



Defined Benefit Supplement Program of the California State Teachers' Retirement System

June 30, 2018 Actuarial Valuation

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May 24, 2019

Teachers' Retirement Board
California State Teachers' Retirement System

Re: **Defined Benefit Supplement Program Actuarial Valuation as of June 30, 2018**

Dear Members of the Board:

At your request, we have performed an actuarial valuation of the Defined Benefit Supplement (DBS) Program of the State Teachers' Retirement Plan as of June 30, 2018. Details about the actuarial valuation are contained in the following report. The major findings of the 2018 Actuarial Valuation are contained in this report. This report reflects the benefit provisions and contribution rates in effect as of the valuation date.

Actuarial Certification

To the best of our knowledge and belief, this report is complete and accurate and contains sufficient information to fully and fairly disclose the funded condition of the DBS Program as of June 30, 2018.

In preparing this report, we relied, without audit, on information (some oral and some in writing) supplied by CalSTRS staff. This information includes, but is not limited to, statutory provisions, employee data, and financial information. In our examination of these data, we have found them to be reasonably consistent and comparable with data used for other purposes. The valuation results depend on the integrity of this information. If any of this information is inaccurate or incomplete our results may be different and our calculations may need to be revised.

All costs, liabilities, rates of interest, and other factors for CalSTRS have been determined on the basis of actuarial assumptions and methods which are individually reasonable (taking into account the experience of CalSTRS and reasonable expectations) and which, in combination, offer a reasonable estimate of anticipated experience affecting CalSTRS. Further, in our opinion, each actuarial assumption used is reasonably related to the experience of CalSTRS and to reasonable expectations which, in combination, represent a reasonable estimate of anticipated experience.

Future actuarial measurements may differ significantly from the current measurements presented in this report due to such factors as the following: plan experience differing from that anticipated by the economic or demographic assumptions; changes in economic or demographic assumptions; increases or decreases expected as part of the natural operation of the methodology used for these measurements (such as the end of an amortization period or additional cost or contribution requirements based on the Plan's funded status); and changes in plan provisions or applicable law. Due to the limited scope of our assignment, we did not perform an analysis of the potential range of future measurements. The Teachers' Retirement Board has sole authority to determine the actuarial assumptions and methods used for the valuation of the DBS Program. The board adopted the actuarial methods and assumptions used in the 2018 valuation.

Actuarial computations presented in this report are for purposes of assessing the funding of the DBS Program. The calculations in the enclosed report have been made on a basis consistent with our understanding of the DBS

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Program funding structure. Determinations for other purposes may be significantly different from the results contained in this report. Accordingly, additional determinations may be needed for other purposes.

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- (b) CalSTRS may provide a copy of Milliman's work, in its entirety, to other governmental entities, as required by law.

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The consultants who worked on this assignment are retirement actuaries. Milliman's advice is not intended to be a substitute for qualified legal or accounting counsel.

The signing actuaries are independent of the plan sponsor. We are not aware of any relationship that would impair the objectivity of our work.

On the basis of the foregoing, we hereby certify that, to the best of our knowledge and belief, this report is complete and accurate and has been prepared in accordance with generally recognized and accepted actuarial principles and practices, including the relevant Actuarial Standards of Practice. We are members of the American Academy of Actuaries and meet the Qualification Standards of the American Academy of Actuaries to render the actuarial opinion contained herein.

We would like to express our appreciation to the CalSTRS staff who gave substantial assistance in supplying the data on which this report is based. We respectfully submit the following report and we look forward to discussing it with you.


Sincerely,

A handwritten signature in black ink that reads 'Nick Collier'.

Nick J. Collier, ASA, EA, MAAA
Consulting Actuary

A handwritten signature in black ink that reads 'Mark C. Olleman'.

Mark C. Olleman, FSA, EA, MAAA
Consulting Actuary

A handwritten signature in black ink that reads 'Julie D. Smith'.

Julie D. Smith, FSA, EA, MAAA
Consulting Actuary

May 24, 2019

Date

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1. Summary of the Findings

As of June 30, 2018, the Actuarial Value of Assets of the Defined Benefit Supplement (DBS) Program exceeds the Actuarial Obligation by \$2,599,246,000. This number is the negative Unfunded Actuarial Obligation (UAO), sometimes referred to as an Actuarial Surplus. Consistent with its policy, the board granted Additional Earnings Credits of \$393,843,000 as of June 30, 2018, as discussed in this report.

(\$ Thousands)	June 30, 2018	June 30, 2017
Actuarial Balance Sheet		
Actuarial Obligation (before Add'l Credits)	\$ 10,574,276	\$ 10,045,176
Actuarial Value of Assets	<u>13,173,522</u>	<u>12,269,382</u>
Unfunded Actuarial Obligation / (Actuarial Surplus)	\$ (2,599,246)	\$ (2,224,206)
Additional Earnings Credit	<u>393,843</u>	<u>356,926</u>
Final Unfunded Actuarial Obligation / (Actuarial Surplus)	\$ (2,205,403)	\$ (1,867,280)
Funded Ratio (Assets ÷ Actuarial Obligation)		
Before Additional Credits	124.58%	122.14%
After Additional Credits	120.11%	117.95%

The Actuarial Value of Assets for this valuation is the Fair Market Value as provided to us by CalSTRS. The actual return for the year for the DBS Program, as measured using uniform cash flow throughout the year, was about 8.8% net of investment and administrative expenses.

