

TEACHER RETIREMENT SYSTEM OF TEXAS

Actuarial Valuation Report

As of August 31, 2018



November 9, 2018

Board of Trustees
Teacher Retirement System of Texas
1000 Red River Street
Austin, TX 78701-2698

Subject: Actuary's Certification of the Actuarial Valuation as of August 31, 2018

We certify that the information included herein and contained in the 2018 Actuarial Valuation Report is accurate and fairly presents the actuarial position of the Teacher Retirement System of Texas (TRS) as of August 31, 2018. This report was prepared at the request of the Board and is intended for use by the TRS staff and those designated or approved by the Board. This report may be provided to parties other than TRS staff only in its entirety and only with the permission of the Board.

All calculations have been made in conformity with generally accepted actuarial principles and practices, and with the Actuarial Standards of Practice issued by the Actuarial Standards Board. In our opinion, the results presented comply with the requirements of the Texas statutes and, where applicable, the Internal Revenue Code, ERISA, and the Statements of the Governmental Accounting Standards Board. The undersigned are independent actuaries. Mr. Siblik and Mr. Newton are Enrolled Actuaries, members of the American Academy of Actuaries and are qualified to give a Statement of Opinion. All are experienced in performing valuations for large public retirement systems.

ACTUARIAL VALUATIONS

The primary purpose of the valuation report is to determine the adequacy of the statutory contribution rates through measuring the resulting funding period, to describe the current financial condition of the System, and to analyze changes in the System's condition. In addition, the report provides various summaries of the data. This report may not be appropriate for other purposes. The information required by the System in connection with Governmental Accounting Standards Board Statement No. 67 (GASB No. 67) will be provided under separate cover.

Valuations are prepared annually, as of August 31 of each year, the last day of the System's plan and fiscal year.

FINANCING OBJECTIVE OF THE PLAN

The employee, employer, and State contribution rates are established by Law that, over time, are intended to remain level as a percent of payroll and provide assets to cover benefits when due. The

actuarially determined employer contribution rates determined in this actuarial valuation are intended to provide for the normal cost plus the level percentage of payroll required to amortize the unfunded actuarial accrued liability over a period not in excess of 30 years.

PROGRESS TOWARD REALIZATION OF FINANCING OBJECTIVE

The actuarial accrued liability, the unfunded actuarial accrued liability (UAAL), and the calculation of the resulting funding period illustrate the progress toward the realization of financing objectives. Based on this actuarial valuation as of August 31, 2018, the System's under-funded status has increased significantly at \$46.2 billion as of August 31, 2018 compared to \$35.5 billion as of August 31, 2017. The primary reason for the increase was the change to the actuarial assumptions adopted by the Board in July of 2018. The increase associated with the change in assumptions (\$10.6 billion) represents nearly all of the change in the UAAL from the previous year. The System's UAAL was expected to increase from the prior due to the interest on the UAAL being greater than the contributions towards the UAAL. However, the System experienced an actuarially gain on both the actuarial value of assets and on the demographic experience which would have offset this increase.

This valuation shows a normal cost equal to 11.58% of pay plus an addition to the normal cost of 0.11% of pay to cover the annual cost of administrative expenses. The State/employers began contributing the current contribution rate of 6.80% in fiscal year 2014 and it is assumed the rate will remain at that level. In addition, covered employers whose employees are not participating in Social Security began contributing 1.50% of salary (capped at the minimum salary schedule) in fiscal year 2015. These contributions are assumed to be approximately 0.91% of total payroll. Combined, these contributions are assumed to approximate 7.71% of total payroll. The member contribution began increasing in fiscal year 2015 and reached its ultimate rate of 7.70% in fiscal year 2017. In addition to these contributions, there are contributions made on behalf of members who are receiving a pension but who have also returned to work. These contributions are assumed to be approximately 0.05% of total payroll. As a result, for FY2019 and thereafter, the System is expected to receive a total contribution rate of 15.46% of pay.

Hence, there is expected to be 3.77% of pay available to amortize the UAAL (15.41% State/employer contributions plus 0.05% for return to work retirees less the normal cost of 11.58% less administrative expenses of 0.11%). If payroll grows as expected (3.0% per year), the contributions provided by this portion of the contribution rate are sufficient to amortize the current unfunded actuarial accrued liabilities of the System over a period of 87 years based on the smoothed asset value as the valuation date. Therefore, the financing objectives of the System are not currently being met.

The actuarial valuation report as of August 31, 2018 reveals that the funded ratio (the ratio of actuarial assets to actuarial accrued liability) is 76.9%. The funded status is one of many metrics used to show trends and develop future expectations about the health of the System. The funded status measure itself is not appropriate for assessing the sufficiency of plan assets to cover the estimated cost of settling the plan's benefit obligations or assessing the need for or the amount of future

contributions since it does not reflect normal cost contributions, the timing of amortization payments, or future experience other than expected.

The System earned less than the prior year's assumed rate of return during fiscal year 2018 (7.7% on market value compared to an assumed 8.00%). Even with the current year shortfall, the System experienced an actuarial gain on assets from the prior year's excess that was being deferred. The System is now deferring net investment excess of \$0.5 billion and the funded status using the market value of assets is 77.2%. If there are no significant investment shortfalls or other actuarial losses over the next several years, the funded status of the System would be expected to increase towards this number. This \$0.5 billion in net deferred excess compares to the last valuation when the System was deferring \$1.1 billion.

As stated previously, the System's UAAL is significantly increased from the prior year. The UAAL had been expected to increase by \$0.4 billion without any gains or losses thus the UAAL increased by \$10.3 billion more than expected during the year. Offsetting the gain of \$0.2 billion on the actuarial assets was a \$10.5 billion loss on the liabilities. This \$10.5 billion loss was split into the impact of the assumption changes, which increased the liabilities by \$10.6 billion, and a liability experience gain of \$0.1 billion. This \$0.1 billion represents a gain of 0.05% of total liabilities and was due to the liabilities growing slower than expected due to salary increases being slightly less than expected, more terminations than expected and fewer retirements than expected during the year.

Based on the actuarial (smoothed) value of assets, the number of years needed to amortize the UAAL will decrease annually if all assumptions are met. Please note that this annual decrease in the funding period will only occur if the currently scheduled contribution levels remain in place over the funding period. Any decrease in the contribution rates will result in higher funding periods. It should be noted that with the \$0.5 billion in deferred investment excess still to be recognized in the actuarial value of assets, future gains in the actuarial value of assets will result in a decrease in the funding period in future valuations until the gains are fully recognized.

Due to the current funding policy which utilizes level percentage of payroll amortization, the amortization payments will not be sufficient to cover all of the interest charges on the UAAL until the funding period reaches approximately 20 years. Table 11a provides a 10 year projection of various valuation results, including the UAAL, and that projection shows the UAAL is expected to increase to \$63.7 billion in 2028. Extending the projection further would show the UAAL increases each year until it starts to decrease in 2085 and is fully amortized 20 years after that (assuming all assumptions are exactly met including a 7.25% return on assets).

Please note these expectations are based on the current benefit provisions, assumptions, and contribution rates and a level active population. Any additional benefit enhancements (ad hoc Cost of Living Adjustments or "COLAs") granted without additional funding would increase the ultimate UAAL and extend the funding period before the funding status begins to improve. Thus, we continue to advise against any future benefit enhancements without additional sources of funding.

Furthermore, as discussed earlier, the current contributions are not sufficient to meet the financing goals (funding period of 30 years or less) of the System. We strongly recommend increases in the contribution rates (whether employers, members or both) to bring the funding period back down to a level that satisfies the System's financing goals.

PLAN PROVISIONS

The plan provisions used in the actuarial valuation are described in Appendix 1 of the valuation report. There have been no changes to the benefit and contribution provisions of the System since the prior valuation.

DISCLOSURE OF PENSION INFORMATION

Beginning with fiscal year 2014, the System began reporting financial information in accordance with Governmental Accounting Standards Board (GASB) Statement No. 67. The disclosure information for GASB No. 67 is provided in a separate report and is not contained herein.

This report should not be relied on for any purpose other than the purpose described above. Determinations of the financial results associated with the benefits described in this report in a manner other than the intended purpose may produce significantly different results.

ACTUARIAL METHODS AND ASSUMPTIONS

The actuarial methods and assumptions have been selected by the Board of Trustees of the Teacher Retirement System of Texas based upon our analysis and recommendations. These assumptions and methods are detailed in Appendix 2 of the valuation report. The Board of Trustees has sole authority to determine the actuarial assumptions used for the plan. The actuarial methods and assumptions are primarily based on a study of actual experience for the three year period ending August 31, 2017 and adopted on July 27, 2018. The investment return assumption being decreased from 8.00% to 7.25% was the most significant change although other assumptions were changed as well. Please see our experience study report dated July 27, 2018 for more information on the assumption changes. In our opinion, the actuarial assumptions and methods used in this funding valuation meet the parameters set by the Actuarial Standards of Practice issued by the Actuarial Standards Board for such purposes.

The results of the actuarial valuation are dependent on the actuarial assumptions used. Actual results can and almost certainly will differ, as actual experience deviates from the assumptions. Even seemingly minor changes in the assumptions can materially change the liabilities, calculated contribution rates and funding periods. To illustrate this point, on page 7 of this report we have shown illustrative results based on future investment experience deviating from the assumptions. Based on the scope of this engagement, we have not performed analysis on the potential range of future measurements based on other factors. The actuarial calculations are intended to provide information for rational decision making.

In our opinion, the actuarial assumptions used are appropriate for purposes of the valuation and are internally consistent and reasonably related to the experience of the System and to reasonable expectations.

Data

Member data for retired, active and inactive members was supplied as of August 31, 2018 by the TRS staff. The staff also supplied asset information as of August 31, 2018. While GRS did not audit this data, but we did apply a number of tests to the data and concluded that it was reasonable and consistent with the prior year's data. It is also our understanding that TRS's auditor has attested to this information. GRS is not responsible for the accuracy or completeness of the information provided to us by TRS.

The following schedules in the Actuarial Section of the TRS CAFR were prepared by GRS:

- Actuarial Present Value of Future Benefits
- Schedule of Retirees and Beneficiaries Added to and Removed from Rolls
- Schedule of Funding Progress
- Post-Retirement Mortality
- Rates of Retirement
- Probability of Decrement due to Withdrawal
- Active Mortality

All other schedules shown in the actuarial section were prepared by TRS staff based upon our work. For further information please see the full actuarial valuation report.

This document and the PowerPoint presentation of the actuarial valuation results presented to the TRS Board in December 2018 comprise the full actuarial report.

Respectfully submitted,
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SECTION A

DISCUSSION

Executive Summary

The actuarial valuation of the Teacher Retirement System of Texas (TRS) as of August 31, 2018 indicates that the System's UAAL is increased from \$35.5 billion in 2017 to \$46.2 billion in 2018. There was a significant increase in the liabilities of the System due to the adoption of new actuarial assumptions.

As such, the financial outlook of the System is significantly worse than last year. Without future actuarial gains, the System is not expected to be fully funded until the next century. For that reason, we recommend TRS seek an increase in the contributions the System receives (whether from the employers, the employees, or both). The key results of this valuation as of August 31, 2018 may be summarized as follows.

Item	2018	2017
Membership		
• Number of		
- Active members [#]	872,999	864,261
- Service retirees	391,927	379,765
- Disabled retirees	11,914	11,802
- Beneficiaries	16,617	16,201
- Inactive, vested	105,000	98,110
- Inactive, nonvested	<u>193,498</u>	<u>174,918</u>
- Total	1,591,955	1,545,057
• Projected Payroll for Contributions	\$ 44.956 billion	\$ 43.164 billion
Statutory contribution rates (of payroll)		
• Combined State/Employers *	7.710%	7.700%
• Member	7.700%	7.700%
Actuarial Information		
• Normal cost %	11.58%	9.94%
• Unfunded actuarial accrued liability (UAAL)	\$ 46.165 billion	\$ 35.471 billion
• UAAL as % of pay	102.7%	82.2%
• Funded ratio	76.9%	80.5%
• Funding period (years)	87	32
• Actuarially Determined Employer Contribution (ADEC) (30 Year Amortization based on the Actuarial Value of Assets) **	9.48%	7.85%

Includes members in Deferred Retirement Option Plan (DROP)

* In addition to the 6.8% statutory payroll contribution rate for the State/Employers, beginning in fiscal year 2015, covered employers whose employees are not participating in Social Security began contributing 1.50% of the minimum salary schedule. Combined, it is expected that these contributions will be approximately 7.71% of total payroll. Not included in the 7.71%, the System also receives contributions on behalf of retired members who have returned to work which yields an approximate additional 0.05%.

** Aggregate contribution rate for State and local employers.

Executive Summary (Continued)

Item	2018	2017
Assets		
• Market value	\$ 154.569 billion	\$ 147.362 billion
• Actuarial value	154.051 billion	146.282 billion
• Estimated yield on market value	7.7%	12.9%
• Estimated yield on actuarial value	8.1%	8.2%
• Ratio of actuarial to market value	99.7%	99.3%
• Employee contributions, including service purchases	\$ 3,402.3 million	\$ 3,297.6 million
• State contributions	1,743.5 million	1,722.9 million
• Employer contributions	1,671.3 million	1,588.3 million
• Benefit, refund, and expense payments	11,378.9 million	10,698.0 million
• Net external cash flow	(4,466.4) million	(4,089.1) million
Gains/(losses)		
• Asset experience	\$ 172.7 million	\$ 270.0 million
• Assumption changes/Legislative changes	(10,591.9) million	(700.9) million
• Liability experience	<u>95.3 million</u>	<u>827.9 million</u>
• Total	\$ (10,323.9) million	\$ 397.0 million
Actuarial Information based on Market Value of Assets		
• Unfunded actuarial accrued liability (UAAL)	\$ 45.647 billion	\$ 34.391 billion
• UAAL as % of pay	101.5%	79.7%
• Funded ratio	77.2%	81.1%
• Funding period (years)	80.0	29.6
• Actuarially Determined Employer Contribution (ADEC)	9.41%	7.69%

Item	UAAL (\$ Millions)	Funding Period
(1)	(2)	(3)
1. 2017 Valuation	\$35,471	32
2. Restated 2017 Valuation with Legislative changes (if applicable)	35,471	32
3. Expected 2018 UAAL using actual contributions*	35,841	31
4. 2018 UAAL using expected assets and actual liabilities	35,746	31
5. 2018 UAAL using actual assets and liabilities, expected payroll	35,573	30
6. 2018 UAAL using actual payroll	35,573	29
7. 2018 UAAL after change in actuarial assumptions	46,165	87

* The funding period for this entry uses the expected UAAL and expected payroll.
Expected payroll is the prior year's valuation payroll, increased by the 3.0% payroll growth rate.

Introduction

The valuation of the Teacher Retirement System of Texas (TRS) as of August 31, 2018, reflects the following contribution rates: (a) a member contribution rate of 7.70%, and (b) a State/Employer combined contribution rate approximating 7.71%, and (c) an additional amount on behalf of rehired retirees that equates to approximately 0.05% of payroll. For purposes of determining the funding period, it was assumed that these contribution rates (both member and State/employer) would remain in place indefinitely.

