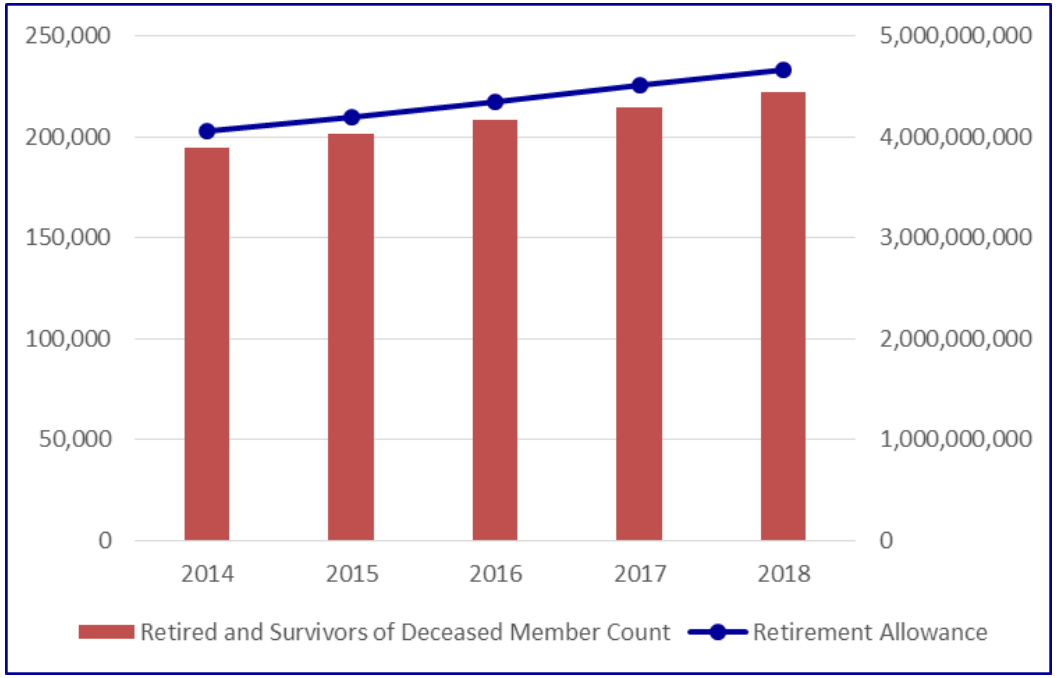


Reported compensation has increased by 3.8% and has averaged 2.8% over the past four years. Covered payroll is expected to increase by approximately 3.5% annually in the future. Payroll that is not increasing as fast as we assume results in less benefits accruing than we anticipate, but also fewer contributions supporting the system.

A detailed summary of the membership data used in this valuation is provided in Section 3 and Appendix B.

Membership Data

The graph below provides a history of the number of retired members and survivors of deceased members and benefit amounts payable over the past five years.



The number of retired members and survivors of deceased members and the benefits paid to these members has been increasing steadily, as expected based on plan assumptions.

A detailed summary of the membership data used in this valuation is provided in Section 3 and Appendix B.

Asset Data

The table below provides details of the Market Value of Assets for the current and prior year's valuations.

Asset Data as of	12/31/2018	12/31/2017
Beginning of Year Market Value of Assets	$ 70,607,887,248	$ 64,246,523,614
Employer Contributions	1,758,110,760	1,524,591,744
Employee Contributions	927,251,021	895,822,376
Benefit Payments Other Than Refunds	(4,666,520,152)	(4,456,849,037)
Refunds	(109,504,134)	(112,511,881)
Administrative Expense	(11,856,738)	(11,205,880)
Investment Income	(968,887,696)	8,521,516,312
Net Increase/(Decrease)	(3,071,406,939)	6,361,363,634
End of Year Value of Assets	$ 67,536,480,309	$ 70,607,887,248
Estimated Net Investment Return	-1.39%	13.49%

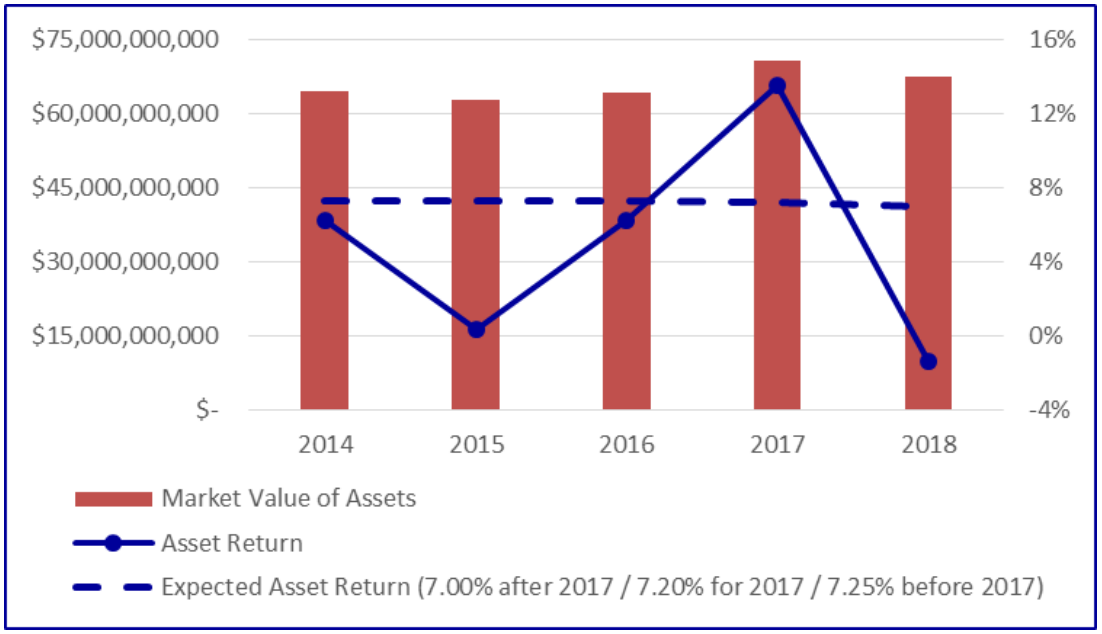
TSERS assets are held in trust and are invested for the exclusive benefit of plan members.

Incoming contributions cover roughly half of the outgoing benefit payments and administrative expenses. Over the long term, benefit payments and administrative expenses not covered by contributions are expected to be covered with investment income, illustrating the benefits of following actuarial pre-funding since inception.

A detailed summary of the market value of assets is provided in Section 4.

Asset Data

The graph below provides a history of the market value of assets and asset returns over the past five years.

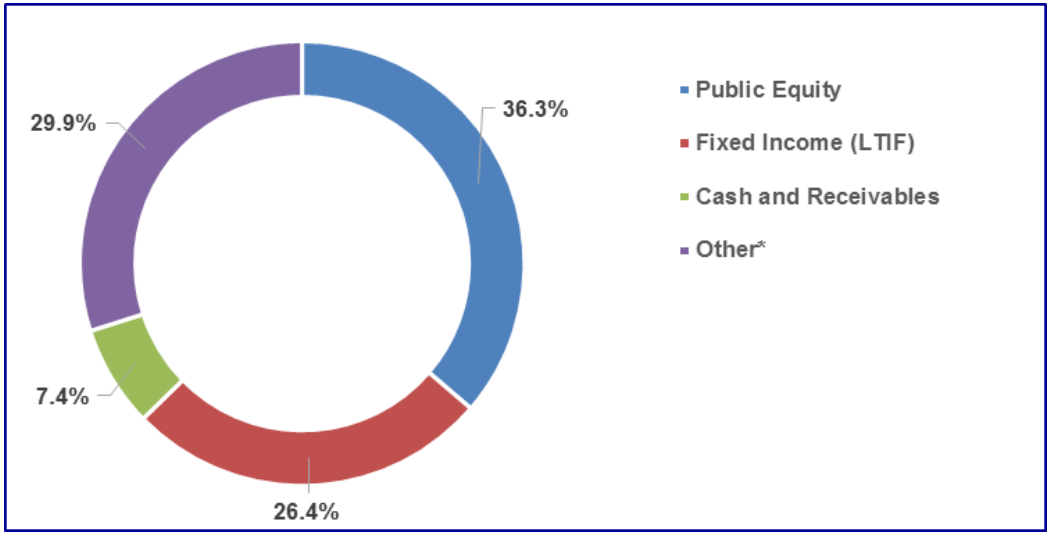


The investment return for the market value of assets for 2018 was -1.39%, far below the expected return of 7.00%. The return on the actuarial value of assets which is used to determine the contribution rates also fell short of the 7.00% expected return at 5.10%. This resulted in an increase in the UAAL of $1.3 billion. Market value returns have exceeded expectations only once in the last five years.

A detailed summary of the market value of assets is provided in Section 4.

Asset Data

The graph below provides the breakdown of the market value of assets at December 31, 2018 by asset category.



Based on historical market returns, the current asset allocation, the current investment policy, and the expectation of future asset returns, as reviewed in the last experience study, the 7.00% discount rate used in this valuation is reasonable and appropriate.

A detailed summary of the market value of assets is provided in Section 4.

Benefit Provisions

Benefit provisions are described in North Carolina General Statutes, Chapter 135.

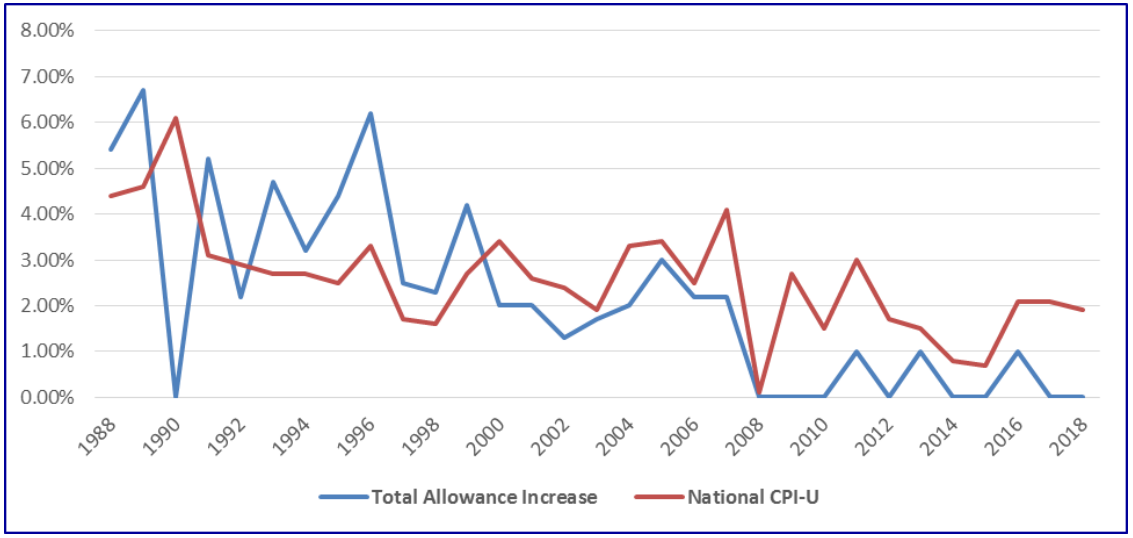
- There have been no changes to the benefit provisions since the last valuation.

Many Public Sector Retirement Systems in the United States have undergone pension reform where the benefits of members (active or future members) have been reduced. Because of the well-funded status of TSERS due to the legislature contributing the actuarially determined employer contribution, benefit cuts have not been made in North Carolina as they have been in most other states. Instead, we have seen a modest expansion of benefits in recent years based on sound plan design.

A detailed summary of the benefit provisions is provided in Appendix C.

Benefit Provisions

The graph below provides a 30-year history of allowance increases for TSERS and the national CPI-U. It does not include one-time supplements granted in recent years.



Generally the ad-hoc retirement allowance increase policy has helped retirees maintain purchasing power while helping to moderate contribution increases during times of down markets. This graph does not include one-time pension supplements that are sometimes granted.

A detailed summary of the benefit provisions is provided in Appendix C of the actuarial report.

Actuarial Assumptions

Actuarial assumptions bridge the gap between the information that we know with certainty as of the valuation date and what may happen in the future. The assumptions used include the following:

- Demographic
  - Retirement
  - Termination
  - Disability
  - Death
- Economic
  - Interest rate – 7.00% per year
  - Salary increase (individual, varies by service)
  - Inflation – 3.00%
  - Real wage growth – 0.50%

The assumptions used for the December 31, 2018 actuarial valuation are based on the experience study prepared as of December 31, 2014 and adopted by the Board of Trustees on January 21, 2016. The discount rate was updated to be 7.00%, as adopted by the Board of Trustees on April 26, 2018. The impact on the contribution rate will be direct-rate smoothed over a three year period.

A detailed summary of the actuarial assumptions and methods is provided in Appendix D.

Funding Methodology

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Asset Data
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The Funding Methodology is the payment plan for TSERS and is composed of the Actuarial Cost Method, the Asset Valuation Method and Amortization Method.

- Actuarial Cost Methods allocate costs to the actuarial accrued liability (i.e. the amount of money that should be in the fund) for past service and normal cost (i.e. the cost of benefits accruing during the year) for current service.
  - The Board of Trustees has adopted Entry Age Normal as its actuarial cost method
  - This method develops normal costs that stay level as a percent of payroll

The funding methodology is consistent with GFOA Best Practices.

http://www.gfoa.org/core-elements-funding-policy

A detailed summary of the actuarial assumptions and methods is provided in Appendix D.

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The Funding Methodology is the payment plan for TSERS and is composed of the Actuarial Cost Method, the Asset Valuation Method and Amortization Method.

- Asset Valuation Methods smooth or average the market value returns over time to alleviate contribution volatility that results from market returns.
  - Asset returns in excess of or less than the expected return on market value of assets reflected over a five-year period
  - Assets corridor: not greater than 120% of market value and not less than 80% of market value

The asset smoothing method is consistent with GFOA Best Practices. http://www.gfoa.org/core-elements-funding-policy

A detailed summary of the actuarial assumptions and methods is provided in Appendix D.

Funding Methodology

The Funding Methodology is the payment plan for TSERS and is composed of the Actuarial Cost Method, the Asset Valuation Method and Amortization Method.

- Amortization Methods determine the payment schedule for unfunded actuarial accrued liability (i.e. the difference between the actuarial accrued liability and actuarial value of assets)
  - Payment level: the payment is determined as a level dollar amount, similar to a mortgage payment
  - Payment period: a 12-year closed amortization period was adopted for fiscal year ending 2012. A new amortization base is created each year based on the prior years' experience.
- For fiscal years beginning subsequent to January 1, 2017, the sum of the "normal contribution" and the "accrued liability contribution" shall not be less than the employee contribution.

When compared to other Public Sector Retirement Systems in the United States, the funding policy for TSERS is quite aggressive in that the policy pays down the pension debt over a much shorter period of time (12 years) compared to the national average of around 24 years. In addition, payments are developed to stay level instead of the increasing policy many systems use which results in lower payments early on. As such it is a best practice among public retirement systems.

A detailed summary of the actuarial assumptions and methods is provided in Appendix D.

Actuarial Value of Assets

The table below provides the calculation of the Actuarial Value of Assets (AVA) at the valuation date.

Asset Data as of	12/31/2018
Beginning of Year Actuarial Value of Assets	$ 69,568,450,606
Beginning of Year Market Value of Assets	70,607,887,248
Total Contributions	2,685,361,781
Benefit Payments, Refunds and Administrative Expenses	(4,787,881,024)
Net Cash Flow	(2,102,519,243)
Expected Investment Return	4,870,208,534
Expected End of Year Market Value of Assets	73,375,576,539
End of Year Market Value of Assets	67,536,480,309
Excess of Market Value over Expected Market Value of Assets	(5,839,096,230)
80% of 2018 Asset Gain/(Loss)	(4,671,276,984)
60% of 2017 Asset Gain/(Loss)	2,376,346,969
40% of 2016 Asset Gain/(Loss)	(252,680,494)
20% of 2015 Asset Gain/(Loss)	(875,002,622)
Total Deferred Asset Gain/(Loss)	(3,422,613,131)
Preliminary End of Year Actuarial Value of Assets	70,959,093,440
Final End of Year Actuarial Value of Asset (not less than 80% and not greater than 120% of Market Value)	70,959,093,440
Estimated Net Investment Return on Actuarial Value	5.10%

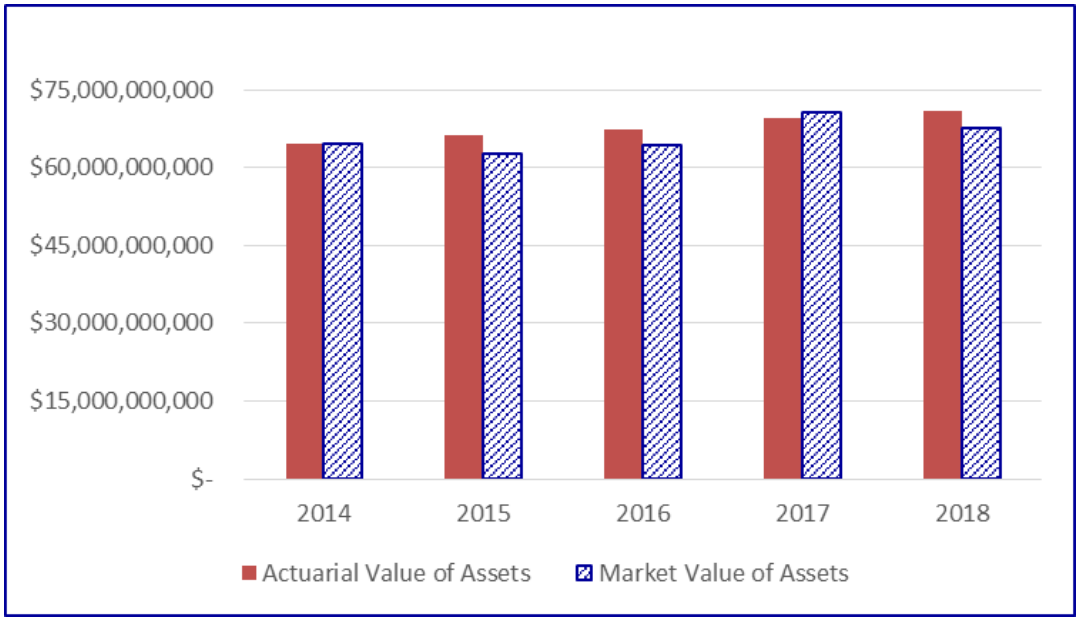
A detailed summary of the Actuarial Value of Assets is provided in Section 4.

The actuarial value of assets smooths investment gains/losses, resulting in less volatility in the employer contribution. The asset valuation recognizes asset returns in excess of or less than the expected return on the market value of assets over a five-year period. Actuarial value of assets was reset to the market value of assets at December 31, 2014.

Lower than expected market returns in 2015, 2016 and 2018, which were partially offset by greater than expected market returns in 2017, resulted in an actuarial value of asset return for calendar year 2018 of 5.10% and a recognized actuarial asset loss of $1.3 billion during 2018.

Actuarial Value of Assets

The graph below provides a history of the market value and actuarial value of assets over the past five years.



The market value of assets is lower than the actuarial value of assets, which is used to determine employer contributions. This indicates that overall there are unrecognized asset losses to be recognized in future valuations. In fact, if the investments earn the expected 7.00% over the next four years, a loss will be recognized each of those years.

A detailed summary of the Actuarial Value of Assets is provided in Section 4.

Actuarial Value of Assets

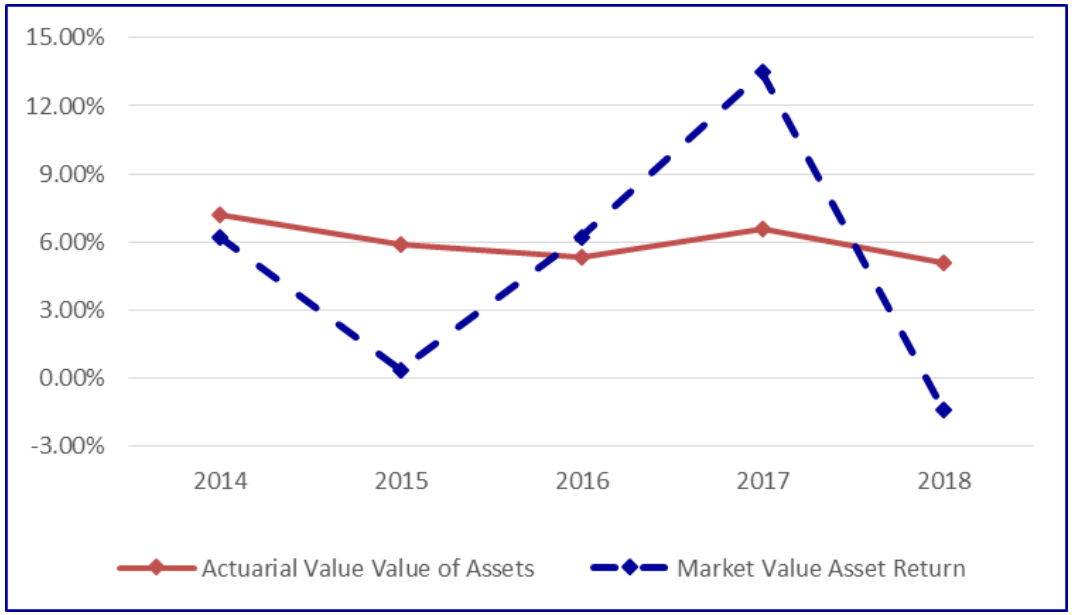
Calendar Year	Expected Asset Return	Actuarial Value of Asset Return	Market Value of Asset Return	20 Year Average Market Return
1996	7.50%	10.18%	9.39%	NA
1997	7.25%	10.18%	18.16%	NA
1998	7.25%	9.92%	16.66%	NA
1999	7.25%	10.60%	10.15%	NA
2000	7.25%	11.55%	2.50%	NA
2001	7.25%	8.51%	-1.87%	NA
2002	7.25%	5.66%	-5.21%	NA
2003	7.25%	7.98%	18.23%	NA
2004	7.25%	8.56%	10.73%	NA
2005	7.25%	8.26%	6.97%	NA
2006	7.25%	8.94%	11.41%	NA
2007	7.25%	8.87%	8.38%	NA
2008	7.25%	2.89%	-19.50%	NA
2009	7.25%	4.74%	14.84%	NA
2010	7.25%	5.89%	11.47%	NA
2011	7.25%	5.15%	2.19%	NA
2012	7.25%	6.32%	11.82%	NA
2013	7.25%	7.43%	12.21%	NA
2014	7.25%	7.19%	6.21%	NA
2015	7.25%	5.87%	0.36%	6.86%
2016	7.25%	5.32%	6.22%	6.71%
2017	7.20%	6.56%	13.49%	6.49%
2018	7.00%	5.10%	-1.39%	5.60%
20-Yr Average	7.23%	7.05%	5.60%	NA
Range	0.50%	8.66%	37.73%	NA

The average investment return recognized for purposes of determining the annual change in contribution each year is the actuarial value of assets return. Currently, the average actuarial return over the past 20 years of 7.05% compares with an average market return of 5.60%. The difference is primarily due to asset gains of the late 1990's being included in the actuarial value of assets and not in the market value as well as the 2018 market value loss only being partially recognized in the actuarial value of assets. The range of returns is markedly more volatile 8.66% versus 37.73%. This results in much lower employer contribution volatility using the actuarial value of assets versus market, while ensuring that the actuarial needs of TSERS are met.

A detailed summary of the Actuarial Value of Assets is provided in Section 4.

Actuarial Value of Assets

The graph below provides a history of the market value and actuarial value of asset returns over the past five years.

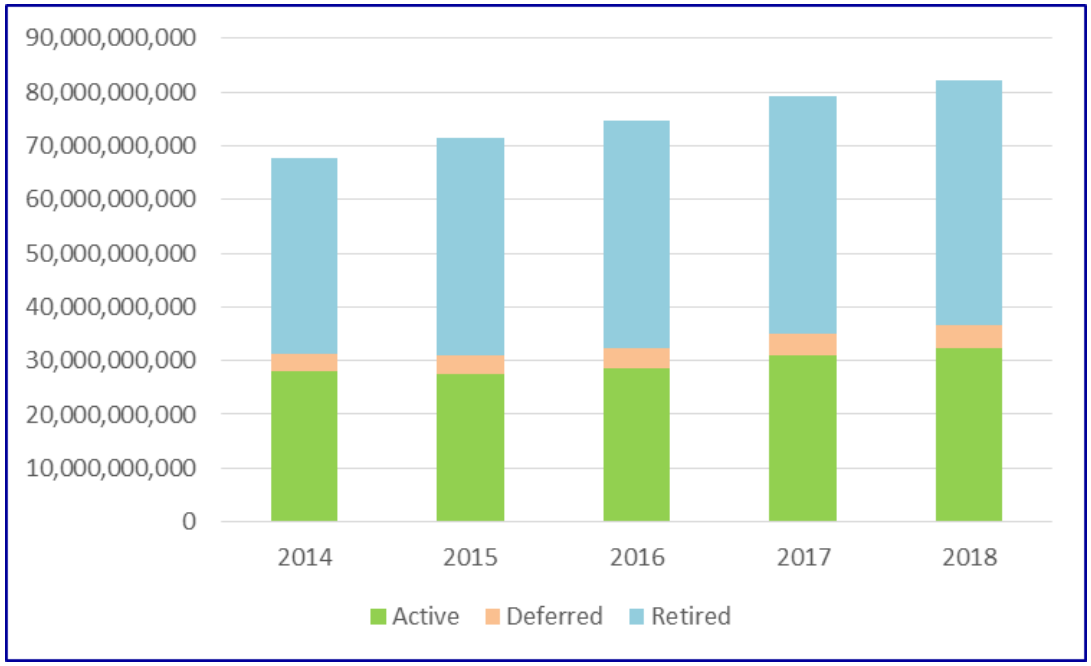


The investment return for the market value of assets for calendar year 2018 was -1.39%. The actuarial value of assets smooths investment gains and losses. Lower than expected market returns in all years except 2017 resulted in an actuarial value of asset return for calendar year 2018 of 5.10% and a recognized actuarial asset loss of $1.3 billion during 2018.

A detailed summary of the Actuarial Value of Assets is provided in Section 4.

Actuarial Accrued Liability

The graph below provides a history of the actuarial accrued liability (AAL) over the past five years.

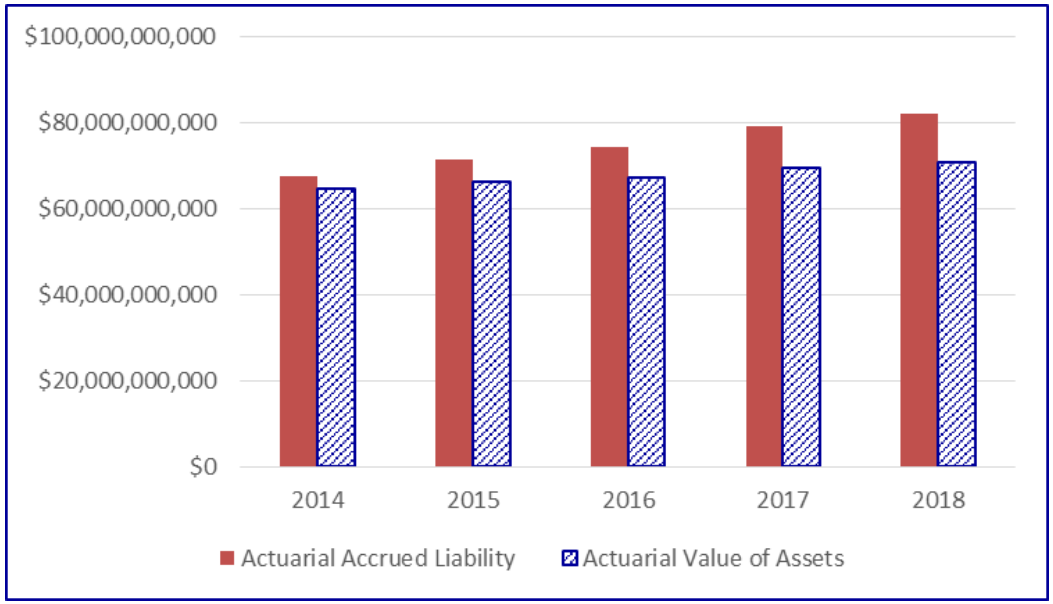


The AAL increased from $79.2 billion to $82.1 billion during 2018. The Retirement System is an open plan, which means that new members enter the plan each year. In an open plan, liabilities are expected to grow from one year to the next as more benefits accrue and the membership approaches retirement. The AAL was $558 million higher than expected resulting from demographic losses. Most of the loss was due to salary increases higher than expected.

A detailed summary of the Actuarial Accrued Liability is provided in Section 5.

AVA and AAL

The graph below provides a history of the actuarial accrued liability and actuarial value of assets.



The difference in the actuarial accrued liability and the actuarial value of assets is known as the Unfunded Actuarial Accrued Liability, or the pension debt. The UAAL is $11.15 billion as of 12/31/2018 and is to be paid off over a 12-year period.

Detailed summaries of the AVA and AAL are provided in Sections 4 and 5 respectively.

Net Actuarial Gain or Loss

The table below provides a reconciliation of the prior year's unfunded actuarial accrued liability to the current year's unfunded actuarial accrued liability.

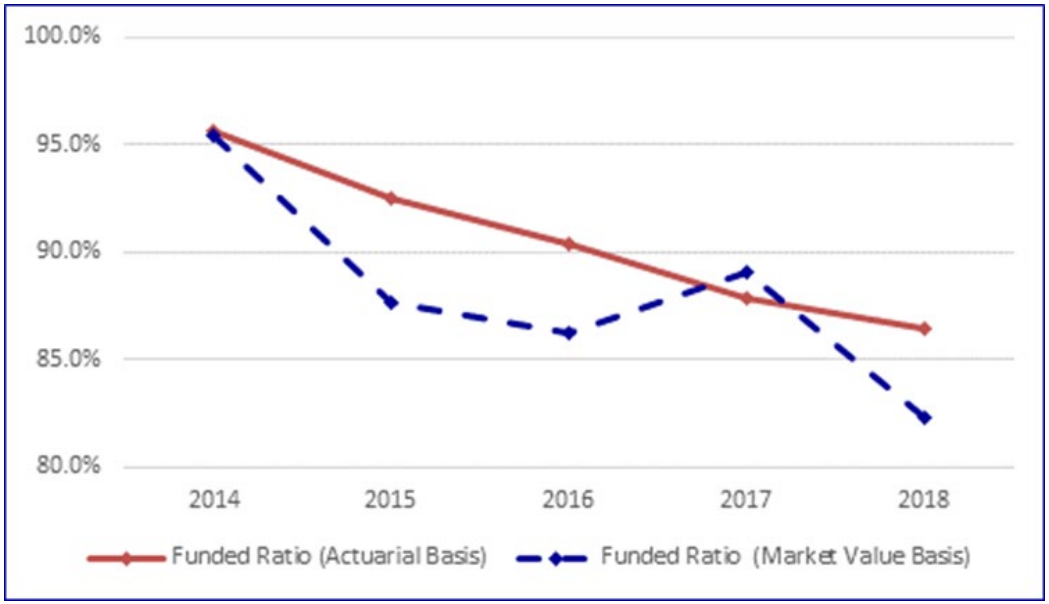
(in millions)		
Unfunded Actuarial Accrued Liability (UAAL) as of 12/31/2017	$	9,641
Normal Cost and Administrative Expense during 2018		1,688
Reduction due to Actual Contributions during 2018		(2,685)
Interest on UAAL, Normal Cost, and Contributions		641
Asset (Gain) / Loss		1,304
Actuarial Accrued Liability (Gain) / Loss		558
Impact of Assumption Changes		-
Impact of Legislative Changes		-
Unfunded Actuarial Accrued Liability (UAAL) as of 12/31/2018	$	11,147

During 2018, the UAAL increased by $1,506 million. The loss recognized in the Actuarial Value of Assets during the year increased the UAAL by $1,304 million. Demographic losses were $558 million primarily due to salary increases larger than expected.

A detailed summary of the net actuarial gain or loss is provided in Section 5.