(\$ Thousands)	Year Ended June 30, 2018	Year Ended June 30, 2017
Additions		
Contributions	\$ 282,377	\$ 263,200
Earnings	<u>1,052,858</u>	<u>1,479,303</u>
Total Additions	\$ 1,335,235	\$ 1,742,503
Deductions		
Benefits	\$ 419,088	\$404,737
Expenses	<u>12,007</u>	<u>11,680</u>
Total Deductions	431,095	416,417
Net Increase (Decrease)	\$ 904,140	\$ 1,326,086
Net Assets		
Beginning of Year	\$ 12,269,382	\$10,943,296
Transfers In/(Out)	-	-
Net Increase (Decrease)	<u>904,140</u>	<u>1,326,086</u>
End of Year	\$ 13,173,522	\$ 12,269,382
Estimated Net Rate of Return	8.8%	13.5%

If the experience had emerged as assumed, the Actuarial Surplus would have increased from \$1,867,280,000 to \$1,997,990,000. The difference between the actual and expected UAO is the actuarial gain or loss for the year.

- There was an actuarial gain of \$186,779,000 due to the actual investment return being greater than last year's assumed long-term return of 7.00%.
- There was an actuarial gain of \$414,477,000 on the actuarial obligation. This was primarily due to the current year's interest credits being less than 7.00% during the year. The Minimum Interest Rate for 2017-2018 was 2.64%.
- The net actuarial gain was \$601,256,000, which increased the Funded Ratio to 124.58% prior to granting the Additional Earnings Credits.
- The Actuarial Obligation increased by \$393,843,000 due to Additional Earnings Credits adopted effective June 30, 2018.

A summary of the actuarial (gains) and losses for the last two years is shown in the following table.

	June 30, 2018	June 30, 2017
Actuarial (Gain) or Loss		
Investment Return on Assets	\$ (186,779)	\$ (679,365)
Assumption Changes	0	22,615
Interest Credits on Accounts	(414,477)	(346,126)
Total Actuarial (Gain) or Loss	\$ (601,256)	\$ (1,002,876)
Expected UAO at End of Year	(1,997,990)	(1,221,330)
Total Unfunded Actuarial Obligation / (Actuarial Surplus) Before Add'l Credits	\$ (2,599,246)	\$ (2,224,206)

The board established a policy ("Additional Credit Policy") on June 9, 2006 that was effective for the Additional Earnings Credit and Additional Annuity Credit decisions beginning in 2006. The board's Additional Credit Policy calls for a two-step determination of the allocation as shown in detail in this report. This policy was updated at the board's April 2015 meeting to increase the thresholds needed to be met to grant Additional Earnings Credits and to remove the Additional Annuity Credit.

At the May 2019 meeting, the board granted an Additional Earnings Credits of \$393,843,000, pursuant to board policy.

The following table shows a history of prior board actions.

(\$ Thousands)				
Valuation Date	Funded Ratio	Available Reserves and Unallocated Gains (Losses)	Additional Credits Adopted	Final Gain and Loss Reserve
June 30, 2008	100.2%	\$ 8,769	\$ 0	\$ 8,769
June 30, 2009	78.0%	(1,453,334)	0	(1,453,334)
June 30, 2010	86.0%	(1,044,262)	0	(1,044,262)
June 30, 2011	103.6%	281,195	0	281,195
June 30, 2012	100.6%	50,527	0	50,527
June 30, 2013	105.8%	788,028	295,872	492,156
June 30, 2014	116.3%	1,820,201	347,846	1,472,355
June 30, 2015	114.5%	1,711,825	324,216	1,387,609
June 30, 2016	111.6%	1,138,769	0	1,138,769
June 30, 2017	118.0%	2,224,206	356,926	1,867,280
June 30, 2018	120.1%	2,599,246	393,843	2,205,403

Future Funding

As of June 30, 2018, the DBS Program has an Actuarial Surplus (negative UAO), since the value of assets is greater than the current value of the Actuarial Obligation. If all assumptions are met, the funding surplus will slowly grow in the future. If future experience is worse than assumed, a UAO may develop.

There is currently no provision in the Education Code to increase contributions to make up for any future shortfalls, if they were to occur. However, the assumed return on investments exceeds the current Minimum Interest Rate. To the extent that the assets earn more than the accounts are credited in the future, this may be sufficient to make up any potential shortfall.

The actuarially determined contribution in accordance with the funding policy is equal to the actual contributions that will be required to be made to the DBS Program according to the California Education Code.

Conclusion

The DBS Program is currently in a surplus funded position; that is, the assets exceed the value of the Actuarial Obligation based on the actuarial assumptions. Given the current funded position, it is consistent with their policy for the board to grant Additional Credits. However, it should be noted that future experience will not exactly conform to the assumptions. To the extent future experience is worse than assumed, it is possible that a UAO could develop in the future.

The board granted an Additional Earnings Credit of 4.36% to active and inactive member accounts, consistent with its policy. The estimated value of the Additional Earnings Credits is \$393,843,000.

2. Findings of the Actuarial Valuation

An actuarial valuation is performed as of June 30 of each year, the last day of the Program's plan year. The primary purpose of the valuation is to determine the financial condition of the DBS Program through the measurement of the Gain and Loss Reserve. We also describe recent changes in the Program's financial condition and provide additional disclosure information.

The findings have been determined according to actuarial assumptions that were adopted on the basis of recent experience and current expectations of future experience. In our opinion, the assumptions used in the valuation are reasonably related to the past experience of the DBS Program and represent a reasonable estimate of future conditions affecting the Program. Nevertheless, the emerging costs of the Program will vary from those presented in this report to the extent that actual experience differs from that projected by the actuarial assumptions.

Actuarial Value of Assets

The Actuarial Value of Assets for this valuation is the Fair Market Value as reported by CalSTRS. A Statement of Program Assets for the last two plan years is shown in **Table 1**, and the Statement of Change in Program Assets is shown in **Table 2**.