In preparing this valuation, Gabriel, Roeder, Smith & Company (GRS) has relied on employee data and asset information provided by the staff of the Teacher Retirement System. While not verifying the data at their source, GRS has performed such tests for consistency and reasonableness as has been deemed necessary to be satisfied with the appropriateness of using the data supplied.

Section A contains an executive summary of the most significant valuation results. The basic results of the valuation are covered on pages 5 – 6. Page 7 discusses the sensitivity of the funded status to future investment performance. Page 9 provides analysis and discussion of changes in assets. Page 10 summarizes the findings of the valuation while Section B provides the tables supporting the report.

There have been no changes in the benefit provisions of TRS since the prior valuation. Please see Appendix 1 of this report for a summary of the major benefit provisions of the System.

As noted previously, new actuarial assumptions were adopted in conjunction with an experience study for the period ending August 31, 2017. The actuarial assumptions were adopted by the Board of Trustees on July 27, 2018 and are effective with the August 31, 2018 valuation. For a detailed description of the actuarial assumptions and methods please see Appendix 2 of this report.

Funded Status of the System

Table 3 details the normal cost of the Retirement System by its various components. This normal cost is developed based on the valuation method known as the entry-age-normal actuarial cost method. The normal cost to pay for the benefits earned under the Retirement System is 11.58% of pay, this amount being inclusive of the amount contributed by the employees. In addition, to the cost of benefits we add an addition to the normal cost to cover annual administrative expenses. It is estimated that administrative expense will be approximately 0.11% of payroll. Thus, the total normal cost is 11.69% of pay and the net employer normal cost is 3.99% of pay based on the member contribution rate of 7.70%.

The State/employers contribution rate increased to 6.8% in fiscal year 2014. Covered employers whose employees are not participating in Social Security began contribute 1.50% of the minimum salary schedule and this equates to approximately 0.91% of total payroll. In addition, contributions are received on behalf of retirees who have returned to work. Combined, it is expected that the aggregate contributions will be approximately 15.46% of total payroll. Please see Table 3b to see how these rates are approximated. Since the total contribution rate is 15.46% and the cost of new benefit accruals and administrative expenses (normal cost) is 11.69%, this allows 3.77% of pay contributed to be available to amortize any unfunded actuarial accrued liabilities.

The funding period is defined as the expected number of years until the UAAL is anticipated to be completely eliminated. This value will take into account all currently known information, including current assumptions, current funding policies, and any anticipated changes to normal cost based on the benefits for future members. This funding period for the System is determined under the entry-age-normal actuarial cost method based on a level percentage of pay. The key points of this method are as follows:

1. The "normal cost" for the System is deemed to be equal to the average cost of benefits for active members.
2. The "actuarial accrued liability" for benefits payable in the future to present active members is calculated as the present value of benefits payable in the future to present active members less the present value of future normal costs.
3. Funding of the unfunded actuarial accrued liability (UAAL) is a function of the rate of future growth in total covered payroll and the contributions established in state statute.

Table 5 develops the funding period under the above approach not only for the current valuation, but also for the valuation as of August 31, 2017. From an actuarial perspective, the contribution rate in excess of the System's normal cost should be sufficient to amortize the UAAL over a reasonable period of time. The ultimate contribution rate in excess of the System's normal cost (3.77%) is sufficient to amortize the System's UAAL over a period of 87.0 years (assuming all actuarial assumptions are exactly met). This is not considered a reasonable period of time and thus we strongly recommend increases to the contribution levels.

Table 2 provides an overall summary of key actuarial data for the 2018 valuation, with comparative data for 2017. This information is summarized from the other tables, which supply more detail. Its value is in providing in one convenient place key comparative valuation results.

Funded Status of the System (Continued)

In determining the number of years that will be required to amortize the UAAL, an assumption is made concerning future growth of the payroll of the System. Our current assumption is 3.00% per year. There is no provision for membership growth in the payroll growth assumption.

As shown in Item B6 of Table 5 and using the assumed rate of increase in covered payroll of 3.00%, the period to fund the UAAL is 87 years. The funding periods using alternative payroll growth assumptions are also shown. An analysis of the change in the UAAL and the funding period since the 2017 valuation is shown on Table 10.

Table 10 traces the changes in the UAAL and the funding period from the valuation as of August 31, 2017, to August 31, 2018. Item 4 of Table 10 shows the funding status if there had been no actuarial gains or losses in the areas of assets, liabilities, and reflecting the actual State contributions for the 2017/2018 plan year. The UAAL would have increased during the year to \$35.8 billion. Item 5 of Table 10 illustrates that the overall liability gain decreased the UAAL to \$35.7 billion and that the prior years' investment experience, as shown in Item 6, was expected to decrease the UAAL to \$35.5 billion. However, Item 7 shows that the current year's investment experience offset some of the prior years' impact and increased the UAAL to \$35.6 billion. Item 8 shows the impact on the funding period of the covered compensation growing at a faster rate than assumed, which decreased the funding period from 30.5 years to 29.3 years. Finally, Item 9 shows the impact of the changes to the actuarial assumptions. The assumption changes increased the UAAL to \$46.2 billion and the funding period to 87.0 years.

The actuarial value of assets is developed in Table 4. It should be noted that the intent of the actuarial asset valuation method is to smooth out year-to-year fluctuations in market rates of return. The current asset method determines the expected actuarial value of assets and then recognizes at least 20% of the difference between that expected actuarial value of assets and the actual market value of assets. As shown in Item 8 of Table 4, if the current year's difference between expected and actual investment income is of the opposite sign from the remaining deferred excesses/(shortfalls), then this year's difference is directly offset against any prior year bases of the opposite sign (starting with the oldest base and working forward). Any remaining bases are then recognized over the remaining number of years. This is intended to ensure the smoothed value of assets will converge towards the market value in a reasonable and finite amount of time. This year's shortfall in investment income of \$389 million was completely offset with the prior years' remaining investment gains, with \$691 million remaining. After recognizing 20% of this amount (\$173 million) in this year's actuarial assets, \$518 million in deferred investment gains remain to be recognized in future valuations. The actuarial value of assets is \$154.1 billion as shown in Item 9 of Table 4.

Sensitivity to Investment Performance

Table 11b provides several additional risk metrics that can help relate the size of the investment risk to the System, the Sponsor, and the membership. As shown on Table 11b, the assets are currently 3.4 times as large as the covered payroll (source of funding). Based on this ratio, assuming a 10% decrease in the asset levels that is never recovered by future gains would increase the 30-year contribution requirement by 2.00% of payroll (from the current 9.48% employer ADEC to 11.48%) and decrease the funded ratio by 7.7% (from 76.9% to 69.2%). Table 11b also shows how these metrics have changed over time. As a System matures and/or achieves higher funded ratios, these risk metrics will actually show proportionately higher investment risk.

The following exhibit projects the actuarial status of the System as of August 31, 2018 based on varying actual investment returns over the next few years. All other assumptions are assumed to be met, including the continuation of the new statutory member and employer contribution rates.

	Based on an Annual 4.25% Actual Investment Return on Market		Based on an Annual 7.25% Actual Investment Return on Market		Based on an Annual 10.25% Actual Investment Return on Market	
	Funded Ratio Measured By:					
August 31,	Actuarial Value of Assets	Market Value of Assets	Actuarial Value of Assets	Market Value of Assets	Actuarial Value of Assets	Market Value of Assets
(1)	(2)	(3)	(4)	(5)	(6)	(7)
2018	76.9%	77.2%	76.9%	77.2%	76.9%	77.2%
2019	76.7%	75.1%	77.2%	77.3%	77.7%	79.5%
2020	75.8%	73.1%	77.5%	77.5%	79.1%	82.0%
2021	74.3%	71.1%	77.7%	77.7%	81.2%	84.7%
2022	72.3%	69.0%	77.9%	77.9%	83.7%	87.5%
2023	70.2%	66.9%	78.0%	78.0%	86.5%	90.4%

The future liability is calculated by rolling forward the liabilities as of August 31, 2018, taking into account interest and benefit payments for the year, including mortality incidence and anticipated cost of living increases (none in this case). The 7.25% scenario above coincides with the actuarial investment return assumption of 7.25%. The 4.25% and 10.25% scenarios were selected because there is statistically a high probability of the return for a five-year period being within +/- 3% of the expected return.

The scenarios above are for illustration purposes only and are in no way to be used as expected investment performance. They assume no other deviations from the expected assumptions taken into consideration besides the asset performance. Careful consideration of this projection should be taken into account before any benefit enhancement is adopted. Note that under the 7.25% return scenario, the funded ratio based on actuarial assets and market assets will have converged by FY2022 and are both expected to trend upward.

GASB Disclosure

The System prepares its financial accounting and disclosure information in accordance with Governmental Accounting Standards Board (GASB) Statement No. 67.

We provide a separate accounting report with the required disclosures under this accounting standard.

Change in Assets During the Year

This section provides an analysis of the change in the Plan Net Assets during the year and an estimate of the yield on mean assets of the total System. Table 8a shows a rearrangement of some of the tables included in the annual financial statements of the System. Table 8b shows the estimated yield on a market value basis and on the actuarial asset valuation method.

To determine estimated yield on "mean assets", the traditional insurance company formula for yield rates is used. The estimated yield is derived by dividing the appropriate income by the corresponding mean assets. This is a "dollar weighted" rate of return, and will differ slightly from the "time weighted" return shown in the System's CAFR.

As indicated by Item A4 of Table 8b, the estimated yield on mean market value is 7.7%, following a 12.9% return in 2017. The actuarial asset yield (Item B4) is 8.1%, compared to 8.2% in 2017, and compared to the 7.25% assumption rate. This difference in the estimated yield on market value and actuarial value illustrates the smoothing effect of the asset valuation method.

As mentioned earlier in the report, the investment results on an actuarial value basis are favorable for the 2017/2018 plan year. On an actuarial value basis the System is above its prior year 8% assumption rate by 0.1%. As a result, the System had an actuarial investment gain of \$0.2 billion. It should also be noted that the asset valuation method is still deferring \$0.5 billion in unrecognized net gains into future years. Absent future adverse investment experience, these deferred gains will be recognized over future actuarial valuations.

Summary and Closing Comments

The results of the actuarial valuation of the Teacher Retirement System as of August 31, 2018 are sobering. The additional \$10.6 billion in liability due to the change in assumptions along with the associated increase in the normal cost rate has increased the funding period from 33 years to 87 years.

The System's funded status is 76.9% on actuarial basis and 77.2% using the market value of assets. While the funded status of the System may not seem troubling, the funding period should give all stakeholders serious concern. While the funding period is an actual number which means that if all assumptions are met the System will eventually be fully funded, it only takes a small change to increase the funding period to "infinite" (or never). With that as the backdrop we strongly urge the System to begin the process with the Legislature to seek additional revenue to the System.

Should the system in the future find itself with a funding period under 30 years, it is important to remember that while the negotiation process by the Legislature included an ad hoc Cost of Living Adjustment (COLA) paid to retirees in September of 2013, the legislation also included substantial increases in contribution rates. This should be the model used in any future year that a COLA is considered. In past negotiations, there were times that COLAs and retroactive benefit enhancements were granted without additional funding sources and that eventually deteriorated the financial health of the System.

SECTION B

ACTUARIAL TABLES

ACTUARIAL TABLES

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Table 1

ACTUARIAL PRESENT VALUE OF FUTURE BENEFITS

	August 31,	
	2018	2017
	(1)	(2)
A. Present Value of Benefits Presently Being Paid:		
1. Service retirement benefits	\$ 97,778,733,445	\$ 88,265,853,858
2. Disability retirement benefits	1,262,559,579	1,159,723,275
3. Death benefits	945,102,660	878,484,700
4. Present survivor benefits	294,529,850	267,992,457
5. Total present value of benefits presently being paid	\$ 100,280,925,534	\$ 90,572,054,290
B. Present Value of Benefits Payable In the Future		
To Present Active Members:		
1. Service retirement benefits	\$ 117,752,030,618	\$ 106,686,289,188
2. Disability retirement benefits	2,473,609,365	1,390,485,196
3. Termination benefits	11,614,967,251	9,104,608,213
4. Death and survivor benefits	2,253,693,291	1,873,738,711
5. Total active member liabilities	\$ 134,094,300,525	\$ 119,055,121,308
C. Present Value of Benefits Payable In the Future To		
Present Inactive Members:		
1. Inactive vested participants	\$ 4,931,520,979	\$ 4,591,531,545
2. Refunds of contributions to inactive nonvested members	501,473,614	444,096,753
3. Future survivor benefits payable on behalf of present annuitants	1,630,036,961	1,462,466,211
4. Total inactive liabilities	\$ 7,063,031,554	\$ 6,498,094,509
D. Total Actuarial Present Value of Future Benefits:	\$ 241,438,257,613	\$ 216,125,270,107

Table 2

SUMMARY OF COST ITEMS

	Valuation as of August 31, 2018		Valuation as of August 31, 2017	
	Cost Item	Cost as %	Cost Item	Cost as %
		(1)		(2)
1. Participants				
a. Active contributing members				
1. Not in DROP	872,978		864,233	
2. In DROP	21		28	
b. Active subtotal	872,999		864,261	
c. Inactive members w/deferred benefits	105,000		98,110	
d. Retired members and beneficiaries	420,458		407,768	
e. Subtotal, members	1,398,457		1,370,139	
f. Inactive nonvested members due refunds	193,498		174,918	
g. Total membership	1,591,955		1,545,057	
2. Average for Active Members				
a. Average age	44.7		44.6	
b. Average years of service	10.4		10.3	
c. Average pay	\$ 48,232		\$ 47,330	
3. Present Value of Future Pay	\$ 371,828,092,034		\$ 361,060,623,065	
4. Normal Cost Rate				
a. Gross normal cost	11.58%		9.94%	
b. Less employee contribution rate	(7.70%)		(7.70%)	
c. Administrative Expenses	0.11%		0.12%	
d. State normal cost	3.99%		2.36%	
5. Present Value of Future Benefits				
a. Retired members - in pay or deferred	\$ 100,280,925,534		\$ 90,572,054,290	
b. Retired members - future survivor benefits	1,630,036,961		1,462,466,211	
c. Vested inactive members	4,931,520,979		4,591,531,545	
d. Active members	134,094,300,525		119,055,121,308	
e. Inactive nonvested members	501,473,614		444,096,753	
f. Total	\$ 241,438,257,613	537.1%	\$ 216,125,270,107	500.7%
6. Present Value of Future Normal Costs (employee plus employer)	\$ 41,221,951,786	91.7%	\$ 34,372,473,392	79.6%
7. Actuarial Accrued Liability	\$ 200,216,305,827	445.4%	\$ 181,752,796,715	421.1%
8. Actuarial Value of Assets	\$ 154,050,930,573	342.7%	\$ 146,282,044,842	338.9%
9. Unfunded Actuarial Accrued Liability	\$ 46,165,375,254	102.7%	\$ 35,470,751,873	82.2%
10. Projected Payroll for Contributions	\$ 44,955,797,311		\$ 43,163,898,280	
11. Employer Contribution Rate *	7.71%		7.70%	
12. Funding Period	87 years		32.2 years	
13. Estimated Yield on Actuarial Assets	8.1%		8.2%	
14. Funded Ratio - Smoothed Basis	76.9%		80.5%	
15. Actuarially Determined Employer Contribution (ADEC)**	9.48%		7.85%	

* The base contribution rate is set at 6.80% of pay. In addition, covered employers whose employees are not participating in Social Security began contributing 1.50% of pay. Combined, it is expected that these sources of contributions will be approximately 7.71% of total payroll. Additional contributions, approximately 0.05% of pay, are received for retired members who have returned to work.