Funded Ratio

The graph below provides a history of the funded ratio on a market and actuarial basis over the past five years.

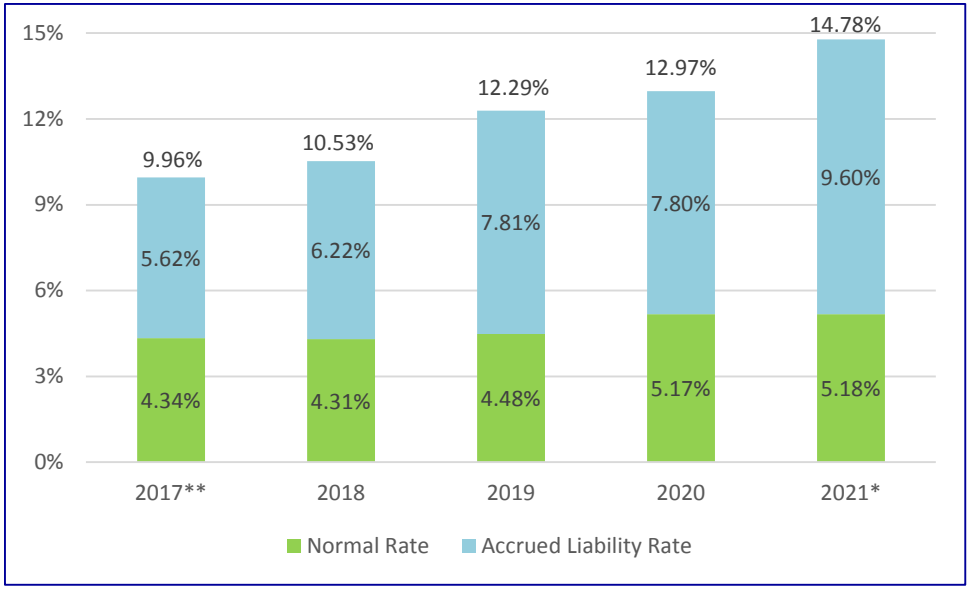


The ratio of assets to liabilities shows the health of the plan on an accrued basis. The funded ratio on an actuarial basis decreased from 87.4% at December 31, 2017 to 86.4% at December 31, 2018.

A detailed summary of the funded ratio is provided in Section 5.

Employer Contributions

The graph below provides a history of actuarially determined employer contribution rates over the past five years before applying funding policy minimums.



The rates are split into the normal rate and the accrued liability rate. The normal rate is the employer's portion of the cost of benefits accruing after reducing for the member contribution. The accrued liability rate is the payment toward the unfunded liability. See slide 26 for more detail.

The actuarially determined employer contribution rate is the amount needed to pay for the cost of the benefits accruing and to pay off the unfunded liability over a 12 year period, offset for the 6% of pay contribution the members make. The 12-year period is a short period for Public Sector Retirement Systems in the United States, with the funding period for most of these Systems much longer. The shorter period results in higher contributions and more benefit security.

A detailed summary of the actuarially determined employer contribution rates is provided in Section 6.

Employer Contributions

The ECRSP (Employer Contribution Rate Stabilization Plan) would result in a recommended contribution rate of 14.78% of payroll for fiscal year ending 2021.

- 15.37% is the actuarially determined employer contribution calculated in this most recent valuation prior to direct-rate smoothing of the assumption change. 14.78% is the actuarially determined contribution after direct-rate smoothing of the assumption change.
- The minimum is 13.32%; the appropriated contribution from last year of 12.97% plus 0.35%.
- The maximum is approximately 63.80%; the estimated actuarially determined employer contribution using a discount rate equal to the long-term Treasury bond yield (3.02%).

The ECRSP adopted by the Board of Trustees on January 21, 2016 requires that recommended contributions be 0.35% of payroll greater than the appropriated contribution during the prior year, with the following bounds: (1) contributions may not be less than the actuarially determined employer contribution (ADEC) and (2) contributions may not be greater than a contribution determined using the same assumptions used to calculate the ADEC based on the long-term Treasury bond yield.

A detailed summary of the actuarially determined employer contribution rates is provided in Section 6.

Employer Contributions

The table below provides a history of the actuarially determined employer contribution and the corresponding appropriated rate.

Valuation Date	Fiscal Year Ending	Normal Rate	Accrued Liability Rate	Change due to Legislation*	Final ADEC**	Appropriated Rate
12/31/2018	06/30/2021	5.18%	10.19%	N/A	N/A	N/A
12/31/2017	06/30/2020	5.17%	8.99%	0.00%	12.97%	12.97%
12/31/2016	06/30/2019	4.48%	7.50%	0.31%	12.29%	12.29%
12/31/2015	06/30/2018	4.31%	5.77%	0.45%	10.53%	10.78%
12/31/2014	06/30/2017	5.21%	3.26%	1.49%	9.96%	9.98%
12/31/2013	06/30/2016	5.19%	3.50%	0.00%	8.69%	9.15%

- The change due to legislation for the contribution for fiscal year ending 6/30/2019 includes a 0.31% increase in the ADEC due to the one-time cost-of-living supplement payable in October, 2018.
- **Final ADEC reduced for direct-rate smoothing of discount rate change for FYE 2020 and 2021.

The appropriated rate for fiscal year ending 2020 is 12.97% of payroll. The preliminary ADEC for fiscal year ending 2021 before direct-rate smoothing is 15.37% of payroll.

In addition to calculating the ADEC, we calculated the increase in ADEC for a 1% COLA to be 0.42% of payroll and the increase in UAAL to be $497,775,000. We also calculated the increase in ADEC for a 0.1% increase in the Defined Benefit Formula to be 0.42% of payroll and the increase in UAAL to be $427,299,000.

A detailed summary of the actuarially determined employer contribution rates is provided in Section 6.

Employer Contributions

The table below provides a reconciliation of the actuarially determined employer contribution rate shown as a percentage of covered payroll.

Fiscal year ending June 30, 2020 Preliminary ADEC (based on December 31, 2017 valuation)	12.97%
Impact of Legislative Changes	0.00%
Fiscal year ending June 30, 2020 ADEC for Reconciliation	12.97%
Change Due to Anticipated Reduction in UAAL*	(0.32%)
Change Due to Demographic (Gain)/Loss	0.50%
Change Due to Investment (Gain)/Loss	1.08%
Change Due to Contributions Greater than ADEC**	(0.05%)
Impact of Assumption Change	0.00%
Impact of Direct Rate Smoothing	0.60%
Fiscal year ending June 30, 2021 Preliminary ADEC (based on December 31, 2018 valuation)	14.78%

** Amortization of the UAAL is determined as a level dollar amount with payments expected to remain the same over the amortization period, but was calculated as a percentage of valuation payroll in the previous valuation. Payroll is expected to increase annually while the expected amortization payment does not increase. This causes the expected amortization payment to be a lesser percentage of the expected payroll.
***Includes impact of ECRSP rate in excess of ADEC

The change in rate due to investment loss is based on the actuarial value of assets return, which was less than the 7.00% assumed return.

The change in rate due to demographics was mostly due to salaries increasing more than expected.

The impact of direct rate smoothing is the deferred recognition of the 12/31/2017 discount rate change from 7.20% to 7.00%.

A detailed summary of the actuarially determined employer contribution rates is provided in Section 6.

Potential COLAs

- Based on the actuarial losses recognized in this December 31, 2018, valuation, no Cost-of-Living Adjustment (COLA) effective July 1, 2020, could be funded by actuarial gains.
- Based on the methods and assumptions used for the projections discussed later in the presentation, we estimate that a potential COLA effective July 1, 2021, may be funded by actuarial investment gains following the December 31, 2019, valuation in the following circumstances:
  - If calendar year 2019 market value returns exceed 19.2% (or about $12.7B for TSERS), the plan is estimated to have an actuarial investment gain (rather than a loss) for 2019 and a COLA that would take effect on July 1, 2021, could be considered.
  - If calendar year 2019 market value returns exceed 23.0% (or about $15.3B for TSERS), the plan is estimated to have an actuarial investment gain (rather than a loss) for 2019 and such gain may be enough to consider providing a 1% COLA that would take effect on July 1, 2021.
    - Estimated actuarial investment gain of $506.7M
    - Estimated cost of 1% COLA payable to retirees effective July 1, 2021 of $497.8M
  - Estimates above assume no other offsetting actuarial losses in the December 31, 2019, valuation
- Note: CMC cannot provide legal advice. This slide should not be interpreted as legal advice as to the Board's ability to provide a COLA to retirees or recommend a COLA to the legislature

A detailed summary of the cost of benefit enhancements is provided in Section 6.

Additional Disclosures

The table below illustrates the sensitivity of certain valuation results to changes in the discount rate on a market value of assets basis.

Discount Rate	3.02%	5.01%	7.00%	8.99%	10.98%
Market Value of Assets	$ 67,536,480,309	$ 67,536,480,309	$ 67,536,480,309	$ 67,536,480,309	$ 67,536,480,309
Actuarial Accrued Liability	$132,734,729,979	$102,619,047,242	$ 82,105,943,131	$ 67,795,453,307	$ 57,528,397,674
Unfunded Accrued Liabilty (AAL)	$ 65,198,249,670	$ 35,082,566,933	$ 14,569,462,822	$ 258,972,998	$ (10,008,082,635)
Funded Ratio	50.9%	65.8%	82.3%	99.6%	117.4%
20-Year Amortization of UAL	$ 4,523,039,166	$ 2,958,648,440	$ 1,471,510,051	$ 30,897,538	N/A
(as % of general state revenue)	14.6%	9.5%	4.7%	0.1%	N/A

Section 6(c) of Session Law 2016-108 requires that the actuarial valuation report provide the valuation results using a 30-year Treasury rate as of December 31 of the year of the valuation as the discount rate. The 30-year treasury rate is 3.02% as of December 31, 2018.

The difference between the UAAL measured at 7.00% and 3.02% is $50.6 billion at December 31, 2018.

A detailed summary of the additional disclosures is provided in Appendix F.

Additional Disclosures

The table below provides an estimate of future market value of asset returns based on the study performed in 2016.

Horizon	95% Chance (19 out of every 20 scenarios)	75% Chance (3 out of every 4 scenarios)	50% Chance (1 out of every 2 scenarios)	25% Chance (1 out of every 4 scenarios)	5% Chance (1 out of every 20 scenarios)
10 Years (2025)	0.2%	4.0%	5.9%	8.0%	11.5%
20 Years (2035)	2.2%	4.8%	6.7%	8.5%	11.8%
30 Years (2045)	3.1%	5.3%	7.1%	8.7%	12.0%

These results are summarized in the "TSERS Asset-Liability and Investment Strategy Project" report dated April 19th, 2016 prepared by Conduent, the prior actuary.

The lower bound of 3.02% falls slightly below the 5th percentile of estimated future 30-year returns. In other words, there is less than a 5% chance of seeing a 30-year return of 3.02% or lower based on the current portfolio structure.

A detailed summary of the additional disclosures is provided in Appendix F.

Projections

- Projections of contribution requirements and funded status into the future can be helpful planning tools for stakeholders. This section provides such projections. The projections of the actuarial valuation are known as deterministic projections. Deterministic projections are based on one scenario in the future. The baseline deterministic projection is based on December 31, 2018 valuation results as assumptions.

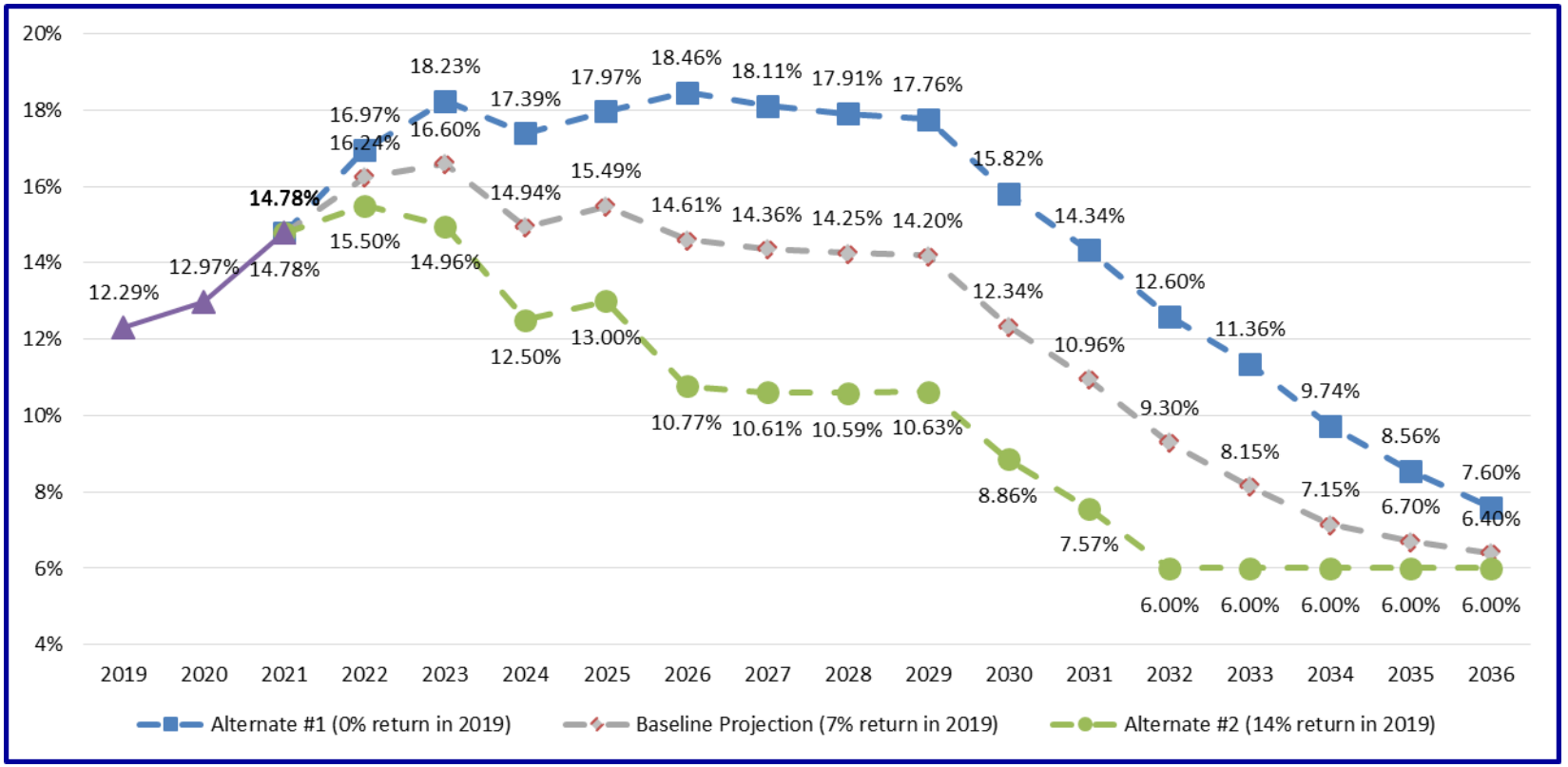
- Key Projection Assumptions
  - Valuation interest rate of 7.00% for all years in conjunction with direct rate smoothing of the employer contribution rate over a 3-year period beginning July 1, 2019.
  - 7.00% investment return on market value of assets
  - Actuarial assumptions and methods as described in Appendix D. All future demographic experience is assumed to be exactly realized.
  - The contribution rate under the Employer Contribution Rate Stabilization Policy (ECRSP) is contributed until fiscal year ending 2022.
  - The actuarially determined employer contribution rate is contributed for fiscal years ending 2023 and beyond.
  - 0% increase in the total active member population
  - No cost-of-living adjustments granted
  - Future pay increases based on long-term salary increase assumptions

- The ECRSP adopted by the Board of Trustees on January 21, 2016 requires that recommended contributions be 0.35% of payroll greater than the appropriated contribution during the prior year, with the following bounds: (1) contributions may not be less than the actuarially determined employer contribution (ADEC) rate and (2) contributions may not be greater than a contribution determined using the same assumptions used to calculate the ADEC but using a discount rate equal to the long-term Treasury bond yield.

- In addition, we have provided two alternate deterministic projections. The first alternate deterministic projection is based on the same assumptions as the baseline deterministic projection except that it assumes a 0.0% asset return for calendar year 2019. The second alternate deterministic projection is based on the same assumptions as the baseline deterministic projection except that it assumes a 14.0% asset return for calendar year 2019.

A detailed summary of the deterministic projections is provided in Section 9.

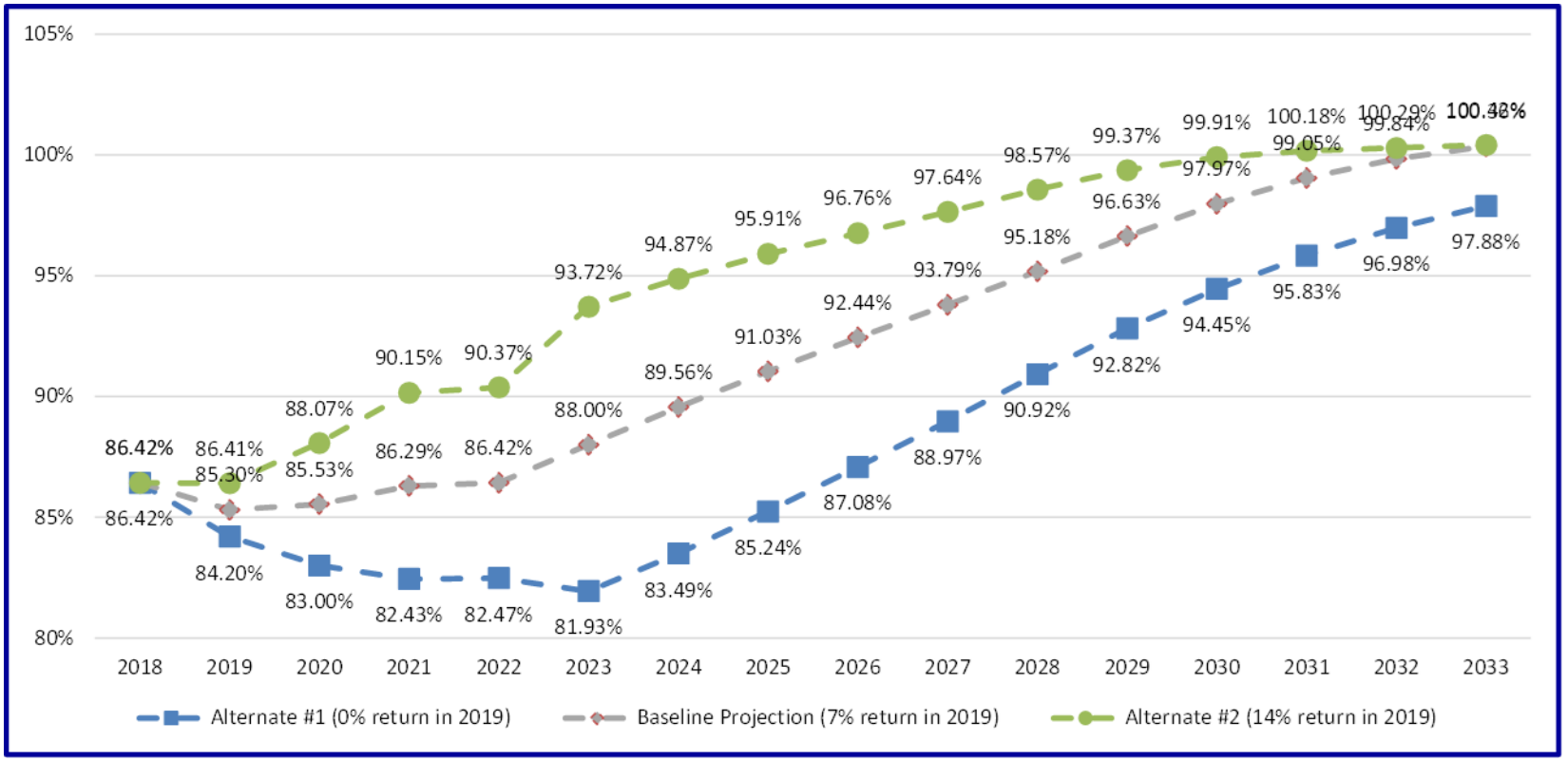
Projected Contribution Rates



But for the floor of 6.00% on the employer contribution, the actuarially determined employer contribution rate trends to around 5.5%, which is the level of the cost of benefits accruing each year, or the long term employer cost of TSERS when there is no unfunded actuarial accrued liability. The amounts above the long term employer cost of TSERS of 5.5% serves to increase the funded ratio above 100%.

A detailed summary of the deterministic projections is provided in Section 9.

Projected Funded Ratio



Note that if the 7.00% return under the Baseline Projection is achieved, the funded ratio reaches the long term target of 100% within 15 years. This is a direct result of using a 12-year period to pay off the unfunded actuarial accrued liability.

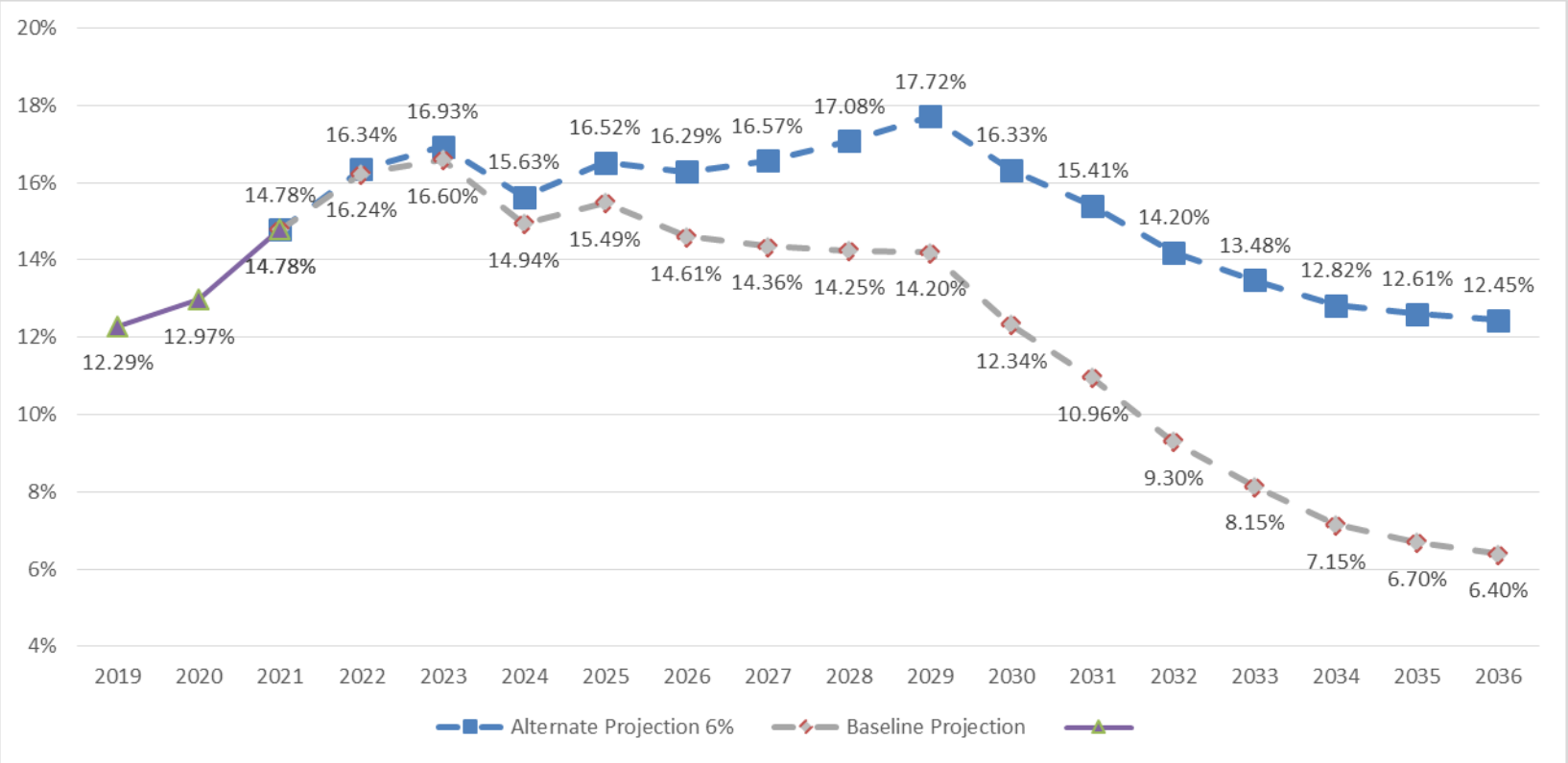
A detailed summary of the deterministic projections is provided in Section 9.

Projections

- The baseline projection uses the same basis described earlier in this presentation. The alternate deterministic projection is based on the same assumptions as the baseline deterministic projection except that it assumes a 6.0% investment return on market value of assets for all calendar years starting in 2019.

A detailed summary of the deterministic projections is provided in Section 9.

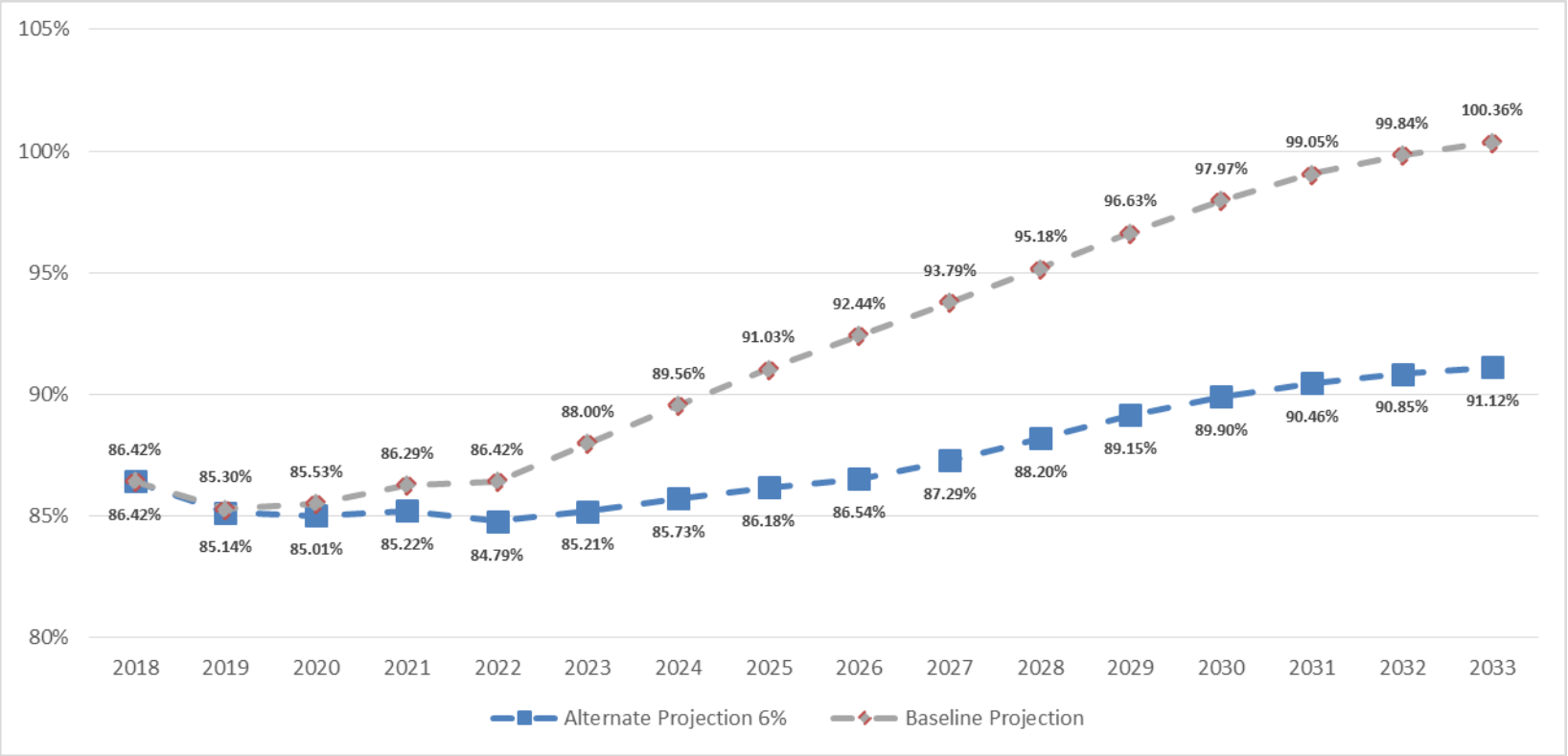
Projected Contribution Rates



Alternate Projection assumes 6.00% asset returns every year starting in 2019 compared to the 7.00% assumption in the Baseline Projection. As a result, the unfunded accrued liability will be higher resulting in higher projected contributions.

A detailed summary of the deterministic projections is provided in Section 9.

Projected Funded Ratio



Alternate Projection assumes 6.00% asset returns every year starting in 2019 compared to the 7.00% assumption in the Baseline Projection. As a result, the unfunded accrued liability will be higher resulting in a lower projected funded ratio.

A detailed summary of the deterministic projections is provided in Section 9.

Key Takeaways

- Key results of the December 31, 2018 valuation were:
  - Market value return of -1.39% compared to 7.00% assumed
  - Actuarial value return of 5.10% resulting in an increase of the UAAL by $1.30 billion and an increase in the employer contribution rate of 1.08% of pay.
  - Demographic losses mostly due to salary increases more than expected increased the UAAL by $0.56 billion and the employer contribution rate by 0.50%.

Key Takeaways (continued)

- When compared to the December 31, 2017 baseline projections, the above resulted in:
  - A lower funded ratio as of December 31, 2018 (86.4% in the valuation compared to 88.3% in the baseline projection)
  - Higher actuarially determined employer contribution rate for fiscal year ending June 30, 2021 (14.78% in the valuation compared to 13.39% in the baseline projection)

Key Takeaways (continued)

- TSERS is well funded compared to its peers. This is due to:
  - Stakeholders working together to keep TSERS well-funded since inception
  - A history of appropriating and contributing the recommended contribution requirements
  - Assumptions that in aggregate are more conservative than peers
  - A funding policy that aggressively pays down unfunded liability over a 12-year period
  - An ad hoc cost-of-living adjustment, which typically only provides benefit increases when certain financial conditions are met, supports the health of the system
  - Modest changes in benefits when compared to peers
- As has been done over the past 75+ years, continued focus on these measures will be needed to maintain the sustainability of TSERS well into the future

Certification

Future actuarial measurements may differ significantly from current measurements due to plan experience differing from that anticipated by the economic and 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. Because of limited scope, Cavanaugh Macdonald performed no analysis of the potential range of such future differences, except for some limited analysis in financial projections or required disclosure information. Results prior to December 31, 2017 were provided by the prior consulting actuary.

We meet the Qualification Standards of the American Academy of Actuaries to render the actuarial opinions contained in this report. This report has been prepared in accordance with all applicable Actuarial Standards of Practice, and we are available to answer questions about it.

Larry Langer, ASA, EA, FCA, MAAA
Principal and Consulting Actuary

Jonathan T. Craven, ASA, EA, FCA, MAAA
Consulting Actuary

Cavanaugh Macdonald
CONSULTING, LLC
The experience and dedication you deserve

Teachers' and State Employees' Retirement System of North Carolina

Report on the Seventy-Sixth Actuarial Valuation Prepared as of December 31, 2018

October 2019

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Cavanaugh Macdonald
CONSULTING, LLC
The experience and dedication you deserve

October 8, 2019

Board of Trustees
Teachers' and State Employees'
Retirement System of North Carolina
3200 Atlantic Avenue
Raleigh, NC 27604

Members of the Board:

We submit herewith our report on the seventy-sixth annual valuation of the Teachers' and State Employees' Retirement System of North Carolina (referred to as "TSERS" or the "State Plan") prepared as of December 31, 2018. The report has been prepared in accordance with North Carolina General Statute 135-6(o). Information contained in our report for plan years prior to December 31, 2017 is based upon valuations performed by the prior actuary.