The investment return for 2017-2018 was calculated to be 8.8% net of all investment and administrative expenses and assuming uniform cash flow throughout the year. This is an estimate only for the purpose of comparing investment experience from one year to the next and will likely differ from information provided by your investment advisors.

Actuarial Balance Sheet

Under the Traditional Unit Credit Actuarial Cost Method, when the assumed investment return is equal to the assumed interest crediting rate, then the Normal Cost is equal to the contributions made during the year and the Actuarial Obligation is equivalent to the current sum of the Members' Account Balances plus a reserve for the present value of the current annuity payments.

Table 3 shows the Actuarial Obligation for this valuation and the prior valuation.

For the purpose of this valuation, the account information was provided to us by CalSTRS, reflecting all Additional Earnings Credits granted prior to 2017. Milliman adjusted the account values provided by CalSTRS to reflect an estimate of the Additional Earnings Credits granted in 2017. We checked the information for reasonableness by reviewing the individual member records supplied to us. We independently calculated the value of the monthly annuity benefits supplied by CalSTRS.

The excess of the Actuarial Obligation over the Actuarial Value of Assets is called the Unfunded Actuarial Obligation (UAO). If the Actuarial Value of Assets exceeds the Actuarial Obligation, the difference is called the Actuarial Surplus.

If all experience emerged as assumed every year, the DBS Program would have an Actuarial Surplus at the end of each year before any Additional Earnings Credits, assuming the Minimum Interest Rate is less than the assumed earnings rate. In order to retain an Actuarial Surplus, the investment returns over a long period of time must exceed the combination of the Minimum Interest Rates and the Additional Earnings Credits.

Although this relationship is projected to hold, there have been situations, such as after the Great Recession of 2008, where investment performance for several prior years was below the long-term assumption and a UAO emerged.

Actuarial Gains and Losses

The Minimum Interest Rate for the year ending on the valuation date was 2.64%. Since the assumed total earnings rate last year was 7.00% per year, the increase in the Actuarial Obligation was less than projected. The total actuarial gain on the Actuarial Obligation was \$414,477,000.

Last year, the assumed earnings rate on the invested assets was 7.00% per year. The actual return for the year was about 8.8% (net of investment and administrative expenses and assuming uniform cash flow through the year, which is slightly different than how interest is actually posted), which produced an investment gain of \$186,779,000.

The assumed earnings rate is 7.00% in all future years, as adopted by the board in February 2017.

The total actuarial gain due to all causes was \$601,256,000 as shown in **Table 4**.

Contributions and Normal Costs

Table 4 shows that the Normal Costs of the DBS Program are equal to the actual contributions. They are shown as the actual dollar amount of contributions. The timing in **Table 4** is therefore consistent with the fact that contributions are spread over the entire year and correspond to payroll timing. The total contributions of \$282,377,000 were made up of \$141,219,000 in member contributions and \$141,158,000 in employer contributions.

Gain and Loss Reserve

Table 5 shows the derivation of the Gain and Loss Reserve. After each actuarial valuation, the Teachers' Retirement Board decides on the adjustment to the prior year's Gain and Loss Reserve and the Additional Earnings Credits, if any.

This report assumes the Teachers' Retirement Board will allocate any unallocated gain or loss to funding after any Additional Earnings Credits are adopted.

Additional Credits Based on Board Policy

Based on the board's Policy, Additional Earnings Credits of \$393,843,000 were granted as of June 30, 2018.

The board's Policy calls for a two-step determination of the allocation.

The first step in the process allocates the excess of the Actuarial Surplus over 1 times the Standard Deviation of the Expected Long-Term Rate of Return on the investment portfolio, but limited by the long-term assumed rate of earnings.

First Allocation

Long-term Expected Net Investment Return	7.00%
Minimum Interest Rate (year prior to valuation)	<u>2.64</u>
Maximum Available in First Allocation (1)	4.36%
Actuarial Surplus	24.58%
First Threshold (1x Portfolio Std. Deviation)	15.00
Maximum credit such that resulting Funded Ratio is not less than 100% + Std. Deviation (2)	9.75%*
First Allocation [lesser of (1) and (2)]	4.36%

* The result is not a simple subtraction of the Actuarial Surplus and the First Threshold, because the maximum credit is determined based on a division of the Actuarial Value of Assets and the Actuarial Obligation with the First Allocation.

The second step in the process allocates 50% of the remaining Actuarial Surplus over 2 times the Standard Deviation of the Expected Long-Term Rate of Return on the investment portfolio.

Second Allocation

Remaining Actuarial Surplus (3)	20.11%
Second Threshold (2 x Portfolio Std. Deviation)(4)	30.00
Target Second Threshold Surplus [Average of (3) and (4), but not less than Second Threshold]	30.00%
Available for Second Allocation	0.00%

The total available is the sum of the two steps, or 4.36% of the Actuarial Obligation for active and inactive member accounts as of June 30, 2018.

Details of the calculation are shown in **Table 6**.

Historical Information

A history of the DBS Program's cash flow and funded status are shown in **Tables 7 and 8**.

Supplemental Information

Supplemental information that is recommended to be disclosed by the California Actuarial Advisory Panel is shown in **Tables 9, 10, and 11**.