** Aggregate contribution rate for State and local employers.

Table 3-a

ANALYSIS OF NORMAL COST BY COMPONENT

Benefit Component (1)	8/31/2018 Cost as % of Pay (2)	8/31/2017 Cost as % of Pay (3)
1. Normal Cost		
a. Retirement Benefits	8.39%	6.99%
b. Disability Benefits	0.32%	0.24%
c. Death Benefits (including survivor benefits)	0.26%	0.26%
d. Termination benefits	2.61%	2.45%
e. Total	11.58%	9.94%
2. Employee Contribution Rate	(7.70%)	(7.70%)
3. Administrative Expenses	0.11%	0.12%
4. State Normal Cost (Item 1e - Item 2+ Item 3)	3.99%	2.36%

Table 3-b

ESTIMATION OF COVERED PAYROLL AND EFFECTIVE EMPLOYER CONTRIBUTION RATES

8/31/2018

1. Covered Payroll	
a. Normal Member Contributions	\$3,360,773,197
b. Member Contribution Rate for Fiscal Year	7.70%
c. Estimated Covered Payroll For Fiscal Year 1a \ 1b	\$43,646,405,156
d. Projected Covered Payroll for Next Fiscal Year 1c increased by one year's payroll growth	\$44,955,797,311
2. Employer Contribution Rate	
a. State Contributions	1,730,138,478
b. Effective State Contribution Rate 2a \ 1c	3.96%
c. Local Employer Normal Contributions	1,240,494,427
d. Effective Local Employer Normal Contributions 2c \ 1c	2.84%
e. Non-OASDI Employer Contributions	398,397,672
f. Effective Non-OASDI Employer Contributions 2e \ 1c	0.91%
g. Total Effective Employer Contribution Rate 2b + 2d + 2f	7.71%
i. Return to Work Contributions	21,733,748
j. 2i \ 1c	0.05%

Table 4

DEVELOPMENT OF ACTUARIAL VALUE OF ASSETS

	Year Ending August 31, 2018					
1. Actuarial value of assets at beginning of year	\$ 146,282,044,842					
2. Net new investments						
a. Contributions	\$ 6,817,023,723					
b. Benefits and refunds paid	\$ (10,700,496,538)					
c. Administrative Expenses	\$ (64,926,169)					
d. Subtotal	\$ (3,948,398,984)					
3. Assumed investment return rate for fiscal year	8.00%					
4. Assumed investment return for fiscal year (Item 1 + Item 2 / 2) x Item 3	\$ 11,544,627,628					
5. Expected Actuarial Value at end of year (1+ 2 + 4)	\$ 153,878,273,486					
6. Market value of assets at end of year	\$ 154,568,901,833					
7. Excess/(Shortfall) (6 - 5)	\$ 690,628,347					
8. Development of amounts to be recognized as of August 31, 2018:						
Fiscal Year End	Remaining Deferrals of Excess (Shortfall) of Investment Income	Offsetting of Gains/(Losses)	Net Deferrals Remaining	Years Remaining	Recognized for this valuation	Remaining after this valuation
	(1)	(2)	(3) = (1) + (2)	(4)	(5) = (3) / (4)	(6) = (3) - (5)
2014	\$ 0	\$ 0	\$ 0	1	\$ 0	\$ 0
2015	0	0	0	2	0	0
2016	0	0	0	3	0	0
2017	1,079,877,278	(389,248,931)	690,628,347	4	172,657,087	517,971,260
2018	(389,248,931)	389,248,931	0	5	0	0
Total	\$ 690,628,347	\$ 0	\$ 690,628,347		\$ 172,657,087	\$ 517,971,260
9. Actuarial value of plan net assets, end of year	\$ 154,050,930,573					
10. Asset gain (loss) for year (Item 9 - Item 5)	\$ 172,657,087					
11. Asset gain (loss) as % of actual actuarial assets	0.11%					
12. Ratio of actuarial value to market value	99.7%					

Notes: Remaining deferrals in Column (1) for prior years are from last year's report column (6). The number in the current year is the difference between the remaining deferrals for prior years and the total Excess/(Shortfall) return shown in Item 7. Column 2 is a direct offset of the current year's excess/(shortfall) return against prior years' excess/(shortfall) of the opposite type.

Table 5

DEVELOPMENT OF YEARS TO FUND THE UNFUNDED ACTUARIAL ACCRUED LIABILITY

	As of August 31, 2018 (1)	As of August 31, 2017 (2)
A. Basic Data		
1. Projected Payroll for Contributions	\$ 44,955,797,311	\$ 43,163,898,280
2. Present value of future pay	\$ 371,828,092,034	\$ 361,060,623,065
3. Normal cost rate of benefits		
a. Total normal cost rate	11.58%	9.94%
b. Less employee contribution rate	(7.70%)	(7.70%)
c. Administrative Expenses	0.11%	0.12%
d. State normal cost rate	3.99%	2.36%
4. State/employer contribution rate for funding unfunded actuarial accrued liability		
a. Total State/employer contribution rate*	7.71%	7.70%
b. Credit for Return to Work contributions	0.05%	0.00%
c. Less State normal cost rate	(3.99%)	(2.36%)
d. Contribution rate available	3.77%	5.34%
5. Actuarial accrued liability for present active members		
a. Present value of benefits payable in the future to present members	\$ 134,094,300,525	\$ 119,055,121,308
b. Less present value of future normal costs	(41,221,951,786)	(34,372,473,392)
c. Actuarial accrued liability	\$ 92,872,348,739	\$ 84,682,647,916
B. Development of Funding Period		
1. Normal cost		
a. Employee normal cost (Item A3b x Item A1)	\$ 3,461,596,393	\$ 3,323,620,168
b. State normal cost (Item A3d x Item A1)	1,793,736,313	1,018,667,999
c. Total normal cost	\$ 5,255,332,706	\$ 4,342,288,167
2. Total actuarial accrued liability		
a. Present value of benefits presently being paid	\$ 100,280,925,534	\$ 90,572,054,290
b. Actuarial accrued liability for present active members (Item A5c)	92,872,348,739	84,682,647,916
c. Present value of benefits for inactive members	\$ 7,063,031,554	\$ 6,498,094,509
d. Total	\$ 200,216,305,827	\$ 181,752,796,715
3. Current actuarial assets	154,050,930,573	146,282,044,842
4. Unfunded actuarial accrued liability (UAAL) (Item B2d - Item B3)	\$ 46,165,375,254	\$ 35,470,751,873
5. Amount of State contribution available to fund unfunded actuarial accrued liability (Item A4d x Item A1)	\$ 1,694,833,559	\$ 2,304,952,168
6. Years to fund unfunded actuarial accrued liability	87 years	32.2 years
	<u>Rate of Increase in Covered Payroll</u>	
	0.00%	Never
	2.30%	Never
	3.00%	87.0
	3.50%	55.0
	4.00%	45.0
7. Actuarially Determined Employer Contribution Rate (ADEC) (Normal cost + 30-year amortization of UAAL)**	9.48%	7.85%

* Beginning in fiscal year 2015, covered employers whose employees are not participating in Social Security will begin contributing 1.50% of pay. Combined it is expected that these contributions will be approximately 7.71% of total payroll.

** Aggregate contribution rate from State and local employers.

Table 6

GROWTH OF COVERED PAYROLL AND ACTIVE MEMBERS

Year Ending August 31, (1)	Total Annualized Salaries		Active Members			Average Salary		
	Amount in \$ Millions (2)	Percent Increase (3)	Number (4)	Percent Increase (5)	Compound Increase Between Year Indicated and 08-31-2018 (6)	Average Salary (7)	Percent Increase (8)	Compound Increase Between Year Indicated and 08-31-2018 (9)
1998	\$ 18,325	7.5%	705,447	3.9%	1.1%	\$ 25,977	3.4%	3.1%
1999	19,529	6.6%	736,058	4.3%	0.9%	26,533	2.1%	3.2%
2000	21,920	12.2%	766,906	4.2%	0.7%	28,583	7.7%	2.9%
2001	23,365	6.6%	797,339	4.0%	0.5%	29,303	2.5%	3.0%
2002	24,818	6.2%	745,923	(6.4%)	1.0%	33,272	13.5%	2.3%
2003	25,756	3.8%	754,715	1.2%	1.0%	34,127	2.6%	2.3%
2004	25,485	(1.1%)	729,411	(3.4%)	1.3%	34,939	2.4%	2.3%
2005	25,957	1.9%	715,495	(1.9%)	1.5%	36,278	3.8%	2.2%
2006	28,397	9.4%	761,658	6.5%	1.1%	37,284	2.8%	2.2%
2007	31,114	9.6%	777,789	2.1%	1.1%	40,003	7.3%	1.7%
2008	33,238	6.8%	801,455	3.0%	0.9%	41,472	3.7%	1.5%
2009	35,097	5.6%	817,537	2.0%	0.7%	42,930	3.5%	1.3%
2010	36,629	4.4%	834,060	2.0%	0.6%	43,916	2.3%	1.2%
2011	36,797	0.5%	828,919	(0.6%)	0.7%	44,392	1.1%	1.2%
2012	36,310	(1.3%)	815,155	(1.7%)	1.1%	44,543	0.3%	1.3%
2013	37,104	2.2%	831,302	2.0%	1.0%	44,634	0.2%	1.6%
2014	39,195	5.6%	857,342	3.1%	0.5%	45,717	2.4%	1.3%
2015	37,122	(5.3%)	828,851	(3.3%)	1.7%	44,787	(2.0%)	2.5%
2016	39,281	5.8%	847,631	2.3%	1.5%	46,343	3.5%	2.0%
2017	40,904	4.1%	864,233	2.0%	1.0%	47,330	2.1%	1.9%
2018	42,105	2.9%	872,978	1.0%	--	48,232	1.9%	--

Note: Beginning August 31, 2002, the definition of active member was changed.
 Beginning August 31, 2005, the method of determining new entrant errors was changed.
 Beginning August 31, 2015, the definition of active member was changed.

Table 7

RELATIVE SIZE OF UNFUNDED ACTUARIAL ACCRUED LIABILITY

Year Ending August 31,	Unfunded Actuarial Accrued Liability in \$ Millions	Relative to Projected Payroll		Relative to Actuarial Value of Assets		Relative to Total Actuarial Liabilities (Present Value of Future Benefits)	
		Projected Payroll In \$ Millions	Percent of Projected Payroll	Assets in \$ Millions	Percent of Assets	Actuarial Liabilities in \$ Millions	Percent of Actuarial Liabilities
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1970	\$ 1,444	\$ 1,528	94.5%	\$ 1,534	94.1%	\$ 4,384	32.9%
1971	1,632	1,758	92.8%	1,726	94.6%	5,100	32.0%
1972	1,720	1,904	90.5%	1,937	88.8%	5,551	31.0%
1973	1,633	2,079	78.5%	2,171	75.2%	5,733	28.5%
1974	1,739	2,246	77.4%	2,394	72.6%	6,207	28.0%
1975	1,998	2,583	77.4%	2,764	72.3%	7,143	28.0%
1976	2,445	2,875	85.0%	3,103	78.8%	8,067	30.3%
1977	2,879	3,246	88.7%	3,531	81.5%	9,626	29.9%
1978	2,422	3,636	66.6%	4,016	60.3%	9,858	24.6%
1979	3,322	3,928	84.6%	4,529	73.3%	12,336	26.9%
1980	2,785	4,378	63.6%	5,342	52.1%	12,181	22.9%
1981	3,300	4,970	66.4%	6,386	51.7%	13,890	23.8%
1982	3,864	5,616	68.8%	7,373	52.4%	16,135	23.9%
1983	4,549	6,378	71.3%	8,586	53.0%	20,277	22.4%
1984	4,849	6,652	72.9%	9,851	49.2%	22,456	21.6%
1985	6,474	7,547	85.8%	12,096	53.5%	29,618	21.9%
1986	5,365	8,237	65.1%	14,939	35.9%	32,273	16.6%
1987	4,096	8,646	47.4%	18,055	22.7%	34,801	11.8%
1988	3,890	9,166	42.4%	20,096	19.4%	37,332	10.4%
1989	3,489	9,764	35.7%	23,302	15.0%	41,084	8.5%
1990	3,343	10,446	32.0%	26,111	12.8%	45,685	7.3%
1991	3,429	11,181	30.7%	28,860	11.9%	49,515	6.9%
1992	3,441	11,959	28.8%	31,201	11.0%	53,123	6.5%
1993	3,440	13,391	25.7%	35,179	9.8%	59,210	5.8%

Table 7 (Continued)

RELATIVE SIZE OF UNFUNDED ACTUARIAL ACCRUED LIABILITY

Year Ending August 31,	Unfunded Actuarial Accrued Liability in \$ Millions	Relative to Projected Payroll		Relative to Actuarial Value of Assets		Relative to Total Actuarial Liabilities (Present Value of Future Benefits)	
		Projected Payroll In \$ Millions	Percent of Projected Payroll	Assets in \$ Millions	Percent of Assets	Actuarial Liabilities in \$ Millions	Percent of Actuarial Liabilities
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1994	825	\$ 14,167	5.8%	\$ 38,843	2.1%	\$ 58,351	1.4%
1995	1,956	14,888	13.1%	43,442	4.5%	65,259	3.0%
1996	1,813	15,983	11.3%	47,487	3.8%	68,948	2.6%
1997	146	17,044	0.9%	53,760	0.3%	74,677	0.2%
1998	(2,463)	18,325	-13.4%	60,357	-4.1%	79,603	-3.1%
1999	(2,190)	19,529	-11.2%	69,435	-3.2%	91,563	-2.4%
2000	(5,446)	21,920	-24.8%	79,328	-6.9%	100,414	-5.4%
2001	(2,135)	23,365	-9.1%	86,352	-2.5%	113,663	-1.9%
2002	3,287	24,818	13.2%	86,035	3.8%	118,100	2.8%
2003	5,230	25,756	20.3%	89,033	5.9%	123,677	4.2%
2004	7,953	25,485	31.2%	88,784	9.0%	121,267	6.6%
2005	13,196	25,957	50.8%	89,299	14.8%	124,556	10.6%
2006	13,694	28,397	48.2%	94,218	14.5%	131,906	10.4%
2007	12,545	31,114	40.3%	103,419	12.1%	142,190	8.8%
2008	11,523	33,238	34.7%	110,233	10.5%	150,999	7.6%
2009	21,646	35,097	61.7%	106,384	20.3%	158,899	13.6%
2010	22,899	36,629	62.5%	111,293	20.6%	166,445	13.8%
2011	24,062	36,797	65.4%	115,253	20.9%	173,204	13.9%
2012	26,101	36,310	73.6%	118,326	22.1%	177,901	14.7%
2013	28,936	37,104	79.3%	121,730	23.8%	184,332	15.7%
2014	31,638	38,522	82.1%	128,398	24.6%	195,893	16.2%
2015	32,968	39,620	83.2%	133,485	24.7%	197,662	16.7%
2016	35,453	42,376	83.7%	138,786	25.5%	207,411	17.1%
2017	35,471	43,164	82.2%	146,282	24.2%	216,125	16.4%
2018	46,165	44,956	102.7%	154,051	30.0%	241,438	19.1%