The primary purpose of the valuation report is to determine the required member and employer contribution rates, to describe the current financial condition of TSERS, and to analyze changes in such condition. In addition, the report provides information that the Office of the State Controller (OSC) requires for its Comprehensive Annual Financial Report (CAFR) and it summarizes census data. Use of this report for any other purposes or by anyone other than OSC and its auditors, or North Carolina Retirement System Division and Department of State Treasurer staff may not be appropriate and may result in mistaken conclusions because of failure to understand applicable assumptions, methods, or inapplicability of the report for that purpose. The attached pages should not be provided without a copy of this cover letter. Because of the risk of misinterpretation of actuarial results, you should ask Cavanaugh Macdonald Consulting (CMC) to review any statement you wish to make on the results contained in this report. CMC will not accept any liability for any such statement made without prior review.

The valuation is based upon membership data and financial information as furnished by the Retirement Systems Division and the Financial Operations Division and as summarized in this report. Although reviewed for reasonableness and consistency with the prior valuation, these elements have not been audited by CMC and we cannot certify as to the accuracy and completeness of the data supplied. Sometimes assumptions are made by CMC to interpret membership data that is imperfect. The valuation is also based on benefit and contribution provisions as presented in this report. If you have reason to believe that the plan provisions are incorrectly described, that important plan provisions relevant to this valuation are not described, or that conditions have changed since the calculations were made, you should contact the authors of this actuarial report prior to relying on this information.

The valuation is further based on the actuarial valuation assumptions, approved by the Board of Trustees, as presented in this report. We believe that these assumptions are appropriate and reasonable and also comply with the requirements of GASB Statement No. 67. We prepared this valuation in accordance with the requirements of this standard and in accordance with all applicable Actuarial Standards of Practice (ASOP).

The assumptions used for the December 31, 2018 actuarial valuation are based on the experience study prepared as of December 31, 2014 and adopted by the Board of Trustees on January 21, 2016, as further updated to use a discount rate of 7.00% in conjunction with direct rate smoothing of the employer contribution rate, as adopted by the Board of Trustees on April 26, 2018. The economic assumptions with respect to investment yield, salary increase and inflation have been based upon a review of the existing portfolio structure as well as recent and anticipated experience.

Where presented, references to "funded ratio" and "unfunded accrued liability" typically are measured on an actuarial value of assets basis. It should be noted that the same measurements using market value of assets would result in different funded ratios and unfunded accrued liabilities. Moreover, the funded ratio presented is appropriate for evaluating the need and level of future contributions but makes no assessment regarding the funded status of the plan if the plan were to settle (i.e. purchase annuities) for a portion or all of its liabilities. In various places in the report the results also show funded ratios and unfunded liabilities based upon varying sets of assumptions as well as market values of assets as that is required for certain disclosure information required per accounting rules or statutes. Where this has been done it has been clearly indicated.

Future actuarial results may differ significantly from the current results presented in this report due to such factors as the following: fund experience differing from that anticipated by the economic or demographic assumptions; changes in economic or demographic assumptions; and changes in plan provisions or applicable law. Such changes in law may include additional costs resulting from future legislated benefit improvements or cost-of-living pension increases or supplements, which are not anticipated in the actuarial valuation. Because of limited scope, CMC performed no analysis of the potential range of such future differences, except for some limited analysis in financial projections or required disclosure information.

We meet the Qualification Standards of the American Academy of Actuaries to render the actuarial opinions contained in this report. This report has been prepared in accordance with all applicable Actuarial Standards of Practice, and we are available to answer questions about it.

Respectfully submitted,

Larry Langer, ASA, EA, FCA, MAAA
Principal and Consulting Actuary

Jonathan T. Craven, ASA, EA, FCA, MAAA
Consulting Actuary

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Executive Summary

Overview

The North Carolina Retirement Systems Division (RSD) was established in 1941 to provide retirement benefits for public servants in the State of North Carolina. Today, under the management of the Department of State Treasurer, RSD administers seven public pension plans (defined benefit plans), three supplemental retirement plans (voluntary defined contributions plans), a health trust fund, a disability income plan, death benefit funds and a number of other benefit programs. As of December 31, 2018, the RSD defined benefit plans cover over one million current and prior public servants of the state of North Carolina. During the fiscal year ending June 30, 2019, RSD paid over $6.4 billion in pensions to more than 310,000 retirees. And as of June 30, 2019, RSD's defined benefit plan assets were valued at over $101 billion.

Under the supplemental retirement plans, the amount of contributions in any given year is defined by law. The amount of benefits derived is dependent on the investment returns the individual achieves. Conversely, under the pension plans, the amount of the benefit paid to a member upon retirement, termination, death or disability is defined by law. The amount of contributions needed to fund these benefits cannot be known with certainty. In North Carolina, like other states, these contributions are paid during a public servant's career so that upon retirement, termination, death, or disability, there are funds available to pay these benefits. These amounts are determined through an actuarial valuation. Actuarial valuations are performed for each of the pension plans administered by RSD and the results are contained in actuarial valuation reports like this.

In 1941, the Teachers' and State Employees' Retirement System (referred to as "TSERS" or the "State Plan") was established. TSERS provides benefits to all full-time teachers and state employees in all public school systems, universities, departments, institutions and agencies of the state. With over $67 billion in assets and over 700,000 members as of December 31, 2018, it is the largest pension plan within the NC Retirement Systems. This actuarial valuation report is our annual analysis of the financial health of TSERS. This report, prepared as of December 31, 2018, presents the results of the seventy-sixth annual valuation of TSERS.

Purpose

An actuarial valuation is performed on TSERS annually as of the end of the calendar year. The actuary determines the amount of contributions to be made to TSERS during each member's career that, when combined with investment return, will be sufficient to pay for retirement benefits.

In addition, the annual actuarial valuation is performed to:

- Determine the progress of funding TSERS,
- Explore why the results of the current valuation differ from the results of the valuation of the previous year, and
- Satisfy regulatory and accounting requirements.

A detailed summary of the valuation process and a glossary of actuarial terms are provided in Appendix A.

Executive Summary

Risk

Measuring pension obligations and actuarially determined contributions requires the use of assumptions regarding future economic and demographic experience. Whenever assumptions are made about future events, there is risk that actual experience will differ from expected. Actuarial valuations include the risk that actual future measurements will deviate from expected future measurements due to actual experience that is different than the actuarial assumptions.

The primary areas of risk in this actuarial valuation are:

- Investment Risk – the potential that investment returns will be different than expected. Section 9 of this report demonstrates the sensitivity of future projected results to asset returns deviating from expected returns.
- Longevity and Other Demographic Risks – the potential that mortality or other demographic experience will be different than expected.
- Interest Rate Risk – To the extent market rates of interest affect the expected return on assets, there is a risk of change to the discount rate which determines the present value of liabilities and actuarial valuation results. Table F-1 of this report demonstrates the sensitivity of valuation results to differing discount rates.
- Contribution Risk – The potential that actual contributions are different than the actuarially determined contributions.

Annual actuarial valuations are performed for RSD which re-measure the assets and liabilities and compute a new actuarially determined contribution. RSD also has experience studies performed every five years to analyze the discrepancies between actuarial assumptions and actual experience and determine if the actuarial assumptions need to be changed. Annual actuarial valuations and periodic experience studies are practical ways to monitor and reassess risk.

Executive Summary

Key Takeaways

The actuarial valuation is performed each year to replace the estimates the actuary assumed for the prior valuation with the actual events that happened. This past year, as expected, some of the assumptions used in the prior valuation were not realized. Key results of the December 31, 2018 valuation as compared to the December 31, 2017 valuation were:

- Market value returns of -1.39% during calendar year 2018 compared to 7.00% assumed

When compared to the December 31, 2017 projections, the above resulted in:

- A lower funded ratio as of December 31, 2018 (86.4% in the valuation compared to 88.3% in the baseline projection)
- Higher actuarially determined employer contribution rates for fiscal year ending June 30, 2021 (14.78% in the valuation compared to 13.39% in the baseline projection)

TSERS is well funded compared to its peers. This is due to:

- Stakeholders working together to keep TSERS well-funded since inception
- A history of appropriating and contributing a minimum of the recommended contribution requirements
- Implementation of the ECRSP which provides additional funding of the System
- Assumptions that in aggregate are more conservative than peers
- A funding policy that aggressively pays down the unfunded liability over a 12-year period
- An ad hoc cost-of-living adjustment, which typically only provides benefit increases when certain financial conditions are met, that supports the health of the system
- Modest changes in benefits when compared to peers

As has been done over the past 78 years, continued focus on these measures will be needed to maintain the solid status of TSERS well into the future.

More details can be found later in this report. We encourage readers to start with Sections 1 and 2 and refer to other sections for additional details as needed.

This report, prepared as of December 31, 2018, presents the results of the annual valuation of the system. The principal results of the valuation and a comparison with the preceding year's results are summarized in the following table.

Section 1: Principal Results

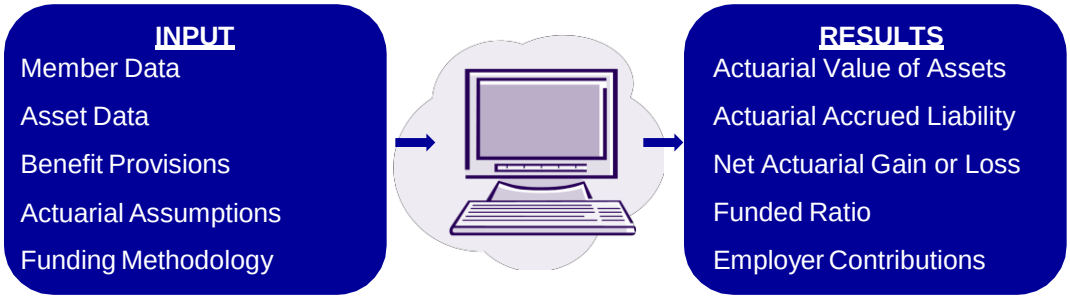
Table 1: Summary of Principal Results

Valuation Results as of	12/31/2018	12/31/2017
Active Members		
Number	304,575	304,554
Reported Compensation	$ 14,436,435,848	$ 13,914,085,325
Valuation Compensation *	$ 15,623,198,876	$ 15,058,805,483
Retired Members and Survivors of Deceased Members Currently Receiving Benefits		
Number	222,084	215,008
Annual Allowances	$ 4,668,925,869	$ 4,521,393,822
Assets		
Actuarial Value (AVA)	$ 70,959,093,440	$ 69,568,450,606
Market Value (MVA)	$ 67,536,480,309	$ 70,607,887,248
Actuarial Accrued Liability (AAL)	$ 82,105,943,131	$ 79,209,347,668
Unfunded Accrued Liability (AAL - AVA)	$ 11,146,849,691	$ 9,640,897,062
Funded Ratio (AVA / AAL) **	86.4%	87.8%
Results for Fiscal Year Ending	**6/30/2021**	**6/30/2020**
Actuarially Determined Employer Contribution (ADEC), as a percentage of payroll		
Normal Cost	5.18%	5.17%
Accrued Liability	10.19%	8.99%
Total Preliminary ADEC	15.37%	14.16%
Total Based on Direct Rate Smoothing	14.78%	12.97%
Impact of Legislative Changes	N/A	0.00%
Final ADEC	14.78%	12.97%
Board of Trustees Recommended Contribution under the Employer Contribution Rate Stabilization Policy (ECRSP)	14.78%	12.97%
Required Employer Contribution NCGS 135-8(d)	14.78%	12.97%
Appropriation Act for Fiscal Year Ending	**6/30/2020**	**6/30/2019**
Employer Contribution Rate as a percentage of payroll		
Normal Cost	5.18%	5.17%
Accrued Liability	7.79%	7.12%
Total	12.97%	12.29%

* Reported compensation annualized for new hires and projected for valuation purposes.
**The Funded Ratio on a Market Value of Assets basis is 82.3% at December 31, 2018.

Section 2: The Valuation Process

The following diagram summarizes the inputs and results of the actuarial valuation process.



A more detailed description of the valuation process is provided in Appendix A.

Valuation Input: Membership Data

As with any estimate, the actuary collects information that we know now. Under the actuarial valuation process, current information about TSERS members is collected annually by the Retirement Systems Division staff at the direction of the actuary. Membership data will assist the actuary in estimating benefits that could be paid in the future. Information about benefit provisions and assets held in the trust as of the valuation date is also collected.

The member information the actuary collects includes data elements such as current service, salary and benefit group identifier for members that have not separated service, and actual benefit amounts and form of payment for members that have separated service. Data elements such as gender and date of birth are used to determine when a benefit might be paid and for how long.

Section 2: The Valuation Process

Valuation Input: Membership Data (continued)

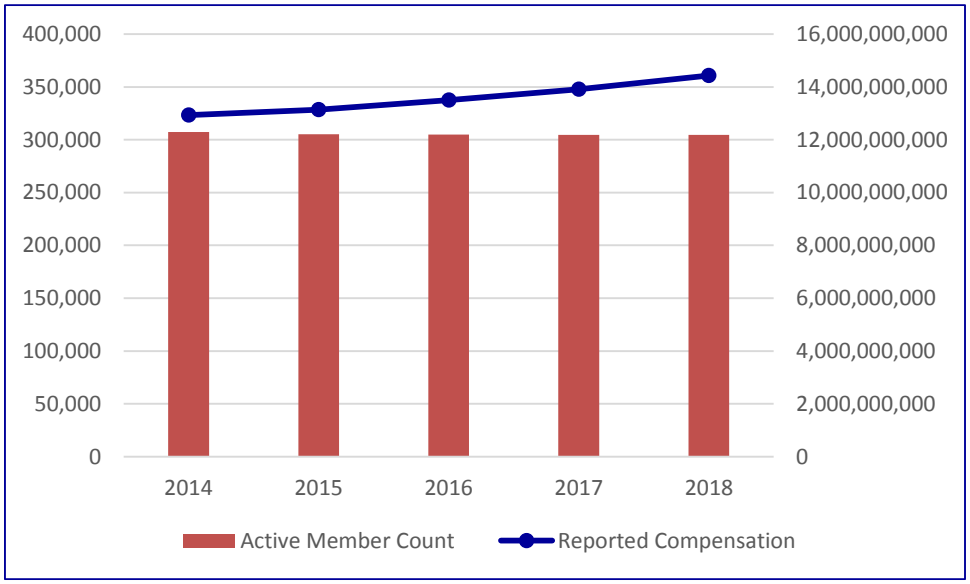
The table below provides a summary of the membership data used in this valuation compared to the prior valuation.

Number as of	12/31/2018	12/31/2017
Active Members	304,575	304,554
Members currently receiving Disability Income Plan benefits	6,190	6,680
Terminated members and survivors of deceased members entitled to benefits but not yet receiving benefits	168,755	160,087
Retired members and survivors of deceased members currently receiving benefits	222,084	215,008
Total	701,604	686,329

Commentary: The number of active members was virtually unchanged from the previous valuation date. The number of retired members and survivors of deceased members currently receiving benefits increased by 3.3% from the previous valuation date. The increase in retiree population is consistent with expectations.

Graph 1: Active Members

The graph below provides a history of the number of active members and reported compensation over the past five years.



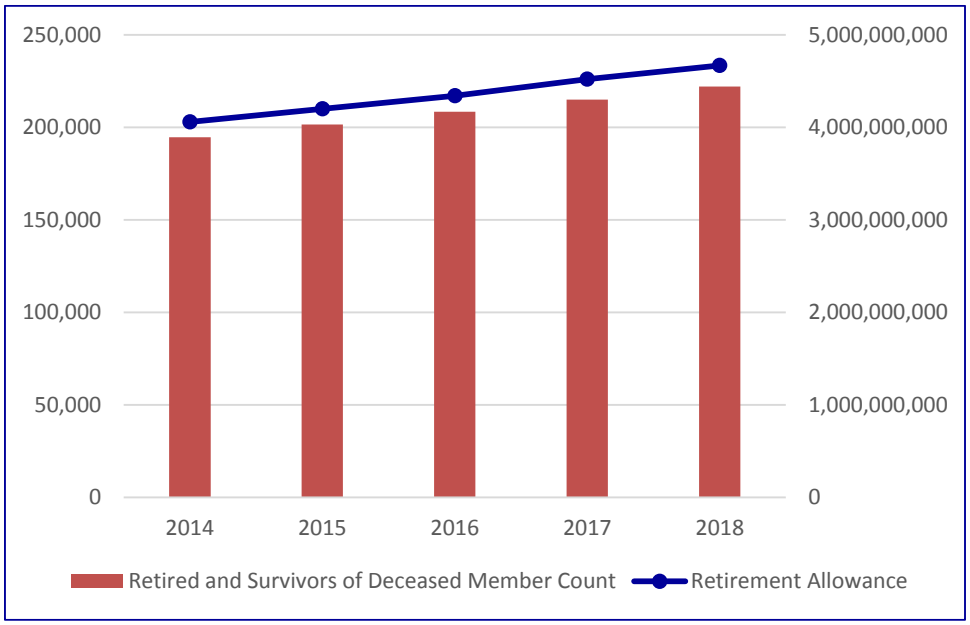
Commentary: Reported compensation has increased by 3.8% and the increase has averaged 2.8% over the past four years. Covered payroll is expected to increase by approximately 3.5% annually in the future. Payroll that is not increasing as fast as we assume results in less benefits accruing than we anticipate, but also fewer contributions supporting the system.

Section 2: The Valuation Process

Valuation Input: Membership Data (continued)

Graph 2: Retired Members and Survivors of Deceased Members

The graph below provides a history of the number of retired members and survivors of deceased members and benefit amounts payable over the past five years.



Commentary: The number of retired members and survivors of deceased members and the benefits paid to these members has been increasing steadily, as expected based on plan assumptions.

A detailed summary of the membership data used in this valuation is provided in Section 3 and Appendix B of this report.

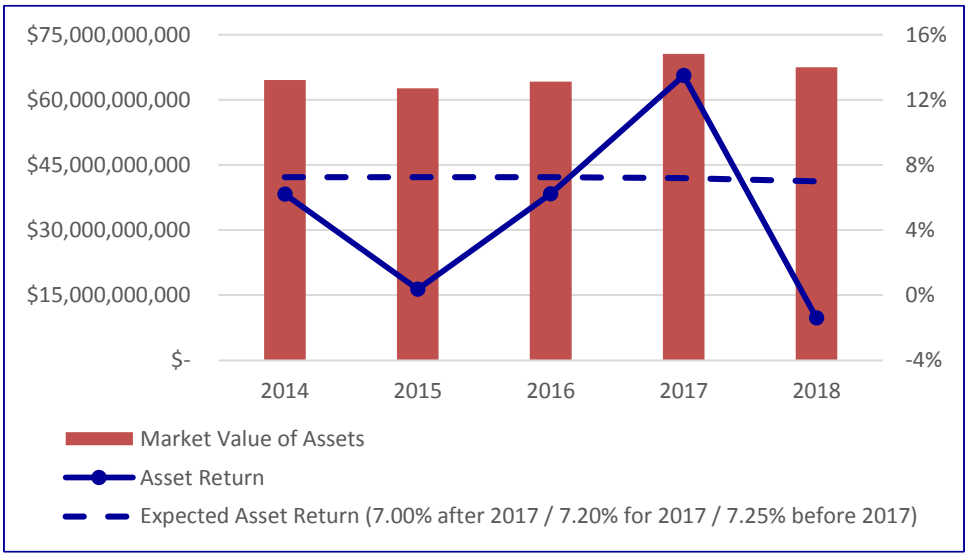
Section 2: The Valuation Process

Valuation Input: Asset Data

TSERS assets are held in trust and are invested for the exclusive benefit of plan members. The Market Value of Assets is $67.5 billion as of December 31, 2018 and was $70.6 billion as of December 31, 2017. The investment return for the market value of assets for calendar year 2018 was -1.39%.

Graph 3: Market Value of Assets and Asset Returns

The graph below provides a history of the market value of assets and asset returns over the past five years.



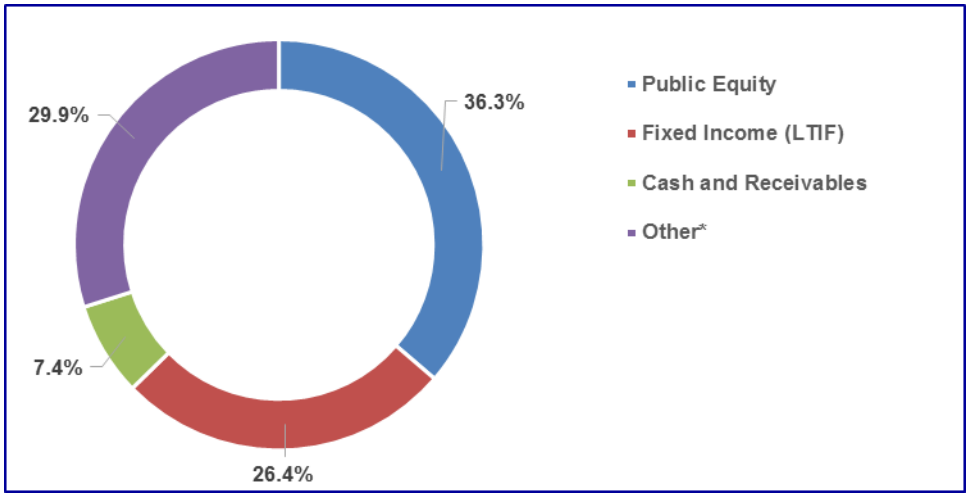
Commentary: Market value returns were much less than the 7.0% assumed rate of return, resulting in higher required contributions and lower funded ratio than anticipated as of the December 31, 2017 baseline projections presented in the December 31, 2017 actuarial report.

Section 2: The Valuation Process

Valuation Input: Asset Data (continued)

Graph 4: Allocation of Investments by Category

The graph below provides the breakdown of the market value of assets at December 31, 2018 by asset category.



* Real Estate, Alternatives, Inflation and Credit

Commentary: Based on historical market returns, the current asset allocation, the current investment policy, and the expectation of future asset returns, as reviewed in the last experience study, the 7.00% discount rate used in this valuation is reasonable and appropriate.

A detailed summary of the market value of assets is provided in Section 4 of this report.

Section 2: The Valuation Process

Valuation Input: Benefit Provisions

Benefit provisions are described in North Carolina General Statutes, Chapter 135.

Highlights of the benefit provisions are described below.

- An unreduced retirement allowance is payable to non-law enforcement members who retire from service:
  - after attaining age 65 and five years of creditable service;
  - after attaining age 60 and 25 years of creditable service; or
  - after attaining 30 years of creditable service
- An unreduced retirement allowance is payable to law enforcement members who retire from service:
  - after attaining age 55 and five years of creditable service; or
  - after attaining 30 years of creditable service
- The unreduced retirement allowance is equal to 1.82% of a member's average final compensation multiplied by the number of years of creditable service. Average final compensation is based on the four highest consecutive years of compensation.
- A reduced retirement allowance is payable to non-law enforcement members who retire from service:
  - after attaining age 60 and five years of creditable service; or
  - after attaining age 50 and 20 years of creditable service
- A reduced retirement allowance is payable to law enforcement members who retire from service after attaining age 50 and 15 years of creditable service or after attaining 25 years of creditable service (15 as an officer).
- Ancillary benefits are also payable upon the death or disability of a member.
- TSERS does not provide for automatic cost of living increases as part of the benefit package. Instead, increases may be provided if certain financial conditions are met. More details on cost-of-living increases are provided in Graph 5.

Commentary: Many Public Sector Retirement Systems in the United States have undergone pension reform where the benefits of members (active or future members) have been reduced. Because of the well-funded status of TSERS, benefit cuts have not been made in North Carolina as they have been in most other states. Instead, we have seen a modest expansion of benefits in recent years based on sound plan design. However, if North Carolina's investment policy shifts substantively or if the system incurs other unfavorable investment, economic, or demographic experience, the system should review likely impacts of the shift and consider corresponding changes to actuarial assumptions, funding policy and/or benefit levels.

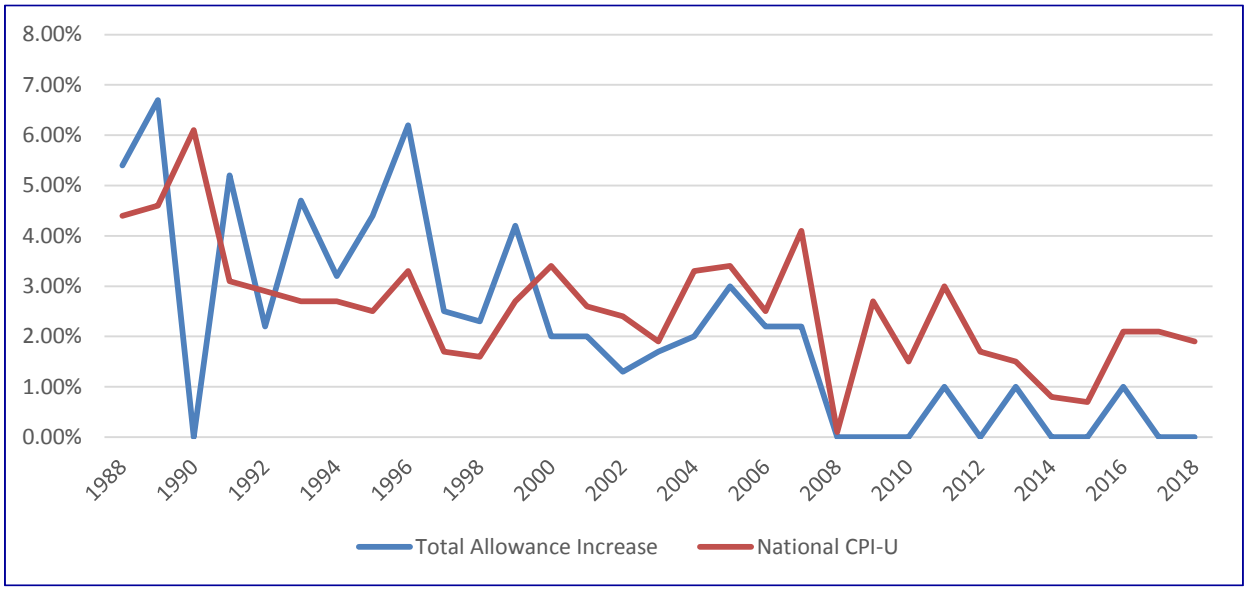
Section 2: The Valuation Process

Valuation Input: Benefit Provisions (continued)

As noted previously, cost-of-living increases are periodically considered by the Board of Trustees to the extent that certain financial conditions are met. Specifically, benefit allowance increases are generally considered when the trust experiences sufficient investment gains to cover the additional actuarial accrued liabilities created by providing the cost-of-living adjustment (generally, limited to the lesser of the CPI increase year-over-year or 4%). In addition to employers consistently contributing the actuary's recommended contribution, this benefit increase policy has helped keep costs manageable when compared to other Public Sector Retirement Systems in the United States. That being said, post-retirement increases help to reduce the risk that the benefit will be eroded by inflation.

Graph 5: Cost-of-Living Increase and CPI-U History

The graph below provides a 30-year history of the allowance increases for TSERS and the national CPI-U.



* Allowance increases are effective at July 1 the following year

Commentary: Generally this allowance increase policy has helped retirees maintain purchasing power while helping to moderate contribution increases during times of down markets. Graph shows only permanent increases to the retirement allowance and not one-time supplements that have been granted.

A detailed summary of the benefit provisions is provided in Appendix C of this report.

Valuation Input: Actuarial Assumptions

Actuarial assumptions bridge the gap between the information that we know with certainty as of the valuation date (age, gender, service, pay, and benefits of the members) and what may happen in the future. The actuarial assumptions of TSERS are reviewed at least every five years. Based on this review, the actuary will make recommendations on the demographic and economic assumptions.

Demographic assumptions describe future events that relate to people such as retirement rates, termination rates, disability rates, and mortality rates. Economic assumptions describe future events such as the interest rate, salary increases, the real return, and payroll growth.

Section 2: The Valuation Process

Valuation Input: Actuarial Assumptions (continued)

The assumptions used for the December 31, 2018 actuarial valuation, with the exception of the discount rate, are based on the experience study prepared as of December 31, 2014 and adopted by the Board of Trustees on January 21, 2016. The discount rate was updated to be 7.00%, as adopted by the Board of Trustees on April 26, 2018.

Valuation Input: Funding Methodology

The Funding Methodology is the payment plan for TSERS and is composed of the following three components:

- Actuarial Cost Methods allocate costs to the actuarial accrued liability (i.e. the amount of money that should be in the fund) for past service and normal cost (i.e. the cost of benefits accruing during the year) for current service.
  - The Board of Trustees has adopted Entry Age Normal as its actuarial cost method
  - Develops normal costs that stay level as a percent of payroll
- Asset Valuation Methods smooth or average the market value returns over time to alleviate contribution volatility that results from market returns. The Board of Trustees has adopted the following:
  - Asset returns in excess of or less than the expected return on market value of assets reflected over a five-year period
  - Asset corridor: not greater than 120% of market value and not less than 80% of market value
- Amortization Methods determine the payment schedule for unfunded actuarial accrued liability (i.e. the difference between the actuarial accrued liability and actuarial value of assets). The Board of Trustees has adopted the following:
  - Payment level: the payment is determined as a level dollar amount, similar to a mortgage payment
  - Payment period: a 12-year closed amortization period was adopted for fiscal year ending 2012. A new amortization base is created each year based on the prior year experience

When compared to other Public Sector Retirement Systems in the United States, the funding policy for TSERS is quite aggressive in that the policy pays down the unfunded accrued liability over a much shorter period of time (12 years) compared to the longer funding periods of most Public Sector Systems. As such it is a best practice in the industry.

A detailed summary of the actuarial assumptions and methods is provided in Appendix D of this report.

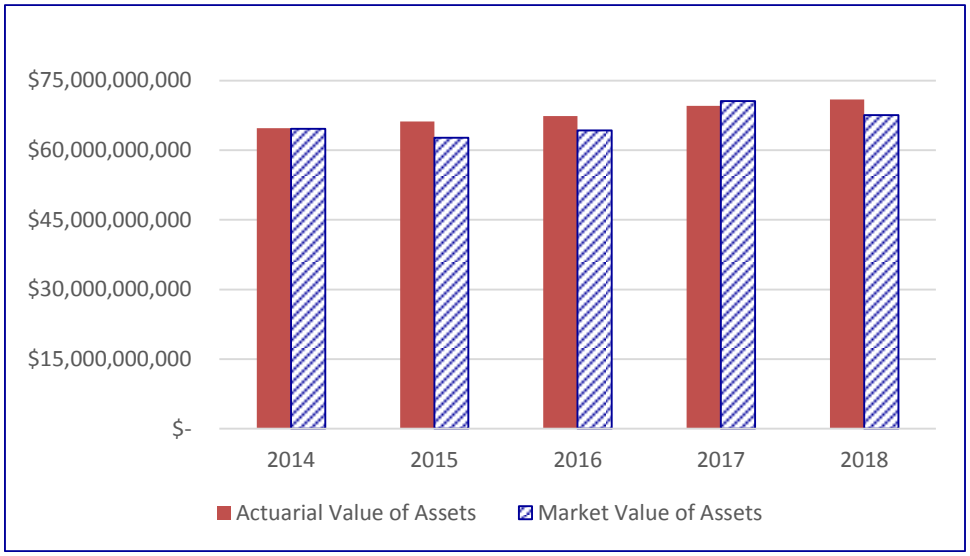
Section 2: The Valuation Process

Valuation Results: Actuarial Value of Assets

In order to reduce the volatility that investment gains and losses can have on required contributions and funded status of TSERS, the Board adopted an asset valuation method to determine the Actuarial Value of Assets used for funding purposes. The Actuarial Value of Assets is $71.0 billion as of December 31, 2018 and $69.6 billion as of December 31, 2017.

Graph 6: Actuarial Value and Market Value of Assets

The graph below provides a history of the market value and actuarial value of assets over the past five years.