Table 1
Statement of Program Assets

<i>(\$ Thousands)</i>	June 30, 2018	June 30, 2017
Invested Assets		
Cash	\$ 9,226	\$ 29,127
Debt Securities	2,599,958	2,105,947
Equity Securities	6,826,007	6,704,218
Alternative Investments	3,816,243	3,520,122
Derivative Instruments	61,297	183
Securities Lending Collateral	1,294,419	0
Other Investments	<u>22,980</u>	<u>0</u>
Total Investments	\$ 14,630,130	\$ 12,359,597
Receivables	(309,365)	(31,027)
Liabilities	<u>(1,765,973)</u>	<u>(59,188)</u>
Fair Market Value of Net Assets	\$ 13,173,522	\$ 12,269,382

Table 2
Statement of Change in Program Assets

<i>(\$ Thousands)</i>	Year Ended June 30, 2018	Year Ended June 30, 2017
Additions		
Contributions		
Members	\$ 141,219	\$ 131,578
Employers	<u>141,158</u>	<u>131,622</u>
Total Contributions	282,377	263,200
Net Earnings	<u>1,082,894</u>	<u>1,479,303</u>
Total Additions	\$ 1,365,271	\$ 1,742,503
Deductions		
Benefit Payments		
Retirement, Death and Survivor	\$ 397,635	\$ 383,828
Refunds of Member Contributions	<u>21,453</u>	<u>20,909</u>
Total Benefits	419,088	404,737
Expenses	<u>12,007</u>	<u>11,680</u>
Total Deductions	\$ 431,095	\$ 416,417
Net Increase (Decrease)	\$ 934,176	\$ 1,326,086
Fair Market Value of Net Assets		
Beginning of Year	\$ 12,269,382	\$ 10,943,296
Accounting Adjustments (GASB 75)	(30,036)	0
Adjustment for Prior Year	0	0
Fair Value Accrual		
Transfers In/(Out)	0	0
Net Increase (Decrease)	<u>934,176</u>	<u>1,326,086</u>
End of Year	\$ 13,173,522	\$ 12,269,382
Estimated Net Rate of Return	8.8%	13.5%
- assuming uniform cash flow through the year		
- net of investment and administrative expenses		

Table 3
Actuarial Balance Sheet

(\$ Thousands)

	<u>June 30, 2018</u>		<u>June 30, 2017</u>
	Without Additional Credits	With Additional Credits Adopted	
Total Requirements			
Actuarial Obligation			
Retirees and Beneficiaries	\$ 1,541,170	\$ 1,541,170	\$ 1,381,932
Inactive Members	698,384	728,833	670,426
Active Members	<u>8,334,722</u>	<u>8,698,116</u>	<u>8,349,744</u>
Total Requirements	\$ 10,574,276	\$10,968,119	\$10,402,102
Total Resources			
Actuarial Value of Assets	\$ 13,173,522	\$ 13,173,522	\$12,269,382
Unfunded Actuarial Obligation or (Actuarial Surplus)	<u>(2,599,246)</u>	<u>(2,205,403)</u>	<u>(1,867,280)</u>
Total Resources	\$ 10,574,276	\$10,968,119	\$10,402,102
Funded Ratio	124.58%	120.11%	117.95%

Table 4
Actuarial Gains and Losses*

(\$ Thousands)

	Actuarial Obligation	Actuarial Value of Assets	Unfunded Actuarial Obligation
Balance at June 30, 2017	\$ 10,402,102	\$ 12,269,382	\$ (1,867,280)
Expected Changes			
Actual Contributions/Normal Cost	282,377	282,377	0
Actual Benefits Paid	(419,088)	(419,088)	0
Expected Earnings / Credits	<u>723,362</u>	<u>854,072</u>	<u>(130,710)</u>
Expected Balance at June 30, 2018	\$ 10,988,753	\$ 12,986,743	\$ (1,997,990)
Actuarial Gains or Losses			
(Gain)/Loss on Actuarial Obligation	(414,477)		
Gain/(Loss) on Assets		186,779	
Net (Gain) or Loss on UAO	<u> </u>	<u> </u>	<u>(601,256)</u>
Actual Balance at June 30, 2018	\$ 10,574,276	\$ 13,173,522	\$ (2,599,246)

* Prior to Additional Earnings Credits.

Table 5
Gain and Loss Reserve

(\$ Thousands)

	June 30, 2018		June 30, 2017
	Without Additional Credits	With Additional Credits Adopted	
Unfunded Actuarial Obligation or (Actuarial Surplus) (prior to any additional earnings credits)	\$ (2,599,246)	\$ (2,599,246)	\$ (2,224,206)
Additional Earnings Credits	<u>0</u>	<u>339,843</u>	<u>356,926</u>
Unfunded Actuarial Obligation or (Actuarial Surplus)	(2,599,246)	(2,205,403)	(1,867,280)
Gain and Loss Reserve			
Beginning of Year	\$ 1,867,280	\$ 1,867,280	\$ 1,138,739
Allocated to Funding	<u>731,966</u>	<u>338,123</u>	<u>728,511</u>
End of Year Gain and Loss Reserve	2,599,246	2,205,403	1,867,280
Unallocated Gains and (Losses)	\$ 0	\$ 0	\$ 0

(\$ Thousands)

Valuation Date	Available Reserves and Unallocated Gains (Losses)	Additional Credits Adopted	Final Gain and Loss Reserve
June 30, 2005	\$ 266,978	\$ 0	\$ 266,978
June 30, 2006	423,269	88,201	335,068
June 30, 2007	954,762	195,223	759,539
June 30, 2008	8,769	0	8,769
June 30, 2009	(1,453,334)	0	(1,453,334)
June 30, 2010	(1,044,262)	0	(1,044,262)
June 30, 2011	281,195	0	281,195
June 30, 2012	50,527	0	50,527
June 30, 2013	788,028	295,872	492,156
June 30, 2014	1,820,201	347,846	1,472,355
June 30, 2015	1,711,825	324,216	1,387,609
June 30, 2016	1,138,769	0	1,138,769
June 30, 2017	2,224,206	356,926	1,867,280
June 30, 2018	2,599,246	339,843	2,205,403

This work product was prepared solely for CalSTRS for the purposes described herein and may not be appropriate to use for other purposes. Milliman does not intend to benefit and assumes no duty or liability to other parties who receive this work. Milliman recommends that third parties be aided by their own actuary or other qualified professional when reviewing the Milliman work product.