Table 8-a

CHANGE IN PLAN NET ASSETS

	Year Ending August 31, 2018	Year Ending August 31, 2017
	(1)	(2)
I. <u>Revenue for the Year</u>		
A. Contribution and fees		
1. Member contributions	\$ 3,360,773,197	\$ 3,242,556,261
2. State contributions - State of Texas	1,739,732,380	1,719,928,098
3. State contributions - 415 Excess Plan	3,722,472	3,008,838
4. State contributions - Employers	1,671,257,303	1,588,309,345
5. State contributions - Legislative Appropriations	-	-
6. Purchase of Service Credit-Refundable	18,361,492	27,561,982
7. Purchase of Service Credit-Non-Refundable	23,176,879	27,530,759
8. Total	\$ 6,817,023,723	\$ 6,608,895,283
B. Income		
1. Interest	\$ -	\$ -
2. Dividends	-	-
3. Net appreciation in fair value of investments	11,381,105,086	17,203,713,635
4. Income from Securities Lending	379,683,903	237,357,886
5. Investment expenses	(517,975,332)	(361,264,174)
6. Total	11,242,813,657	17,079,807,347
C. Other Adjustments	\$ 8,108,248	\$ 1,299,284
D. Total Revenue	\$ 18,067,945,628	\$ 23,690,001,914
II. <u>Expenditures for the Year</u>		
A. Refund of Contributions	\$ 422,335,740	\$ 513,742,959
B. Benefit Payments	\$ 10,278,160,798	\$ 9,778,784,310
C. Expenses	\$ 64,926,169	\$ 44,189,998
D. Other	\$ 95,543,208	\$ -
E. Total Expenditures	\$ 10,860,965,915	\$ 10,336,717,267
III. <u>Net Increase in Plan Net Assets (Item I.D. - Item II.E.)</u>	\$ 7,206,979,713	\$ 13,353,284,647

Table 8-b

ESTIMATION OF YIELDS

Item	Year Ending August 31, 2018	Year Ending August 31, 2017
(1)	(2)	(3)
A. Market value yield		
1. Beginning of year net market assets	\$ 147,361,922,120	\$ 134,008,637,473
2. Investment income (net of investment expenses)	11,250,921,905	17,081,106,631
3. End of year market assets	154,568,901,833	147,361,922,120
4. Estimated market value yield	7.7%	12.9%
B. Actuarial value yield		
1. Beginning of year actuarial assets	\$ 146,282,044,842	\$ 138,786,120,728
2. Investment income	11,717,284,715	11,223,746,098
3. End of year actuarial assets	154,050,930,573	146,282,044,842
4. Estimated actuarial value yield	8.1%	8.2%

Table 9

GAIN OR LOSS FOR THE YEAR

Item (1)	Year Ending August 31, 2018 (2)	Year Ending August 31, 2017 (3)
A. CALCULATION OF TOTAL GAIN OR LOSS		
1. Unfunded actuarial accrued liability (UAAL),		
a. Previous year, before Assumption changes	\$ 35,470,751,873	\$ 35,452,606,074
b. Previous year, after Assumption changes	35,470,751,873	35,452,606,074
2. Normal cost for the year	4,444,917,212	4,280,916,982
3. Contributions for the year	(6,817,023,723)	(6,608,895,283)
4. Interest at 8.00%		
a. On UAAL	\$ 2,837,660,150	\$ 2,836,208,486
b. On normal cost	177,796,688	171,236,679
c. On contributions	(272,680,949)	(264,355,811)
d. Total	\$ 2,742,775,889	\$ 2,743,089,354
5. Expected UAAL (Sum of Items A1 through A4)	35,841,421,251	35,867,717,127
6. Actual UAAL	46,165,375,254	35,470,751,873
7. Gain/(loss) for the year (Item A5 - Item A6)	\$ (10,323,954,003)	\$ 396,965,254
B. SOURCE OF GAINS AND LOSSES		
1. Asset gain/(loss) for the year (Table 4)	\$ 172,657,087	\$ 269,969,319
2. Asset gain/(loss) as a % of actuarial assets	0.11%	0.18%
3. Total actuarial accrued liability gain/(loss) for year (Item A7 - Item B1)	(10,496,611,090)	126,995,935
4. Analysis of actuarial accrued liability gain/(loss)		
a. Assumption/Legislative changes	(10,591,879,970)	(700,880,288)
b. Liability experience	95,268,880	827,876,223
c. Total	\$ (10,496,611,090)	\$ 126,995,935
5. Experience liability gain/(loss) as % of total actuarial accrued liability (Item B4b as % of total actuarial accrued liability)	0.05%	0.46%

Table 10

ANALYSIS OF CHANGE IN FUNDING PERIOD

Basis	UAAL (\$ Millions)	Normal Cost Rate	Total Contribution Rate	Funding Period	Change in Funding Period
(1)	(2)	(3)	(4)	(5)	(6)
1. 2017 Valuation	35,471	10.06%	15.40%	32.2	-
2. Restated 2017 Valuation with Legislative changes (if applicable)	35,471	10.06%	15.40%	32.2	0.0
3. Expected 2018 UAAL using expected contributions	35,911	10.06%	15.40%	31.2	(1.0)
4. Expected 2018 UAAL using actual contributions	35,841	10.06%	15.40%	31.0	(0.2)
5. 2018 UAAL using expected assets and actual liabilities	35,746	10.09%	15.40%	30.8	(0.2)
6. 2018 UAAL recognizing past deferred asset gains/(losses)	35,476	10.09%	15.40%	30.3	(0.6)
7. 2018 UAAL using actual assets and liabilities, expected payroll	35,573	10.09%	15.40%	30.5	0.2
8. 2018 UAAL using actual payroll	35,573	10.09%	15.40%	29.3	(1.2)
9. 2018 UAAL after change in actuarial assumptions	46,165	11.69%	15.46%	87.0	57.7

Notes:

- Row 3 The funding period for this entry uses the expected UAAL and expected payroll. The expected payroll is the prior year's valuation payroll, rolled forward at the prior year 2.5% payroll growth rate.
- Row 4 This entry uses actual contributions based on actual payroll during FY2018.
- Row 5 This entry uses expected assets and payroll growth, while incorporating the actual liabilities as of August 31, 2018.
- Row 6 This entry recognizes deferred investment gains/(losses) as of August 31, 2017 from prior valuations.
- Row 7 This entry includes the current year investment results.
- Row 8 This entry incorporates known assets, liabilities, and payroll growth. The overall payroll growth does not affect the liabilities of the plan, but instead affects the calculation of the ARC because the payroll is the denominator in the calculation of the amortization payment. Higher than expected payroll growth leads to a decrease in the required amortization payment as a percentage of payroll.
- Row 9 This entry reflects the change in the actuarial assumptions adopted by the Board of Trustees in July 2018.

Table 11-a

NEAR TERM OUTLOOK

Valuation as of August 31,	Unfunded Actuarial Liability (UAAL, in Millions)	Funded Ratio	Funding Period	Actuarial Value of Assets (AVA, in Millions)	For Fiscal year Ending August 31,	Projected Payroll for Contributions (in Millions)	Employer Contributions (in Millions)	Employee Contributions (in Millions)	Benefit Payments, Refunds, and Admin Expenses	Net External Cash Flow (in Millions)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
2018	\$ 46,165	76.9%	87	\$ 154,051	2019	\$ 44,956	\$ 3,477	\$ 3,473	\$ 11,470	\$ (4,520)
2019	47,755	77.1%	86	160,539	2020	46,304	3,582	3,577	11,549	(4,390)
2020	49,371	77.2%	85	167,631	2021	47,694	3,689	3,684	12,125	(4,752)
2021	51,022	77.4%	84	174,863	2022	49,124	3,800	3,795	12,717	(5,123)
2022	52,710	77.6%	83	182,236	2023	50,598	3,914	3,909	13,325	(5,503)
2023	54,435	77.7%	82	189,749	2024	52,116	4,031	4,026	13,948	(5,890)
2024	56,200	77.8%	81	197,406	2025	53,680	4,152	4,147	14,593	(6,294)
2025	58,004	78.0%	80	205,199	2026	55,290	4,277	4,271	15,260	(6,712)
2026	59,847	78.1%	79	213,125	2027	56,949	4,405	4,399	15,953	(7,149)
2027	61,732	78.2%	78	221,174	2028	58,657	4,537	4,531	16,672	(7,604)
2028	63,657	78.3%	77	229,334	2029	60,417	4,673	4,667	17,415	(8,075)

Assumes statutory member and State contribution rates.

Assumes 7.25% investment return on actuarial value of assets each year.

Assumes all other assumptions exactly met and a level active population.

Table 11-b

HISTORY OF RISK METRICS

Valuation As of August 31,	Actuarial Value of Assets (in Millions)	Actuarial Accrued Liability (AAL) (in Millions)	Annual Projected Payroll (in Millions)	AVA as % of Projected Payroll (2) / (4)	AAL as % of Projected Payroll (3) / (4)	Increase in ADEC if Assets Decrease 10%	Funded Ratio	Decrease in Funded Ratio if Assets Decrease 10%
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(8)
2018	\$ 154,051	\$ 200,216	\$ 44,956	343%	445%	2.00%	76.9%	7.7%
2017	146,282	181,753	43,164	339%	421%	2.27%	80.5%	8.0%
2016	138,786	174,239	42,376	328%	411%	2.19%	79.7%	8.0%
2015	133,485	166,453	39,620	337%	420%	2.25%	80.2%	8.0%
2014	128,398	160,036	39,195	328%	408%	2.19%	80.2%	8.0%
2013	121,730	150,666	37,104	328%	406%	2.19%	80.8%	8.1%
2012	118,326	144,427	36,310	326%	398%	2.18%	81.9%	8.2%
2011	115,253	139,315	36,797	313%	379%	2.09%	82.7%	8.3%
2010	111,293	134,191	36,629	304%	366%	2.03%	82.9%	8.3%
2009	106,384	128,029	35,097	303%	365%	2.03%	83.1%	8.3%
2008	110,233	121,757	33,238	332%	366%	2.22%	90.5%	9.1%
2007	103,419	115,964	31,114	332%	373%	2.22%	89.2%	8.9%
2006	94,218	107,911	28,397	332%	380%	2.22%	87.3%	8.7%
2005	89,299	102,495	25,957	344%	395%	2.30%	87.1%	8.7%
2004	88,784	96,737	25,485	348%	380%	2.33%	91.8%	9.2%
2003	89,033	94,263	25,756	346%	366%	2.31%	94.5%	9.4%
2002	86,035	89,322	24,818	347%	360%	2.32%	96.3%	9.6%
2001	86,352	84,217	23,365	370%	360%	2.47%	102.5%	10.3%
2000	79,328	73,882	21,920	362%	337%	2.42%	107.4%	10.7%
1999	69,435	67,245	19,529	356%	344%	2.38%	103.3%	10.3%
1998	60,357	57,893	18,325	329%	316%	2.20%	104.3%	10.4%

Note: Amount in \$ millions.

Actuarial assumptions were modified effective 2004, 2008, 2011, 2015 and 2018.

Table 12

HISTORY OF CASH FLOW

Year Ending August 31, (1)	Expenditures During the Year					External Cash Flow for the Year ² (7)	Market Value of Assets (8)	External Cash Flow as Percent of Market Value (9)
	Contributions for the Year ¹ (2)	Benefit Payments (3)	Refund of Contributions (4)	Expenses ³ (5)	Total (6)			
1998	\$ 2,197,477,431	\$ (2,503,386,682)	\$ (183,430,398)	\$ (26,803,767)	\$ (2,713,620,847)	\$ (516,143,416)	\$ 66,456,822,943	(0.8%)
1999	2,334,197,510	(2,639,947,187)	(206,354,473)	(29,146,859)	(2,875,448,519)	(541,251,009)	79,910,553,792	(0.7%)
2000	2,569,218,427	(3,360,116,181)	(214,999,991)	(31,133,307)	(3,606,249,479)	(1,037,031,052)	89,987,158,209	(1.2%)
2001	2,712,395,592	(3,667,711,511)	(214,434,792)	(32,641,273)	(3,914,787,576)	(1,202,391,984)	79,428,239,521	(1.5%)
2002	2,920,429,953	(4,366,038,505)	(186,421,065)	(37,518,541)	(4,589,978,111)	(1,669,548,158)	71,695,802,361	(2.3%)
2003	3,094,280,741	(4,753,849,401)	(186,082,670)	(38,030,992)	(4,977,963,063)	(1,883,682,322)	77,633,002,461	(2.4%)
2004	3,156,205,813	(5,486,849,698)	(220,396,709)	(41,092,036)	(5,748,338,443)	(2,592,132,630)	84,202,981,707	(3.1%)
2005	3,208,090,642	(5,387,605,428)	(243,382,014)	(42,488,318)	(5,673,475,760)	(2,465,385,118)	93,707,816,093	(2.6%)
2006	3,454,514,897	(5,582,306,639)	(265,487,479)	(45,543,800)	(5,893,337,918)	(2,438,823,021)	100,238,963,187	(2.4%)
2007	3,703,755,952	(5,807,036,778)	(277,932,219)	(48,444,678)	(6,133,413,675)	(2,429,657,723)	112,128,799,849	(2.2%)
2008	4,142,958,389	(6,454,687,449)	(275,482,331)	(55,452,812)	(6,785,622,592)	(2,642,664,203)	104,910,497,545	(2.5%)
2009	4,352,908,188	(6,343,563,704)	(266,695,076)	(97,300,965)	(6,707,559,745)	(2,354,651,557)	88,652,971,682	(2.7%)
2010	4,587,520,751	(6,669,304,862)	(265,186,589)	(141,911,262)	(7,076,402,713)	(2,488,881,962)	95,688,405,009	(2.6%)
2011	4,704,016,139	(7,175,255,376)	(399,040,901)	(275,521,878)	(7,849,818,155)	(3,145,802,016)	107,420,786,893	(2.9%)
2012	4,391,331,052	(7,726,105,535)	(452,217,315)	(249,825,059)	(8,428,147,909)	(4,036,816,857)	111,449,887,034	(3.6%)
2013	4,682,290,371	(8,077,729,314)	(466,805,558)	(282,545,932)	(8,827,080,804)	(4,144,790,433)	117,388,143,859	(3.5%)
2014	5,036,110,456	(8,550,916,357)	(490,764,166)	(292,157,107)	(9,333,837,630)	(4,297,727,174)	132,779,243,085	(3.2%)
2015	5,616,774,652	(8,937,328,045)	(475,400,534)	(333,858,664)	(9,746,587,243)	(4,129,812,591)	128,538,706,212	(3.2%)
2016	6,164,030,328	(9,382,696,877)	(462,273,069)	(355,033,407)	(10,200,003,353)	(4,035,973,025)	134,008,637,473	(3.0%)
2017	6,608,895,283	(9,778,784,310)	(513,742,959)	(405,454,172)	(10,697,981,441)	(4,089,086,158)	147,361,922,120	(2.8%)
2018	6,817,023,723	(10,278,160,798)	(422,335,740)	(582,901,501)	(11,283,398,039)	(4,466,374,316)	154,568,901,833	(2.9%)

¹ Column (2) includes employee and employer contributions, as well as any service purchase or account reinstatement receipts during the year.