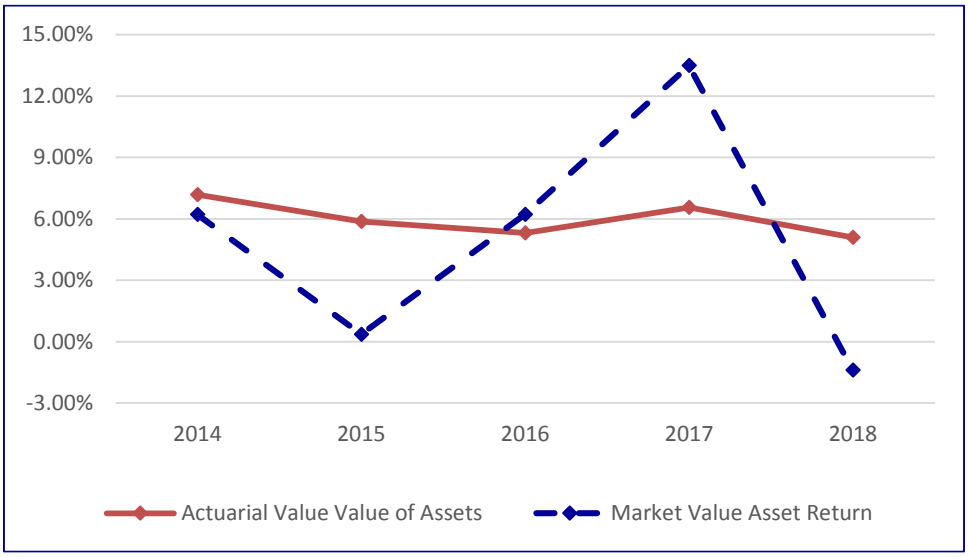


Commentary: The market value of assets is lower than the actuarial value of assets, which is used to determine employer contributions. This indicates that overall there are unrecognized asset losses to be recognized in future valuations.

Valuation Results: Actuarial Value of Assets (continued)

Graph 7: Asset Returns

The graph below provides a history of the market value and actuarial value of asset returns over the past five years.



Commentary: The investment return for the market value of assets for calendar year 2018 was -1.39%. The actuarial value of assets smooths investment gains and losses. Lower than expected market returns, in all years except 2017, resulted in an actuarial value of asset return for calendar year 2018 of 5.10% and a recognized actuarial asset loss of $1.3 billion during 2018.

A detailed summary of the Actuarial Value of Assets is provided in Section 4 of this report.

Section 2: The Valuation Process

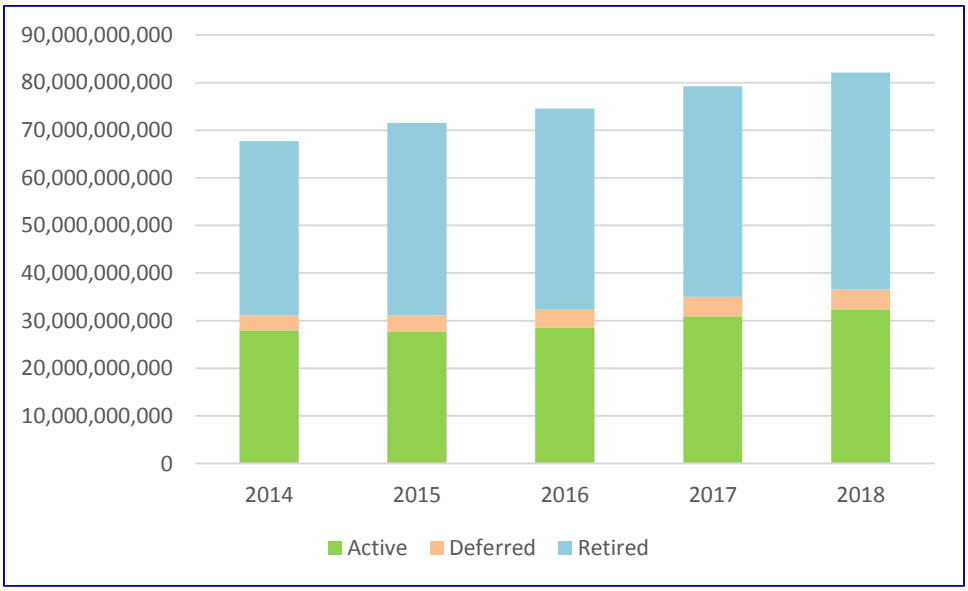
Valuation Results: Actuarial Accrued Liability

Using the provided membership data, benefit provisions, and actuarial assumptions, the future benefit payments of TSERS are estimated. These projected future benefit payments are discounted into today's dollars using the assumed rate of investment return assumption to determine the Present Value of Future Benefits (PVFB) of TSERS. The PVFB is an estimate of the current value of the benefits promised to all members as of a valuation date.

Once the PVFB is developed, an actuarial cost method is used to allocate the PVFB. Under the actuarial cost method, the PVFB is allocated to past, current and future service, respectively known as the actuarial accrued liability (AAL), normal cost (NC) and present value of future normal costs (PVFNC). The AAL is also referred to as the amount of money TSERS should ideally have in the trust. The NC is also referred to as the cost of benefits accruing during the year.

Graph 8: Actuarial Accrued Liability

The graph below provides a history of the actuarial accrued liability over the past five years.



Commentary: The AAL increased from $79.2 billion to $82.1 billion during 2018. The Retirement System is an open plan, which means that new members enter the plan each year. In an open plan, liabilities are expected to grow from one year to the next as more benefits accrue and the membership approaches retirement. The AAL was $558 million higher than expected, resulting from demographic losses.

A detailed summary of the AAL is provided in Section 5 of this report.

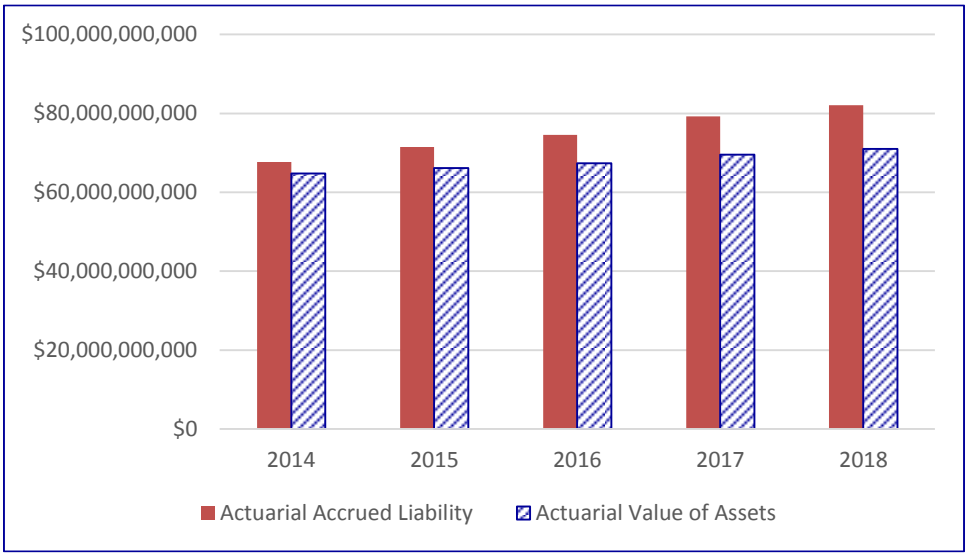
Section 2: The Valuation Process

Valuation Results: Funded Ratio

The funded ratio is a measure of the progress that has been made in funding the plan as of the valuation date. It is the ratio of how much money TSERS actually has in the fund to the amount TSERS should have in the fund.

Graph 9: Actuarial Accrued Liability and Actuarial Value of Assets

The graph below provides a history of the actuarial accrued liability compared to the actuarial value of assets over the past five years.



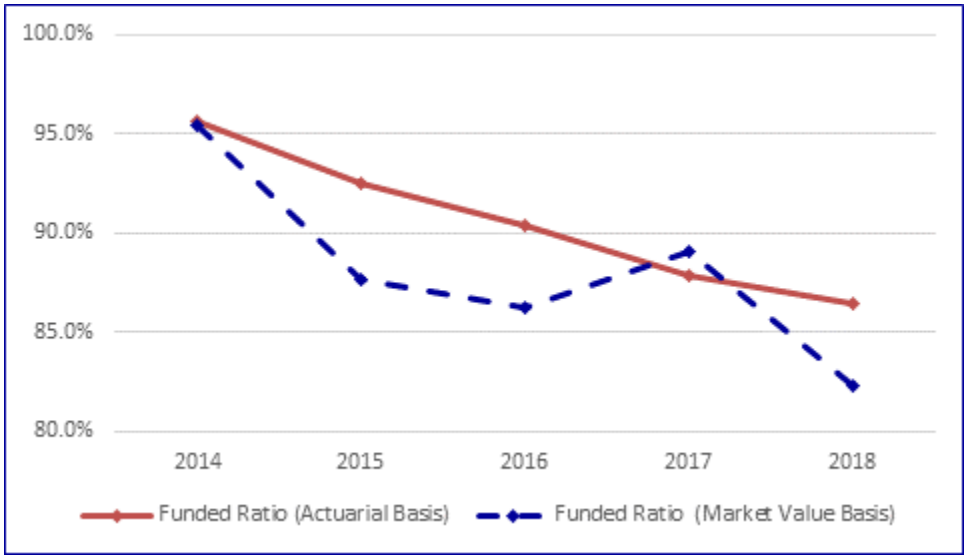
Commentary: The actuarial value of assets basis is used for computing contributions to alleviate contribution volatility. The difference in the actuarial accrued liability and the actuarial value of assets is the amount of unfunded actuarial accrued liability to be paid off over a 12 year period.

Section 2: The Valuation Process

Valuation Results: Funded Ratio (continued)

Graph 10: Funded Ratios

The graph below provides a history of the funded ratio on a market and actuarial basis over the past five years.



Commentary: The ratio of assets to liabilities shows the health of the plan on an accrued basis. The funded ratio on an actuarial basis decreased from 87.8% at December 31, 2017 to 86.4% at December 31, 2018.

Section 2: The Valuation Process

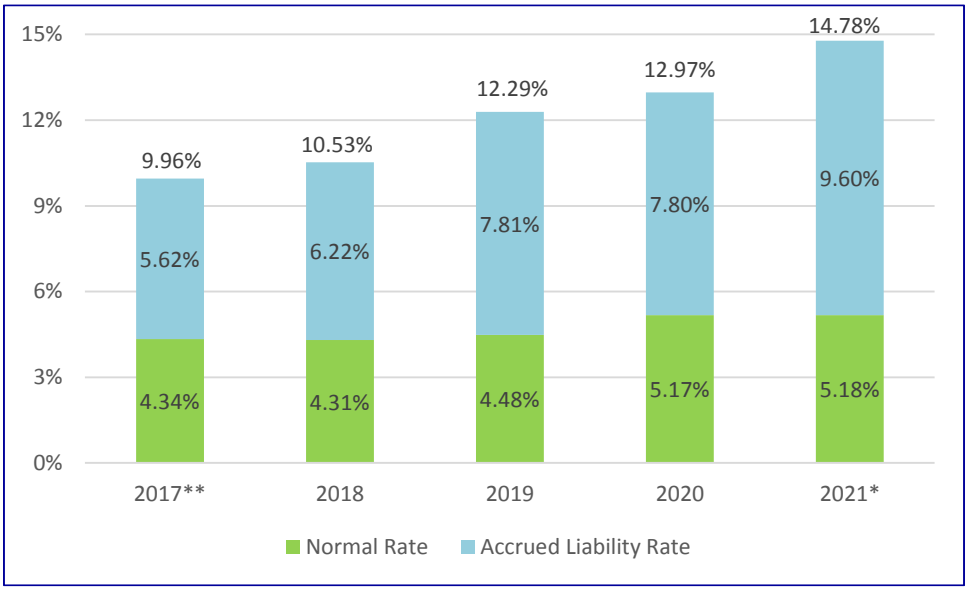
Valuation Results: Employer Contributions

The North Carolina General Statutes provide that the contributions of employers shall consist of a normal contribution and an accrued liability contribution. G.S. 135-8(g) allows for the Board of Trustees of TSERS to make changes to accounting methods and procedures that, in its opinion, are in the interest of sound and proper administration of TSERS.

The December 31, 2017 valuation suggested that the preliminary total employer contribution rate be set at 12.97% of payroll for the fiscal year ending June 30, 2020. As a result of this December 31, 2018 valuation, the preliminary actuarially determined employer contribution rate is 14.78% of payroll for the fiscal year ending June 30, 2021, subject to the impact of any future legislative changes effective during that fiscal year.

Graph 11: Employer Actuarially Determined Employer Contribution Rates Before Applying Funding Policy Minimums

The graph below provides a history of actuarially determined employer contribution rates over the past five years.



* Subject to the impact of future legislative changes effective before or during that fiscal year
** Includes impact of the experience study

Commentary: The actuarially determined employer contribution rate is the amount needed to pay for the cost of the benefits accruing and to pay off the unfunded actuarial accrued liability over a 12-year period, offset for the 6% of pay contribution the members make. The 12-year period is a relatively short period for Public Sector Retirement Systems in the United States, with the funding period for most of these Systems much longer. The shorter period results in higher contributions and more benefit security.

A detailed summary of the actuarially determined employer contribution rates is provided in Section 6 of this report.

Section 2: The Valuation Process

Valuation Results: Projections

Projections of contribution requirements and funded status into the future can be helpful planning tools for stakeholders. This section provides such projections. The projections of the actuarial valuation are known as deterministic projections. Deterministic projections are based on one scenario in the future. The baseline deterministic projection is based on December 31, 2018 valuation results as assumptions.

Key Projection Assumptions:

- Valuation interest rate of 7.00% for all years, with direct rate smoothing of the employer contribution rates over a three-year period beginning July 1, 2019.
- 7.00% investment return on market value of assets
- Actuarial assumptions and methods as described in Appendix D. All future demographic experience is assumed to be exactly realized.
- The contribution rate under the Employer Contribution Rate Stabilization Policy (ECRSP) is contributed until fiscal year ending 2022.
- The actuarially determined contribution rate is contributed for fiscal years ending 2023 and beyond.
- 0% increase in the total active member population
- No cost-of-living adjustments granted
- Future pay increases based on long-term valuation assumptions

The ECRSP adopted by the Board of Trustees on January 21, 2016 requires that recommended contributions be 0.35% of payroll greater than the appropriated contribution during the prior year, with the following bounds: (1) contributions may not be less than the actuarially determined employer contribution (ADEC) rate and (2) contributions may not be greater than a contribution determined using the same assumptions used to calculate the ADEC but using a discount rate equal to the long-term Treasury bond yield.

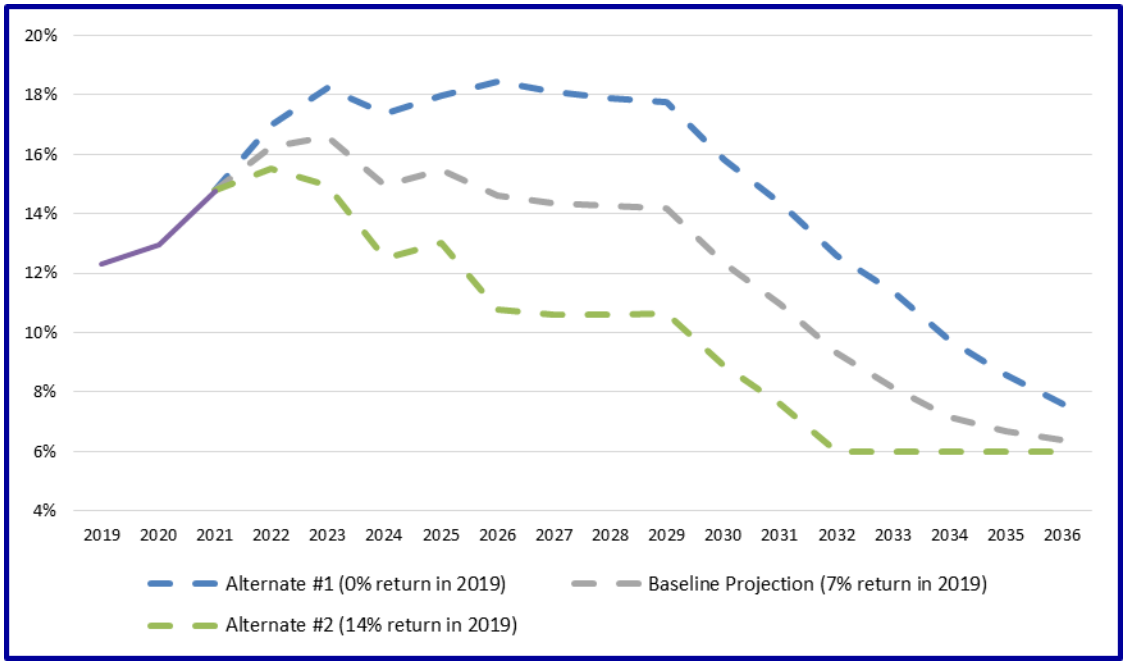
In addition, we have provided two alternate deterministic projections. The first alternate deterministic projection is based on the same assumptions as the baseline deterministic projection except that it assumes a 0.0% asset return for calendar year 2019. The second alternate deterministic projection is based on the same assumptions as the baseline deterministic projection except that it assumes a 14.0% asset return for calendar year 2019.

Finally, stochastic projections, where hundreds of projections based on varying rates of return are performed and results are ordered, are periodically performed by the Investment Management Division and shared with the Board of Trustees and RSD staff.

Valuation Results: Projections (continued)

Graph 12: Projected Actuarially Determined Employer Contribution Rates

The graph below provides the actuarially determined employer contributions rates for general employees and firefighters projected for 15 years.



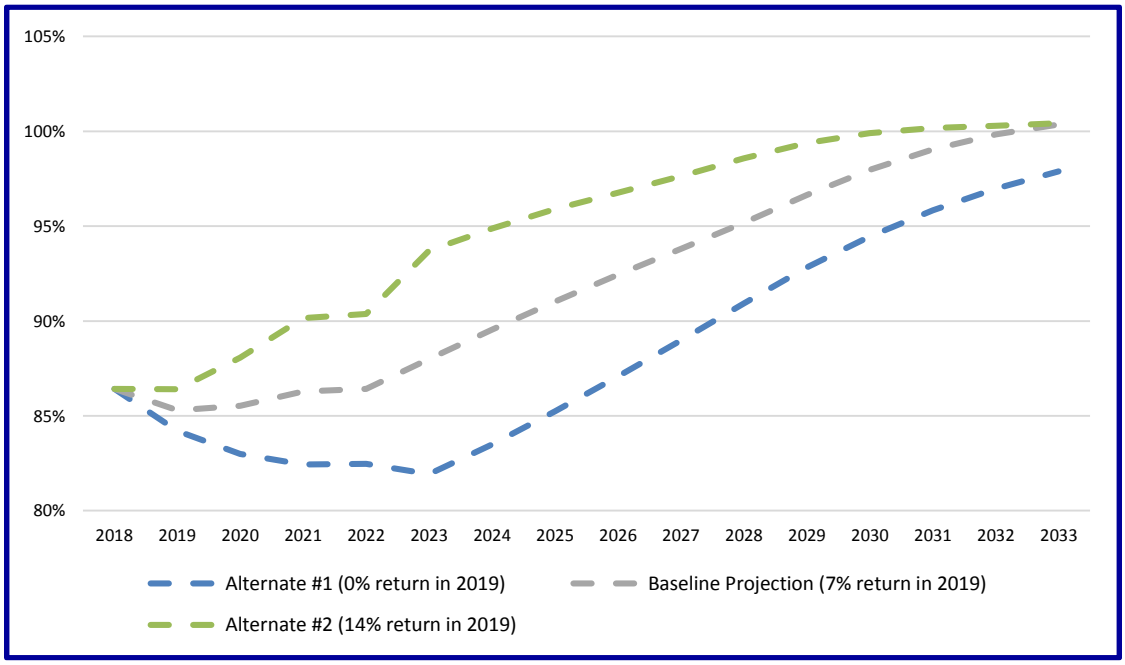
Commentary: The minimum employer contribution rate is equal to the employee contribution rate of 6.00%.

Section 2: The Valuation Process

Valuation Results: Projections (continued)

Graph 13: Projected Funded Ratio

The graph below provides the funded ratio projected for 15 years.



Commentary: Note that if the 7.00% return under the Baseline Projection is achieved, the funded ratio reaches the long term target of 100% within 15 years. This is a direct result of using a 12 year period to pay off the unfunded actuarial accrued liability.

A detailed summary of the deterministic projections is provided in Section 9 of this report.

Valuation Results: Accounting Information

The Governmental Accounting Standards Board (GASB) issues statements which establish financial reporting standards for defined benefit pension plans and accounting for pension expenditures and expenses for governmental employers.

The valuation has been prepared in accordance with the parameters of Statement No. 67 of the GASB and all applicable Actuarial Standards of Practice. The Net Pension Liability (Asset) under GASB 67 for the fiscal year ending June 30, 2019, is $10,366,957,000 (compared to $9,956,089,000 for fiscal year ending June 30, 2018). The required financial reporting information for TSERS under GASB No. 67 can be found in Section 8 of this report.

Section 3: Membership Data

The Retirement Systems Division provided membership data as of the valuation date for each member of TSERS. The membership data assists the actuary in estimating benefits that could be paid in the future. The tables below provide a summary of the membership data used in this valuation. Detailed tabulations of data are provided in Appendix B.

Table 2: Active Member Data

	Member Count	Average Age	Average Service	Reported Compensation
Teachers, Librarians and Counselors	149,075	43.45	10.65	$ 7,011,352,489
Other Education	49,061	49.36	11.24	2,041,171,634
General Employees	101,026	46.80	10.72	5,083,070,791
Law Enforcement Officers	5,413	40.28	11.82	300,840,934
Total	304,575	45.46	10.79	$ 14,436,435,848

The table above includes members not in receipt of benefits who had reported compensation in 2018.

Table 3: Disabled Member Data
(Receiving Benefit from the Disability Income Plan of North Carolina)

	Member Count	Average Age	Average Service	Valuation Compensation
Teachers, Librarians and Counselors	1,926	55.24	13.76	$ 73,762,374
Other Education	758	56.52	13.64	21,448,794
General Employees	3,473	55.84	12.97	124,570,094
Law Enforcement Officers	33	50.55	16.11	2,165,748
Total	6,190	55.71	13.31	$ 221,947,010

The table above includes members not in receipt of benefits who did not have reported compensation in 2018 and who were reported as disabled in the current or prior valuations and not subsequently reported as returned to work.

Section 3: Membership Data

Table 4: Terminated Vested Member Data

	Member Count	Average Age	Average Service	Accumulated Contributions
Teachers, Librarians and Counselors	66,851	41.31	4.31	$ 860,868,442
Other Education	15,313	45.97	4.15	179,206,757
General Employees	85,245	46.51	3.73	1,102,809,127
Law Enforcement Officers	1,346	41.31	5.31	25,857,376
Total	168,755	44.36	4.01	$ 2,168,741,702

The table above includes members not in receipt of benefits who did not have reported compensation in 2018 and who were not valued as disabled members.

Table 5: Data for Members Currently Receiving Benefits

	Member Count	Average Age	Annual Retirement Allowances
Retired Members (Healthy at Retirement)			
Teachers and Other Education	108,502	70.58	$ 2,633,670,779
General Employees	82,621	71.94	1,493,163,277
Law Enforcement Officers	3,023	65.64	96,656,716
Total	194,146	71.08	$ 4,223,490,772
Retired Members (Disabled at Retirement)*			
Teachers and Other Education	4,363	70.75	$ 86,708,564
General Employees	7,992	70.33	124,911,565
Law Enforcement Officers	178	68.92	4,390,089
Total	12,533	70.46	$ 216,010,218
Survivors of Deceased Members			
Teachers and Other Education	5,087	73.35	$ 93,231,947
General Employees	9,861	73.80	126,315,556
Law Enforcement Officers	457	72.37	9,877,376
Total	15,405	73.61	$ 229,424,879
Grand Total	222,084	71.22	$ 4,668,925,869

* Includes retired members reported as disabled in a prior valuation and not subsequently reported as returned to work.

Section 4: Asset Data

Assets are held in trust and are invested for the exclusive benefit of TSERS members. The tables below provide the details of the Market Value of Assets for the current and prior years' valuations.

Table 6: Market Value of Assets

Asset Data as of	12/31/2018	12/31/2017
Beginning of Year Market Value of Assets	$ 70,607,887,248	$ 64,246,523,614
Employer Contributions	1,758,110,760	1,524,591,744
Employee Contributions	927,251,021	895,822,376
Benefit Payments Other Than Refunds	(4,666,520,152)	(4,456,849,037)
Refunds	(109,504,134)	(112,511,881)
Administrative Expense	(11,856,738)	(11,205,880)
Investment Income	(968,887,696)	8,521,516,312
Net Increase/(Decrease)	(3,071,406,939)	6,361,363,634
End of Year Value of Assets	$ 67,536,480,309	$ 70,607,887,248
Estimated Net Investment Return	-1.39%	13.49%

Table 7: Allocation of Investments by Category of the Market Value of Assets

Asset Data as of	12/31/2018	12/31/2017
Allocation by Dollar Amount		
Public Equity	$ 24,485,299,104	$ 27,967,988,982
Fixed Income (LTIF)	17,806,074,839	18,496,611,481
Cash and Receivables	4,987,337,332	2,355,812,624
Other*	20,257,769,034	21,787,474,161
Total Market Value of Assets	$ 67,536,480,309	$ 70,607,887,248
Allocation by Percentage of Asset Value		
Public Equity	36.3%	39.6%
Fixed Income (LTIF)	26.4%	26.2%
Cash and Receivables	7.4%	3.3%
Other*	29.9%	30.9%
Total Market Value of Assets	100.0%	100.0%

***** Real Estate, Alternatives, Inflation and Credit

Section 4: Asset Data

In order to reduce the volatility that investment gains and losses can have on the required contributions and funded status of TSERS, the Board adopted an asset valuation method to determine the Actuarial Value of Assets used for funding purposes. The table below provides the calculation of the Actuarial Value of Assets at the valuation date.

Table 8: Actuarial Value of Assets

Asset Data as of	12/31/2018
Beginning of Year Actuarial Value of Assets	$ 69,568,450,606
Beginning of Year Market Value of Assets	70,607,887,248
Total Contributions	2,685,361,781
Benefit Payments, Refunds and Administrative Expenses	(4,787,881,024)
Net Cash Flow	(2,102,519,243)
Expected Investment Return	4,870,208,534
Expected End of Year Market Value of Assets	73,375,576,539
End of Year Market Value of Assets	67,536,480,309
Excess of Market Value over Expected Market Value of Assets	(5,839,096,230)
80% of 2018 Asset Gain/(Loss)	(4,671,276,984)
60% of 2017 Asset Gain/(Loss)	2,376,346,969
40% of 2016 Asset Gain/(Loss)	(252,680,494)
20% of 2015 Asset Gain/(Loss)	(875,002,622)
Total Deferred Asset Gain/(Loss)	(3,422,613,131)
Preliminary End of Year Actuarial Value of Assets	70,959,093,440
Final End of Year Actuarial Value of Assets (not less than 80% and not greater than 120% of Market Value)	70,959,093,440
Estimated Net Investment Return on Actuarial Value	5.10%

Commentary: The actuarial value of assets smooths investment gains/losses, resulting in less volatility in the employer contribution. The asset valuation recognizes asset returns in excess of or less than the expected return on the market value of assets over a five-year period. Actuarial value of assets was reset to the market value of assets at December 31, 2014.

Lower than expected market returns, in all years except 2017, resulted in an actuarial value of asset return for calendar year 2018 of 5.10% and a recognized actuarial asset loss of $1.3 billion during 2018.

Section 4: Asset Data

The valuation assumes that the funds will earn a 7.00% asset return. The table below provides a history of the Actuarial Value and Market Value of Asset returns.

Table 9: Historical Asset Returns

Calendar Year	Expected Asset Return	Actuarial Value of Asset Return	Market Value of Asset Return	20 Year Average Market Return
1996	7.50%	10.18%	9.39%	NA
1997	7.25%	10.18%	18.16%	NA
1998	7.25%	9.92%	16.66%	NA
1999	7.25%	10.60%	10.15%	NA
2000	7.25%	11.55%	2.50%	NA
2001	7.25%	8.51%	-1.87%	NA
2002	7.25%	5.66%	-5.21%	NA
2003	7.25%	7.98%	18.23%	NA
2004	7.25%	8.56%	10.73%	NA
2005	7.25%	8.26%	6.97%	NA
2006	7.25%	8.94%	11.41%	NA
2007	7.25%	8.87%	8.38%	NA
2008	7.25%	2.89%	-19.50%	NA
2009	7.25%	4.74%	14.84%	NA
2010	7.25%	5.89%	11.47%	NA
2011	7.25%	5.15%	2.19%	NA
2012	7.25%	6.32%	11.82%	NA
2013	7.25%	7.43%	12.21%	NA
2014	7.25%	7.19%	6.21%	NA
2015	7.25%	5.87%	0.36%	6.86%
2016	7.25%	5.32%	6.22%	6.71%
2017	7.20%	6.56%	13.49%	6.49%
2018	7.00%	5.10%	-1.39%	5.60%
20-Yr Average	7.23%	7.05%	5.60%	NA
Range	0.50%	8.66%	37.73%	NA

Commentary: The average investment return recognized for purposes of determining the annual change in contribution each year is the actuarial value of assets return. Currently, the average actuarial return over the past 20 years of 7.05% compares with an average market return of 5.60%. The difference is primarily due to asset gains of the late 1990's being included in the actuarial value and not in the market value as well as the 2018 market value loss only being partially recognized in the actuarial value of assets. The range of returns on market value of assets is markedly more volatile, 8.66% versus 37.73%. This results in much lower employer contribution volatility using the actuarial value of assets versus market, while ensuring that the actuarial needs of TSERS are met.

Section 5: Liability Results

Using the provided membership data, benefit provisions, and actuarial assumptions, the Retirement System's future benefit payments are estimated. These projected future benefit payments are discounted into today's dollars using the assumed rate of investment return assumption to determine the Present Value of Future Benefits. The Present Value of Future Benefits is allocated to past, current and future service, respectively known as the actuarial accrued liability, normal cost and present value of future normal costs. The table below provides these liability numbers for the current and prior years' valuations.

Table 10: Liability Summary

Valuation Results as of	12/31/2018	12/31/2017
(a) Present Value of Future Benefits		
(1) Active Members	$ 45,769,146,668	$ 43,997,634,462
(2) Terminated Members	4,337,483,404	4,053,311,655
(3) Members Currently Receiving Benefits	45,534,377,845	44,212,274,274
(4) Total	$ 95,641,007,917	$ 92,263,220,391
(b) Present Value of Future Normal Costs		
(1) Employee Future Normal Costs	$ 7,228,909,149	$ 6,972,473,402
(2) Employer Future Normal Costs	6,306,155,637	$ 6,081,399,321
(3) Total	$ 13,535,064,786	$ 13,053,872,723
(c) Actuarial Accrued Liability: (a4) - (b3)	$ 82,105,943,131	$ 79,209,347,668
(d) Actuarial Value of Assets	$ 70,959,093,440	$ 69,568,450,606
(e) Unfunded Actuarial Accrued Liability: (c) - (d)	$ 11,146,849,691	$ 9,640,897,062

Section 5: Liability Results

The table below provides a reconciliation of the prior year's unfunded actuarial accrued liability to the current year's unfunded actuarial accrued liability.

Table 11: Reconciliation of Unfunded Actuarial Accrued Liability

(in millions)	
Unfunded Actuarial Accrued Liability (UAAL) as of 12/31/2017	$ 9,641
Normal Cost and Administrative Expense during 2018	1,688
Reduction due to Actual Contributions during 2018	(2,685)
Interest on UAAL, Normal Cost, and Contributions	641
Asset (Gain) / Loss	1,304
Actuarial Accrued Liability (Gain) / Loss	558
Impact of Assumption Changes	-
Impact of Legislative Changes	-
Unfunded Actuarial Accrued Liability (UAAL) as of 12/31/2018	$ 11,147

Commentary: During 2018, the UAAL increased faster than expected primarily due to the asset loss during the year of $1.304 billion.

Section 6: Actuarially Determined Employer Contribution

The actuarially determined employer contribution consists of a normal cost rate, an accrued liability rate and an administrative expense rate. The normal cost rate is the employer's portion of the cost of benefits accruing during the year after reducing for the member contribution. The accrued liability rate is the payment toward the unfunded accrued liability in order to pay off the unfunded accrued liability over 12 years. The expense rate is the payment for expected administrative expenses.