Table 6
Additional Credits Based on Board Policy

	June 30, 2018	June 30, 2017
Funded Ratio before Additional Credits	124.58%	122.14%
Actuarial Surplus	24.58%	22.14%
First Threshold	15.00%	15.00%
Second Threshold	30.00%	30.00%
First Allocation		
Long-term Net Investment Return	7.00%	7.00%
Minimum Interest Rate (MIR) (year prior to valuation)	<u>2.64</u>	<u>2.88</u>
Maximum Available in First Allocation (1)	4.36%	4.12%
First Threshold (1 x Std. Deviation of Portfolio Return)	15.00	15.00
Maximum credit such that resulting Funded Ratio is not less than 100% + Std. Deviation (2)	9.75%*	7.20%*
First Allocation [lesser of (1) and (2)]	4.36%	4.12%
<i>* The result is not a simple subtraction of the Actuarial Surplus and the First Threshold, because the maximum credit is determined based on a division of the Actuarial Value of Assets and the Actuarial Obligation with the First Allocation.</i>		
Second Allocation		
Remaining Actuarial Surplus after First Allocation	\$2,205,403	\$1,867,280
Total Actuarial Obligation after First Allocation	\$10,968,119	\$10,402,102
Remaining Actuarial Surplus % (3)	20.11%	17.95%
Second Threshold (2 x Std. Deviation of Portfolio Return) (4)	30.00%	30.00%
Target Second Threshold Surplus [Average of (3) and (4), but not less than Second Threshold]	30.00%	30.00%
Maximum Credit to meet Target Surplus	\$0	\$0
Non-Retired Actuarial Obligation	\$9,033,106	\$8,663,244
Available for Second Allocation	0.00%	0.00%
Additional Earnings Credits based on Board Policy		
As a percentage of Actuarial Obligation (actives and inactive only) as of the valuation date	4.36%	4.12%
As a dollar amount (\$ Thousands)	\$393,843	\$356,926

Table 7
History of Cash Flow

(\$ Thousands)

Year End	Contributions for the Year	Expenditures During the Year				External Cash Flow	Fair Market Value of Assets
		Benefit Payments	Contribution Refunds	Expenses	Total		
2002	\$ 487,185	\$ 0	\$ 4,982	\$ 255	\$ 5,237	\$ 481,948	\$ 660,148
2003	604,853	0	17,102	580	17,682	587,171	1,311,269
2004	691,081	41,991	3,078	1,206	46,275	644,806	2,203,682
2005	669,706	75,426	8,599	1,740	85,765	583,941	3,023,177
2006	703,104	97,997	14,032	1,952	113,981	589,123	3,951,327
2007	749,844	97,221	18,026	2,464	117,711	632,133	5,381,585
2008	802,380	139,435	17,716	2,903	160,054	642,326	5,636,113
2009	822,010	156,458	29,823	3,385	189,666	632,344	5,145,981
2010	796,743	223,733	13,673	6,113	243,519	553,224	6,412,180
2011	410,820	249,949	25,956	6,140	282,045	128,775	8,054,962
2012	102,570	223,411	24,436	6,886	254,733	(152,163)	8,042,090
2013	160,771	279,284	25,131	7,568	311,983	(151,212)	8,983,919
2014	159,663	300,031	23,960	8,385	332,376	(172,713)	10,493,062
2015	216,128	300,058	19,473	8,145	327,676	(111,548)	10,940,917
2016	251,393	332,845	19,761	11,243	363,849	(112,456)	10,943,296
2017	263,200	383,828	20,909	11,680	416,417	(153,217)	12,269,382
2018	282,377	397,635	21,453	12,007	431,095	(148,718)	13,173,522

Table 8
Schedule of Funding Progress

(\$ Thousands)

Year End	Actuarial Value of Assets	Actuarial Accrued Liability	Unfunded Actuarial Accrued Liability	Funded Ratio Assets/AAL	Estimated Covered Payroll	Coverage Ratio UAAL/Pay
2002	\$ 660,148	\$ 711,440	\$ 51,292	93%	\$ 21,732,000	0%
2003	1,311,269	1,358,635	47,366	97%	22,654,000	0%
2004	2,203,682	2,035,052	(168,630)	108%	22,589,000	(1)%
2005	3,023,177	2,756,199	(266,978)	110%	23,257,000	(1)%
2006	3,951,327	3,616,259	(335,068)	109%	24,240,000	(1)%
2007	5,381,585	4,622,046	(759,539)	116%	25,906,000	(3)%
2008	5,636,113	5,627,344	(8,769)	100%	27,118,000	0%
2009	5,145,981	6,599,315	1,453,334	78%	27,327,000	5%
2010	6,412,180	7,456,442	1,044,262	86%	26,274,000	4%
2011	8,054,962	7,773,767	(281,195)	104%	25,536,000	(1)%
2012	8,042,090	7,991,563	(50,527)	100%	25,091,000	(0)%
2013	8,983,919	8,491,763	(492,156)	106%	24,994,000	(2)%
2014	10,493,062	9,020,707	(1,472,355)	116%	25,805,000	(6)%
2015	10,940,917	9,553,308	(1,387,609)	115%	27,143,000	(5)%
2016	10,943,296	9,804,527	(1,138,769)	112%	28,788,000*	(4)%
2017	12,269,382	10,402,102	(1,867,280)	118%	29,971,000*	(6)%
2018**	13,173,522	10,968,119	(2,205,403)	120%	30,650,000*	(7)%

* Covered payroll estimated for active members with a non-zero DBS account.