² Column (7) = Column (2) + Column (6)

³ Column (5) includes both administrative and investment expenses.

Table 13

HISTORY OF CONTRIBUTION RATES

Fiscal Year	Actuarially Determined Employer Contribution Rate	Aggregate Employer Contribution Rate	Percentage Contributed	Member Contribution Rate	Total Contribution Rate (3) + (5)
(1)	(2)	(3)	(4)	(5)	(6)
1979/80		8.500%		6.650%	15.150%
1980/81		8.500%		6.650%	15.150%
1981/82		8.500%		6.650%	15.150%
1982/83		8.500%		6.650%	15.150%
1983/84		7.100%		6.000%	13.100%
1984/85		7.100%		6.000%	13.100%
1985/86		8.000%		6.400%	14.400%
1986/87		8.000%		6.400%	14.400%
1987/88		7.200%		6.400%	13.600%
1988/89		7.200%		6.400%	13.600%
1989/90		7.650%		6.400%	14.050%
1990/91		7.650%		6.400%	14.050%
1991/92		7.310%		6.400%	13.710%
1992/93		7.310%		6.400%	13.710%
1993/94		7.310%		6.400%	13.710%
1994/95		7.310%		6.400%	13.710%
1995/96		6.000%		6.400%	12.400%
1996/97	6.00%	6.000%	100%	6.400%	12.400%
1997/98	6.00%	6.000%	100%	6.400%	12.400%
1998/99	4.12%	6.000%	146%	6.400%	12.400%
1999/00	4.92%	6.000%	122%	6.400%	12.400%
2000/01	4.12%	6.000%	146%	6.400%	12.400%
2001/02	5.70%	6.000%	105%	6.400%	12.400%
2002/03	7.15%	6.000%	84%	6.400%	12.400%
2003/04	7.39%	6.000%	81%	6.400%	12.400%
2004/05	7.31%	6.000%	82%	6.400%	12.400%
2005/06	7.19%	6.000%	83%	6.400%	12.400%
2006/07	7.02%	6.000%	85%	6.400%	12.400%
2007/08	6.47%	6.580%	102%	6.400%	12.980%
2008/09	6.10%	6.580%	108%	6.400%	12.980%
2009/10	7.72%	6.644%	86%	6.400%	13.044%
2010/11	7.77%	6.644%	86%	6.400%	13.044%
2011/12	8.13%	6.000%	74%	6.400%	12.400%
2012/13	8.62%	6.400%	74%	6.400%	12.800%
2013/14	8.67%	6.800%	78%	6.400%	13.200%
2014/15	8.25%	7.700%	93%	6.700%	14.400%
2015/16	7.92%	7.700%	97%	7.200%	14.900%
2016/17	7.94%	7.700%	97%	7.700%	15.400%
2017/18	7.85%	7.710%	98%	7.700%	15.410%
2018/19	9.48%	7.710%	81%	7.700%	15.410%

Note: Aggregate employer contribution rate and total contribution rate for fiscal year 2018/2019 is estimated.

Table 14

SCHEDULE OF FUNDING PROGRESS

Valuation As of August 31, (1)	Actuarial Value of Assets (in Millions) (2)	Actuarial Accrued Liability (AAL) (in Millions) (3)	Unfunded AAL (UAAL) (3) - (2) (in Millions) (4)	Funding Ratio Assets as % of AAL (2) / (3) (5)	Projected Payroll (in Millions) (6)	UAAL as a % of Projected Payroll (4) / (6) (7)
2018	\$ 154,051	\$ 200,216	\$ 46,165	76.9%	\$ 44,956	102.7%
2017	146,282	181,753	35,471	80.5%	43,164	82.2%
2016	138,786	174,239	35,453	79.7%	42,376	83.7%
2015	133,485	166,453	32,968	80.2%	39,620	83.2%
2014	128,398	160,036	31,638	80.2%	38,522	82.1%
2013	121,730	150,666	28,936	80.8%	37,104	78.0%
2012	118,326	144,427	26,101	81.9%	36,310	71.9%
2011	115,253	139,315	24,062	82.7%	36,797	65.4%
2010	111,293	134,191	22,899	82.9%	36,629	62.5%
2009	106,384	128,029	21,646	83.1%	35,097	61.7%
2008	110,233	121,757	11,523	90.5%	33,238	34.7%
2007	103,419	115,964	12,545	89.2%	31,114	40.3%
2006	94,218	107,911	13,694	87.3%	28,397	48.2%
2005	89,299	102,495	13,196	87.1%	25,957	50.8%
2004	88,784	96,737	7,953	91.8%	25,485	31.2%
2003	89,033	94,263	5,230	94.5%	25,756	20.3%
2002	86,035	89,322	3,287	96.3%	24,818	13.2%
2001	86,352	84,217	(2,135)	102.5%	23,365	(9.1%)
2000	79,328	73,882	(5,446)	107.4%	21,920	(24.8%)
1999	69,435	67,245	(2,190)	103.3%	19,529	(11.2%)
1998	60,357	57,893	(2,463)	104.3%	18,325	(13.4%)
1997	53,760	53,906	146	99.7%	17,044	0.9%
1996	47,487	49,300	1,813	96.3%	15,983	11.3%
1995	43,442	45,398	1,956	95.7%	14,888	13.1%
1994	38,843	39,668	825	97.9%	14,167	5.8%
1993	35,179	38,619	3,440	91.1%	13,391	25.7%

Note: Actuarial assumptions were modified in 2004, 2008, 2011, 2015 and 2018.

Table 15-a

STATISTICAL INFORMATION - ACTIVE AND INACTIVE MEMBERS

	August 31,		
	2018	2017	2016
	(1)	(2)	(3)
A. Number			
1. Active Members			
a. Total active members	872,978	864,233	847,631
b. Average age	44.7	44.6	44.5
c. Average service	10.4	10.3	10.2
2. Inactive Vested Members			
a. Male members	21,958	20,106	19,435
b. Female members	83,042	78,004	75,643
c. Total inactive vested members	105,000	98,110	95,078
3. Inactive Nonvested Members	193,498	174,918	167,275
B. Annualized Salaries			
1. Active members			
a. Total active members	\$ 42,105,171,176	\$ 40,904,273,685	\$ 39,281,469,186
b. Average annual salary	48,232	47,330	46,343
C. Accumulated Members Contributions			
1. Total Active Members			
	33,753,182,032	32,447,572,128	31,073,306,648
2. Inactive Vested Members			
a. Male members	\$ 748,467,482	\$ 679,273,859	\$ 646,221,791
b. Female members	2,830,596,440	2,635,336,621	2,515,161,045
c. Total inactive vested members	\$ 3,579,063,922	\$ 3,314,610,480	\$ 3,161,382,836
3. Inactive Nonvested Members	\$ 501,473,614	\$ 444,096,753	\$ 413,997,543
D. Active Members in DROP (not included in above totals)			
1. Number	21	28	42
2. DROP Balance	\$ 2,046,353	\$ 2,677,479	\$ 3,921,984

Table 15-b

STATISTICAL INFORMATION - RETIRED MEMBERS

	August 31,		
	2018 (1)	2017 (2)	2016 (3)
E. Persons Receiving Benefits			
1. Number			
a. Life annuities	391,927	379,765	368,720
b. Annuities certain	2,103	2,108	2,041
c. Disability annuities - less than 10 years of service	183	202	209
d. Disability annuities - 10 or more years of service	11,731 [^]	11,600 [^]	9,441
e. Incomplete data records	0	0	0
f. Survivor annuities			
1) Currently in pay	13,600	13,160	12,579
2) Deferred	914	933	924
3) Total	<u>14,514</u>	<u>14,093</u>	<u>13,503</u>
g. Total persons receiving benefits	420,458	407,768	393,914
2. Annual Annuities			
a. Life annuities *	\$ 9,774,145,253	\$ 9,387,309,784	\$ 9,005,480,125
b. Annuities certain *	29,104,400	28,457,471	27,184,510
c. Disability annuities - less than 10 years of service	329,400	363,600	376,200
d. Disability annuities - 10 or more years of service	167,215,756 [^]	163,985,308 [^]	139,506,557
e. Survivor annuities			
1) Currently in pay	40,929,149	39,614,276	37,855,026
2) Deferred	2,732,060	2,788,460	2,762,960
3) Total	<u>43,661,209</u>	<u>42,402,736</u>	<u>40,617,986</u>
f. Total persons receiving benefits	\$ 10,014,456,018	\$ 9,622,518,899	\$ 9,213,165,378
g. Average monthly annuities			
1) Life annuities *	\$ 2,078	\$ 2,060	\$ 2,035
2) Annuities certain *	1,153	1,125	1,110
3) Disability annuities - 10 or more years of service	1,188	1,178	1,231
h. DROP Lump Sum payments during year	\$ 5,231,060	\$ 5,231,060	\$ 5,166,851
i. Partial Lump Sum Option payments during year	\$ 263,705,342	\$ 263,705,342	\$ 300,420,702

* Annual and average life annuity amounts represent values after Partial Lump Sum Option Elections.

[^] Prior to 2017 disabled retirees only included those receiving a standard annuity. Beginning in 2017 disabled retirees include all benefit options.

Table 16

STATEMENT OF PLAN NET ASSETS

	August 31, 2018	August 31, 2017
	(1)	(2)
A. ASSETS		
1. Current Assets		
a. Cash and short term investments		
1) Cash on hand and State Treasury	\$ 454,416,760	\$ 436,207,567
2) Short term investments	5,345,619,565	3,910,139,417
b. Accounts Receivable		
1) Member contributions	18,088,683	17,629,379
2) School districts	365,101,424	294,007,295
3) Employees Retirement System	2,041,387	1,941,433
4) State	0	66,647,068
5) Sale of investments	724,326,292	670,312,268
6) Interest and dividends	257,453,245	234,907,858
7) Other	157,376	199,308
c. Prepaid assets	565,170	131,981
d. Total current assets	7,167,769,902	5,632,123,574
2. Long Term Investments		
a. Fixed income	\$ 23,020,637,600	\$ 21,741,743,293
b. Alternative assets	65,103,640,143	58,980,377,270
c. Equities	48,187,952,545	49,791,863,021
d. Pooled investments	13,041,675,296	11,492,278,916
e. Invested securities lending collateral	20,335,310,295	17,654,070,642
f. Total long term investments	\$ 169,689,215,879	\$ 159,660,333,142
3. Other Assets		
a. Non-depreciable assets	\$ 65,969,044	\$ 65,380,826
b. Building and equipment after depreciation	19,499,098	21,504,422
c. Deferred assets	2,436,007	0
d. Total other assets	\$ 87,904,149	\$ 86,885,248
4. Total Assets	\$ 176,944,889,930	\$ 165,379,341,964
B. LIABILITIES		
1. Current Liabilities		
a. Accounts payable	\$ 25,718,014	\$ 34,326,586
b. Benefits payable	120,464,638	128,997,802
c. Due to Employees Retirement System	8,108,482	8,093,936
d. Due to State's General Revenue Fund	63,997,185	7,689
e. Investments purchased payable	1,726,935,210	801,219,038
f. Other Liabilities	81,920,524	241,725
g. Securities lending collateral	20,320,455,707	17,035,654,924
h. Total current liabilities	\$ 22,347,599,760	\$ 18,008,541,700
2. Deferred Credits	28,388,337	8,878,144
3. Total Liabilities and Deferred credits	22,375,988,097	18,017,419,844
C. NET ASSETS HELD IN TRUST	\$ 154,568,901,833	\$ 147,361,922,120
D. ASSET ALLOCATION FOR CASH & LONG TERM INVESTMENTS		
1. Cash	3.2%	2.6%
2. Fixed Income	13.0%	13.2%
3. Alternative Assets	37.1%	36.0%
4. Equities	27.5%	30.4%
5. Pooled investments	7.4%	7.0%
6. Invested securities lending collateral	11.6%	10.8%
7. Total	99.8%	100.0%

Table 17

DISTRIBUTION OF ACTIVE MEMBERS BY AGE AND BY YEARS OF SERVICE AS OF 08/31/2018

Attained Age	Years of Credited Service												Total
	0	1	2	3	4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	
	Count & Avg. Comp.	Count & Avg. Comp.	Count & Avg. Comp.	Count & Avg. Comp.	Count & Avg. Comp.	Count & Avg. Comp.	Count & Avg. Comp.	Count & Avg. Comp.	Count & Avg. Comp.	Count & Avg. Comp.	Count & Avg. Comp.	Count & Avg. Comp.	Count & Avg. Comp.
Under 25	543 \$13,888	10,945 \$28,444	4,702 \$31,780	1,466 \$25,252	543 \$23,714	196 \$25,436							18,395 \$28,441
25-29	788 \$14,845	18,598 \$33,692	18,520 \$41,370	16,097 \$44,415	12,328 \$45,972	15,272 \$47,251	109 \$39,483						81,712 \$41,758
30-34	597 \$15,657	12,846 \$32,858	11,967 \$40,567	11,412 \$43,730	11,008 \$45,663	44,053 \$51,285	10,954 \$53,291	67 \$45,478					102,904 \$46,302
35-39	537 \$16,831	10,736 \$32,486	9,646 \$39,780	9,130 \$43,096	8,514 \$44,733	31,141 \$50,495	37,898 \$56,763	7,799 \$58,616	111 \$51,961				115,512 \$49,367
40-44	388 \$16,002	8,676 \$31,079	7,955 \$38,663	7,452 \$41,669	7,079 \$43,621	24,367 \$48,746	26,993 \$55,303	26,854 \$62,037	6,209 \$63,992	70 \$52,206			116,043 \$51,276
45-49	384 \$17,325	7,490 \$30,793	6,876 \$38,105	6,580 \$40,594	6,323 \$42,103	23,015 \$46,378	24,736 \$51,947	21,209 \$58,366	22,178 \$66,006	5,338 \$67,159	76 \$56,222		124,205 \$51,927
50-54	303 \$15,054	5,657 \$29,532	5,342 \$37,335	5,065 \$38,854	4,854 \$39,767	17,861 \$43,326	21,034 \$47,932	17,749 \$52,364	15,169 \$59,122	15,591 \$68,436	3,217 \$68,797	57 \$65,086	111,899 \$50,592
55-59	248 \$15,635	4,610 \$28,255	4,272 \$34,935	4,090 \$36,989	3,804 \$38,370	14,472 \$41,960	17,598 \$46,412	16,805 \$49,539	14,694 \$53,661	9,311 \$61,756	7,233 \$71,370	1,768 \$71,396	98,905 \$48,967
60-64	138 \$13,322	2,600 \$27,601	2,638 \$35,061	2,470 \$37,015	2,517 \$37,755	9,586 \$41,225	11,817 \$45,793	11,648 \$48,802	9,311 \$51,430	6,484 \$56,289	3,398 \$64,440	2,995 \$75,062	65,602 \$47,939
65 +	89 \$15,270	1,827 \$22,407	1,584 \$27,652	1,607 \$29,733	1,597 \$31,425	6,361 \$36,284	7,103 \$43,112	5,608 \$47,379	4,488 \$49,381	3,550 \$53,489	2,040 \$57,684	1,947 \$70,822	37,801 \$43,752
Total	4,015 \$13,594	83,985 \$27,478	73,502 \$36,596	65,369 \$40,881	58,567 \$42,848	186,324 \$47,313	158,242 \$51,752	107,739 \$55,320	72,160 \$58,935	40,344 \$63,430	15,964 \$67,555	6,767 \$72,801	872,978 \$48,232

Note: Table includes contributing members but excludes members in DROP.