The table below provides the calculation of the actuarially determined employer contribution for the current and prior years' valuations.

The Employer Contribution Rate Stabilization Policy (ECRSP) adopted by the Board of Trustees on January 21, 2016 requires that recommended contributions be 0.35% of payroll greater than the appropriated contribution during the prior year, with the following bounds: (1) contributions may not be less than the actuarially determined employer contribution (ADEC) calculated below and (2) contributions may not be greater than a contribution determined using the same assumptions used to calculate the ADEC but using a discount rate equal to the long-term Treasury bond yield.

The ECRSP would result in a recommended contribution rate of 14.78% of payroll for fiscal year ending 2021.

- The minimum (before considering the ADEC) is 13.32%; the appropriated contribution from last year of 12.97% plus 0.35%.
- 15.37% is the actuarially determined employer contribution calculated in this most recent valuation prior to direct-rate smoothing of the assumption change. 14.78% is the actuarially determined contribution after direct-rate smoothing of the assumption change.
- The maximum is approximately 63.80%; the estimated actuarially determined employer contribution using a discount rate equal to the long-term Treasury bond yield (3.02%).

Table 12: Calculation of the Actuarially Determined Employer Contribution (ADEC)

Valuation Date ADEC for Fiscal Year Ending	12/31/2018 6/30/2021	12/31/2017 6/30/2020
Normal Cost Rate Calculation		
(a) Normal Cost Rate	5.08%	5.07%
(b) Expense Rate	0.10%	0.10%
(c) Total Normal Cost Rate	5.18%	5.17%
Accrued Liability Rate Calculation		
(d) Total Annual Amortization Payments*	$ 1,653,288,562	$ 1,405,896,562
(e) Projected Compensation**	16,223,213,913	15,635,747,845
(f) Accrued Liability Rate: (d) / (e)	10.19%	8.99%
Preliminary ADEC: (c) + (f)	15.37%	14.16%
ADEC With Direct Rate Smoothing	14.78%	12.97%
Impact of Legislative Changes	N/A	N/A
Final ADEC	N/A	N/A

*See Table 15 for more detail

** Beginning with the December 31, 2017 valuation, compensation is projected to the fiscal year over which contributions will occur

Section 6: Actuarially Determined Employer Contribution

The table below provides a reconciliation of the actuarially determined employer contributions.

Table 13: Reconciliation of the Change in the ADEC

Fiscal year ending June 30, 2020 Preliminary ADEC (based on December 31, 2017 valuation)	12.97%
Impact of Legislative Changes	0.00%
Fiscal year ending June 30, 2020 ADEC for Reconciliation	12.97%
Change Due to Anticipated Reduction in UAAL*	(0.32%)
Change Due to Demographic (Gain)/Loss	0.50%
Change Due to Investment (Gain)/Loss	1.08%
Change Due to Contributions Greater than ADEC**	(0.05%)
Impact of Assumption Change	0.00%
Impact of Direct Rate Smoothing	0.60%
Fiscal year ending June 30, 2021 Preliminary ADEC (based on December 31, 2018 valuation)	14.78%

* Amortization of the UAAL is determined as a level dollar amount with payments expected to remain the same over the amortization period, but was calculated as a percentage of valuation payroll in the previous valuation. Payroll is expected to increase annually while the expected amortization payment does not increase. This causes the expected amortization payment to be a lesser percentage of the expected payroll.

**Includes impact of ECRSP rate in excess of ADEC

Section 6: Actuarially Determined Employer Contribution

Amortization methods determine the payment schedule for the unfunded actuarial accrued liability. TSERS adopted a 12-year closed amortization period for fiscal year ending 2012. A new amortization base is created each year based on the prior years' experience. The tables below provide the calculation of the new amortization base and the amortization schedule for the current year's valuation.

Table 14: Calculation of the New Amortization Base

Calculation as of	12/31/2018	12/31/2017
(a) Unfunded Actuarial Accrued Liability	$ 11,146,849,691	$ 9,596,558,487
(b) Prior Years' Outstanding Bases	$ 9,310,418,300	$ 7,044,928,819
(c) New Amortization Base: (a) - (b)	$ 1,836,431,391	$ 2,551,629,668
(d) New Amortization Payment	$ 247,392,000	$ 343,738,824

* The unfunded actuarial accrued liability as of December 31, 2017 does not include the cost of the one-time cost-of-living supplement to be paid in October 2018, as the entire cost of this supplement was funded in the appropriated contribution for fiscal year ending June 30, 2019.

Table 15: Amortization Schedule for Unfunded Accrued Liability

Date Established	Original Balance	12/31/2018 Outstanding Balance	Annual Payment
December 31, 2009	$ 2,360,173,025	$ 1,244,880,806	$ 320,944,137
December 31, 2010	242,581,914	151,318,135	32,954,055
December 31, 2011	911,037,989	650,121,437	123,641,188
December 31, 2012	78,277,759	62,415,820	10,613,353
December 31, 2013	(114,027,863)	(99,827,517)	(15,446,283)
December 31, 2014	(206,952,282)	(196,251,826)	(28,008,711)
December 31, 2015	2,586,581,023	2,628,109,954	349,707,749
December 31, 2016	1,983,860,720	2,139,407,746	267,752,250
December 31, 2017	2,551,629,668	2,730,243,745	343,738,824
December 31, 2018	1,836,431,391	1,836,431,391	247,392,000
Total		$ 11,146,849,691	$ 1,653,288,562

Commentary: This is the payment schedule for the unfunded actuarial accrued liability of TSERS.

Section 6: Actuarially Determined Employer Contribution

The tables below provide a history of the actuarially determined employer contribution and the corresponding appropriated rate.

Table 16: History of Actuarially Determined Employer Contribution and Appropriated Rates

Valuation Date	Fiscal Year Ending	Normal Rate	Accrued Liability Rate	Change due to Legislation*	Final ADEC**	Appropriated Rate
12/31/2018	06/30/2021	5.18%	10.19%	N/A	N/A	N/A
12/31/2017	06/30/2020	5.17%	8.99%	0.00%	12.97%	12.97%
12/31/2016	06/30/2019	4.48%	7.50%	0.31%	12.29%	12.29%
12/31/2015	06/30/2018	4.31%	5.77%	0.45%	10.53%	10.78%
12/31/2014	06/30/2017	5.21%	3.26%	1.49%	9.96%	9.98%
12/31/2013	06/30/2016	5.19%	3.50%	0.00%	8.69%	9.15%

*The change due to legislation for the contribution for fiscal year ending 6/30/2019 includes a 0.31% increase in the ADEC due to the one-time cost-of-living supplement payable in October, 2018.

**Final ADEC reduced for direct-rate smoothing of discount rate change for FYE 2020 and 2021.

The following table shows estimates of the potential cost of two types of benefit improvements if they were enacted based on the results of the December 31, 2018 or December 31, 2017 valuations. The first benefit improvement is a permanent one-time cost-of-living increase and the second is an increase in the defined benefit formula multiplier.

Table 17: Cost of Benefits Enhancements

Calculation as of	12/31/2018	12/31/2017
Increase in UAAL for a 1% COLA	$ 497,775,000	$ 484,872,000
Increase in ADEC for a 1% COLA	0.42%	0.43%
Increase in UAAL for a 0.1% Increase in the Defined Benefit Formula	$ 427,299,000	$ 412,702,000
Increase in ADEC for a 0.1% Increase in the Defined Benefit Formula	0.42%	0.43%

The 1% COLA in the 12/31/2018 column would be effective July 1, 2020 and includes expected costs of COLAs paid for retirements after 12/31/2018 and before June 30, 2020. The COLA would be paid in full to retired members and survivors of deceased members on the retirement roll on July 1, 2019 and would be prorated for retired members and survivors of deceased members who commence benefits after July 1, 2019 but before June 30, 2020.

A corresponding increase in retirement allowances would be paid in the event of an increase in the defined benefit formula.

Section 7: Valuation Balance Sheet

The valuation balance sheet shows the projected assets and liabilities of TSERS. The items shown in the balance sheet are present values actuarially determined as of the relevant valuation date. The table below provides the valuation balance sheet for the current year and prior year.

Table 18: Valuation Balance Sheet on a Projected Basis

Balance Sheet as of	12/31/2018	12/31/2017
Assets		
Current Actuarial Value of Assets		
Annuity Savings Fund	$13,409,691,083	$ 12,976,432,877
Pension Accumulation Fund	57,549,402,357	56,592,017,729
Total	$ 70,959,093,440	$ 69,568,450,606
Future Member Contributions to the Annuity Savings Fund	$ 7,228,909,149	$ 6,972,473,402
Prospective Contributions to the Pension Accumulation Fund		
Normal Contributions	$ 6,306,155,637	$ 6,081,399,321
Unfunded Accrued Liability Contributions	11,146,849,691	9,640,897,062
Total	$ 17,453,005,328	$ 15,722,296,383
Total Assets	$ 95,641,007,917	$ 92,263,220,391
Liabilities		
Annuity Savings Fund		
Past Member Contributions	$ 13,409,691,083	$ 12,976,432,877
Future Member Contributions	7,228,909,149	6,972,473,402
Total Contributions	$ 20,638,600,232	$ 19,948,906,279
Pension Accumulaton Fund		
Benefits Currently in Payment	$ 45,534,377,845	$ 44,167,935,699
Benefits to be Paid to Current Active and Inactive Members	29,468,029,840	28,102,039,838
Reserve for Increases in Retirement Allowances	-	44,338,575
Total Benefits Payable	$ 75,002,407,685	$ 72,314,314,112
Total Liabilities	$ 95,641,007,917	$ 92,263,220,391

Section 8: Accounting Results

This section contains the accounting information for Governmental Accounting Standards Board (GASB) Statement No. 67 for fiscal year ending June 30, 2019 based on a valuation date of December 31, 2018.

Please note that GASB Statement No. 67 (*Financial Reporting for Pension Plans)* is applicable for fiscal years ending 2014 and later.

The June 30, 2019 total pension liability presented in this section was determined by an actuarial valuation as of December 31, 2018, based on the assumptions, methods and plan provisions described in this report. The actuarial cost method used to develop the total pension liability is the Entry Age Normal Cost method, as required by GASB Statement No. 67.

GASB Statement No. 67 set forth certain items of information to be disclosed in the financial statements of the Plan. The tables below provide a distribution of the number of employees by type of membership.

Table 19: Number of Active and Retired Members as of December 31, 2018

Group	Number
Retired members and survivors of deceased members currently receiving benefits	222,084
Terminated members and survivors of deceased members entitled to benefits but not yet receiving benefits	168,755
Active Members*	310,765
Total	701,604

* Includes current recipients of DIP benefits.

Section 8: Accounting Results

GASB Statement No. 67 set forth certain items of information to be disclosed in the financial statements of the Plan. The tables below provide the schedule of changes in Net Pension Liability (Asset).

Table 20: Schedule of Changes in Net Pension Liability (Asset)

Schedule of Changes in Net Pension Liability as of June 30, 2019	
Total Pension Liability	
Service Cost	$ 1,782,475,000
Interest	5,460,427,000
Changes of Benefit Terms	0
Difference between Expected and Actual Experience	535,860,000
Change of Assumptions	0
Benefit Payments, including Refund of Member Contributions	(4,835,144,000)
Net Change in Total Pension Liability	2,943,618,000
Total Pension Liability - Beginning of Year	$ 80,382,787,000
Total Pension Liability - End of Year	$ 83,326,405,000
Plan Fiduciary Net Position	
Employer Contributions	$ 1,915,146,000
Member Contributions	951,566,000
Net Investment Income	4,514,117,000
Benefit Payments, including Refund of Member Contributions	(4,835,144,000)
Administrative Expenses	(11,815,000)
Other	(1,120,000)
Net Change in Plan Fiduciary Net Position	2,532,750,000
Plan Fiduciary Net Position - Beginning of Year	$ 70,426,698,000
Plan Fiduciary Net Position - End of Year	$ 72,959,448,000

Table 21: Net Pension Liability (Asset)

Net Pension Liability (Asset)	June 30, 2019	June 30, 2018
Total Pension Liability	$ 83,326,405,000	$ 80,382,787,000
Plan Fiduciary Net Position	72,959,448,000	70,426,698,000
Net Pension Liability (Asset)	$ 10,366,957,000	$ 9,956,089,000
Plan Fiduciary Net Position as a Percentage of the Total Pension Liability (Asset)	87.56%	87.61%

Section 8: Accounting Results

The table below is the sensitivity of the net pension liability to changes in the discount rate.

Table 22: Sensitivity of the Net Pension Liability (Asset) at June 30, 2019 to Changes in the Discount Rate

Sensitivity of the Net Pension Liability to Changes in the Discount Rate			
	1% Decrease	Current	1% Increase
Discount Rate	6.00%	7.00%	8.00%
Net Pension Liability (Asset)	$ 19,731,203,000	$ 10,366,957,000	$ 2,511,548,000

The discount rate used to measure the total pension liability was 7.00%. The projection of cash flows used to determine the discount rate assumed that for fiscal year ending 2020 to fiscal year ending 2022, System contributions will follow the Employer Contribution Rate Stabilization Policy as adopted by the Board of Trustees on January 21, 2016, and "direct-rate smoothing" as adopted by the Board of Trustees on April 26, 2018. It is assumed that for fiscal years ending 2023 and beyond, System contributions will be based on the actuarially determined contribution rates. Based on those policies, the System's fiduciary net position was projected to be available to make all projected future benefit payments of current plan members. Please see Appendix E for additional details.

The table below provides the methods and assumptions used to calculate the actuarially determined contribution rate.

Table 23: Additional Information for GASB Statement No. 67

Valuation Date	12/31/2018
Actuarial Cost Method	Entry Age
Amortization Method	Level dollar closed
Amortization Period	12 year closed periods
Asset Valuation Method	Asset returns in excess of or less than the expected return on market value of assets reflected over a five-year period (not greater than 120% of market value and not less than 80% of market value)
Actuarial Assumptions:	
Investment Rate of Return*	7.00%
Projected Salary Increases**	3.50% - 8.10%
*Includes Inflation of	3.00%
**Includes Inflation and Productivity of	3.50%
Cost-of-living Adjustments	N/A

Section 9: Projections

Projections of contribution requirements and funded status into the future can be helpful planning tools for stakeholders. This section provides such projections. The projections of the actuarial valuation are known as deterministic projections. Deterministic projections are based on one scenario in the future. The baseline deterministic projection is based on December 31, 2018 valuation results and assumptions.

Key Projection Assumptions

- Valuation interest rate of 7.00% for all years in conjunction with direct rate smoothing of the employer contribution rate over a 3-year period beginning July 1, 2019.
- 7.00% investment return on market value of assets
- Actuarial assumptions and methods as described in Appendix D. All future demographic experience is assumed to be exactly realized.
- The contribution rate under the Employer Contribution Rate Stabilization Policy (ECRSP) is contributed until fiscal year ending 2022.
- The actuarially determined contribution rate is contributed for fiscal years ending 2023 and beyond.
- 0% increase in the total active member population
- No cost-of-living adjustments granted
- Future pay increases based on long-term salary increase assumptions

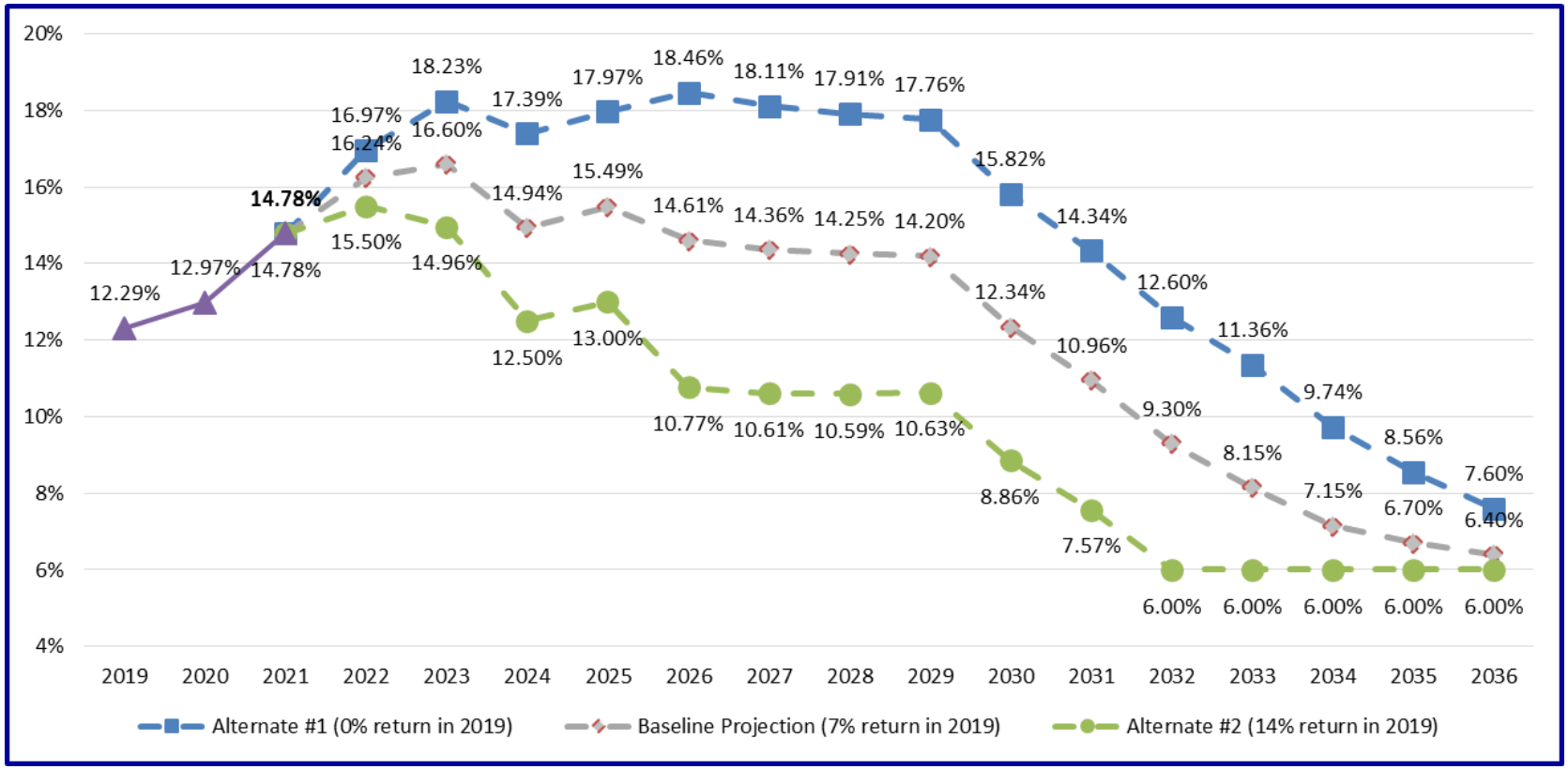
The ECRSP adopted by the Board of Trustees on January 21, 2016 requires that recommended contributions be 0.35% of payroll greater than the appropriated contribution during the prior year, with the following bounds: (1) contributions may not be less than the actuarially determined employer contribution (ADEC) rate and (2) contributions may not be greater than a contribution determined using the same assumptions used to calculate the ADEC but using a discount rate equal to the long-term Treasury bond yield.

In addition, we have provided two alternate deterministic projections. The first alternate deterministic projection is based on the same assumptions as the baseline deterministic projection except that it assumes a 0.0% asset return for calendar year 2019. The second alternate deterministic projection is based on the same assumptions as the baseline deterministic projection except that it assumes a 14.0% asset return for calendar year 2019.

Section 9: Projections

The graph below provides the actuarially determined employer contribution rates projected for 15 years.

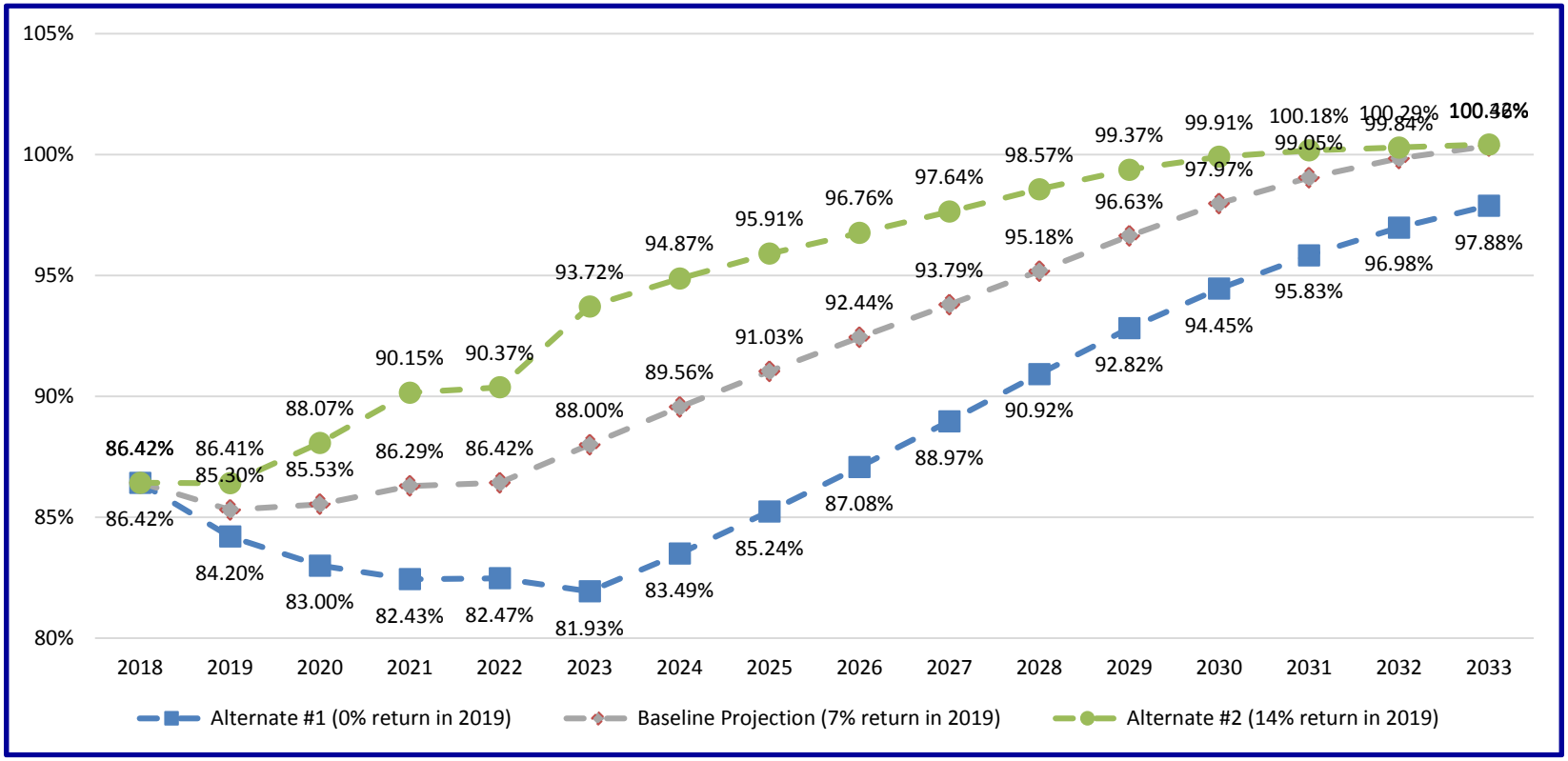
Projected Actuarially Determined Employer Contribution Rates



Section 9: Projections

The graph below provides the funded ratio projected for 15 years.

Projected Funded Ratio



Appendix A: Valuation Process and Glossary of Actuarial Terms

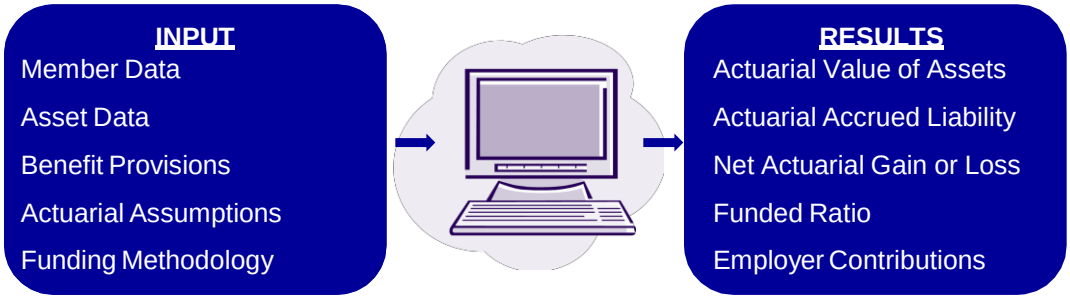
Purpose of an Actuarial Valuation

The majority of Public Sector Retirement Systems in the State of North Carolina are defined benefit (DB) retirement systems. Under a DB retirement system, the amount of benefits payable to a member upon retirement, termination, death or disability is defined in various contracts and legal instruments and is based, in part, on the member's years of credited service and final compensation. The amount of contribution needed to fund these benefits cannot be known with certainty. A primary responsibility of the Board of Trustees of a Retirement System is to establish and monitor a funding policy for the contributions made to the Retirement System.

While somewhat uncommon, in some jurisdictions, contributions are made by the plan sponsor as benefits come due. This is known as pay-as-you-go financing. More commonly, contributions for benefits are made in advance during the course of active employment of the members. This is known as actuarial pre-funding. For example, the State of North Carolina mandates for the Teachers' and State Employees' Retirement System ("TSERS") under G.S.135-8(d), that "on account of each member there shall be paid into the pension accumulation fund by employers an amount equal to a certain percentage of the actual compensation of each member to be known as the 'normal contribution' and an additional amount equal to a percentage of the member's actual compensation to be known as the 'accrued liability contribution'. The rate per centum of such contributions shall be fixed on the basis of the liabilities of the Retirement System as shown by actuarial valuation, duly approved by the Board of Trustees, and shall be called the 'actuarially determined employer contribution rate'…The actuarially determined employer contribution rate shall be calculated annually by the actuary using assumptions and a cost method approved by the Actuarial Standards Board of the American Academy of Actuaries and selected by the Board of Trustees."

The Actuarial Valuation Process

The following diagram summarizes the inputs and results of the actuarial valuation process. A narrative of the process follows the diagram. The reader may find it worthwhile to refer to the diagram from time to time.



Under the actuarial valuation process, current information about Retirement System members is collected annually by staff at the direction of the actuary, namely member data, asset data and information on benefit provisions. Member data is collected for each member of the Retirement System. The member data will assist the actuary in estimating benefits that could be paid in the future. The member information the actuary collects to estimate the amount of benefit includes elements such as current service, salary and benefit group identifier for members that have not separated service; for those that have, the actual benefit amounts are collected. The actuary collects information such as gender and date of birth to determine when a benefit might be paid and for how long.

Appendix A: Valuation Process and Glossary of Actuarial Terms

The actuary collects summary information about assets as of the valuation date and information on cash flows for the year ending on the valuation date. Information about benefit provisions as of the valuation date is also collected. To bridge the gap between the information collected and potential benefits to be paid in the future, the actuary must make assumptions about future activities. These assumptions are recommended by the actuary to the Boards based on the results of an experience review. An experience review is a review of the Retirement System over a period of time, typically five years, where the actuary analyzes the demographic and economic assumptions of the Retirement System. Based on this review, the actuary will make recommendations on the demographic assumptions, such as when members will be projected to retire, terminate, become disabled and/or die in the future, as well as the economic assumptions, such as what rate of return is projected to be earned by the fund based on the Retirement System investment policy and what level of future salary increases is expected for members. To maintain the assumptions, the Board should adopt a prudent policy of having an experience review being performed every five years. The next experience review for the North Carolina Retirement Systems will be based on the five-year period ending on December 31, 2019 and will be presented during 2020. Using these assumptions, the actuary is able to use the member data, asset data and benefit provision information collected to project the benefits that will be paid from the Retirement System to current members. These projected future benefit payments are based not only on service and pay through the valuation date but includes future pay and service, which has not yet been earned by the members but is expected to be earned.

These projected future benefit payments are discounted into today's dollars using the assumed rate of investment return assumption to determine the Present Value of Future Benefits (PVFB) of the Retirement System. The PVFB is an estimate of the value of the benefits promised to all members as of a valuation date. If the Retirement System held assets equal to the PVFB and all the assumptions were realized, there would be sufficient funds to pay off all the benefits to be paid in the future for members in the Retirement System as of the valuation date.

The PVFB is a large sum of money, typically much larger than the amount of Retirement System assets held in the trust. The next step is for the actuary to apply the Funding Policy as adopted by the Board to determine the employer contributions to be made to the Retirement System so that the gap between the PVFB and assets is systematically paid off over time. The Funding Policy is adopted by the Board based on discussions with the actuary. When the Board develops a funding policy, a balance between contributions which are responsive to the needs of the Retirement System yet stable should be struck. There are many different funding policies for the Board to consider, and the actuary is responsible for discussing the various features of the funding policies under consideration. Funding Policies are generally reviewed during an experience review, but it is not uncommon to review a funding policy in between, particularly during period where large increases or decreases in contributions are expected. The Funding Policy is composed of three components: the actuarial cost method, the asset valuation method, and the amortization method.

Once the PVFB is developed, an actuarial cost method is used to allocate the PVFB. Under the actuarial cost method, the PVFB is allocated to past, current and future service, respectively known as the actuarial accrued liability (AAL), normal cost (NC) and present value of future normal costs (PVFNC). The actuary computes the liability components (PVFB, NC, AAL, and PVFNC) for each participant in the Retirement System at the valuation date. These liability components are then totaled for the Retirement System. There are many actuarial cost methods. Different actuarial methods will produce different contribution patterns, but do not change the ultimate cost of the benefits. The entry age normal cost method is the most prevalent method used for public sector plans in the United States, because the expected normal cost is calculated in such a way that it will tend to stay level as a percent of pay over a member's career.

The actuarial accrued liability (AAL) is also referred to as the amount of money the Retirement System should ideally have in the trust. The unfunded actuarial accrued liability (UAAL) is the portion of actuarial accrued liability that is not covered by the assets of the Retirement System. The UAAL can be a negative number, which means that the Retirement System has more assets than actuarial accrued liability. We refer to this condition as overfunded liability in this summary. Having UAAL does not indicate that the Retirement System is in failing actuarial health. Most retirement systems have UAAL. Another related statistic of the Retirement System is the funded ratio. The funded ratio is the percent of the actuarial accrued liabilities covered by the actuarial value of assets. The assets used for these purposes are an actuarial value of assets (AVA), not market. The actuarial value of assets is based on the asset valuation method as recommended by the actuary and adopted by the Board. An actuarial value of assets is a smoothed, or averaged, value of assets, which is used to limit employer contribution volatility. Typically, assets are smoothed, or averaged, over a period of 3 to 5 years. By averaging returns, the UAAL is not as volatile, which we will see later results in contributions that are not as volatile as well. The North Carolina Retirement Systems use an actuarial value of assets with a smoothing period of 5 years.

While having UAAL is common, it is acceptable only if it is systematically being paid off. The method by which the UAAL is paid off is known as the amortization method. The concept is similar to that of a mortgage payment. The Board adopts the amortization method used to pay off the UAAL over a period of time. The amortization method is composed of the amortization period, the amount of payment increase, whether the period is open or closed and by the amount of amortization schedules. The amortization period is the amount of time over which the UAAL will be paid off. This is generally a period of thirty years or less, but actuaries are beginning to recommend shorter periods. The payments can be developed to stay constant from year to year like a mortgage, but often they are developed to increase each year at the same level payroll increases. Amortization type can be closed or open. Under a closed period, the UAAL is expected to be paid off over the amortization period. This is similar to a typical mortgage. Under an open period, the amortization period remains unchanged year after year. The concept is similar to re-mortgaging annually. In many instances, an amortization schedule is developed, whereby the UAAL is amortized over a closed period from the point the UAAL is incurred. Finally, some amortization methods are defined by a schedule of payments, where a new schedule of payments is added with each valuation. Regardless of the amortization type or period, the funding policy should generate a contribution that pays off the UAAL, which results in the funded ratio trending to 100% over time. Caution should be used when an open method is used, because typically an open amortization policy does not result in the UAAL being paid off. North Carolina pays off a much larger amount of UAAL compared to other states. While many states struggle to pay a 30-year level percent of pay UAAL contribution, which doesn't even reduce the amount of UAAL, North Carolina pays down the UAAL with level dollar payments over a 12 year period. This aggressive payment schedule of the UAAL results in North Carolina being home to many of the best funded Public Retirement Systems in the United States.