** Results include Additional Earnings Credits adopted at the May 2019 Teachers' Retirement Board meeting.

Table 9
Reconciliation of Changes in Unfunded Actuarial Obligation

(\$ Thousands)

Year End	Beginning of Year UAO	Expected Earnings/ Credits	(G)/L on Actuarial Obligation	(G)/L on Assets	Additional Credits	End of Year UAO
2011	\$ 1,044,262	\$ 75,709	\$ (363,073)*	\$ (1,038,093)	\$ 0	(281,195)
2012	(281,195)	(21,089)	(214,512)	466,269	0	(50,527)
2013	(50,527)	(3,789)	(246,009)	(487,703)	295,872	(492,156)
2014	(492,156)	(36,912)	(285,294)	(1,005,839)	347,846	(1,472,355)
2015	(1,472,355)	(110,427)	(360,887)	231,844	324,216	(1,387,609)
2016	(1,387,609)	(104,070)	(360,271)*	713,181	0	(1,138,769)
2017	(1,138,769)	(82,561)	(323,511)*	(679,365)	356,926	(1,867,280)
2018**	(1,867,280)	(130,710)	(414,477)	(186,779)	393,843	(2,205,403)

* Includes impact of changes in assumptions.

** Results include Additional Earnings Credits adopted at the May 2019 Teachers' Retirement Board meeting.

Table 10
Changes in Economic Assumptions

Year	Price Inflation	Wage Inflation	Investment Return
2011	3.00%	3.75%	7.50%
2012	3.00%	3.75%	7.50%
2013	3.00%	3.75%	7.50%
2014	3.00%	3.75%	7.50%
2015	3.00%	3.75%	7.50%
2016	2.75%	3.50%	7.25%
2017	2.75%	3.50%	7.00%
2018	2.75%	3.50%	7.00%

Table 11
Smoothing and Volatility Ratios

Year	Asset Smoothing Ratio AVA/MVA	Asset Volatility Ratio MVA/Payroll	Liability Volatility Ratio AAL/Payroll
2002	100%	3.0%	3.3%
2003	100%	5.8%	6.0%
2004	100%	9.8%	9.0%
2005	100%	13.0%	11.9%
2006	100%	16.3%	14.9%
2007	100%	20.8%	17.8%
2008	100%	20.8%	20.8%
2009	100%	18.8%	24.1%
2010	100%	24.4%	28.4%
2011	100%	31.5%	30.4%
2012	100%	32.1%	31.9%
2013	100%	35.9%	34.0%
2014	100%	40.7%	35.0%
2015	100%	40.3%	35.2%
2016	100%	38.0%	34.1%
2017	100%	40.9%	34.7%
2018*	100%	43.0%	35.8%

** Results include Additional Earnings Credits adopted at the May 2019 Teachers' Retirement Board meeting.*

Appendix A Provisions of Governing Law

All of the actuarial calculations contained in this report are based upon our understanding of the Defined Benefit Supplement (DBS) Program of the State Teachers' Retirement Plan as contained in Part 13 of the California Education Code. The provisions used in this valuation are summarized below for reference purposes.

Membership

Eligibility Requirement: All members of the Defined Benefit Program who perform creditable service and earn creditable compensation after December 31, 2000.

Member: An eligible employee with creditable service subject to coverage in the DBS Program.

Account Balance

Account Balance: Nominal accounts established for the purpose of determining benefits payable to the Member. Accounts are credited with Contributions, a Minimum Interest Rate (MIR) and Additional Earnings Credits.

Contributions: One-quarter (2% of compensation) of the DB Program Member contributions on creditable compensation was allocated to the Member's DBS Account through December 31, 2010.

Member and employer contributions will be credited to the Member's DBS Account for creditable compensation that is not credited to the DB Program.

Minimum Interest Rate: Annual rate determined for the plan year by the board in accordance with federal laws and regulations. The MIR is equal to the average of the yields on 30-year Treasuries for the 12 months ending in February preceding the beginning of the plan year, rounded to the next highest 0.01%.

Additional Earnings Credits: Annual rate determined for the plan year by the board pursuant to earnings credit policy adopted at the April 2015 meeting.

Additional Annuity Credit: No longer applies, per the board annuity credit policy adopted at the April 2015 meeting.

Normal Retirement

Eligibility Requirement: Receipt of a corresponding benefit under the DB Program.

Benefit: The DBS Account Balance at the benefit effective date subject to limits imposed under Internal Revenue Code Section 415.

Form of Payment: The normal form of payment is a lump sum distribution. Annuity options are available if the DBS Account equals or exceeds \$3,500.

Early Retirement

Eligibility Requirement: Same as Normal Retirement.

Benefit and Form: Same as Normal Retirement.

Late Retirement

Benefit and Form: Same as Normal Retirement.

Contributions and earnings continue to be credited to the Account Balances until distributed.

Deferred Retirement

Benefit: A Member must receive a DBS benefit when the corresponding benefit is received under the DB Program.

Disability Benefit

Eligibility Requirement: Receipt of a corresponding benefit under the DB Program.

Benefit: The DBS Account Balance at the date the disability benefit becomes payable. An annuity benefit is discontinued upon the termination of the corresponding DB Program benefit.

Form of Payment: Same as Normal Retirement.

Death before Retirement

Eligibility Requirement: Deceased Member has a DBS Account Balance.

Benefit: The DBS Account Balance at the date of death, plus minimum interest credited through the date of payment, payable to the designated beneficiary.

Form of Payment: Same as Normal Retirement, except annuity options are limited to a Period Certain Annuity.