Table 18

DISTRIBUTION OF LIFE ANNUITIES BY AGE

Age (1)	Number (2)	Annual Annuities (3)	Monthly Average Annuity (4)
Up to 35	441	\$ 5,949,076	\$ 1,124
35-40	363	5,428,446	1,246
40-44	495	7,512,688	1,265
45-49	773	11,476,202	1,237
50-54	4,553	159,835,300	2,925
55-59	24,326	845,266,576	2,896
60-64	59,185	1,797,485,091	2,531
65-69	93,994	2,424,268,230	2,149
70-74	84,508	1,956,467,063	1,929
75-79	56,042	1,171,572,624	1,742
80-84	35,672	727,991,532	1,701
85-89	20,900	442,105,199	1,763
90-94	8,287	170,673,310	1,716
95-99	2,077	42,036,945	1,687
100 & up	311	6,076,971	1,628
TOTAL	391,927	\$ 9,774,145,253	\$ 2,078

Table 19

DISTRIBUTION OF DISABLED ANNUITIES BY AGE

Age (1)	Number (2)	Annual Annuities (3)	Monthly Average Annuity (4)
Up to 35	2	\$ 19,283	\$ 803
35-40	28	328,345	977
40-44	135	1,958,152	838
45-49	474	7,928,633	1,482
50-54	1,042	18,002,309	5,777
55-59	1,878	29,098,992	26,358
60-64	2,508	34,883,496	61,989
65-69	2,216	28,353,836	96,383
70-74	1,446	17,580,168	86,071
75-79	846	10,584,141	56,956
80-84	582	8,714,328	36,298
85-89	418	7,278,637	21,353
90-94	128	2,104,613	8,429
95 -99	26	355,772	2,105
100 & up	2	25,053	313
TOTAL	11,731	\$ 167,215,756	\$ 1,188

Table 20

RETIREES, BENEFICIARIES, AND DISABLED PARTICIPANTS ADDED TO AND REMOVED FROM ROLLS

Valuation August 31, (1)	Added to Rolls		Removed from Rolls		Rolls-End of Year		% Increase in Annual Allowances (8)	Average Annual Allowances (9)
	Number (2)	Annual Allowances (3)	Number (4)	Annual Allowances (5)	Number (6)	Annual Allowances (7)		
2003	23,061	\$ 477,035,602	7,025	\$ 125,196,802	217,477	\$ 4,381,354,800	8.7%	\$ 20,146
2004	30,288	640,407,566	7,138	108,483,938	240,627	4,913,278,428	12.1%	20,419
2005	15,153	292,452,315	7,271	127,291,874	248,509	5,078,438,869	3.4%	20,436
2006	15,810	324,292,542	7,175	120,623,840	257,144	5,282,107,571	4.0%	20,541
2007	15,861	336,348,640	7,698	131,295,705	265,307	5,487,160,506	3.9%	20,682
2008	17,727	391,920,863	7,806	135,160,090	275,228	5,743,921,279	4.7%	20,870
2009	17,326	392,452,923	7,940	136,537,511	284,614	5,999,836,691	4.5%	21,081
2010	20,076	473,512,423	8,199	142,187,645	296,491	6,331,161,469	5.5%	21,354
2011	24,688	620,038,676	8,499	147,985,004	312,680	6,803,215,141	7.5%	21,758
2012	27,915	697,134,389	8,848	155,597,838	331,747	7,344,751,692	8.0%	22,140
2013	25,825	743,998,946	9,344	165,231,795	348,228	7,923,518,843	7.9%	22,754
2014	24,429	573,876,713	9,475	174,915,127	363,182	8,322,480,429	5.0%	22,915
2015	25,134	604,436,264	10,578	191,966,951	377,738	8,734,949,742	5.0%	23,124
2016	27,018	673,313,552	10,842	195,097,916	393,914	9,213,165,378	5.5%	23,389
2017	24,739	613,145,920	10,885	203,792,399	407,768	9,622,518,899	4.4%	23,598
2018	24,317	611,173,964	11,627	219,236,845	420,458	10,014,456,018	4.1%	23,818

APPENDIX 1

SUMMARY OF BENEFIT PROVISIONS OF THE RETIREMENT SYSTEM

APPENDIX 1

Summary of Benefit Provisions of the Retirement System As of August 31, 2018

The Teacher Retirement System of Texas makes retirement, disability, and death and survivor benefits to all employees of the public school system of Texas. The major provisions of the System may be summarized as follows:

A. RETIREMENT BENEFITS

1. Grandfather Criteria:

To be grandfathered, you must have met at least one of the following requirements as a member on or before August 31, 2005: (i) at least 50 years old, or (ii) age and years of service credit equal at least 70, or (iii) have at least 25 years of service credit.

2. Normal Retirement:

(a) end of month following age 65 and 5 years of creditable service,

(b) (i) For members hired before August 31, 2007: end of month following attainment of "Rule of 80"

(ii) For members hired on or after August 31, 2007 and who are vested as of August 31, 2014: end of month following attainment of "Rule of 80" with minimum age of 60.

(iii) For members who are not vested as of August 31, 2014: end of month following attainment of "Rule of 80" with minimum age of 62.

Standard Annuity:

The product of 2.3% of the member's average compensation multiplied by years of creditable service. The average compensation is calculated as the average of the highest five annual salaries (based on creditable compensation). Members who as of August 31, 2005, were either age 50, had 25 years of service, or whose age plus service totaled 70 have their standard annuity calculated using the average of their highest three annual salaries.

Normal Retirement Benefits:

Greater of standard annuity, or \$150 per month.

3. Early Retirement:

(a) after age 55 with 5 or more years of creditable service, or

(b) after 30 years of creditable service, regardless of age.

(c) For members hired after August 31, 2007, end of month following attainment of "Rule of 80".

APPENDIX 1 (Continued)

Early Retirement Benefits:

- (a) If a member was hired prior to September 1, 2007, has more than 30 years of service but does not meet the Rule of 80, and has maintained continuous membership until retirement, the early retirement benefit is equal to the normal retirement benefit earned to the date of retirement, reduced by 2% for each point the member is less than age 50.
- (b) If a member is grandfathered the early retirement benefit is equal to the normal retirement benefit earned to the date of retirement, reduced according to the following table:

Years of Service	AGE AT DATE OF RETIREMENT					
	55	56	57	58	59	60
20	90%	92%	94%	96%	98%	100%
21	92%	94%	96%	98%	100%	100%
22	94%	96%	98%	100%	100%	100%
23	96%	98%	100%	100%	100%	100%
24	98%	100%	100%	100%	100%	100%
25	100%	100%	100%	100%	100%	100%
26	100%	100%	100%	100%	100%	100%
27	100%	100%	100%	100%	100%	100%
28	100%	100%	100%	100%	100%	100%
29	100%	100%	100%	100%	100%	100%
30 or more	100%	100%	100%	100%	100%	100%

- (c) If the member was hired after August 31, 2007 and is vested as of August 31, 2014 and the member has met the “Rule of 80” or has 30 years of service the benefit is reduced 5% per year from age 60.
- (d) If the member is not vested as of August 31, 2014 and the member has met the “Rule of 80” or has 30 years of service the benefit is reduced 5% per year from age 62.
- (e) If the member does not meet any of the conditions (a) – (d) above, the early retirement benefit is equal to the normal retirement benefit earned to the date of retirement, reduced according to the following table:

AGE AT DATE OF RETIREMENT										
55	56	57	58	59	60	61	62	63	64	65
47%	51%	55%	59%	63%	67%	73%	80%	87%	93%	100%

APPENDIX 1 (Continued)

4. Normal Form of Benefit:

Straight life annuity payable monthly with benefits commencing at end of month following retirement with the last payment payable on behalf of the annuitant in the month of death.

5. Optional Forms:

Option 1 - joint and 100% survivor, benefit reverts to normal form following the death of the joint annuitant.

Option 2 - joint and 50% contingent survivor, benefit reverts to normal form following the death of the joint annuitant.

Option 3 - 5 years certain and life.

Option 4 - 10 years certain and life.

Option 5 - Joint and 75% contingent survivor, benefit reverts to normal form following the death of the joint annuitant.

6. Deferred Retirement Option Plan (DROP):

(a). Eligibility:

- 1) Must be an active contributing member.
- 2) Must be eligible for a standard service retirement annuity that is not reduced for retirement at an early age.
- 3) Must have at least 25 years of creditable service.
- 4) Must have entered the DROP program before January 1, 2006.

(b). Program Summary:

- 1) Participation begins the 1st of the month following the member's application and TRS approval of the application. Participation may begin in any month.
- 2) Participation may range from a minimum of one year to a maximum of five years, in 12-month increments. The member elects the period of participation at the outset.
- 3) The amount of the member's standard annuity is established as of the date of participation in the DROP. This amount is also used in determining the monthly deposit to the DROP account. A member will not accumulate further retirement annuity benefits during DROP participation, i.e., no further credit will be achieved from years of service or compensation changes.

APPENDIX 1 (Continued)

- 4) Any special service credit that a member wishes to purchase must be paid in full prior to DROP participation.
- 5) A separate DROP account will be established for each participating member. Each month, an amount equal to 60 percent of the calculated standard annuity will be deposited into the account. At retirement, the account plus interest at the rate of five percent per annum will be distributed.
- 6) Member and employer contributions continue during DROP participation. Contributions are not deposited into the member's DROP account and will not be refunded.
- 7) Three events terminate participation - death, retirement or expiration of the participation period.
- 8) Upon retirement, participating members will receive their retirement annuity plus the balance in their DROP account including interest. DROP balances may be paid by TRS in a lump sum or on a time payout selected by the member.

7. Partial Lump-Sum Option Program:

Members, eligible for unreduced retirement and either (1) grandfathered or (2) meeting the Rule of 90, and not participating in the DROP program, may select a partial lump-sum distribution not to exceed an amount equal to 36 months of a standard service retirement annuity. When this option is selected, the member's annuity will be actuarially reduced to reflect that distribution and will be computed so that no actuarial loss results to TRS.

The percentage shown in the following table will be applied to reduce the standard annuity when the partial lump-sum option is elected.

APPENDIX 1 (Continued)

Age	Percentage of Standard Annuity		
	12 Months	24 Months	36 Months
45	91.66	83.32	74.98
46	91.62	83.23	74.85
47	91.57	83.13	74.70
48	91.51	83.03	74.54
49	91.46	82.92	74.37
50	91.40	82.79	74.19
51	91.33	82.66	73.99
52	91.26	82.52	73.78
53	91.18	82.37	73.55
54	91.10	82.20	73.31
55	91.01	82.03	73.04
56	90.92	81.84	72.75
57	90.81	81.63	72.44
58	90.70	81.41	72.11
59	90.58	81.17	71.75
60	90.46	80.91	71.37
61	90.32	80.64	70.95
62	90.24	80.48	70.71
63	90.01	80.03	70.04
64	89.85	79.69	69.54
65	89.67	79.34	69.01
66	89.48	78.96	68.44
67	89.28	78.56	67.84
68	89.06	78.13	67.19
69	88.84	77.67	66.51
70	88.59	77.18	65.77
71	88.32	76.65	64.97
72	88.03	76.07	64.10
73	87.72	75.43	63.15
74	87.37	74.74	62.12
75	87.00	74.00	61.00
76	86.59	73.19	59.78
77	86.15	72.31	58.46
78	85.68	71.35	57.03
79	85.16	70.31	55.47
80	84.59	69.18	53.78
81	83.98	67.96	51.94
82	83.32	66.64	49.96
83	82.61	65.21	47.82
84	81.83	63.67	45.50
85	81.00	62.00	42.99
86	80.09	60.18	40.27
87	79.09	58.19	37.28
88	78.00	56.00	34.00
89	76.81	53.62	30.43
90	75.52	51.04	26.56
91	74.13	48.26	22.39

APPENDIX 1 (Continued)

8. Minimum Annuity Payments:

Total annuity payments shall in no case be less than the member's accumulated contributions at retirement. Upon the death of a retiree, the excess, if any, of accumulated contributions over total annuity payments received prior to death will be paid to the beneficiary.

B. DISABILITY BENEFITS

1. Less than 10 years of creditable service: \$150.00 per month for the shorter of:
 - (a) disability, or
 - (b) number of months of creditable service as of date of disability retirement.
2. At least 10 years of creditable service: the greater of accrued retirement income or \$6.50 per month per year of creditable service, payable for duration of disability; disability presumed continuous if it continues past age 60. The minimum disability payment made on behalf of a member will be no less than \$150.00 per month.

C. DEATH BENEFITS

1. Eligibility: applicable if death occurs:
 - (a) in service,
 - (b) while absent from service for good cause,
 - (c) while not in service but eligible to retire,
 - (d) while not in service but would be eligible to retire without additional service before April 15 of the sixth school year after last creditable year of service, or
 - (e) while receiving a disability benefit, but only eligible for 2f, below.
2. Benefit: any one of the following, at the option of the beneficiary:
 - (a) a lump sum (not to exceed \$80,000) equal to two times the rate of pay for the last year of service,
 - (b) a lump sum (not to exceed \$80,000) equal to two times annual pay for the year preceding last year of service,
 - (c) 60 monthly payments of accrued standard annuity,
 - (d) a life annuity payable under Option 1 as if the member had retired on the last day of the month preceding death,
 - (e) a refund of accumulated contributions, or

APPENDIX 1 (Continued)

- (f) the survivor benefits, if eligible.

Note: Items (c) and (d) available only if member has at least 5 years of creditable service.

- 3. Benefit if Absent from Service Without Good Cause: return of accumulated contributions.

D. SURVIVOR BENEFITS

- 1. Benefits: (a) or (b) at the election of the beneficiary:

- (a) lump sum payment of \$10,000, or
- (b) lump sum payment of \$2,500 plus one of the following, if the designated beneficiary is eligible:
 - (i) if a spouse or dependent parent, \$250 per month commencing at age 65,
 - (ii) if a spouse with children under age 18, \$350 per month until youngest child reaches 18, then \$250 per month commencing at spouse's age 65, or
 - (iii) if dependent children, \$350 per month as long as at least two dependent children under 18, reducing to \$250 per month when there is only one child under 18.