To satisfy the requirements of the State of North Carolina, the actuary calculates the total annual contribution to the Retirement System as the normal cost plus a contribution towards UAAL. Said another way, this contribution is sufficient to pay for the cost of benefits accruing during the year (normal cost) plus the mortgage payment (UAAL payment). The total contribution is reduced by the amount of member contributions, if any, to arrive at the employer contribution. Continuing to follow the aggressive North Carolina contribution policy will keep the North Carolina Retirement Systems among the best funded in the United States.

Appendix A: Valuation Process and Glossary of Actuarial Terms

An actuarial valuation report is produced annually, which contains the contribution for the fiscal year as well as the funded ratio of the Retirement System. The primary purpose of performing an actuarial valuation annually is to replace the estimated activities from the previous valuation, which were based on assumptions, with the actual experience of the Retirement System for the prior year. The experience gain (loss) is the difference between the expected and the actual UAAL of the Retirement System. An experience loss can be thought of as the amount of additional UAAL over and above the amount that was expected from the prior year due to deviation of actual experience from the assumption. Similarly, an experience gain can be thought of as having less UAAL than that which was expected from the prior year assumptions. As an example, if the Retirement System achieves an asset return of 15% when the assumption was a 7.00% return, an actuarial gain is said to have happened, which typically results in lower contributions and higher funded ratio, all else being equal. Alternatively, a return of 2% under the same circumstances would result in an actuarial loss, requiring an increase in contributions and a funded ratio that is lower than anticipated. Experience gains and losses are common within the valuation process. Typically gains and losses offset each other over time. To the extent that does not occur, the reasons for the gains and losses should be understood, and appropriate recommendations should be made by the actuary after an experience review to adjust the assumptions.

The actuarial valuation report will contain histories of key statistics from prior actuarial valuation reports. In particular, a history of the funded ratio of the Retirement System is an important exhibit. Trustees should understand the reason for the trend of the funded ratio of the Retirement System over time. The actuary will discuss the reasons for changes in the funded ratio of the Retirement System with each valuation report. To the extent that there are unexplained changes in funded ratio corrective action should be explored and the actuary will make recommendations as to whether there should be changes in the assumptions, funding policy, or some other portion of the actuarial valuation process.

In addition to historical information, projections of contributions and funded ratio based on current assumptions can sometimes be found in an actuarial valuation report. Projections of contributions can allow the employer to plan their budget accordingly. Surprises in Retirement System contributions to be paid by the employer serve no one. A one-year projection based on “bad” asset returns can provide ample time for the employer to plan, or allow for a discussion of changing the funding policy to occur. Contribution surprises are a primary contributor to employers considering pension reform. It is important to keep the employer apprised of future contribution requirements. A projection of funded ratio can serve the Trustees by illustrating the trend of the funded ratio over time. The funded ratio, under a prudent funding policy, should trend to 100% over a period of less than 30 years. (It is worthwhile to note that while 30 years has served as an industry standard for the longest period over which 100% funding should be achieved, that period is coming under scrutiny by the actuarial community and will likely be shortened.) If a projection of funded ratio does not trend to 100% over time, consideration should be given to fixing the funding policy to achieve this goal. For the North Carolina Retirement Systems, projections are generally performed for the January board meetings.

Appendix A: Valuation Process and Glossary of Actuarial Terms

The actuarial report will contain schedules of information about the census, plan and asset information submitted by Retirement System staff upon which the actuarial valuation is based. It is important that the Board of Trustees review that information and determine if the information is consistent with their understanding of the Retirement System. If after questioning staff, the Board of Trustees is not comfortable that the information provided is correct, the actuary should be notified to determine if the actuarial valuation report should be corrected.

Finally, the valuation report and/or presentation should contain sufficient information in an understandable fashion to allow the Board to take action and adopt the contribution rate for the upcoming year. It should also allow stakeholders to understand key observations over the past year that resulted in contributions increasing (or decreasing) and where contributions are headed. The actuary is always open to making the results understandable. CMC works with the North Carolina Retirement Systems Division to make your reports and presentations understandable and actionable. If something doesn't make sense – speak up!!

Appendix A: Valuation Process and Glossary of Actuarial Terms

Glossary

Note that the first definitions given are the "official" definitions of the term. For some terms there is a second definition, in italics, which is the unofficial definition.

Actuarial Accrued Liability (AAL). The portion of the Present Value of Projected Benefits (PVFB) allocated to past service. Also difference between (i) the actuarial present value of future benefits, and (ii) the present value of future normal cost. Sometimes referred to as "accrued liability" or "past service liability." The amount of money that should be in the fund. The funding target.

Actuarial Assumptions. Estimates of future plan experience with respect to rates of mortality, disability, retirement, investment income and salary increases. Demographic ("people") assumptions (rates of mortality, separation, and retirement) are generally based on past experience, often modified for projected changes in conditions. Economic ("money") assumptions (salary increases and investment income) consist of an underlying rate appropriate in an inflation-free environment plus a provision for a long-term average rate of inflation. Estimates of future events used to project what we know now- current member data, assets, and benefit provisions – into an estimate of future benefits.

Actuarial Cost Method. A mathematical budgeting procedure for allocating the dollar amount of the Present Value of Projected Benefits (PVFB) between the normal costs to be paid in the future and the actuarial accrued liability. Sometimes referred to as the "actuarial funding method."

Actuarial Methods. The collective term for the Actuarial Cost Method, the Amortization Payment for UAAL Method, and the Asset Valuation Method used to develop the contribution requirements for the Retirement System. *The funding policy*.

Actuarial Equivalent. Benefits whose actuarial present values are equal.

Actuarial Present Value. The amount of funds presently required to provide a payment or series of payments in the future. It is determined by discounting the future payments at a predetermined rate of interest, taking into account the probability of payment.

Actuarial Value of Assets (AVA). A smoothed value of assets which is used to limit contribution volatility. Also known as the funding value of assets*. Smoothed value of assets.*

Amortization Payment for UAAL. Payment of the unfunded actuarial accrued liability by means of periodic contributions of interest and principal, as opposed to a lump sum payment. The components of the amortization payment for UAAL include:

- Amortization Period Length – Generally amortization periods up to 15 to 20 years (and certainly not longer than 30) are allowed. Similar to a mortgage, the shorter the amortization period, the higher the payment and the faster the UAAL is paid off.
- Amortization payment increases – Future payments can be level dollar, like a mortgage, or as a level percent of pay. Most Retirement Systems amortize UAAL as a level percent of pay which when combined with the employer normal cost that is developed as a level percent of pay can result in contributions that are easier to budget.
- Amortization type – An amortization schedule can be closed or open. A closed amortization schedule is similar to a mortgage – at the end of the amortization period the UAAL is designed to be paid off. An open amortization period is similar to refinancing the UAAL year after year.
- Amortization schedule – UAAL can be amortized over a single amortization period, or it can be amortized over a schedule.

The amortization payment for UAAL can be thought of as the UAAL mortgage payment.

Appendix A: Valuation Process and Glossary of Actuarial Terms

Asset Valuation Method. The components of how the actuarial value of assets is to be developed. TSERS uses a five-year smoothing of asset gains and losses, which is the most commonly used method

Experience Gain (Loss). A measure of the difference between actual experience and experience anticipated by a set of actuarial assumptions during the period between two actuarial valuation dates, in accordance with the actuarial cost method being used. *The experience Gain (Loss) represents how much the actuary missed the mark in a given year.*

Funded Ratio. The percent of the actuarial accrued liabilities covered by the actuarial value of assets. Also known as the funded status. *The ratio of how much money you actually have in the fund to the amount you should have in the fund.*

Normal Cost. The annual cost assigned, under the actuarial funding method, to current and subsequent plan years. Sometimes referred to as "current service cost." An amortization payment toward the unfunded actuarial accrued liability is paid in addition to the normal cost to arrive at the total contribution in a given year. *The cost of benefits accruing during the year*.

Present Value of Future Normal Cost (PVFNC). The portion of the Present Value of Projected Benefits (PVFB) allocated to future service. *The value in today's dollars of the amount of contribution to be made in the future for benefits accruing for members in the Retirement System as of the valuation date.*

Present Value of Future Benefits (PVFB). The projected future benefit payments of the plan are discounted into today's dollars using an assumed rate of investment return assumption to determine the Present Value of Future Benefits (PVFB) of the Retirement System. The PVFB is the discounted value of the projected benefits promised to all members as of a valuation date, including future pay and service for members which has not yet been earned. *If the Retirement System held assets equal to the PVFB and all the assumptions were realized, there would be sufficient funds to pay off all the benefits to be paid in the future for members in the Retirement System as of the valuation date.*

Reserve Account. An account used to indicate that funds have been set aside for a specific purpose and are not generally available for other uses.

Unfunded Actuarial Accrued Liability (UAAL). The difference between the actuarial accrued liability (AAL) and actuarial value of assets (AVA). The UAAL is sometimes referred to as "unfunded accrued liability." *Funding shortfall, or prefunded amount if negative.*

Valuation Date. The date that the actuarial valuation calculations are performed as of. *Also known as the "snapshot date".*

Appendix B: Detailed Tabulation of Member Data

Table B-1: The Number and Average Reported Compensation of Active Members Distributed by Age and Service as of December 31, 2018

Age	Years of Service										
	Under 1	1 to 4	5 to 9	10 to 14	15 to 19	20 to 24	25 to 29	30 to 34	35 to 39	40 & Up	Total
Under 25	2,889	4,303	8	0	0	0	0	0	0	0	7,200
	13,281	33,037	38,492	0	0	0	0	0	0	0	25,116
25 to 29	3,162	18,495	4,730	13	0	0	0	0	0	0	26,400
	12,541	37,671	43,419	35,780	0	0	0	0	0	0	35,690
30 to 34	2,067	12,216	12,973	3,639	23	0	0	0	0	0	30,918
	12,339	39,332	46,476	49,802	45,066	0	0	0	0	0	41,762
35 to 39	1,709	9,468	8,283	11,067	4,200	63	0	0	0	0	34,790
	12,476	41,106	48,396	53,025	56,087	48,613	0	0	0	0	47,049
40 to 44	1,551	8,512	7,181	8,146	9,511	3,567	27	0	0	0	38,495
	12,026	40,787	48,448	53,364	58,863	60,701	53,342	0	0	0	50,039
45 to 49	1,429	8,581	7,565	8,519	7,978	9,467	3,153	32	0	0	46,724
	12,315	41,194	47,136	51,641	55,748	61,769	64,331	49,321	0	0	51,398
50 to 54	1,167	6,933	6,657	8,017	7,361	6,250	6,173	1,084	8	0	43,650
	12,218	40,781	46,062	49,290	52,098	57,262	65,318	65,826	57,006	0	50,749
55 to 59	897	5,717	5,686	7,366	7,161	6,040	4,033	1,949	314	7	39,170
	11,695	41,639	45,941	47,668	49,604	52,546	60,963	66,983	69,312	50,089	49,324
60 to 64	429	3,469	3,970	5,225	4,896	4,137	2,400	1,132	474	155	26,287
	11,337	43,753	45,781	48,289	50,630	53,497	60,198	67,322	74,161	69,227	50,461
65 to 69	138	1,032	1,489	1,841	1,408	988	580	381	176	187	8,220
	11,893	42,702	47,857	51,699	56,570	55,759	63,696	72,903	89,702	81,822	53,856
70 & Over	65	384	414	598	483	287	185	104	77	124	2,721
	11,395	40,523	42,043	48,837	50,130	53,980	67,582	70,657	91,896	94,324	51,907
Total	15,503	79,110	58,956	54,431	43,021	30,799	16,551	4,682	1,049	473	304,575
	12,455	39,709	46,683	50,819	54,198	57,519	63,275	67,240	76,488	80,503	47,399

Appendix B: Detailed Tabulation of Member Data

Table B-2: The Number and Reported Compensation of Active Member Distributed by Age as of December 31, 2018

Age	Men		Women	
	Number	Compensation	Number	Compensation
18	3	18,291	2	22,934
19	38	482,417	20	224,469
20	96	1,736,016	77	1,162,986
21	164	3,328,287	196	3,106,700
22	326	7,780,894	598	10,733,484
23	647	16,048,213	1,594	34,497,646
24	979	29,836,441	2,460	71,855,256
25	1,187	38,959,382	3,080	98,519,635
26	1,343	46,209,924	3,398	115,347,155
27	1,548	55,578,071	3,840	136,740,891
28	1,703	64,543,143	4,195	154,379,197
29	1,822	70,690,036	4,284	161,243,477
30	1,843	75,068,563	4,251	164,742,574
31	1,790	74,281,394	4,292	170,278,647
32	1,831	80,736,359	4,213	173,363,814
33	1,882	85,807,852	4,395	184,752,236
34	1,973	91,373,113	4,448	190,782,696
35	1,979	95,070,359	4,477	196,842,441
36	2,080	101,792,954	4,683	212,471,409
37	2,113	105,383,079	4,941	227,680,424
38	2,152	108,422,529	5,037	234,773,040
39	2,219	116,819,606	5,109	237,578,230
40	2,168	115,943,415	5,235	250,720,346
41	2,288	122,075,818	5,346	256,969,974
42	2,267	124,986,425	5,486	262,670,504
43	2,245	124,041,158	5,328	258,158,897
44	2,380	132,231,561	5,752	278,446,471
45	2,521	138,463,688	5,799	283,059,035
46	2,582	146,242,681	6,076	295,181,606
47	2,846	160,042,122	6,567	324,454,372
48	3,083	174,977,891	7,188	351,569,625
49	2,960	174,991,050	7,102	352,553,696
50	2,843	167,797,570	6,679	331,002,576
51	2,675	153,808,963	6,233	300,794,023
52	2,550	144,738,549	6,105	293,632,040
53	2,546	145,272,647	5,834	275,212,157
54	2,443	133,836,950	5,742	269,083,584
55	2,470	137,167,080	5,730	269,606,329
56	2,451	135,283,990	5,584	259,705,510

Appendix B: Detailed Tabulation of Member Data

Table B-2: The Number and Reported Compensation of Active Members Distributed by Age as of December 31, 2018 (continued)

Age	Men		Women	
	Number	Compensation	Number	Compensation
57	2,371	129,465,179	5,600	261,176,438
58	2,351	129,368,250	5,309	250,196,826
59	2,156	116,086,898	5,148	243,946,869
60	2,150	115,316,741	4,721	222,913,029
61	1,989	108,738,173	4,222	200,121,129
62	1,777	99,991,074	3,731	179,435,962
63	1,382	78,297,709	2,823	138,360,249
64	1,262	74,326,257	2,230	108,971,557
65	1,047	61,794,353	1,812	89,942,327
66	734	43,707,622	1,243	61,612,556
67	584	36,224,760	840	43,835,802
68	455	28,411,857	676	34,476,236
69	364	21,383,064	465	21,306,264
70	321	20,084,470	336	15,662,462
71	237	14,535,697	278	12,603,219
72	236	14,909,729	236	10,073,828
73	125	7,378,294	131	5,430,650
74	103	5,295,933	107	4,515,241
75	83	5,012,152	82	3,546,258
76	71	3,783,761	67	2,758,034
77	43	2,445,676	50	2,188,797
78	28	1,661,049	26	997,943
79	30	2,084,617	18	856,744
80	19	1,044,317	16	700,231
81	13	461,665	7	198,022
82	7	331,406	7	291,699
83	5	324,329	6	322,836
84	6	403,376	3	69,790
85	5	341,868	3	133,171
86	1	62,717	5	147,485
87	3	269,083	1	52,926
88	1	56,049	0	0
89	2	110,053	0	0
90	1	32,499	0	0
93	0	0	1	23,384
94	0	0	1	38,640
Total	92,998	4,825,609,158	211,577	9,610,826,690

Appendix B: Detailed Tabulation of Member Data

Table B-3: The Number and Reported Compensation of Active Members Distributed by Service as of December 31, 2018

Service	Men		Women	
	Number	Compensation	Number	Compensation
0	4,207	52,789,375	11,296	140,303,998
1	7,524	266,878,661	16,286	530,289,233
2	6,650	300,175,542	14,317	562,058,729
3	5,770	270,599,781	12,358	498,378,923
4	5,162	245,945,044	11,043	467,077,488
5	4,562	217,711,757	9,775	419,744,048
6	4,369	213,788,824	9,565	417,896,913
7	3,853	194,646,545	7,886	359,494,913
8	3,295	172,396,671	6,842	321,254,250
9	2,910	153,686,738	5,899	281,615,773
10	2,423	136,445,007	5,390	257,807,177
11	3,783	201,682,089	8,555	408,572,292
12	3,411	193,144,584	8,230	399,385,501
13	3,436	194,828,683	8,505	420,191,073
14	3,150	176,571,345	7,548	377,497,815
15	2,842	164,396,830	7,071	359,892,197
16	2,574	150,422,941	6,141	321,534,813
17	2,168	131,886,408	5,624	295,799,449
18	2,284	141,834,929	6,142	319,308,439
19	2,226	135,259,676	5,949	311,328,848
20	2,117	133,016,928	5,574	292,191,508
21	1,953	124,038,027	4,822	260,536,363
22	1,728	111,163,154	4,244	235,192,736
23	1,677	110,460,680	3,864	217,375,833
24	1,458	94,368,623	3,362	193,169,879
25	1,556	103,253,608	3,025	175,573,818
26	1,209	84,432,151	2,584	156,061,521
27	1,135	78,363,809	2,242	136,958,194
28	761	54,855,003	1,643	102,453,454
29	787	55,620,002	1,609	99,696,757
30	485	34,377,525	1,196	73,812,883
31	375	27,235,808	785	48,041,774
32	277	21,238,942	529	35,848,101
33	179	14,600,086	378	25,806,566
34	146	11,568,399	332	22,286,733
35	129	10,681,532	243	16,170,821

Appendix B: Detailed Tabulation of Member Data

Table B-3: The Number and Reported Compensation of Active Members Distributed by Service as of December 31, 2018 (continued)

Service	Men		Women	
	Number	Compensation	Number	Compensation
36	86	7,828,543	147	10,318,644
37	57	5,499,601	108	8,296,388
38	66	6,016,312	82	5,375,389
39	46	4,589,268	85	5,459,535
40	45	4,686,439	81	5,471,658
41	25	3,078,502	64	4,128,608
42	22	1,945,054	44	3,219,609
43	14	1,378,180	26	1,980,807
44	14	1,011,851	18	1,639,228
45	14	1,156,020	20	1,246,591
46	7	715,208	10	570,667
47	11	994,014	10	639,121
48	3	403,591	8	554,947
49	5	505,166	10	664,074
50	2	308,950	1	56,164
51	8	925,725	2	112,655
52	1	99,704	0	0
56	0	0	2	194,957
57	0	0	2	98,207
58	1	101,323	1	51,686
59	0	0	1	65,533
63	0	0	1	73,409
Total	92,998	4,825,609,158	211,577	9,610,826,690

Appendix B: Detailed Tabulation of Member Data

Table B-4: The Number and Valuation Compensation of Disabled Members Distributed by Age as of December 31, 2018

Age	Men		Women	
	Number	Compensation	Number	Compensation
30	1	28,961	1	46,220
31	0	0	3	116,902
32	1	28,997	3	90,181
33	1	28,987	6	184,372
34	0	0	5	181,617
35	3	86,781	9	263,387
36	2	71,317	14	487,045
37	6	214,259	15	571,622
38	7	237,166	11	440,708
39	5	190,034	19	656,368
40	8	249,598	30	1,088,426
41	11	413,513	33	1,191,121
42	11	375,658	50	1,897,540
43	15	590,102	50	1,861,220
44	25	1,012,696	67	2,628,646
45	31	1,293,746	50	1,953,254
46	36	1,432,464	69	2,586,629
47	35	1,278,658	105	3,955,967
48	46	1,938,275	105	3,721,782
49	48	1,728,288	139	5,078,678
50	55	2,165,383	135	5,022,807
51	77	2,863,916	150	5,570,261
52	62	2,836,370	160	5,868,271
53	74	2,852,675	198	7,285,810
54	91	3,454,604	217	7,765,147
55	79	2,899,394	235	7,898,912

Table B-4: The Number and Valuation Compensation of Disabled Members Distributed by Age as of December 31, 2018 (continued)

Age	Men		Women	
	Number	Contributions	Number	Contributions
56	107	3,809,592	232	8,414,879
57	112	3,944,078	252	8,245,509
58	107	3,927,575	346	11,367,826
59	122	4,767,218	297	10,223,310
60	133	4,928,484	272	9,183,565
61	120	4,636,065	243	8,187,303
62	130	4,797,886	225	7,508,609
63	105	3,993,946	230	7,838,618
64	107	4,035,951	220	7,584,471
65	60	2,298,944	143	5,041,333
66	4	114,759	2	52,266
67	1	26,577	2	25,782
68	1	22,081	1	19,488
69	0	0	5	216,804
71	0	0	2	49,356
Total	1,839	69,574,998	4,351	152,372,012

Appendix B: Detailed Tabulation of Member Data

Table B-5: The Number and Accumulated Contributions of Terminated Vested Members Distributed by Age as of December 31, 2018

Age	Men		Women	
	Number	Contributions	Number	Contributions
17	0	0	3	300
19	3	1,375	5	1,406
20	19	12,849	9	14,512
21	44	42,073	43	89,752
22	106	109,555	100	92,419
23	185	300,061	250	319,878
24	281	516,188	517	924,585
25	498	1,052,049	874	2,199,008
26	707	1,825,668	1,183	3,882,300
27	814	2,569,053	1,719	6,538,120
28	998	3,556,287	2,227	9,859,718
29	1,096	4,841,510	2,575	13,107,994
30	1,173	5,462,383	2,796	15,503,953
31	1,209	6,149,400	2,978	18,681,665
32	1,340	7,610,803	3,053	21,391,318
33	1,390	8,469,114	3,320	25,340,377
34	1,508	10,679,846	3,643	29,550,619
35	1,373	10,538,017	3,859	35,345,015
36	1,598	12,397,371	3,927	38,487,801
37	1,578	14,547,962	4,127	42,744,001
38	1,535	16,014,387	3,968	44,341,353
39	1,575	16,131,038	4,044	46,272,058
40	1,498	16,970,859	3,806	46,170,593
41	1,465	17,865,417	3,719	46,088,798
42	1,504	19,391,624	3,567	46,088,610
43	1,410	20,096,727	3,339	44,078,075
44	1,443	21,442,404	3,455	48,474,537
45	1,425	21,992,969	3,195	46,930,838
46	1,450	24,670,455	3,179	48,426,375
47	1,480	25,917,537	3,212	48,787,769
48	1,630	28,407,196	3,532	56,924,934
49	1,480	27,087,250	3,430	54,901,502
50	1,355	25,325,333	3,139	52,850,266
51	1,273	23,165,100	2,896	48,541,724
52	1,211	23,231,419	2,659	44,507,578
53	1,199	21,599,326	2,511	41,600,386
54	1,174	23,196,476	2,690	44,171,771
55	1,107	21,797,613	2,570	44,571,877
56	1,097	22,535,830	2,528	46,029,320
57	1,006	19,663,637	2,516	44,374,183
58	1,116	23,543,121	2,462	47,433,347
59	994	22,582,780	2,274	45,047,072

Appendix B: Detailed Tabulation of Member Data

Table B-5: The Number and Accumulated Contributions of Terminated Vested Members Distributed by Age as of December 31, 2018 (continued)

Age	Men		Women	
	Number	Contributions	Number	Contributions
60	884	20,638,551	2,078	43,111,966
61	701	14,145,026	1,606	31,039,230
62	664	13,168,950	1,417	27,278,668
63	612	10,373,682	1,252	22,027,204
64	609	9,439,027	1,272	21,077,037
65	468	7,899,426	972	16,484,813
66	358	4,839,940	676	10,133,224
67	303	4,384,676	492	6,443,760
68	303	3,731,963	499	5,882,985
69	259	1,890,078	523	4,960,572
70	228	2,136,429	380	4,034,158
71	138	1,097,842	216	2,528,263
72	58	858,513	77	770,180
73	37	625,899	53	673,353
74	36	444,830	40	377,885
75	32	361,718	22	256,046
76	21	124,038	19	119,527
77	14	52,760	22	217,760
78	13	77,837	14	136,353
79	11	84,622	10	79,116
80	13	158,891	8	42,613
81	11	104,498	9	79,310
82	9	54,816	5	39,777
83	5	42,377	3	20,481
84	7	48,079	5	51,642
85	4	2,475	2	(228)
86	3	24,273	1	252
87	3	920	3	2,581
88	1	5,242	2	551
89	2	1,699	0	0
90	2	6,395	0	0
91	1	1	0	0
92	1	17,074	2	6,055
93	1	33	2	234
94	1	22,684	2	54
95	1	2,078	2	26
96	0	0	1	87
97	0	0	2	242
98	1	143	1	345
99	0	0	1	250
100+	0	0	3	76
Total	51,162	670,177,547	117,593	1,498,564,155

Appendix B: Detailed Tabulation of Member Data

Table B-6: The Number and Annual Retirement Allowances of Retired Members (Healthy at Retirement) and Survivors of Deceased Members Distributed by Age as of December 31, 2018

Age	Men		Women	
	Number	Allowances	Number	Allowances
18	3	10,329	3	33,983
19	1	7,712	1	8,875
20	4	26,834	2	16,779
21	3	50,569	1	2,463
22	4	12,419	1	15,519
23	3	36,645	4	84,040
24	3	33,093	4	52,954
25	4	24,102	2	46,194
26	2	15,467	6	88,092
27	2	45,568	5	30,719
28	4	36,369	7	84,314
29	8	97,586	11	103,274
30	9	80,899	5	66,519
31	9	139,322	12	138,145
32	6	57,673	10	121,219
33	7	48,157	10	112,253
34	8	108,654	12	143,463
35	11	112,659	10	110,048
36	11	140,939	15	192,402
37	19	157,233	19	272,758
38	19	300,220	17	110,775
39	10	109,894	13	150,531
40	10	77,596	15	162,173
41	14	155,990	27	311,829
42	21	270,921	28	269,158
43	13	188,015	29	409,150
44	18	181,303	27	361,301
45	22	248,750	25	240,725
46	23	228,754	35	375,948
47	32	577,358	34	343,915
48	45	766,071	52	666,549
49	78	1,749,080	53	900,996
50	112	2,736,267	115	2,050,780
51	201	5,350,783	215	4,525,980
52	322	8,988,144	385	8,851,943
53	412	12,215,199	555	14,595,880
54	507	15,113,628	814	22,327,184
55	644	19,219,699	968	27,643,164
56	776	23,866,831	1,182	33,394,877
57	812	25,192,858	1,396	40,318,582
58	877	27,454,589	1,698	48,290,509
59	934	29,451,079	1,880	54,182,049

Appendix B: Detailed Tabulation of Member Data

Table B-6: The Number and Annual Retirement Allowances of Retired Members (Healthy at Retirement) and Survivors of Deceased Members Distributed by Age as of December 31, 2018 (continued)

Age	Men		Women	
	Number	Allowances	Number	Allowances
60	1,087	32,808,954	2,317	62,525,110
61	1,368	39,346,532	3,385	88,812,970
62	1,649	42,303,576	4,188	102,070,181
63	2,034	48,082,769	5,010	107,618,416
64	2,249	51,893,906	5,667	120,976,872
65	2,471	56,479,922	6,539	137,121,808
66	2,867	65,395,019	7,305	152,163,821
67	3,128	71,196,286	7,520	154,294,002
68	3,168	70,696,121	7,349	151,385,512
69	3,127	71,714,669	7,201	144,420,872
70	3,253	74,145,761	7,175	141,424,050
71	3,312	75,555,736	7,120	137,456,729
72	3,582	83,350,414	7,554	146,574,966
73	2,470	56,849,628	5,176	97,048,605
74	2,446	55,394,039	4,819	89,267,093
75	2,221	51,108,515	4,827	89,337,613
76	2,254	54,850,586	4,772	87,249,779
77	1,840	42,875,055	3,917	70,499,078
78	1,641	38,839,898	3,563	63,168,868
79	1,503	35,787,338	3,248	57,064,770
80	1,400	33,513,764	2,924	50,953,159
81	1,294	30,637,395	2,841	48,324,876
82	1,119	28,148,175	2,551	43,856,584
83	1,069	25,919,589	2,448	41,362,116
84	917	22,385,271	2,412	40,322,184
85	835	20,532,597	1,927	30,776,665
86	751	18,069,738	1,770	28,912,054
87	685	16,455,833	1,669	26,504,497
88	575	14,660,504	1,473	24,145,600
89	497	12,408,664	1,295	21,239,565
90	357	8,991,590	1,166	18,116,429
91	300	7,019,512	968	15,149,569
92	242	5,668,794	784	12,027,567
93	183	4,240,362	681	9,937,106
94	141	2,879,608	521	7,514,259
95	90	1,771,047	392	5,385,013
96	72	1,413,148	279	3,655,143
97	44	1,528,072	240	3,176,774
98	38	899,934	170	2,026,053
99	14	257,772	104	1,321,953
100+	26	596,034	239	3,161,974
Total	64,342	1,552,357,385	145,209	2,900,558,266

Appendix B: Detailed Tabulation of Member Data

Table B-7: The Number and Annual Retirement Allowances of Retired Members (Healthy at Retirement) and Survivors of Deceased Members Distributed by Annuity Type as of December 31, 2018

Annuity Type	Men		Women	
	Number	Allowances	Number	Allowances
0:Maximum	22,136	514,063,802	79,552	1,559,642,958
1:Option 1: 10-year guaranteed	667	19,411,276	2,755	45,881,516
2:Option 2: 100% joint and survivor	11,289	269,034,165	6,731	111,503,389
3:Option 3: 50% joint and survivor	3,397	100,353,391	3,287	67,893,354
4:Option 4: Social security leveling	9,030	225,868,614	23,510	531,348,717
5:Option 5- 2:100% joint and surv.	121	3,755,347	52	533,948
6:Option 5-3: 50% joint and surv.	72	2,409,442	79	1,459,366
7:Option 6-2: 100% joint and surv. w/ pop-up	9,820	244,046,467	9,935	207,778,711
8:Option 6-3: 50% joint and surv. w/ pop-up	4,266	129,791,539	7,437	188,409,069
9:Special	7	242,441	3	63,260
Survivors of Deceased Members	3,537	43,380,901	11,868	186,043,978
Total	64,342	1,552,357,385	145,209	2,900,558,266

Appendix B: Detailed Tabulation of Member Data

Table B-8: The Number and Annual Retirement Allowances of Retired Members (Disabled at Retirement) Distributed by Age of December 31, 2018

Age	Men		Women	
	Number	Allowances	Number	Allowances
50	4	76,034	1	22,052
51	3	63,861	1	17,268
52	9	198,154	6	142,331
53	13	241,974	4	89,003
54	24	478,327	21	440,704
55	27	623,422	30	623,753
56	29	635,797	47	999,083
57	33	646,978	58	1,264,372
58	31	678,573	65	1,365,998
59	42	964,218	56	1,177,115
60	66	1,290,155	109	2,147,515
61	92	2,023,279	168	3,476,509
62	100	2,043,356	178	3,483,902
63	109	2,192,241	256	5,101,072
64	119	2,388,154	282	5,563,184
65	171	3,151,032	406	7,511,259
66	242	4,138,454	552	9,858,482
67	261	4,498,598	597	10,711,033
68	261	4,491,997	635	11,132,869
69	270	4,531,117	555	9,445,564
70	255	4,351,936	534	9,693,543
71	309	5,575,281	529	9,059,429
72	266	4,969,901	547	9,366,665
73	188	3,307,899	381	6,302,011
74	151	2,527,423	385	6,094,313
75	147	2,397,755	340	4,976,305

Appendix B: Detailed Tabulation of Member Data

Table B-8: The Number and Annual Retirement Allowances of Retired Members (Disabled at Retirement) Distributed by Age of December 31, 2018 (continued)

Age	Men		Women	
	Number	Allowances	Number	Allowances
76	150	2,645,466	340	5,378,894
77	106	1,887,197	269	4,060,627
78	105	1,583,057	211	2,835,693
79	106	1,651,930	165	2,315,122
80	53	726,676	172	2,245,528
81	64	964,674	158	2,080,191
82	35	529,785	84	1,168,344
83	27	500,013	71	857,955
84	23	362,028	44	619,982
85	12	212,575	48	691,100
86	13	299,287	38	435,629
87	13	221,306	25	341,878
88	19	281,592	35	402,618
89	7	86,556	22	306,650
90	6	133,325	23	267,729
91	4	48,700	17	191,079
92	4	30,035	21	294,302
93	6	90,460	18	237,336
94	5	51,197	7	54,124
95	2	9,455	11	92,419
96	4	55,118	8	76,868
97	1	6,805	1	7,086
98	0	0	3	7,034
99	0	0	9	68,888
100+	0	0	3	44,655
Total	3,987	70,863,153	8,546	145,147,065

Appendix B: Detailed Tabulation of Member Data

Table B-9: The Number and Annual Retirement Allowances of Retired Members (Disabled at Retirement) Distributed by Annuity Type of December 31, 2018

Annuity Type	Men		Women	
	Number	Allowances	Number	Allowances
0:Maximum	2,032	38,622,367	6,129	107,082,427
1:Option 1: 10-year guaranteed	70	1,303,703	237	3,584,564
2:Option 2: 100% joint and survivor	734	10,141,225	575	7,457,975
3:Option 3: 50% joint and survivor	215	4,053,031	264	4,035,385
4:Option 4: Social security leveling	145	3,214,160	402	7,293,770
5:Option 5-2: 100% joint and surv.	3	44,754	1	8,214
6:Option 5-3: 50% joint and surv.	1	14,645	1	16,086
7:Option 6-2: 100% joint and surv. w/ pop-up	559	8,776,281	547	8,376,687
8:Option 6-3: 50% joint and surv. w/ pop-up	228	4,692,987	389	7,270,995
9:Special	0	0	1	20,962
Total	3,987	70,863,153	8,546	145,147,065

Appendix B: Detailed Tabulation of Member Data

Table B-10: The Number and Annual Retirement Allowances of Retired Members and Survivors of Deceased Members Distributed by Amount of Annual Retirement Allowance of December 31, 2018

Amount of Annual Retirement Allowance	Number of Retired Members and Suvivors	Sum of Annual Retirement Allowances
$0 -$ 4,999	30,479	$ 90,170,894
$5,000 - $9,999	35,931	265,864,035
$10,000 - $14,999	30,150	374,923,443
$15,000 - $19,999	24,170	420,545,328
$20,000 - $24,999	21,620	487,115,460
$25,000 - $29,999	21,419	588,369,884
$30,000 - $34,999	20,195	654,472,680
$35,000 - $39,999	14,199	530,069,737
$40,000 -$ 44,999	8,844	373,988,957
$45,000 - $49,999	5,258	248,388,918
$50,000 & over	9,819	635,016,533
Total	222,084	$ 4,668,925,869

Appendix C: Summary of Main Benefit & Contribution Provisions

A summary of the main benefit provisions of the Retirement System and of the sources of revenue from which benefits are paid is presented in the following digest. Items in parentheses in the text are the provisions applicable to law enforcement officers.