Death after Retirement

Eligibility Requirement: The deceased Member was receiving an annuity.

Benefit: According to the terms of the annuity elected by the Member.

Termination from the Program

Eligibility Requirement: Termination of all CalSTRS-covered employment.

Benefit: Lump-sum distribution of the DBS Account Balance as of the date of distribution. The benefit is payable six months from the termination of creditable service.

Appendix B Actuarial Methods and Assumptions

This section of the report discloses the actuarial methods and assumptions used in this Actuarial Valuation. These methods and assumptions have been chosen on the basis of recent experience of the DBS Program and on current expectations as to future economic conditions. The assumptions were reviewed and changed for the June 30, 2016 Actuarial Valuation as a result of the 2016 Experience Analysis. Please refer to that Experience Analysis report dated December 30, 2016 for the data and rationale used in the selection and recommendation of each assumption.

The assumptions are intended to estimate the future experience of the members of the DBS Program and of the DBS Program itself in areas that affect the projected benefit flow and anticipated investment earnings. Any variations in future experience from that expected from these assumptions will result in corresponding changes in estimated costs of the DBS Program's benefits.

Actuarial Cost Method

The accruing costs of all benefits are measured by the Traditional Unit Credit Actuarial Cost Method. Under this method, the projected benefits of each individual member are allocated by a consistent formula to valuation years. The actuarial present value of future projected benefits allocated to the current year is called the Normal Cost. The actuarial present value of future projected benefits allocated to periods prior to the valuation year is called the Actuarial Obligation.

The Actuarial Obligation is equal to the accumulated account balances and the Normal Cost is equal to the total annual contribution.

Asset Valuation Method

The assets are valued at Fair Market Value.

Actuarial Assumptions

The Actuarial Standards Board has adopted Actuarial Standard of Practice No. 27, *Selection of Economic Assumptions for Measuring Pension Obligations*. This Standard provides guidance on selecting economic assumptions under defined benefit retirement programs such as the System. In our opinion, the economic assumptions have been developed in accordance with the Standard.

The Actuarial Standards Board has adopted Actuarial Standard of Practice No. 35, *Selection of Demographic and Other Noneconomic Assumptions for Measuring Pension Obligations*. This Standard provides guidance on selecting demographic assumptions under defined benefit retirement programs such as the System. In our opinion, the demographic assumptions have been developed in accordance with the Standard.

The assumptions are intended to estimate the future experience of the members of the DBS Program and of the System itself in areas that affect the projected benefit flow and anticipated investment earnings. Any variations in future experience from that expected from these assumptions will result in corresponding changes in estimated costs of the Program's benefits.

The demographic assumptions are listed in **Table B.1** and illustrated at selected ages and duration combinations in **Table B.2**.

Table B.1
List of Major Valuation Assumptions

Economic Assumptions

A.	Investment Return (net of investment and administrative expenses)	7.00%
B.	Interest on Member Accounts	7.00%
C.	Wage Growth	3.50%
D.	Inflation	2.75%
E.	Standard Deviation of Portfolio	15.00%

Demographic Assumptions

A.	Mortality ⁽¹⁾		
	Retired & Beneficiary	- Male - Female	2016 CalSTRS Retired Male 2016 CalSTRS Retired Female Table B.2 Table B.2
	Disabled	- Male - Female	RP-2014 Disabled Retiree Male set back 2 years Table B.2 RP-2014 Disabled Retiree Female set back 2 years Table B.2 (select rates in first three years for both Males and Females)

1. All tables use 110% of the MP-2016 Ultimate Projection Scale. The combined base tables and projection scale specified contain a margin for expected future mortality improvement.

Note: Assumptions for active and inactive members do not apply to the DBS Program valuation, as each active and inactive member's liabilities are equal to the member's account balance.

Table B.2
Mortality as of June 30, 2018

Age	Retired Members and Beneficiaries ⁽¹⁾		Disabled Members (After Year 3) ⁽¹⁾	
	Male	Female	Male	Female
50	0.238%	0.132%	1.827%	1.032%
55	0.350	0.208	2.125	1.291
60	0.469	0.277	2.410	1.524
65	0.667	0.418	2.805	1.820
70	1.068	0.689	3.478	2.363
75	1.915	1.266	4.586	3.363
80	3.514	2.428	6.349	4.981
85	6.756	4.842	9.223	7.401
90	13.026	9.847	13.983	10.932
95	22.246	18.442	20.892	16.170
Select rates for disability:				
	First year of disability		4.0%	3.0%
	Second year of disability		3.5	2.5
	Third year of disability		3.0	2.0

1. The mortality assumption uses a generational mortality approach with a base year of 2016. Projected improvement is based on 110% of the MP-2016 Ultimate Projection Scale. The rates shown reflect mortality improvement through June 30, 2018. The projection scale does not apply to the select minimum rates.

Appendix C Valuation Data

The membership data for this actuarial valuation was supplied by CalSTRS. Although we did not audit this data, we compared the data for this and the prior valuation and tested for reasonableness, as well as for consistency with prior periodic reports from the CalSTRS staff. Based on these tests, we believe the data to be sufficiently accurate for the purposes of this valuation. Since the valuation results are dependent on the integrity of the data supplied, the results can be expected to differ if the underlying data is incomplete or missing. It should be noted that if any data or other information is materially inaccurate or incomplete, our calculations may need to be revised.

Tables C.1 through **C.4** summarize the census data used in this valuation.