If benefits are payable under (i) or (ii) above and eligible spouse or dependent dies, payments will revert in accordance with (iii) above.

- 2. Eligibility:

- (a) all employees eligible for a death benefit other than refund of accumulated contributions,
- (b) any retired member, in addition to any benefit provided by his or her option of payment, or
- (c) any disabled participant, in lieu of other death benefits (Item C2).

E. VESTING OF BENEFITS

- 1. Vesting: a member is fully vested after 5 years of creditable service.
- 2. Benefits upon Vesting: a fully vested member is entitled to the following:
 - (a) upon becoming inactive, not required to withdraw accumulated contributions within seven years,

APPENDIX 1 (Continued)

- (b) may apply at age 65 for normal retirement benefit equal to accrued standard annuity, or
- (c) may apply for any other retirement benefits for which he or she is eligible upon satisfying age requirement (if applicable) if he or she satisfied the corresponding service requirement at time of last termination; benefit is based on his or her full accrued standard annuity.

F. MEMBER CONTRIBUTIONS

6.70% of compensation per year for fiscal year 2015, 7.20% for fiscal year 2016, and 7.70% for years on and after 2017.

G. STATE CONTRIBUTIONS

State will contribute 6.80% of member compensation for FY2015, and each year thereafter. Beginning in fiscal year 2015, covered employers whose employees are not participating in Social Security will begin contributing 1.50% of pay (capped at the minimum salary schedule). Combined it is expected that these contributions will be approximately 7.70% of total payroll.

H. LEGISLATIVE CHANGES MADE BY THE 1991 STATE LEGISLATURE

1. The minimum retirement benefit increased from \$75 to \$100 per month.
2. The disability death benefit changed to the same as a service retirement death benefit.
3. An ad hoc cost of living increase was approved for members who retired prior to May 1, 1989. The increase does not apply to a survivor benefit or to a disability benefit for a member who had less than 10 years of service at the time of retirement or death. The amount of the increase is five-tenths of one percent of each full six-month period between the latest effective date of retirement (or date of death) and August 1, 1991. The increase begins August 1991.

I. LEGISLATIVE CHANGES MADE BY THE 1993 STATE LEGISLATURE

1. Increase in survivor benefit by \$50 per month.
2. Retroactive minimum benefit of \$6.50 per year of service for members retired as of November 1, 1991.
3. An ad hoc cost of living increase approximating a 25% CPI catch-up. The actual percentage increase varies by year of retirement and has a minimum increase of 5%. The increase begins with the January, 1994 annuity check and covers all benefit recipients who began receiving benefits before August 31, 1991, except that it does not apply to survivor benefits or to a disability benefit for a member who had less than 10 years of service at the time of retirement or death.
4. ERS/TRS transfer provisions.

APPENDIX 1 (Continued)

- (a) Service credit transfers allowed if the participant is a member of both ERS and TRS and has at least three years of service credit in the System from which the member is retiring.
- (b) A member may reinstate or purchase service credit in the other System prior to making the transfer if that member has at least three years of service credit in the current System.
- (c) TRS and ERS will jointly set rules for the assumptions used in computing asset transfer amounts. The transfer of funds between ERS and TRS takes place at the time of actual retirement.

J. LEGISLATIVE CHANGES MADE BY THE 1995 STATE LEGISLATURE

- 1. Unreduced benefits at retirement were expanded to include participants age 50 or older with 30 or more years of service.
- 2. Annuitants' benefits increased in an amount equal to the greater of:
 - (a) A recalculation of benefits based on
 - (i) January 1, 1995 law with all intervening ad hoc increases, plus
 - (ii) A CPI catch-up increase.
 - (b) A recalculation of benefits for retirees who retired before September 1, 1993, based on a 2% multiplier and a minimum annual salary of a classroom teacher or full-time librarian as described by the Education Code. This annual salary is currently \$17,000 based on current Education Code.
- 3. Treat all Option 1 and Option 2 benefits as including the pop-up feature.
- 4. The annuity payment in the month of death is payable on behalf of the annuitant.
- 5. The disability benefit payable when a member has less than ten years of service increased from \$50 per month to \$150 per month for both current and future disabled members. The minimum disability payment made on behalf of a member with ten or more years of service shall be no less than \$150 per month.
- 6. The benefit increase reserve account in TRS was eliminated, resulting in the liability for all annuity benefits being included within the retired reserve account.
- 7. The maximum two-times-pay death benefit payable on behalf of a member would increase from \$60,000 to \$80,000.

K. LEGISLATIVE CHANGES MADE BY THE 1997 STATE LEGISLATURE

APPENDIX 1 (Continued)

1. Driver's education pay is added to plan compensation for the determination of a member's best 3-year average compensation.
2. Disabled participants are allowed to select a Joint and Survivor annuity option after commencement of disability benefits, if they become married after date of disability.
3. Retirees are allowed to change the designated beneficiary for pension benefits payable after their death under certain conditions.
4. Adoption of "Rule of 80" criteria for unreduced standard retirement annuity (i.e., sum of member's age & credited service is greater than or equal to 80).
5. Elimination of \$6.50 per month per year of service minimum standard retirement annuity benefit.
6. Addition of \$50.00 to the minimum survivor benefit.
7. Creation of a Deferred Retirement Option Program (DROP), described in Item A8 above.
8. A CPI catch-up ad hoc cost-of-living increase for retired members.

L. LEGISLATIVE CHANGES MADE BY THE 1999 STATE LEGISLATURE

1. Increased multiplier from 2.0% to 2.2% effective September 1, 1999, and an equivalent 10% increase for all retirees.
2. A CPI catch-up ad hoc cost-of-living increase for retired members.
3. Established a partial lump-sum option at time of retirement.
4. DROP participant enrolled on or before August 31, 1999, have a one-year window from September 1, 1999 to revoke DROP participation.
5. For members entering DROP on or after September 1, 1999, the monthly DROP deposit will be reduced from 79% to 60% of the standard annuity.
4. Provides a lump-sum death benefit of \$160,000 for an active member employed by a school district who dies due to a physical assault during the performance of their regular duties.
5. Allows a return to teaching after being retired at least 12 months without a reduction in the retirement benefit under certain circumstances.

M. LEGISLATIVE CHANGES MADE BY THE 2001 STATE LEGISLATURE

1. Increased multiplier from 2.2% to 2.3% effective September 1, 2001, and an equivalent 4.5% increase for all retirees.

APPENDIX 1 (Continued)

2. A 6% ad hoc increase for retired members.
3. Increase in survivor benefits of \$50 per month.
4. Allows a return to work as a bus driver with no reduction in the monthly benefit if retired with an unreduced benefit.
5. Permits purchase of up to 3 years of “air time” if the member has at least 7 years of actual membership service. Purchase price is the full actuarial cost of the purchased service.

N. LEGISLATIVE CHANGES MADE BY THE 2003 STATE LEGISLATURE

1. For employees hired on or after September 1, 2003, a 90-day waiting period is required for participation in TRS. Members may have the option to purchase this service. This provision is set to expire on September 1, 2005.
2. Limits the collection of overpayments to the three years prior to the overpayment discovery, except in cases of fraud or knowledge by the participant that the payments were incorrect.
3. Repealed the requirement that in order to reinstate service withdrawn after August 31, 2003, for the purposes of ERS/TRS transfer, the member must belong to the system from which the service is purchased.
4. Retirees who are employed by a third-party entity are considered to be employees of the school for return to work purposes unless the retiree does not perform duties or provide services in behalf of the school
5. Retirees may work as a substitute and on a half-time basis during a single calendar month as long as the total days worked do not exceed the number of days for one-half time employment for that month.

O. LEGISLATIVE CHANGES MADE BY THE 2005 STATE LEGISLATURE

1. Final average salary at retirement will be determined by the highest five years (instead of three years) of salary, subsidized early retirement will be eliminated, and partial lump sum option eligibility will require a combined age plus years of creditable service that equals at least 90 (“Rule of 90”).
2. Future members (those who establish TRS membership on or after September 1, 2007) will have the following eligibility requirements to qualify for an unreduced annuity at retirement: (i) age 65 with 5 years of service, or (ii) age 60 with at least 5 years of service and meets the Rule of 80 (combined age and years of service equal at least 80).
3. Employers will be required to pay a monthly surcharge to the pension fund for each retiree working in a TRS-covered position and reported to TRS.

APPENDIX 1 (Continued)

4. The Deferred Retirement Option Plan (DROP) is being discontinued for new participation effective December 31, 2005.

P. LEGISLATIVE CHANGES MADE BY THE 2007 STATE LEGISLATURE

1. The State contribution rate was increased to 6.58% for fiscal year 2008. In addition, the new law requires the State contribution rate to be at least equal to the member contribution rate.
2. The Legislature authorized TRS to make a one-time payment (13th check) in January 2008, if the August 31, 2007 actuarial valuation showed that the funding period would be less than 31 years with the payment. The payment is equal to the lesser of the member's December monthly payment or \$2,400. To be eligible a retiree must have retired on or before December 31, 2006.

Q. LEGISLATIVE CHANGES MADE BY THE 2009 STATE LEGISLATURE

The Legislature included funding for a one-time supplemental payment of \$500 million for current retirees. This appropriation was contingent upon a ruling by the Attorney General's office that such a payment is permissible under State law. The Attorney General determined this payment was not permissible, and therefore the additional appropriation will be contributed to the Trust as additional contributions, increasing the State contribution rate to an effective 6.644% for the biennium.

R. LEGISLATIVE CHANGES MADE BY THE 2013 STATE LEGISLATURE

1. The normal retirement eligibility for members who are not vested as of August 31, 2014 to the "Rule of 80" with minimum age 62 (was minimum age of 60).
2. For members who are not vested as of August 31, 2014, their early retirement benefit will be reduced from age 62 (was 60) if they meet the Rule of 80" but are not eligible for normal retirement.
3. The Legislature granted an ad hoc COLA for members in payment status since August 31, 2004. The payment is equal to the lesser of \$100 or 3% of their monthly payment.
4. The member contribution rate will increase to 6.70% in fiscal year 2015, 7.20% in fiscal year 2016, and 7.70% for fiscal years on and after 2017.
5. The State's contribution rate increased to 6.80% in fiscal year 2014.
6. Covered employers whose employees are not participating in Social Security whose positions are subject to the state statutory minimum salary schedule will begin contributing 1.50% of pay in fiscal year 2015.

APPENDIX 2

ACTUARIAL ASSUMPTIONS AND METHODS

APPENDIX 2

Actuarial Assumptions and Methods (Adopted July 27, 2018)

The following assumptions were developed and recommended based on an experience study performed in 2018. All of the assumptions are based on a combination of anticipated future experience and market observations. We believe all of the assumptions are reasonable and appropriate for this measurement. Please see our report dated July 27, 2018 for more discussion about the selection of these assumptions.

ACTUARIAL ASSUMPTIONS

1. Investment Return Rate 7.25% per annum, compounded annually, composed of an assumed 2.30% inflation rate and a 4.95% real rate of return, net of investment expenses

2. Mortality, Withdrawal, Disability Retirement, and Service Retirement Rates:

Rates and scales developed in the actuarial investigation as of August 31, 2017, with values at specimen ages shown in the tables below:

- a. Active Mortality: RP-2014 Employee Mortality Tables for male and female multiplied by 90%, with full generational projection using the ultimate calendar (i.e. 2027) of rates in the mortality projection scale MP-2014, 2D for male and female. Below are the samples rates for 2018 and 2048.

Age	2018 Mortality Rates		Age	2048 Mortality Rates	
	Male	Female		Male	Female
20	0.000351	0.000140	20	0.000260	0.000104
30	0.000391	0.000188	30	0.000289	0.000139
40	0.000543	0.000342	40	0.000402	0.000253
50	0.001458	0.000953	50	0.001078	0.000705
60	0.004053	0.002111	60	0.002998	0.001562
70	0.011977	0.005454	70	0.008860	0.004035
80	0.033554	0.015890	80	0.024820	0.011754
90	0.119209	0.089535	90	0.090069	0.067649

APPENDIX 2 (Continued)

b. Rates of Termination (net of applying rehire assumption)

Probability of Decrement Due to Termination

Years of Service	Male	Female
1	0.155507	0.162296
2	0.124963	0.133070
3	0.100839	0.111030
4	0.075417	0.087064
5	0.065169	0.077625
6	0.057971	0.068467
7	0.049227	0.056290
8	0.043267	0.048891
9	0.038586	0.043639
10	0.035246	0.039995

The following table is used for all years after the first ten years of employment.

Probability of Decrement Due to Termination Based on Years from Normal Retirement

Years from NR	Male	Female	Years from NR	Male	Female
1	0.012969	0.012300	17	0.026491	0.030497
2	0.015445	0.015360	18	0.026876	0.031061
3	0.017108	0.017491	19	0.027245	0.031604
4	0.018394	0.019181	20	0.027599	0.032128
5	0.019459	0.020603	21	0.027941	0.032634
6	0.020374	0.021843	22	0.028270	0.033125
7	0.021181	0.022949	23	0.028589	0.033600
8	0.021907	0.023952	24	0.028897	0.034061
9	0.022567	0.024874	25	0.029196	0.034510
10	0.023174	0.025728	26	0.029486	0.034947
11	0.023738	0.026526	27	0.029768	0.035372
12	0.024264	0.027276	28	0.030042	0.035787
13	0.024759	0.027985	29	0.030309	0.036191
14	0.025226	0.028658	30	0.030570	0.036587
15	0.025668	0.029298	31	0.030823	0.036973
16	0.026089	0.029911	32	0.031071	0.037351

APPENDIX 2 (Continued)

c. Rates of Disability Retirement

The disability retirement rates for members once they reach the Rule of 80 but not eligible for unreduced retirement are adjusted by an additional 1%.

Probability of Decrement Due to Disability

Age	For Service >= 10		For Service < 10	
	Male	Female	Male	Female
20	0.000147	0.000262	0.000018	0.000028
30	0.000147	0.000262	0.000018	0.000028
40	0.000344	0.000446	0.000043	0.000047
50	0.001594	0.001726	0.000199	0.000182
60	0.002804	0.002616	0.000351	0.000275

d. Rates of Retirement

Age	Normal Retirement		Age	Early Retirement	
	Male	Female		Male	Female
50	0.1300	0.1400	45	0.0100	0.0100
51	0.1300	0.1400	46	0.0100	0.0100
52	0.1300	0.1400	47	0.0100	0.0100
53	0.1300	0.1400	48	0.0100	0.0100
54	0.1300	0.1400	49	0.0100	0.0100
55	0.1300	0.1500	50	0.0100	0.0100
56	0.1400	0.1600	51	0.0100	0.0100
57	0.1500	0.1700	52	0.0100	0.0100
58	0.1600	0.1800	53	0.0100	0.0100
59	0.1700	0.1900	54	0.0100	0.0100
60	0.1800	0.2000	55	0.0100	0.0100
61	0.1900	0.2100	56	0.0100	0.0100
62	0.2000	0.2200	57	0.0100	0.0100
63	0.2100	0.2300	58	0.0100	0.0100
64	0.2200	0.2400	59	0.0100	0.0100
65	0.2500	0.2500	60	0.0100	0.0200
66	0.2500	0.2500	61	0.0200	0.0200
67	0.2500	0.2500	62	0.0400	0.0400
68	0.2500	0.2500	63	0.0500	0.0500
69	0.2500	0.2500	64	0.0500	0.0500
70-74	0.2500	0.2500	65	0.0500	0.0500
75	1.0000	1.0000			

APPENDIX 2 (Continued)

Rates for members younger than age 65 will be reduced by 15% to reflect anticipated behavior changes stemming from the modifications to TRS CARE in the 2017 legislature. 5% will be added to the rate at age 65 for members who reach normal retirement age prior to age 65.