"Average final compensation" as used in the summary means the average annual compensation during the four consecutive years of membership service which afford the highest such average. "Membership service" means service represented by regular contributions. "Creditable service" means membership service and may also include certain special purchased service.

BENEFITS

Unreduced Retirement Allowance

Condition for Allowance

An unreduced retirement allowance is payable to any member who retires from service:

(a) after age 65 (55) and completion of five years of creditable service;

(b) after age 60 and completion of 25 years of creditable service (not applicable to law enforcement officers); or

(c) after completion of 30 years of creditable service.

Amount of Allowance

1.82% of average final compensation multiplied by the number of years of creditable service. In no event will a member whose creditable service commenced on or before June 30, 1963 receive a smaller retirement allowance than he would have received under the benefit provisions of the system in effect on that date.

Reduced Retirement Allowance

Condition for Allowance	A reduced retirement allowance is payable to any member who retires from service prior to becoming eligible for an unreduced retirement allowance but after age 60 and completion of five years of membership service (age 55 and five years of creditable service).
Amount of Allowance	The member's reduced retirement allowance is equal to 1.82% of average final compensation multiplied by the number of years of creditable service at date of retirement reduced by 1/4 of 1% for each month by which the member's age at retirement is less than age 65. In no event will a member whose creditable service commenced on or before June 30, 1963 receive a smaller retirement allowance than he or she would have received under the benefit provisions of the system in effect on that date.

OR

Condition for Allowance	A reduced retirement allowance is payable to any member who retires from service after age 50 and completion of 20 (15) years of creditable service, but prior to becoming eligible for a reduced or unreduced retirement allowance.
Amount of Allowance	The member's reduced retirement allowance is equal to 1.82% of average final compensation multiplied by the number of years of creditable service at date of retirement reduced by the lesser of: (i) 5/12 (1/3) of 1% for each month by which his age is less than 60 (55), plus, if the member is not a law enforcement officer, 1/4 of 1% for each month by which age 60 is less than 65. (ii) 5% times the difference between 30 years and creditable service at retirement.

OR

Condition for Allowance	A reduced retirement allowance is payable to any law enforcement officer who retires from service at any age with 25 years of service (15 years as an officer), but prior to becoming eligible for a reduced or unreduced retirement allowance.
Amount of Allowance	The member's reduced retirement allowance is equal to 1.82% of average final compensation multiplied by the number of years of creditable service at date of retirement reduced by the lesser of: (i) 1/3 of 1% for each month by which his age is less than 55, (ii) 5% times the difference between 30 years and creditable service at retirement plus 4% times the difference between age 50 and the member's age at retirement.

Deferred Retirement Allowance	Any member who separates from service after completing five or more years of membership service prior to becoming eligible for an unreduced or reduced retirement allowance and who leaves his or her total accumulated contributions in the system may receive a deferred retirement allowance, beginning at age 60 (55), computed in the same way as a reduced retirement allowance, or, if the member has 20 (15) or more years of service, at age 50 computed in the same way as a reduced service retirement allowance, on the basis of creditable service and compensation to the date of separation.
Return of Contributions	Upon the withdrawal of a member without a retirement allowance and upon his or her request, the member's contributions are returned, together with accumulated regular interest. Upon the death of a member before retirement, his or her contributions, together with the full accumulated regular interest thereon, are paid to the estate or to person(s) designated by the member unless the designated beneficiary, if eligible, elects the survivor's alternate benefit described below. The current interest rate on member contributions is 4%.
Survivor's Alternate Benefit	Upon the death of a member in service who has met conditions (a) or (b) below, his designated beneficiary may elect to receive a benefit equal to that which would have been payable under the provisions of Option 2 had the member retired on the first day of the month following his death and elected such option, in lieu of the member's accumulated contributions, provided the member had not instructed the Board of Trustees in writing that he or she did not wish the alternate benefit to apply. (a) age 60 (55) and completion of five years of membership (creditable) service; or (b) completion of 20 years of creditable service. Members receiving a benefit from the Disability Income Plan are eligible for this benefit.
Death After Retirement	Upon the death of a beneficiary who did not retire under an effective election of Option 2, 3, 5 or 6, an amount equal to the excess if any, of the member's accumulated contributions at retirement over the retirement allowance payments received is paid to a designated person or to the beneficiary's estate.

Upon the death of the survivor of a beneficiary who retired under an effective election of Option 2, 3, 5 or 6, an amount equal to the excess, if any, of the beneficiary's accumulated contributions at retirement over the total retirement allowance payments received is paid to such other person designated by the beneficiary or to the beneficiary's estate.

Upon the death of a beneficiary, a benefit may be provided by the Retirees' Contributory Death Benefit Plan.

Other Death Benefits

Upon the death of a member in service, other benefits may be provided by the Death Benefit Plan or Separate Insurance Benefit Plan for Law Enforcement Officers.

Optional Arrangements at Retirement

In lieu of the full retirement allowance, any member may elect to receive a reduced retirement allowance equal in value to the full allowance, with the provision that:

Option 1 - A member retiring prior to July 1, 1993, may elect that at his or her death within 10 years from retirement date, an amount equal to the member's accumulated contributions at retirement, less 1/120 for each month he or she has received a retirement allowance, is paid to the estate, or to a person(s) designated by the member, or

Option 2 - At the death of the member his or her allowance shall be continued throughout the life of such other person as the member shall have designated at the time of retirement, or

Option 3 - At the death of the member one-half of his or her allowance shall be continued throughout the life of such other person as the member shall have designated at the time of retirement.

Option 4 - A member may elect to receive a retirement allowance in such amount that, together with his Social Security benefit, he or she will receive approximately the same income per annum before and after the earliest age at which he or she becomes eligible to receive the Social Security benefit.

Option 5 - A member retiring prior to July 1, 1993 may elect to receive a reduced retirement allowance under the provisions of Option 2 or Option 3 in conjunction with the provisions of Option 1.

Option 6 - A member may elect either Option 2 or Option 3 with the added provision that in the event the designated beneficiary predeceases the member, the retirement allowance payable to the member after the designated beneficiary's death shall be equal to the retirement allowance which would have been payable had the member not elected the option.

Post-Retirement Increases in Allowances	Future increases in allowances may be granted at the discretion of the State.
Service Reciprocity	For the purpose of determining eligibility for a deferred, reduced or unreduced service retirement allowance, the membership and creditable service of a member shall include such prior service earned as a member of the Local Governmental Employees' Retirement System (LGERS), the Consolidated Judicial Retirement System (CJRS), or the Legislative Retirement System (LRS). In addition, if the member's accumulated contributions and reserves are transferred from the prior System to this System, the creditable service earned as a member of the prior System may be included for purposes of determining the amount of benefits payable under this System.
Military Service	Periods of active duty in the United States military may be counted as creditable service if the member was an employee upon entering the military and returned to employment within two years of discharge or for a period of 10 additional years.
Service Purchases	Additional creditable service may include service that the member purchased to restore a period of service for which the member (1) received a refund of contributions, (2) had a leave of absence for educational purposes, extended illness or parental or maternity reasons, (3) had full-time temporary or part-time local or State government employment, (4) was in a probationary or waiting period with a unit of the LGERS, (5) had a leave of absence under Workers' Compensation, (6) performed service with a unit of local government not covered by LGERS, (7) performed service with the federal government not covered by any other retirement system, (8) performed service with a public community service entity funded entirely with federal funds, (9) performed service as a member of the General Assembly, (10) performed service as a member of a charter school not participating in the system, (11) was employed by The University of North Carolina and participated in the Optional Retirement Program but not eligible to receive any benefits from that program, or (12) performed service which was omitted by reason of error.
Unused Sick Leave	Unused sick leave counts as creditable service at retirement. Sick leave which was converted from unused vacation leave is also creditable. One month of credit is allowed for each 20 days of unused sick leave, plus an additional month for any part of 20 days left over.

Transfer of Defined Contribution Balances (Special Retirement Allowances)

A member may make a one-time election to transfer any portion of their eligible accumulated contributions to this plan on or after retirement. Eligible accumulated contributions are those from the Supplemental Retirement Income Plan or Public Employee Deferred Compensation Plan, not including Roth after-tax contributions. A member who became a member of the Supplemental Retirement Income Plan prior to retirement and who remains a member of the Supplemental Retirement Income Plan may also make a one-time election to transfer eligible balances, not including any Roth after-tax contributions, from any of the following plans to the Supplemental Retirement Income Plan, subject to the applicable requirements of the Supplemental Retirement Income Plan, and then through the Supplemental Retirement Income Plan to this Retirement System:

(1) A plan participating in the North Carolina Public School Teachers' and Professional Educators' Investment Plan.

(2) A plan described in section 403(b) of the Internal Revenue Code.

(3) A plan described in section 457(b) of the Internal Revenue Code that is maintained by a state, political subdivision of a state, or any agency or instrumentality of a state or political subdivision of a state.

(4) An individual retirement account or annuity described in Section 408(a) or 408(b) of the Internal Revenue Code that is eligible to be rolled over and would otherwise be includible in gross income.

(5) A tax-qualified plan described in section 401(a) or 403(a) of the Internal Revenue Code.

The member may elect to convert the accumulated contributions to a life annuity with or without annual increases equal to the annual increase in the U.S. Consumer Price Index. Any ad-hoc COLA increases granted will not apply to benefits under this section. A member may elect Options 2, 3, or 6 under the Plan and may also elect either a guaranteed number of months of payments or a guarantee of total payments at least equal to the amount of contributions transferred to the Plan. In addition, any transfer may be paid in whole or in part with employer contributions paid directly to the Retirement System at the time of transfer.

Appendix C: Summary of Main Benefit & Contribution Provisions

Contributions	
Member Contributions	Each member contributes 6% of his or her compensation.
Employer Contributions	Employers make annual contributions consisting of a normal contribution and an accrued liability contribution. The normal contribution covers the liability on account of current service and is determined by the actuary after each valuation. The accrued liability contribution covers the past service liability that exceeds the actuarial value of assets. The minimum total employer contribution rate is 6.00%.
Changes Since Prior Valuation	None.

Appendix D: Actuarial Assumptions and Methods

Assumptions are based on the experience investigation prepared as of December 31, 2014 and adopted by the Board of Trustees on January 21, 2016 for use beginning with the December 31, 2015 annual actuarial valuation. The interest rate of 7.00% was adopted by the Board of Trustees on April 26, 2018.

Interest Rate: 7.00% per annum, compounded annually.

Inflation: Both general and wage inflation are assumed to be 3.00% per annum.

Real Wage Growth: 0.50% per annum.

Payroll Growth: 3.50% per annum.

Separations from Active Service: Representative values of the assumed rates of separation from active service are as follows:

Annual Rates of Withdrawal

	General Employees		Teachers, Librarians and Counselors		Law Enforcement Officers		Other Education	
Service	Male	Female	Male	Female	Male	Female	Male	Female
0	.180	.195	.190	.170	.130	.130	.190	.165
1	.155	.170	.160	.145	.100	.100	.160	.135
2	.130	.145	.140	.135	.090	.090	.130	.120
3	.110	.115	.120	.120	.060	.060	.115	.100
4	.090	.100	.095	.100	.060	.060	.100	.085

General Employees

Age	Annual Rates of Withdrawal and Vesting*		Base Mortality**		Disability	
	Male	Female	Male	Female	Male	Female
25	.0800	.1100	.0005	.0002	.0002	.0002
30	.0700	.0850	.0005	.0002	.0004	.0004
35	.0525	.0600	.0005	.0003	.0010	.0010
40	.0400	.0450	.0006	.0004	.0030	.0018
45	.0350	.0375	.0010	.0007	.0050	.0032
50	.0350	.0375	.0017	.0011	.0084	.0050
55	.0350	.0375	.0028	.0017	.0144	.0088
60	.0350	.0375	.0047	.0024	.0240	.0138
65			.0083	.0037		
69			.0125	.0057		

* These rates apply only after five years of membership in the system.

** Base mortality rates as of 2014.

Appendix D: Actuarial Assumptions and Methods

Teachers, Librarians and Counselors

Age	Annual Rates of Withdrawal and Vesting*		Base Mortality**		Disability	
	Male	Female	Male	Female	Male	Female
25	.0800	.0900	.0003	.0001	.0001	.0002
30	.0700	.0750	.0003	.0002	.0001	.0003
35	.0450	.0450	.0004	.0002	.0003	.0006
40	.0350	.0340	.0004	.0003	.0007	.0010
45	.0325	.0325	.0007	.0006	.0014	.0018
50	.0325	.0325	.0012	.0009	.0023	.0032
55	.0325	.0325	.0020	.0014	.0047	.0055
60	.0325	.0325	.0033	.0021	.0077	.0102
65			.0058	.0031		
69			.0092	.0049		

* These rates apply only after five years of membership in the system.

** Base mortality rates as 2014.

Other Education Employees

Age	Annual Rates of Withdrawal and Vesting*		Base Mortality**		Disability	
	Male	Female	Male	Female	Male	Female
25	.0800	.1200	.0003	.0001	.0002	.0002
30	.0600	.0700	.0003	.0002	.0004	.0004
35	.0450	.0450	.0004	.0002	.0010	.0010
40	.0400	.0400	.0004	.0003	.0030	.0018
45	.0400	.0375	.0007	.0006	.0050	.0032
50	.0400	.0375	.0012	.0009	.0084	.0050
55	.0400	.0375	.0020	.0014	.0144	.0088
60	.0400	.0375	.0033	.0021	.0240	.0138
65			.0058	.0031		
69			.0092	.0049		

* These rates apply only after five years of membership in the system.

** Base mortality rates as 2014.

Appendix D: Actuarial Assumptions and Methods

Law Enforcement Officers

Age	Annual Rates of Withdrawal and Vesting*		Base Mortality**		Disability	
	Male	Female	Male	Female	Male	Female
25	.0400	.0400	.0005	.0002	.0033	.0033
30	.0350	.0350	.0005	.0002	.0043	.0043
35	.0300	.0300	.0005	.0003	.0060	.0060
40	.0300	.0300	.0006	.0004	.0079	.0079
45	.0400	.0400	.0010	.0007	.0110	.0110
50	.0400	.0400	.0017	.0011	.0176	.0176
55	.0400	.0400	.0028	.0017		
60	.0400	.0400	.0047	.0024		
65			.0083	.0037		
69			.0125	.0057		

* These rates apply only after five years of membership in the system.

** Base mortality rates as of 2014.

Retirements: Representative values of the assumed rates of retirement from active service are as follows:

General Employees - Male

Age	Service 5	10	15	20	25	30	35
50				0.0350	0.0800	0.3500	0.2000
55				0.0500	0.1000	0.3500	0.2000
60	0.0850	0.0850	0.0850	0.0850	0.2750	0.3000	0.2250
65	0.2500	0.2750	0.2750	0.2750	0.2750	0.2750	0.2750
70	0.3250	0.2250	0.2250	0.2250	0.2250	0.2250	0.2250
75	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

General Employees - Female

Age	Service 5	10	15	20	25	30	35
50				0.0350	0.0600	0.4000	0.3000
55				0.0500	0.0800	0.3250	0.2250
60	0.0950	0.0950	0.0950	0.0950	0.2500	0.3000	0.2000
65	0.4000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
70	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
75	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Appendix D: Actuarial Assumptions and Methods

Teachers, Librarians and Counselors - Male

	Service						
Age	5	10	15	20	25	30	35
50				0.0250	0.0650	0.3000	0.3000
55				0.0450	0.0900	0.3250	0.2500
60	0.1200	0.1200	0.1200	0.1200	0.3000	0.2500	0.2500
65	0.3000	0.3250	0.3250	0.3250	0.2000	0.2000	0.2000
70	0.2250	0.2250	0.2250	0.2250	0.2250	0.2250	0.2250
75	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Teachers, Librarians and Counselors - Female

	Service						
Age	5	10	15	20	25	30	35
50				0.0350	0.0550	0.2750	0.2750
55				0.0600	0.0950	0.4000	0.3000
60	0.1350	0.1350	0.1350	0.1350	0.4500	0.5000	0.3250
65	0.3500	0.3750	0.3750	0.3750	0.3500	0.3500	0.3500
70	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
75	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Other Education Employees - Male

	Service						
Age	5	10	15	20	25	30	35
50				0.0350	0.0800	0.3000	0.1500
55				0.0400	0.1000	0.2500	0.2000
60	0.0900	0.0900	0.0900	0.0900	0.2250	0.2500	0.2500
65	0.2750	0.3000	0.3000	0.3000	0.2750	0.2750	0.2750
70	0.2250	0.2250	0.2250	0.2250	0.2250	0.2250	0.2250
75	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Other Education Employees - Female

	Service						
Age	5	10	15	20	25	30	35
50				0.0400	0.0550	0.3250	0.2250
55				0.0500	0.0900	0.2250	0.2250
60	0.1100	0.1100	0.1100	0.1100	0.2500	0.2500	0.2500
65	0.2500	0.2750	0.2750	0.2750	0.3500	0.3500	0.3500
70	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500
75	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Law Enforcement Officers

	Service						
Age	5	10	15	20	25	30	35
50			0.0900	0.0900	0.0900	0.6000	0.6000
55	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
60	0.2000	0.2000	0.2000	0.2000	0.2000	0.5000	0.5000
65	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500
70	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
75	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Salary Increases: Representative values of the assumed annual rates of salary increases are as follows:

	Annual Rate of Salary Increase			
Service	Teachers, Librarians and Counselors	Other Education Employees	General Employees	Law Enforcement Officers
0	7.55%	7.00%	5.50%	8.10%
5	6.05	6.25	4.50	6.10
10	5.10	5.50	4.00	4.40
15	4.35	4.75	3.50	3.95
20	3.65	4.00	3.50	3.65
25 or more	3.50	3.50	3.50	3.50

Appendix D: Actuarial Assumptions and Methods

Post-Retirement Mortality: Representative values of the assumed post-retirement mortality rates as of 2014 prior to any mortality improvements are as follows:

Annual Rate of Death after Retirement

(Members Healthy at Retirement)

Age	Teachers & Other Education Employees		General Employees		Law Enforcement Officers	
	Male	Female	Male	Female	Male	Female
55	.0036	.0021	.0062	.0029	.0057	.0036
60	.0048	.0030	.0084	.0042	.0078	.0052
65	.0070	.0051	.0119	.0065	.0110	.0080
70	.0114	.0082	.0181	.0104	.0168	.0129
75	.0196	.0137	.0290	.0170	.0268	.0209
80	.0448	.0329	.0555	.0394	.0447	.0348

Annual Rate of Death after Retirement

(Survivors of Deceased Members and Members Disabled at Retirement)

Age	Male Survivors of Deceased Members	Female Survivors of Deceased Members	Male Retired Members Disabled at Retirement	Female Retired Members Disabled at Retirement
55	.0071	.0045	.0241	.0143
60	.0096	.0064	.0274	.0168
65	.0135	.0099	.0326	.0207
70	.0206	.0158	.0416	.0279
75	.0330	.0258	.0559	.0406
80	.0550	.0429	.0789	.0604

Deaths After Retirement (General Employees): Mortality rates are based on the RP-2014 Total Data Set for Healthy Annuitants Mortality Table. Rates for male members are multiplied by 108% for ages 50-78 and by 124% for ages greater than 78. Rates for female members are multiplied by 81% for ages 50-78 and by 113% for ages greater than 78. The RP-2014 annuitant tables have no rates prior to age 50. The RP-2014 Total Data Set Employee Mortality Table (with no adjustments) is used for ages less than 50.

Deaths After Retirement (Teachers and Other Education Employees): Mortality rates are based on the RP-2014 Total Data Set for Healthy Annuitants Mortality Table (with White-Collar Adjustment). Rates for male members are multiplied by 92% for ages 50-78 and by 120% for ages greater than 78. Rates for female members are multiplied by 78% for ages 50-78 and by 108% for ages greater than 78. The RP-2014 annuitant tables have no rates prior to age 50. The RP-2014 Total Data Set Employee Mortality Table (with White Collar Adjustment) is used for ages less than 50.

Deaths After Retirement (Law Enforcement Officers): Mortality rates are based on the RP-2014 Total Data Set for Healthy Annuitants Mortality Table. The RP-2014 annuitant tables have no rates prior to age 50. The RP-2014 Total Data Set Employee Mortality Table (with no adjustments) is used for ages less than 50.

Appendix D: Actuarial Assumptions and Methods

Deaths After Retirement (Survivors of Deceased Members): Mortality rates are based on the RP-2014 Total Data Set for Healthy Annuitants Mortality Table. Rates for all members are multiplied by 123% for ages greater than 50. The RP-2014 annuitant tables have no rates prior to age 50. The RP-2014 Total Data Set Employee Mortality Table (with no adjustments) is used for ages less than 50.

Deaths After Retirement (Disabled Members at Retirement): Mortality rates are based on the RP-2014 Total Data Set for Disabled Annuitants Mortality Table. Rates for male members are multiplied by 103% for all ages. Rates for female members are multiplied by 99% for all ages.

Deaths Prior to Retirement: Mortality rates are based on the RP-2014 Total Data Set Employee Mortality Table for general employees and law enforcement officers. Mortality rates are based on the RP-2014 White Collar Employee Mortality Table for teachers and other education employees.

Mortality Projection: All mortality rates are projected from 2014 using generational improvement with Scale MP-2015.

Timing of Assumptions: All withdrawals, deaths, disabilities, retirements and salary increases are assumed to occur July 1 of each year.

Leave Conversions: Sick leave can be converted to increase creditable service and used to meet the eligibility requirements for retirement. Unused vacation leave can be converted to increase creditable service or compensation, but does not add to the eligibility service. The assumed impact of these conversions is shown in the table below.

	Teachers, Librarians and Counselors		General		Law Enforcement		Other Education Employees	
	Males	Females	Males	Females	Males	Females	Males	Females
Increase in AFC	2.00%	2.00%	2.50%	2.50%	1.75%	1.75%	1.75%	1.75%
Increase in Creditable Service (years)								
Credited	1.10	0.85	1.00	0.70	1.50	1.50	1.30	1.00
Eligibility	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Liability for Inactive Members: The data provided for inactive members does not contain all the elements to calculate the member's deferred benefit. The liability for these members is estimated to be 200% of the member's accumulated contributions. The actuary is collecting data so that future members' deferred benefits can be estimated.

Administrative Expenses: 0.10% of payroll added to the normal cost rate.

Marriage Assumption: 100% married with male spouses four years older than female spouses.

Appendix D: Actuarial Assumptions and Methods

Reported Compensation: Calendar year compensation as furnished by the system's office.

Valuation Compensation: Reported compensation adjusted to reflect the assumed rate of pay as of the valuation date.

Actuarial Cost Method: Entry age normal cost method. Entry age is established on an individual basis.

Normal Cost: Normal cost rate reflects the impact of new entrants during the year.

Amortization Period: 12-year closed, level-dollar amount. The first amortization base was created for the contribution payable for fiscal year ending 2012.

Asset Valuation Method: Actuarial value, as developed in Table 8. The actuarial value of assets is based upon a smoothed market value method. Under this method, asset returns in excess of or less than the expected return on market value of assets will be reflected in the actuarial value of assets over a five-year period. The Actuarial Value of Assets was reset to the market value of assets at December 31, 2014. The calculation of the Actuarial Value of Assets is based on the following formula:

$MV - 80\% \times G/(L)_1 - 60\% \times G/(L)_2 - 40\% \times G/(L)_3 - 20\% \times G/(L)_4$

MV = the market value of assets as of the valuation date

$G/(L)_i$ = the asset gain or (loss) for the i-th year preceding the valuation date

Changes Since Prior Valuation: None.

Appendix E: GASB 67 Fiduciary Net Position Projection

Table E-1: Projection of Fiduciary Net Positions (in thousands)

Calendar Year	Beginning Fiduciary Position	Member Contributions	Employer Contributions	Benefit Payments	Administrative Expenses	Investment Earnings	Ending Fiduciary Position
2019	$ 67,536,480	$ 937,392	$ 1,875,998	$ 5,431,808	$ 15,623	$ 4,636,921	$ 69,539,361
2020	69,539,361	887,371	2,084,026	5,566,718	14,790	4,777,946	71,707,196
2021	71,707,196	845,425	2,360,396	5,701,117	14,090	4,933,161	74,130,971
2022	74,130,971	807,457	2,508,410	5,840,481	13,458	5,101,838	76,694,737
2023	76,694,737	771,883	2,544,459	5,987,585	12,865	5,276,277	79,286,906
2024	79,286,906	737,782	2,457,152	6,150,374	12,296	5,447,969	81,767,140
2025	81,767,140	704,486	2,324,603	6,328,325	11,741	5,609,776	84,065,939
2026	84,065,939	671,151	2,215,679	6,510,533	11,186	5,759,546	86,190,596
2027	86,190,596	637,485	2,118,426	6,694,388	10,625	5,897,461	88,138,955
2028	88,138,955	603,873	2,091,024	6,880,864	10,065	6,025,350	89,968,272
2029	89,968,272	570,160	2,083,099	6,472,179	9,503	6,166,051	92,305,900
2030	92,305,900	536,305	1,892,911	6,660,024	8,938	6,315,532	94,381,685
2031	94,381,685	502,361	1,555,337	6,844,482	8,373	6,441,726	96,028,254
2032	96,028,254	468,665	1,221,151	7,022,217	7,811	6,538,232	97,226,273
2033	97,226,273	435,140	898,014	7,191,108	7,252	6,604,029	97,965,097
2034	97,965,097	402,088	651,027	7,348,389	6,701	6,640,718	98,303,840
2035	98,303,840	369,943	489,939	7,419,951	6,166	6,655,338	98,392,943
2036	98,392,943	338,432	397,946	7,630,000	5,641	6,650,116	98,143,796
2037	98,143,796	307,918	270,877	7,752,325	5,132	6,623,062	97,588,196
2038	97,588,196	278,404	174,814	7,855,024	4,640	6,576,332	96,758,082
2039	96,758,082	251,099	154,693	7,939,279	4,185	6,513,709	95,734,119
2040	95,734,119	225,125	135,268	8,011,276	3,752	6,438,007	94,517,491
2041	94,517,491	199,765	116,600	8,074,373	3,329	6,349,172	93,105,326
2042	93,105,326	174,966	98,316	8,129,975	2,916	6,246,939	91,492,656
2043	91,492,656	150,298	81,174	8,175,265	2,505	6,131,069	89,677,427
2044	89,677,427	126,629	65,635	8,203,364	2,110	6,001,701	87,665,918
2045	87,665,918	104,628	51,811	8,212,965	1,744	5,859,345	85,466,993
2046	85,466,993	84,467	39,357	8,202,789	1,408	5,704,660	83,091,280
2047	83,091,280	65,852	28,515	8,170,642	1,098	5,538,463	80,552,370
2048	80,552,370	49,144	19,987	8,111,768	819	5,361,906	77,870,820
2049	77,870,820	35,446	14,387	8,017,486	591	5,176,786	75,079,361
2050	75,079,361	25,884	10,523	7,888,611	431	4,985,361	72,212,088
2051	72,212,088	19,195	7,612	7,734,974	320	4,789,612	69,293,213
2052	69,293,213	14,182	5,461	7,562,317	236	4,590,988	66,341,291
2053	66,341,291	10,431	3,906	7,372,821	174	4,390,693	63,373,327
2054	63,373,327	7,643	2,786	7,170,425	127	4,189,767	60,402,971
2055	60,402,971	5,583	1,967	6,955,656	93	3,989,134	57,443,905
2056	57,443,905	4,062	1,387	6,728,543	68	3,789,742	54,510,485
2057	54,510,485	2,946	968	6,490,399	49	3,592,545	51,616,496
2058	51,616,496	2,129	670	6,246,354	35	3,398,325	48,771,232
2059	48,771,232	1,535	465	5,999,570	26	3,207,621	45,981,256
2060	45,981,256	1,106	309	5,751,289	18	3,020,845	43,252,209
2061	43,252,209	788	203	5,502,450	13	2,838,360	40,589,097
2062	40,589,097	556	128	5,253,889	9	2,660,484	37,996,367
2063	37,996,367	387	78	5,006,162	6	2,487,509	35,478,173
2064	35,478,173	266	44	4,759,812	4	2,319,707	33,038,374
2065	33,038,374	179	23	4,515,331	3	2,157,329	30,680,571
2066	30,680,571	117	9	4,273,222	2	2,000,611	28,408,084
2067	28,408,084	74	1	4,033,979	1	1,849,767	26,223,946
2068	26,223,946	44	-	3,798,097	1	1,704,993	24,130,885

Appendix E: GASB 67 Fiduciary Net Position Projection

Table E-1: Projection of Fiduciary Net Positions (in thousands) (continued)