Table C.1
Summary of Statistical Information

	June 30, 2018	June 30, 2017
Number of Members⁽¹⁾		
Active Members	449,595	445,935
Inactive Members	133,413	131,823
Annuitants	<u>67,918</u>	<u>63,416</u>
Total Membership in Valuation	650,926	641,174
Active Members Statistics⁽¹⁾		
Earned Salaries (\$ millions)	\$ 31,884	\$ 31,136
Average Salary	\$ 70,918	\$ 69,822
Average Age	45.2 years	45.3 years
Average Service	12.1 years	12.1 years

1. Active member statistics include all active members in the DB Program, as they are eligible to participate in the DBS Program. Inactive and annuitant counts only include those with non-zero DBS Program account balances and monthly benefits, respectively.

Table C.2
Age and Service Distribution – All Active Members

Total						
Age	Years of Service					
	1 & Under	Greater than 1				
		& Under 5	5-9	10-14	15-19	20-24
Less than 25	5,325	1,950	2			
25 to 30	11,662	24,069	2,879			
30 to 35	6,495	20,895	17,477	3,223	2	
35 to 40	5,065	13,669	15,539	23,778	3,677	3
40 to 45	3,901	9,864	9,957	18,131	23,847	3,186
45 to 50	3,198	7,909	7,828	11,843	19,548	18,855
50 to 55	2,196	5,655	5,580	7,978	11,600	13,451
55 to 60	1,703	4,260	4,210	6,298	8,940	9,189
60 to 65	973	2,806	2,828	4,135	5,833	5,727
65 to 70	536	1,408	1,332	1,601	2,244	2,043
70 and over	310	842	712	658	707	556
Age Unknown	-	-	-	-	-	-
Total	41,364	93,327	68,344	77,645	76,398	53,010

Age	Years of Service					Total
	25-29	30-34	35-39	40-44	45 & Over	
Less than 25						7,277
25 to 30						38,610
30 to 35						48,092
35 to 40						61,731
40 to 45	5					68,891
45 to 50	1,253	3				70,437
50 to 55	9,432	969	3			56,864
55 to 60	8,663	6,639	512	4		50,418
60 to 65	4,314	2,754	1,440	71		30,881
65 to 70	1,236	632	326	209	21	11,588
70 and over	392	266	143	99	121	4,806
Age Unknown	-	-	-	-	-	-
Total	25,295	11,263	2,424	383	142	449,595

**Table C.3
 Inactive Members**

Fiscal Year Ending June 30	Number	Account Balances⁽¹⁾
2008	89,201	\$200,750,000
2009	99,654	249,838,000
2010	112,556	303,047,000
2011	121,653	356,289,000
2012	127,763	403,271,000
2013	130,776	444,279,000
2014	129,961	468,268,000
2015	129,698	496,059,000
2016	130,456	525,465,000
2017	131,823	551,790,000
2018	133,413	576,987,000

1. Does not include Additional Earnings Credits.

**Table C.4
 Annuitants**

Fiscal Year Ending June 30	Number	Accounts at Retirement
2008	17,8971	\$ 206,275,000
2009	23,002	312,732,000
2010	30,028	472,547,000
2011	36,066	627,629,000
2012	41,991	783,543,000
2013	46,927	926,192,000
2014	50,852	1,042,152,000
2015	54,742	1,163,868,000
2016	58,880	1,305,902,000
2017	63,416	1,472,730,000
2018	67,918	1,641,958,000

Appendix D Glossary

The following definitions are largely excerpts from a list adopted by the major actuarial organizations in the United States. In some cases, the definitions have been modified for specific applicability to the CalSTRS DBS Program. Defined terms are capitalized throughout this Appendix.

Account Balance

The nominal account amount of an individual's benefit as of a specific date, determined in accordance with the terms of the Plan. The Account Balance is accumulated with contributions and interest.

Actuarial Assumptions

Assumptions as to the occurrence of future events affecting pension costs, such as mortality, withdrawal, disablement and retirement, changes in compensation, rates of investment earnings and asset appreciation or depreciation, and procedures used to determine other relevant items.

Actuarial Cost Method

A procedure for determining the Actuarial Present Value of pension plan benefits and expenses and for developing an actuarially equivalent allocation of such value to time periods, usually in the form of a Normal Cost and an Actuarial Obligation.

Actuarial Equivalent

Of equal Actuarial Present Value, determined as of a given date with each value based on the same set of Actuarial Assumptions.

Actuarial Gain or Loss

A measure of the difference between actual experience and that expected based upon a set of Actuarial Assumptions during the period between two actuarial valuation dates, as determined in accordance with a particular Actuarial Cost Method.

Actuarial Obligation

That portion, as determined by a particular Actuarial Cost Method, of the Actuarial Present Value of pension plan benefits and expenses which is not provided for by future Normal Costs.

Actuarial Present Value

The value of an amount or series of amounts payable or receivable at various times, determined as of a given date by the application of a particular set of Actuarial Assumptions.

Actuarial Surplus

The excess, if any, of the Actuarial Value of Assets over the Actuarial Obligation.

Actuarial Valuation

The determination, as of a Valuation Date, of the Normal Cost, Actuarial Obligation, Actuarial Value of Assets and related Actuarial Present Values for a pension plan.

Actuarial Value of Assets

The value of cash, investments and other property belonging to a pension plan, as used by the actuary for the purpose of an actuarial valuation.

Normal Cost

The Actuarial Present Value of benefits expected to accrue in the plan year subsequent to the valuation date. The Normal Cost is equivalent to the expected Member and Employer contributions for the next year.

Traditional Unit Credit Actuarial Cost Method

A method under which the Actuarial Obligation is equal to the Actuarial Present Value of benefits for service accrued to the valuation date.

Unfunded Actuarial Obligation

The excess, if any, of the Actuarial Obligation over the Actuarial Value of Assets.

Valuation Date

June 30, 2018.