For members hired after August 31, 2007 and who are vested as of August 31, 2014, the retirement rates for members once they reach unreduced retirement eligibility at age 60 are increased 10% for each year the member is beyond the Rule of 80 (i.e. if the member reached the Rule of 80 at age 58 then the probability of retirement at age 60 is 120% of the rate shown above).

For members hired after August 31, 2007 and who are not vested as of August 31, 2014, or, for members hired after August 31, 2014, the retirement rates for members once they reach unreduced retirement eligibility at age 62 are increased 10% for each year the member is beyond the Rule of 80 (i.e. if the member reached the Rule of 80 at age 58 then the probability of retirement at age 62 is 140% of the rate shown above).

APPENDIX 2 (Continued)

3. Rates of Salary Increase

Inflation rate of 2.30%, plus productivity component of 0.75%, plus step-rate/promotional component as shown:

Years of Service	Merit, Promotion, Longevity		General		Total	
1	6.00	%	3.05	%	9.05	%
2	2.50		3.05		5.55	
3	1.90		3.05		4.95	
4	1.50		3.05		4.55	
5	1.40		3.05		4.45	
6	1.20		3.05		4.25	
7	1.10		3.05		4.15	
8	1.00		3.05		4.05	
9	1.00		3.05		4.05	
10	1.00		3.05		4.05	
11	0.90		3.05		3.95	
12	0.90		3.05		3.95	
13	0.80		3.05		3.85	
14	0.70		3.05		3.75	
15	0.60		3.05		3.65	
16	0.50		3.05		3.55	
17	0.50		3.05		3.55	
18	0.40		3.05		3.45	
19	0.30		3.05		3.35	
20	0.30		3.05		3.35	
21	0.20		3.05		3.25	
22	0.20		3.05		3.25	
23	0.10		3.05		3.15	
24	0.10		3.05		3.15	
25 & up	0.00		3.05		3.05	

APPENDIX 2 (Continued)

4. Post-retirement Mortality: The 2018 TRS of Texas Healthy Pensioner Mortality Tables, with full generational projection using the ultimate calendar (i.e.2027) of rates in the mortality projection scale MP-2014, 2D for male and female, used for service retirement annuitants, beneficiaries and survivors. These tables are developed based on the experience in the actuarial investigation as of August 31, 2017 Below are the samples rates for 2018 and 2048.

Age	2018 Mortality Rates		Age	2048 Mortality Rates	
	Male	Female		Male	Female
40	0.000615	0.000388	40	0.000455	0.000287
50	0.001652	0.001080	50	0.001222	0.000799
60	0.004651	0.002668	60	0.003440	0.001974
70	0.014356	0.008969	70	0.010619	0.006634
80	0.046716	0.032270	80	0.034556	0.023870
90	0.152340	0.116359	90	0.115101	0.087915
100	0.490265	0.422361	100	0.404369	0.348362
110	0.496658	0.496658	110	0.466303	0.466303
120	1.000000	1.000000	120	1.000000	1.000000

For disabled retirees, a three-year set forward of the above tables are used, with minimum mortality rates of 0.0200 for female and 0.0400 for male, respectively.

Age	2018 Mortality Rates		Age	2048 Mortality Rates	
	Male	Female		Male	Female
40	0.040000	0.020000	40	0.040000	0.020000
50	0.040000	0.020000	50	0.040000	0.020000
60	0.040000	0.020000	60	0.040000	0.020000
70	0.040000	0.020000	70	0.040000	0.020000
80	0.066557	0.047384	80	0.049232	0.035050
90	0.217371	0.171112	90	0.166740	0.131256
100	0.492192	0.492192	100	0.422199	0.422199
110	0.498452	0.498452	110	0.485168	0.485168
120	1.000000	1.000000	120	1.000000	1.000000

APPENDIX 2 (Continued)

HANDLING OF ACTIVE DATA WITH MISSING INFORMATION:

As of the close of each fiscal year there is a large number of records for whom no statistical data has been received. The only information TRS has is social security number and initial contributions. Any of these records that were in the prior year's data are treated as non-vested terminated members. The remaining records are treated as new entrants. These records are added to the count of active members, but have no liability.

There are other records provided by TRS that have missing gender and/or missing date of births. These records are handled as follows:

1. 80% of records with missing gender are assumed to be female. The overall male/female ratio of the active membership is used to set this assumption.
2. Records with missing dates of birth are assigned a date of birth that produces an entry age equal to the average entry age for the overall active population, based on the member's actual service.

ASSUMPTION FOR DROP PARTICIPATION

Current active members are not eligible to participate in DROP, therefore no new DROP members are assumed.

BENEFIT ELECTION OF VESTED TERMINATING MEMBERS:

In determining the liabilities developed for future terminating vested members, it is assumed that the member elects either a refund or a deferred vested benefit, whichever is more valuable. The deferred benefit is assumed to commence at the earliest age the member is eligible for unreduced retirement.

ELECTION RATES FOR ACTIVE MEMBER DEATH BENEFITS:

If the member was eligible for retirement at the time of death, it is assumed that the beneficiary will elect the option 1 death benefit. Otherwise, it is assumed the value of the member's lump sum cash value will be the greater of two times their account balance or the minimum of \$80,000 or two times their salary at the time of death.

DECREMENT TIMING:

Retirement is assumed to occur at the end of the year. Termination from service is assumed to occur at the beginning of the year. All other decrements are assumed to occur mid-year.

BENEFIT ELECTION OPTIONS:

It is assumed that future healthy retirees will select the normal form of payment. For disabled members, 80% are assumed to select the normal form of payment and 20% to select the 100% joint and survivor option.

APPENDIX 2 (Continued)

MARRIAGE ASSUMPTION:

While not implicitly used in the valuation, 100% of active members are assumed to be married when setting other benefit election and eligibility assumptions.

SPOUSAL AGE DIFFERENCE:

Husbands are assumed to be three years older than their wives.

CLASSIFICATION OF WHO ARE ACTIVE MEMBERS:

Members who contributed during the just-completed plan year but did not retire before August 31st are considered active.

ACTUARIAL VALUE OF ASSETS:

- A. The actuarial value of assets is equal to the market value of assets less a five-year phase in of the excess/(shortfall) between expected investment return and actual income. The actual calculation is based on the difference between actual market value and the expected actuarial value of assets each year, and recognizes the cumulative excess return (or shortfall) over a minimum rate of 20% per year. Each year a base is set up to reflect this difference. If the current year's base is of opposite sign to the deferred bases then it is offset dollar for dollar against the deferred bases. Any remaining bases are then recognized over the remaining period for the base (5 less the number of years between the bases year and the valuation year). This is intended to ensure the smoothed value of assets will converge towards the market value in a reasonable amount of time.
- B. Expected earnings are determined using the assumed investment return rate and the beginning of year actuarial value of assets (adjusted for receipts and disbursements during the year). Beginning in fiscal year 2016, the returns are computed net of investment expenses.

PAYROLL GROWTH FOR FUNDING OF UNFUNDED ACTUARIAL ACCRUED LIABILITY:

Total payroll is expected to grow at 3.00% per year. The total general wage increase assumption of 3.00% is made up of an inflation rate of 2.30% plus a 0.70% real wage growth. This value is also used to increase the wages for each annual cohort of new entrants in an open group projection based on the current demographics and the current assumptions.

APPENDIX 2 (Continued)

ACTUARIAL COST METHOD:

The actuarial valuation is used to determine the adequacy of the State contribution rate (established by Legislative appropriation) and employer contribution rate (established by statute) and to describe the current financial condition of TRS.

The actuarial valuation uses the Entry Age Normal actuarial cost method. Under this method, the first step is to determine the contribution rate (level as a percentage of pay) required to provide the benefits to each member, or the normal cost rate. The normal cost rate consists of two pieces: (i) the member's contribution rate, and (ii) the remaining portion of the normal cost rate which is the employer's normal cost rate. The total normal cost rate is based on the benefits payable to each individual active member.

The Unfunded Actuarial Accrued Liability (UAAL) is the liability for future benefits which is in excess of (i) the actuarial value of assets, and (ii) the present value of future normal costs. The employer contribution provided in excess of the employer normal cost is applied to amortize the UAAL.

The funding period is calculated as the number of years required to fully amortize the UAAL, and is calculated with the use of an open group projection that takes into account: (a) future market earnings, net of investment-related expenses, will equal 7.25% per year, (b) there will be no changes in assumptions, (c) the number of active members will remain unchanged, (d) active members who leave employment will be replaced by new entrants each year, and (e) State and employer contributions will remain the same percentage of payroll.

The Entry Age actuarial cost method is an "immediate gain" method (i.e., experience gains and losses are separately identified as part of the UAAL). However, they are amortized over the same period applied to all other components of the UAAL.

PROJECTED PAYROLL FOR CONTRIBUTIONS:

The aggregate projected payroll for the fiscal year following the valuation date is calculated by increasing the actual payroll paid during the previous fiscal year by the payroll growth rate.

USE OF CELLED DATA:

For valuation purposes, every record in the census is valued individually.

For legislative purposes, the active valuation data is celled by benefit tier, gender, years of service, month and year of birth. The individual cell is valued using the sum of the salary and account balances of the members in the cell. Every year we test this approach against using the individual records and the results are consistently less than 0.02% different in total present value of benefits.

APPENDIX 2 (Continued)

CHANGES SINCE THE PRIOR VALUATION:

The Board adopted new assumptions on July 27, 2018 based on recommendations from the experience study for the period ending August 31, 2017.

GLOSSARY

DEFINITION OF ACTUARIAL TERMS

GLOSSARY

Definition of Actuarial Terms

H.B. 2206 as passed by the 1979 Legislature requires that any actuarial study of a public retirement system include "a complete definition of each actuarial term used in the study". In our report we have attempted to avoid the use of a multitude of complex actuarial terminology, but we realize that different users of our reports may have differing opinions as to what constitutes an "actuarial term". Accordingly, in keeping with the intent and the spirit of the law, we offer the following definitions of several terms contained in this report which might be considered actuarial in nature. Any qualified user of our report who believes that additional terms should be included is invited to communicate such terms either directly to us or through the Teacher Retirement System of Texas.

1. *Actuarial Accrued Liability* - for benefits payable in the future to present members, it will equal the present value of benefits payable in the future to them less the present value of future normal costs.
2. *Actuarial Assumptions* - assumptions as to future experience under the System. Current actuarial assumptions are detailed in Appendix 2 of the current annual valuation report. Assumptions include future fund earning rates, rates of future salary increases, and rates of death (both before and after retirement), disability, retirement, and withdrawal as well as overall payroll growth. Effective August 31, 1985, select and ultimate assumptions were adopted for retirement and withdrawal rates and the salary scale.
3. *Actuarial Gain or Actuarial Loss* - a measure of the difference between actual experience and assumed experience of the System. Through the actuarial assumptions, rates of decrements, rates of salary increases, and rates of fund earnings have been forecasted. To the extent that actual experience differs from that assumed, actuarial liabilities emerge which may be the same as forecasted, or they may be larger or smaller than projected. Actuarial gains are due to favorable experience, e.g., the System's assets earn more than projected, salaries do not increase as fast as assumed, members retire later than assumed, etc. Favorable experience means actual results produce actuarial liabilities not as large as projected by the actuarial assumptions. On the other hand, actuarial losses are the result of unfavorable experience, i.e., actual results that produce actuarial liabilities which are larger than projected. Actuarial gains will shorten the time required for funding of the actuarial balance sheet deficiency while actuarial losses will lengthen the funding period.
4. *Actuarial Liabilities* - the actuarially determined present value of future benefits to be provided by the System. There are separate actuarially determined present values for retired members and non-retired members (either active or inactive). When applied to active members, it takes into account benefits which will be earned through future service and future salary increases.
5. *Actuarial Value of Assets* - the value of present System assets for valuation purposes. Prior to August 31, 1985, this value was the same as the book value of assets. Beginning August 31, 1985, through August 31, 1993, this value was calculated under the "market over book adjusted asset valuation method." Beginning August 31, 1993, this value is calculated under a five-year phase in of the excess (shortfall) between expected and actual income return on the market value of assets.

Glossary (Continued)

6. *Actuarially Determined* - values which have been determined utilizing the principles of actuarial science. An actuarially determined value is derived by application of the appropriate actuarial assumptions to specified values determined by provisions of the law.
7. *Decrements* - those types of activities by members of the System which cause them no longer to be members, i.e., death, retirement, disability, and withdrawal. It is a general term referring to any or all of these membership terminating events.
8. *Defined Benefits* - in a retirement plan, benefits which are defined by a specific formula applied to specific member compensation and/or specific years of service. The amount of the benefit is not a function of contributions or actual earnings on those contributions.
9. *Defined Contributions* - in a retirement plan, periodic contributions to the plan which are defined as a specific percent of compensation.
10. *Experience Study* - a periodic review and analysis of the actual experience of the System which may lead to a revision of one or more actuarial assumptions. Actual rates of decrement and salary increases are compared to the actuarially assumed values and modified as deemed appropriate by the Actuary.
11. *Funding Period* - the number of years in the future that will be required to fund (i.e., pay off or eliminate) the unfunded actuarial accrued liability, based on the actuarial assumptions and assuming no future actuarial gains or losses.
12. *Future Benefits* - benefits specified in the law which will become payable at some time in the future when the member satisfies the requirement to receive such benefits.
13. *Future Contributions* - contributions to be made by the member or the State in the future, as required by the law.
14. *Normal Cost* - the actuarial cost to fund the benefits provided by the System were the funding to begin at date of hire. It is expressed as a percent of pay and is equal to the present value at hire of all possible benefits of the System divided by the present value of anticipated future compensation to be received by the new member. In the aggregate, it must be less than the total future contribution to the System if the unfunded actuarial accrued liability is to be amortized. Otherwise there must be a funding surplus sufficient in size to offset any contribution rate shortfall.
15. *Present Value* - the actuarially determined lump sum value as of the valuation date of a series of payments to be made in the future, where the lump sum value is equal to the sum of the discounted value of each future payment. The discounted value of each payment is the product of (a) the amount of the payment, (b) the probability that the payment will be made (based on the current actuarial assumptions as to future experience), and (c) the time value of money (based on the current assumed interest rate).
16. *Unfunded Actuarial Accrued Liability* - that portion of the actuarial accrued liability (including the present value of benefits presently being paid to retired members) that exceeds the value of current actuarial assets. A funding surplus exists if the actuarial accrued liability is less than the actuarial assets.