Calendar Year	Beginning Fiduciary Position	Member Contributions	Employer Contributions	Benefit Payments	Administrative Expenses	Investment Earnings	Ending Fiduciary Position
2069	$ 24,130,885	$ 25	$ -	$ 3,566,109	$ -	$ 1,566,460	$ 22,131,261
2070	22,131,261	13	-	3,338,545	-	1,434,316	20,227,045
2071	20,227,045	6	-	3,115,963	-	1,308,679	18,419,767
2072	18,419,767	2	-	2,898,923	-	1,189,638	16,710,484
2073	16,710,484	1	-	2,687,948	-	1,077,247	15,099,784
2074	15,099,784	-	-	2,483,512	-	971,532	13,587,804
2075	13,587,804	-	-	2,286,066	-	872,487	12,174,225
2076	12,174,225	-	-	2,096,030	-	780,075	10,858,271
2077	10,858,271	-	-	1,913,760	-	694,230	9,638,741
2078	9,638,741	-	-	1,739,541	-	614,858	8,514,057
2079	8,514,057	-	-	1,573,612	-	541,839	7,482,285
2080	7,482,285	-	-	1,416,189	-	475,032	6,541,127
2081	6,541,127	-	-	1,267,466	-	414,268	5,687,929
2082	5,687,929	-	-	1,127,611	-	359,356	4,919,675
2083	4,919,675	-	-	996,762	-	310,081	4,232,993
2084	4,232,993	-	-	875,020	-	266,202	3,624,174
2085	3,624,174	-	-	762,434	-	227,458	3,089,198
2086	3,089,198	-	-	658,996	-	193,569	2,623,771
2087	2,623,771	-	-	564,632	-	164,236	2,223,376
2088	2,223,376	-	-	479,208	-	139,148	1,883,315
2089	1,883,315	-	-	402,531	-	117,982	1,598,766
2090	1,598,766	-	-	334,345	-	100,409	1,364,830
2091	1,364,830	-	-	274,330	-	86,099	1,176,599
2092	1,176,599	-	-	222,109	-	74,720	1,029,210
2093	1,029,210	-	-	177,248	-	65,946	917,908
2094	917,908	-	-	139,263	-	59,462	838,107
2095	838,107	-	-	107,607	-	54,965	785,464
2096	785,464	-	-	81,679	-	52,172	755,958
2097	755,958	-	-	60,831	-	50,824	745,951
2098	745,951	-	-	44,400	-	50,689	752,240
2099	752,240	-	-	31,726	-	51,565	772,079
2100	772,079	-	-	22,174	-	53,283	803,187
2101	803,187	-	-	15,148	-	55,702	843,741
2102	843,741	-	-	10,113	-	58,714	892,341
2103	892,341	-	-	6,603	-	62,237	947,975
2104	947,975	-	-	4,226	-	66,213	1,009,962
2105	1,009,962	-	-	2,662	-	70,606	1,077,906
2106	1,077,906	-	-	1,662	-	75,396	1,151,641
2107	1,151,641	-	-	1,040	-	80,579	1,231,180
2108	1,231,180	-	-	661	-	86,160	1,316,679
2109	1,316,679	-	-	434	-	92,153	1,408,397
2110	1,408,397	-	-	297	-	98,578	1,506,678
2111	1,506,678	-	-	212	-	105,460	1,611,927
2112	1,611,927	-	-	157	-	112,829	1,724,599
2113	1,724,599	-	-	119	-	120,718	1,845,198
2114	1,845,198	-	-	91	-	129,161	1,974,267
2115	1,974,267	-	-	70	-	138,196	2,112,394
2116	2,112,394	-	-	53	-	147,866	2,260,206
2117	2,260,206	-	-	40	-	158,213	2,418,379
2118	2,418,379	-	-	30	-	169,285	2,587,634

Appendix E: GASB 67 Fiduciary Net Position Projection

Table E-2: Actuarial Present Value of Projected Benefit Payments (in thousands)

Calendar Year	Beginning Fiduciary Position	Benefit Payments	Funded Benefit Payments	Unfunded Benefit Payments	Present Value of Benefit Payments		
					Funded Payments at 7.00%	Unfunded Payments at 3.50%	Using Single Discount Rate of 7.00%
2019	$ 67,536,480	$ 5,431,808	$ 5,431,808	$ -	$ 5,251,127	$ -	$ 5,251,127
2020	69,539,361	5,566,718	5,566,718	-	5,029,485	-	5,029,485
2021	71,707,196	5,701,117	5,701,117	-	4,813,938	-	4,813,938
2022	74,130,971	5,840,481	5,840,481	-	4,608,986	-	4,608,986
2023	76,694,737	5,987,585	5,987,585	-	4,415,955	-	4,415,955
2024	79,286,906	6,150,374	6,150,374	-	4,239,266	-	4,239,266
2025	81,767,140	6,328,325	6,328,325	-	4,076,563	-	4,076,563
2026	84,065,939	6,510,533	6,510,533	-	3,919,568	-	3,919,568
2027	86,190,596	6,694,388	6,694,388	-	3,766,594	-	3,766,594
2028	88,138,955	6,880,864	6,880,864	-	3,618,238	-	3,618,238
2029	89,968,272	6,472,179	6,472,179	-	3,180,686	-	3,180,686
2030	92,305,900	6,660,024	6,660,024	-	3,058,880	-	3,058,880
2031	94,381,685	6,844,482	6,844,482	-	2,937,943	-	2,937,943
2032	96,028,254	7,022,217	7,022,217	-	2,817,042	-	2,817,042
2033	97,226,273	7,191,108	7,191,108	-	2,696,069	-	2,696,069
2034	97,965,097	7,348,389	7,348,389	-	2,574,800	-	2,574,800
2035	98,303,840	7,419,951	7,419,951	-	2,429,790	-	2,429,790
2036	98,392,943	7,630,000	7,630,000	-	2,335,116	-	2,335,116
2037	98,143,796	7,752,325	7,752,325	-	2,217,339	-	2,217,339
2038	97,588,196	7,855,024	7,855,024	-	2,099,732	-	2,099,732
2039	96,758,082	7,939,279	7,939,279	-	1,983,415	-	1,983,415
2040	95,734,119	8,011,276	8,011,276	-	1,870,469	-	1,870,469
2041	94,517,491	8,074,373	8,074,373	-	1,761,870	-	1,761,870
2042	93,105,326	8,129,975	8,129,975	-	1,657,946	-	1,657,946
2043	91,492,656	8,175,265	8,175,265	-	1,558,114	-	1,558,114
2044	89,677,427	8,203,364	8,203,364	-	1,461,187	-	1,461,187
2045	87,665,918	8,212,965	8,212,965	-	1,367,193	-	1,367,193
2046	85,466,993	8,202,789	8,202,789	-	1,276,167	-	1,276,167
2047	83,091,280	8,170,642	8,170,642	-	1,188,006	-	1,188,006
2048	80,552,370	8,111,768	8,111,768	-	1,102,285	-	1,102,285
2049	77,870,820	8,017,486	8,017,486	-	1,018,200	-	1,018,200
2050	75,079,361	7,888,611	7,888,611	-	936,292	-	936,292
2051	72,212,088	7,734,974	7,734,974	-	857,998	-	857,998
2052	69,293,213	7,562,317	7,562,317	-	783,968	-	783,968
2053	66,341,291	7,372,821	7,372,821	-	714,321	-	714,321
2054	63,373,327	7,170,425	7,170,425	-	649,263	-	649,263
2055	60,402,971	6,955,656	6,955,656	-	588,614	-	588,614
2056	57,443,905	6,728,543	6,728,543	-	532,144	-	532,144
2057	54,510,485	6,490,399	6,490,399	-	479,729	-	479,729
2058	51,616,496	6,246,354	6,246,354	-	431,487	-	431,487
2059	48,771,232	5,999,570	5,999,570	-	387,326	-	387,326
2060	45,981,256	5,751,289	5,751,289	-	347,007	-	347,007
2061	43,252,209	5,502,450	5,502,450	-	310,274	-	310,274
2062	40,589,097	5,253,889	5,253,889	-	276,877	-	276,877
2063	37,996,367	5,006,162	5,006,162	-	246,562	-	246,562
2064	35,478,173	4,759,812	4,759,812	-	219,093	-	219,093
2065	33,038,374	4,515,331	4,515,331	-	194,242	-	194,242
2066	30,680,571	4,273,222	4,273,222	-	171,801	-	171,801
2067	28,408,084	4,033,979	4,033,979	-	151,573	-	151,573
2068	26,223,946	3,798,097	3,798,097	-	133,373	-	133,373

Table E-2: Actuarial Present Value of Projected Benefit Payments (in thousands) (continued)

Calendar Year	Beginning Fiduciary Position	Benefit Payments	Funded Benefit Payments	Unfunded Benefit Payments	Present Value of Benefit Payments		
					Funded Payments at 7.00%	Unfunded Payments at 3.50%	Using Single Discount Rate of 7.00%
2069	$ 24,130,885	$ 3,566,109	$ 3,566,109	$ -	$ 117,034	$ -	$ 117,034
2070	22,131,261	3,338,545	3,338,545	-	102,398	-	102,398
2071	20,227,045	3,115,963	3,115,963	-	89,319	-	89,319
2072	18,419,767	2,898,923	2,898,923	-	77,661	-	77,661
2073	16,710,484	2,687,948	2,687,948	-	67,298	-	67,298
2074	15,099,784	2,483,512	2,483,512	-	58,112	-	58,112
2075	13,587,804	2,286,066	2,286,066	-	49,993	-	49,993
2076	12,174,225	2,096,030	2,096,030	-	42,838	-	42,838
2077	10,858,271	1,913,760	1,913,760	-	36,554	-	36,554
2078	9,638,741	1,739,541	1,739,541	-	31,053	-	31,053
2079	8,514,057	1,573,612	1,573,612	-	26,253	-	26,253
2080	7,482,285	1,416,189	1,416,189	-	22,081	-	22,081
2081	6,541,127	1,267,466	1,267,466	-	18,469	-	18,469
2082	5,687,929	1,127,611	1,127,611	-	15,356	-	15,356
2083	4,919,675	996,762	996,762	-	12,686	-	12,686
2084	4,232,993	875,020	875,020	-	10,408	-	10,408
2085	3,624,174	762,434	762,434	-	8,476	-	8,476
2086	3,089,198	658,996	658,996	-	6,847	-	6,847
2087	2,623,771	564,632	564,632	-	5,482	-	5,482
2088	2,223,376	479,208	479,208	-	4,349	-	4,349
2089	1,883,315	402,531	402,531	-	3,414	-	3,414
2090	1,598,766	334,345	334,345	-	2,650	-	2,650
2091	1,364,830	274,330	274,330	-	2,032	-	2,032
2092	1,176,599	222,109	222,109	-	1,538	-	1,538
2093	1,029,210	177,248	177,248	-	1,147	-	1,147
2094	917,908	139,263	139,263	-	842	-	842
2095	838,107	107,607	107,607	-	608	-	608
2096	785,464	81,679	81,679	-	431	-	431
2097	755,958	60,831	60,831	-	300	-	300
2098	745,951	44,400	44,400	-	205	-	205
2099	752,240	31,726	31,726	-	137	-	137
2100	772,079	22,174	22,174	-	89	-	89
2101	803,187	15,148	15,148	-	57	-	57
2102	843,741	10,113	10,113	-	36	-	36
2103	892,341	6,603	6,603	-	22	-	22
2104	947,975	4,226	4,226	-	13	-	13
2105	1,009,962	2,662	2,662	-	8	-	8
2106	1,077,906	1,662	1,662	-	4	-	4
2107	1,151,641	1,040	1,040	-	3	-	3
2108	1,231,180	661	661	-	2	-	2
2109	1,316,679	434	434	-	1	-	1
2110	1,408,397	297	297	-	1	-	1
2111	1,506,678	212	212	-	-	-	-
2112	1,611,927	157	157	-	-	-	-
2113	1,724,599	119	119	-	-	-	-
2114	1,845,198	91	91	-	-	-	-
2115	1,974,267	70	70	-	-	-	-
2116	2,112,394	53	53	-	-	-	-
2117	2,260,206	40	40	-	-	-	-
2118	2,418,379	30	30	-	-	-	-

Appendix F: Additional Disclosures

Table F-1 illustrates the sensitivity of certain valuation results to changes in the discount rate on a market value of assets basis. Table F-2 summarizes historical actuarial value and market value asset returns. Table F-3 provides an estimate of future market value of asset returns based on the current portfolio structure and summarized in the "TSERS Asset-Liability and Investment Strategy Project" report dated April 19th, 2016.

Section 6(c) of Session Law 2016-108 requires that the actuarial valuation report provide the valuation results using a 30-year treasury rate as of December 31 of the year of the valuation as the discount rate. This is 3.02% at December 31, 2018 and has been used as the lower bound of the sensitivity analysis presented. The range between the current discount rate (7.00%) and the 30-year treasury rate (3.02%) was used to establish an upper bound for sensitivity analysis (10.98%). The remaining rates illustrated represent mid-points between the selected rates. Table F-3 illustrates our best estimate of the plausibility of such rates. The lower bound of 3.02% falls below the 5th percentile of estimated future 30-year returns while the upper bound of 10.98% falls between the 75th and 95th percentiles of estimated future 30-year returns.

Table F-1: Sensitivity of Valuation Results as of December 31, 2018

Discount Rate	3.02%	5.01%	7.00%	8.99%	10.98%
Market Value of Assets	$ 67,536,480,309	$ 67,536,480,309	$ 67,536,480,309	$ 67,536,480,309	$ 67,536,480,309
Actuarial Accrued Liability	$132,734,729,979	$102,619,047,242	$ 82,105,943,131	$ 67,795,453,307	$ 57,528,397,674
Unfunded Accrued Liabilty (AAL)	$ 65,198,249,670	$ 35,082,566,933	$ 14,569,462,822	$ 258,972,998	$ (10,008,082,635)
Funded Ratio	50.9%	65.8%	82.3%	99.6%	117.4%
20-Year Amortization of UAL	$ 4,523,039,166	$ 2,958,648,440	$ 1,471,510,051	$ 30,897,538	N/A
(as % of general state revenue)	14.6%	9.5%	4.7%	0.1%	N/A

Table F-2: Historical Asset Returns

Calendar Year	Actuarial Value of Asset Return	Market Value of Asset Return	Calendar Year	Actuarial Value of Asset Return	Market Value of Asset Return	Calendar Year	Actuarial Value of Asset Return	Market Value of Asset Return
1998	9.92%	16.66%	2005	8.26%	6.97%	2012	6.32%	11.82%
1999	10.60%	10.15%	2006	8.94%	11.41%	2013	7.43%	12.21%
2000	11.55%	2.50%	2007	8.87%	8.38%	2014	7.19%	6.21%
2001	8.51%	-1.87%	2008	2.89%	-19.50%	2015	5.87%	0.36%
2002	5.66%	-5.21%	2009	4.74%	14.84%	2016	5.32%	6.22%
2003	7.98%	18.23%	2010	5.89%	11.47%	2017	6.56%	13.49%
2004	8.56%	10.73%	2011	5.15%	2.19%	2018	5.10%	-1.39%

The average investment return recognized for the purposes of determining the annual change in contribution each year is the Actuarial Value of Asset Return. The Actuarial Value of Assets smooths investment gains and losses over a five-year period and is used to reduce volatility that investment gains and losses can have on required contributions and the funded status of the Plan.

Appendix F: Additional Disclosures

Table F-3: Statistical Likelihood of Minimum Future Asset Returns as of 12/31/2015

Horizon	95% Chance (19 out of every 20 scenarios)	75% Chance (3 out of every 4 scenarios)	50% Chance (1 out of every 2 scenarios)	25% Chance (1 out of every 4 scenarios)	5% Chance (1 out of every 20 scenarios)
10 Years (2025)	0.2%	4.0%	5.9%	8.0%	11.5%
20 Years (2035)	2.2%	4.8%	6.7%	8.5%	11.8%
30 Years (2045)	3.1%	5.3%	7.1%	8.7%	12.0%

Other than the discount rate, these results are based on the other economic and demographic assumptions presented in the report. For purposes of simplicity in this disclosure, no adjustments to the valuation assumption for inflation were reflected in the sensitivities above. The statute also requires that the actuarial valuation report show the results using a market value of assets basis. The "funded ratio" and "unfunded accrued liability" in Table F-1 are based upon the market value of assets. In order to alleviate volatility, future employer contributions are determined based on the actuarial value of assets, which smooths market value returns.

None of the liability amounts shown are intended to imply the amount that might represent the cost of any settlement of the plan's obligations. The various caveats, constraints, and discussions presented earlier in the report apply to these results as well.

Appendix G: Data for Section 2 Graphs

The tables below provide the numbers associated with the graphs in Section 2 of this report.

Graph 1: Active Members

	Active Member Count	Reported Compensation
2014	307,313	$ 12,932,045,817
2015	305,291	13,145,602,154
2016	305,013	13,497,815,754
2017	304,554	13,914,085,325
2018	304,575	14,436,435,848

Graph 2: Retired Members and Survivors of Deceased Members

	Retired and Survivors of Deceased Member Count	Retirement Allowance
2014	194,607	$ 4,057,596,822
2015	201,522	4,202,371,724
2016	208,443	4,343,259,132
2017	215,008	4,521,393,822
2018	222,084	4,668,925,869

Graph 3: Market Value of Assets and Asset Returns

	Market Value of Assets	Asset Return
2014	$ 64,587,417,979	6.21%
2015	62,669,341,716	0.36%
2016	64,246,523,614	6.22%
2017	70,607,887,248	13.49%
2018	67,536,480,309	-1.39%

Appendix G: Data for Section 2 Graphs

Graph 5: Cost-of-Living Increase and CPI-U History

	Total Allowance Increase	National CPI-U
1988	5.40%	4.40%
1989	6.70%	4.60%
1990	0.00%	6.10%
1991	5.20%	3.10%
1992	2.20%	2.90%
1993	4.70%	2.70%
1994	3.20%	2.70%
1995	4.40%	2.50%
1996	6.20%	3.30%
1997	2.50%	1.70%
1998	2.30%	1.60%
1999	4.20%	2.70%
2000	2.00%	3.40%
2001	2.00%	2.60%
2002	1.30%	2.40%
2003	1.70%	1.90%
2004	2.00%	3.30%
2005	3.00%	3.40%
2006	2.20%	2.50%
2007	2.20%	4.10%
2008	0.00%	0.10%
2009	0.00%	2.70%
2010	0.00%	1.50%
2011	1.00%	3.00%
2012	0.00%	1.70%
2013	1.00%	1.50%
2014	0.00%	0.80%
2015	0.00%	0.70%
2016	1.00%	2.10%
2017	0.00%	2.10%
2018	0.00%	1.90%

* Allowance increases are effective at July 1 the following year

Appendix G: Data for Section 2 Graphs

Graph 6: Actuarial Value and Market Value of Assets

	Actuarial Value of Assets	Market Value of Assets
2014	$ 64,734,119,837	$ 64,587,417,979
2015	66,169,352,203	62,669,341,716
2016	67,376,892,466	64,246,523,614
2017	69,568,450,606	70,607,887,248
2018	70,959,093,440	67,536,480,309

Graph 7: Asset Returns

	Actuarial Value Value of Assets	Market Value Asset Return
2014	7.19%	6.21%
2015	5.87%	0.36%
2016	5.32%	6.22%
2017	6.56%	13.49%
2018	5.10%	-1.39%

Graph 8: Actuarial Accrued Liability

Fiscal Year Ending	Active	Deferred	Retired	Total
2014	$ 27,948,998,177	$ 3,188,560,504	$ 36,577,507,863	$ 67,715,066,544
2015	27,630,686,237	3,482,641,054	40,408,588,106	71,521,915,397
2016	28,548,308,913	3,764,216,305	42,235,329,807	74,547,855,025
2017	30,943,761,739	4,053,311,655	44,212,274,274	79,209,347,668
2018	32,234,081,882	4,337,483,404	45,534,377,845	82,105,943,131

Appendix G: Data for Section 2 Graphs

Graph 9: Present Value of Future Benefits, Actuarial Accrued Liability and Actuarial Value of Assets

	Actuarial Accrued Liability	Actuarial Value of Assets
2014	$ 67,715,066,544	$ 64,734,119,837
2015	71,521,915,397	66,169,352,203
2016	74,547,855,025	67,376,892,466
2017	79,209,347,668	69,568,450,606
2018	82,105,943,131	70,959,093,440

Graph 10: Funded Ratios

	Funded Ratio (Actuarial Basis)	Funded Ratio (Market Value Basis)
2014	95.6%	95.4%
2015	92.5%	87.6%
2016	90.4%	86.2%
2017	87.8%	89.1%
2018	86.4%	82.3%

Graph 11: Actuarially Determined Employer Contribution Rates

Fiscal Year Ending	Normal Rate	Accrued Liability Rate	Total ADEC
2017**	4.34%	5.62%	9.96%
2018	4.31%	6.22%	10.53%
2019	4.48%	7.81%	12.29%
2020	5.17%	7.80%	12.97%
2021*	5.18%	9.60%	14.78%

* Subject to the impact of future legislative changes effective during that fiscal year
** Includes impact of the experience study

Appendix G: Data for Section 2 Graphs

Graph 12: Projected Actuarially Determined Employer Contribution Rates

	Alternate #1 (0.0% 2019 Return)	Baseline Projection	Alternate #2 (14.0% 2019 Return)
2019	12.29%	12.29%	12.29%
2020	12.97%	12.97%	12.97%
2021	14.78%	14.78%	14.78%
2022	16.97%	16.24%	15.50%
2023	18.23%	16.60%	14.96%
2024	17.39%	14.94%	12.50%
2025	17.97%	15.49%	13.00%
2026	18.46%	14.61%	10.77%
2027	18.11%	14.36%	10.61%
2028	17.91%	14.25%	10.59%
2029	17.76%	14.20%	10.63%
2030	15.82%	12.34%	8.86%
2031	14.34%	10.96%	7.57%
2032	12.60%	9.30%	6.00%
2033	11.36%	8.15%	6.00%
2034	9.74%	7.15%	6.00%
2035	8.56%	6.70%	6.00%
2036	7.60%	6.40%	6.00%

Graph 13: Projected Funded Ratio

	Alternate #1 (0.0% 2019 Return)	Baseline Projection	Alternate #2 (14.0% 2019 Return)
2018	86.42%	86.42%	86.42%
2019	84.20%	85.30%	86.41%
2020	83.00%	85.53%	88.07%
2021	82.43%	86.29%	90.15%
2022	82.47%	86.42%	90.37%
2023	81.93%	88.00%	93.72%
2024	83.49%	89.56%	94.87%
2025	85.24%	91.03%	95.91%
2026	87.08%	92.44%	96.76%
2027	88.97%	93.79%	97.64%
2028	90.92%	95.18%	98.57%
2029	92.82%	96.63%	99.37%
2030	94.45%	97.97%	99.91%
2031	95.83%	99.05%	100.18%
2032	96.98%	99.84%	100.29%
2033	97.88%	100.36%	100.42%

Appendix H: Participating Employers

Employer	Employer Code
A Childs Garden Charter (Aka Cross Creek Charter)	33501
Academy of Moore County	36301
Administrative Office of the Courts	10800
Alamance Community College	30105
Alamance County Schools	30100
Alexander County Schools	30200
Alleghany County Schools	30300
American Renaissance Middle School	34901
Anson County Schools	30400
Appalachian State University	20100
Arapahoe Charter School	36901
Arts Based Elementary Charter	33402
Ashe County Schools	30500
Asheboro City Schools	37610
Asheville City Schools	31110
Asheville-Buncombe Technical College	31105
Avery County Schools	30600
Barber Examiners, State Board of	18600
Bear Grass Charter School	33206
Beaufort County Community College	30705
Beaufort County Schools	30700
Bertie County Schools	30800
Bethany Community Middle School	37901
Bladen Community College	30905
Bladen County Schools	30900
Blue Ridge Community College	34505
Brevard Academy Charter School	38801
Bridges Charter Schools	38601
Brunswick Community College	31005
Brunswick County Schools	31000
Buncombe County Schools	31100
Burke County Schools	31200
Cabarrus County Schools	31300
Caldwell Community College	31405
Caldwell County Schools	31400
Camden County Schools	31500
Cape Fear Community College	36505
Cape Fear Center For Inquiry	36501
Carolina International School	31301
Carteret Community College	31605

Employer	Employer Code
Carteret County Schools	31600
Casa Esperanza Montessori	39209
Caswell County Schools	31700
Catawba County Schools	31800
Catawba Valley Community College	31805
Central Carolina Community College	35305
Central Park School For Children	33202
Central Piedmont Community College	36005
Chapel Hill - Carboro City Schools	36810
Charlotte Secondary Charter	36009
Charlotte-Mecklenburg County Schools	36000
Chatham County Schools	31900
Cherokee County Schools	32000
Childrens Village Academy	35401
Clay County Schools	32200
Cleveland County Schools	32300
Cleveland Technical College	32305
Clinton City Schools	38210
Clover Garden Charter School	30102
Coastal Carolina Community College	36705
College of the Albemarle	37005
Columbus County Schools	32400
Community Charter School	36001
Community Colleges Administration	19005
Community School of Davidson	36003
Cornerstone Academy	33027
Corvian Community School	36004
Craven Community College	32505
Cumberland County Schools	32600
Currituck County Schools	32700
Dare County Schools	32800
Davidson County Community College	32905
Davidson County Schools	32900
Davie County Schools	33000
Department of Administration	10900
Department of Agriculture	18400
Department of Commerce	12510
Department of Cultural Resources	10700
Department of Justice	10400
Department of Public Instruction	22000

Appendix H: Participating Employers

Employer	Employer Code
Department of Public Safety	19100
Duplin County Schools	33100
Durham Public Schools	33200
Durham Technical Institute	33205
East Carolina University	20300
East Wake Academy	39208
Edenton-Chowan County Schools	32100
Edgecombe County Schools	33300
Edgecombe Technical College	33305
Elizabeth City and Pasquotank County Schools	37000
Elizabeth City State University	20400
Elkin City Schools	38620
Endeavor Charter School	39201
Environment and Natural Resources	11300
Evergreen Community Charter School	31102
F Delany New School For Children	31101
Fayetteville State University	20600
Fayetteville Technical Community College	32605
Fernleaf Community Charter	36310
Forsyth Technical Institute	33405
Franklin County Schools	33500
Gaston College	33605
Gaston College Preparatory Charter	36601
Gaston County Schools	33600
Gates County Schools	33700
General Assembly	12160
Governor's Office	12100
Graham County Schools	33800
Grandfather Academy	30601
Granville County Schools and Oxford Orphanage	33900
Gray Stone Day School	38402
Greene County Schools	34000
Guilford County Schools	34100
Guilford Technical Community College	34105
Halifax Community College	34205
Halifax County Schools	34200
Haliwa-Saponi Tribal Charter	39301
Harnett County Schools	34300
Haywood County Schools	34400
Haywood Technical College	34405

Employer	Employer Code
Health & Human Svcs	12220
Healthy Start Academy	33203
Henderson Collegiate Charter School	39401
Henderson County Schools	34500
Hertford County Schools	34600
Hickory City Schools	31810
Highway - Administrative	51000
Hoke County Schools	34700
Hyde County Schools	34800
Information Technology Services	10930
Insurance Department	12600
Invest Collegiate Charter (Buncombe)	33207
Invest Collegiate Charter School	32901
Iredell County Schools	34900
Isothermal Community College	38105
Jackson County Schools	35000
James Sprunt Technical College	33105
Johnston County Schools	35100
Johnston Technical College	35105
Jones County Schools	35200
Kannapolis City Schools	31320
Kipp Charlotte Charter	36102
Labor Department	12700
Lake Norman Charter School	36006
Lenoir County Community College	35405
Lenoir County Schools	35400
Lexington City Schools	32910
Lincoln County Schools	35500
Lt Governor's Office	12150
Macon County Schools	35600
Madison County Schools	35700
Martin Community College	35805
Martin County Schools	35800
Mayland Technical College	36105
Mcdowell County Schools	35900
Mcdowell Technical College	35905
Millennium Charter Academy	38602
Mitchell Community College	34905
Mitchell County Schools	36100
Montgomery Community College	36205

Appendix H: Participating Employers

Employer	Employer Code
Montgomery County Schools	36200
Moore County Schools	36300
Mooresville City Schools	34910
Mount Airy City Schools	38610
Mountain Community School	34501
Mtn Discovery Charter	38701
NC Auctioneers Licensing Board	18740
NC Central University	20800
NC Innovative School District	39220
NC School of Science & Mathematics	10950
NC School of the Arts	20200
NC State Board of Examiners of Practicing Psychology	18780
NC State University	21300
N.E. Academy of Aerospace & Adv.Tech	37001
N.E. Regional School For Biotechnology	33001
N.E. Academy of Aerospace & Adv.Tech	37001
Nash-Rocky Mount Schools	36400
NC A&T University	20700
NC Housing Finance Agency	11310
Neuse Charter School	35106
New Bern/Craven County Board of Education	32500
New Hanover County Schools	36500
Newton-Conover City Schools	31820
North Carolina Education Lottery	10200
Northampton County Schools	36600
Office of Administrative Hearing	10850
Office of State Budget & Management	10910
Office of State Controller	10940
Onslow County Schools	36700
Orange Charter School	36802
Orange County Schools	36800
Pamlico Community College	36905
Pamlico County Schools	36900
Pender County Schools	37100
Perquimans County Schools	37200
Person County Schools	37300
Piedmont Community College	37305
Pine Lake Prep Charter	36008
Pinnacle Classical Academy	39703
Pioneer Springs Community Charter	33209

Employer	Employer Code
Pitt Community College	37405
Pitt County Schools	37400
Polk County Schools	37500
Randolph Community College	37605
Randolph County Schools	37600
Revenue Department	13500
Richmond County Schools	37700
Richmond Technical College	37705
River Mill Academy Charter	30103
Roanoke Rapids City Schools	34220
Roanoke-Chowan Community College	34605
Robeson Community College	37805
Robeson County Schools	37800
Rockingham Community College	37905
Rockingham County Schools	37900
Rowan-Cabarrus Community College	38005
Rowan-Salisbury School System	38000
Roxboro Community School	37301
Rutherford County Schools	38100
Sampson Community College	38205
Sampson County Schools	38200
Sandhills Community College	36305
Sanford-Lee County Board of Education	35300
Scotland County Schools	38300
Secretary of State	13700
Socrates Academy	36007
South Piedmont Community College	30405
Southeastern Academy Charter School	37801
Southeastern Community College	32405
Southern Wake Academy	39204
Southwestern Community College	35005
Stanly Community College	38405
Stanly County Schools	38400
Stars Charter School	36302
State Auditor	10500
State Board of Elections	11900
State Division of Health Services	12200
State Treasurer	14300
Stokes County Schools	38500
Success Institute	34903

Appendix H: Participating Employers

Employer	Employer Code
Surry Community College	38605
Surry County Schools	38600
Swain County Schools	38700
The Hawbridge School	30104
Thomasville City Schools	32920
Transylvania County Schools	38800
Tri-County Community College	32005
Two Rivers Comm School	39501
Tyrrell County Schools	38900
UNC - Pembroke	21200
UNC Health Care System	21550
UNC-Ch Cb 1260	21520
UNC-General Administration	21525
Union County Schools	39000
University of North Carolina at Asheville	23000
University of North Carolina at Charlotte	23100
University of North Carolina at Greensboro	20900
University of North Carolina at Wilmington	23200
University of North Carolina Press	21570
Uwharrie Charter Academy	37601
Vance Charter School	39101
Vance County Schools	39100
Vance-Granville Community College	39105
Voyager Academy	33204
Wake County Schools	39200
Wake Technical College	39205
Warren County Schools	39430
Washington County Schools	39400
Watauga County Schools	39500
Wayne Community College	39605
Wayne County Schools	39600
Weldon City Schools	34230
Western Carolina University	21800
Western Piedmont Community College	31205
Whiteville City Schools	32410
Wildlife Resources Commission	11600
Wilkes Community College	39705
Wilkes County Schools	39700
Wilmington Prep Academy	36502
Wilson Community College	39805
Wilson County Schools	39800
Winston-Salem State University	21900
Winston-Salem-Forsyth County Schools	33400
Yadkin County Schools	39900
Yancey County Schools	30000
Zeca School of the Arts and Technology	36701