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California State Teachers' Retirement System

Experience Analysis
July 1, 2010 – June 30, 2015

February 2017 Meeting

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Teachers' Retirement Board
California State Teachers' Retirement System

Dear Members of the Board:

It is a pleasure to submit this report of our investigation of the experience of the California State Teachers' Retirement System (CalSTRS) for the period July 1, 2010 through June 30, 2015. The results of this investigation are the basis for the actuarial assumptions and methods to be used in the actuarial valuations to be performed as of June 30, 2016.

The actuarial valuations as of June 30, 2016 will become the cornerstone for analyzing the funding status of the System's Defined Benefit (DB) Program, Defined Benefit Supplement (DBS) Program, and the Cash Balance Benefit (CBB) Program. The new assumptions will also be used for the June 30, 2017 actuarial projection of the Supplemental Benefit Maintenance Account (SBMA) and June 30, 2016 valuation of the Medicare Premium Payment (MPP) Program.

The purpose of this report is to communicate the results of our review of the actuarial methods and the economic and demographic assumptions to be used in the completion of the upcoming valuations. Several of our recommendations represent changes from the prior methods or assumptions and are designed to better anticipate the emerging experience of CalSTRS.

We have provided financial information showing the estimated impact of the recommended assumptions, as if they had been reflected in the June 30, 2015 actuarial valuation. We believe the recommended assumptions provide a reasonable estimate of anticipated experience affecting CalSTRS. Nevertheless, the emerging costs will vary from those presented in this report to the extent that actual experience differs from that projected by the actuarial assumptions. Future actuarial measurements may differ significantly from the current measurements presented in this report due to factors such as the following:

- Plan experience differing from the actuarial assumptions,
- Future changes in the actuarial assumptions,
- Increases or decreases expected as part of the natural operation of the methodology used for these measurements (such as potential additional contribution requirements due to changes in the plan's funded status), and
- Changes in the plan provisions or accounting standards.

Due to the scope of this assignment, we did not perform an analysis of the potential range of such measurements.

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, after discussion with CalSTRS and certain adjustments, we have found the data to be reasonably consistent and comparable with data used for other purposes. Since the experience study 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 inaccurate or incomplete, our determinations might need to be revised.

This investigation of experience report recommends assumptions to be used in the valuation to provide an estimate of the System's financial condition as of a single date. The valuation can neither predict the System's future condition nor guarantee future financial soundness. Actuarial valuations do not affect the ultimate cost of System benefits, only the timing of System contributions. While the valuation is based on an array of individually reasonable assumptions, other assumption sets may also be reasonable and valuation results based on those assumptions would be different. No one set of assumptions is uniquely correct. Determining results using alternative assumptions is outside the scope of our engagement.

Milliman's work is prepared solely for the internal business use of CalSTRS. To the extent that Milliman's work is not subject to disclosure under applicable public records laws, Milliman's work may not be provided to third parties without Milliman's prior written consent. Milliman does not intend to benefit or create a legal duty to any third party recipient of its work product. Milliman's consent to release its work product to any third party may be conditioned on the third party signing a Release, subject to the following exceptions:

(a) The System may provide a copy of Milliman's work, in its entirety, to the System's professional service advisors who are subject to a duty of confidentiality and who agree to not use Milliman's work for any purpose other than to benefit the System.

(b) The System 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 pension 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.

We would like to acknowledge the help in the preparation of the data for this investigation given by the CalSTRS staff. We look forward to our discussions and the opportunity to respond to your questions and comments at your next meeting.

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.

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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.

Respectfully submitted,

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Section 1:   Executive Summary

Any actuarial valuation is based on certain underlying assumptions. The results of the actuarial valuation, including the determination of the sufficiency of the contributions being made by members, employers, and the state, are highly dependent on the assumptions that the actuary uses to project the future benefit payments and then to discount the future benefits to determine the present values. Thus, the assumptions are critical in assisting the system in adequately monitoring the funding of the promised benefits.

Overview

To ensure the on-going reasonableness of the assumptions used in the valuation, they should be studied regularly. This process is called an experience analysis (or experience study).

Summary of Results

This section describes the key findings of this experience analysis of the California State Teachers' Retirement System (CalSTRS) for the period July 1, 2010 through June 30, 2015. Note that because 2016 valuation data was not available when the experience study commenced, we have performed a five-year study ending in 2015.

We are recommending several changes to the demographic assumptions, as well as certain changes to the economic assumptions. Throughout this report, we will refer to our recommended assumptions as the "proposed" assumptions and the current assumptions as the "expected" assumptions.

Following are the three significant changes that we are recommending, with the first two having the greatest expected impact.

- **Investment Return Assumption:** Based on CalSTRS capital market assumptions and our recommended 2.75% inflation assumption, we believe there is slightly less than a 50% probability that the current return assumption for the DB Program (7.50%) will be met over the long term. We are recommending a decrease in this assumption to 7.25%.

- **Mortality Assumption:** We are recommending changes in the mortality assumptions to reflect recent experience and expected future improvements in mortality. In particular, we are recommending a generational mortality assumption. Generational mortality explicitly recognizes that mortality rates are expected to gradually decline in the future. The overall impact of this change is an increase in life expectancies.

- **Wage Growth Assumption:** We are recommending a decrease in the general wage growth assumptions (from 3.75% to 3.50%) to reflect recent experience and lower future expectations. This assumption will also be used to project payroll in the future.

All other recommended changes are expected to have lesser impacts on the funded status of the system.

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Summary of Results (continued)

If adopted, the new assumptions would result in a decrease in the Funded Ratio and an increase in the Projected Level Funding Rate needed, as compared to the current assumptions. This is discussed further in the Financial Impact section at the end of the Executive Summary.

Summary of Recommend Changes (Economic)

The following table shows a summary of our recommendations for the economic assumptions.

	DB Program		CBB / DBS Programs	
	Current	**Recommended**	**Current**	**Recommended**
Consumer Price Inflation	3.00 %	**2.75** %	3.00 %	**2.75** %
Net Real Rate of Return	4.50	4.50	4.00/4.50	4.00/4.50
Investment Return [1]	7.50 %	**7.25** %	7.00/7.50 %	**6.75/7.25** %
Interest on Member Accounts	4.50 %	**3.00** %	7.00/7.50 %	**6.75/7.25** %
Consumer Price Inflation	3.00 %	**2.75** %	n/a	n/a
Real Wage Inflation	0.75	0.75	n/a	n/a
Wage Growth [2]	3.75 %	**3.50** %	n/a	n/a
Portfolio Standard Deviation	N/A %	N/A %	13.90/13.20 %	**15.00/13.00** %

1. Net of investment and administrative expenses.
2. Payroll growth is assumed to equal wage growth (See Payroll Increase discussion).

Summary of Recommend Changes (Demographic)

The following table shows a summary of our recommendations for the demographic assumptions (i.e., those relating to member behavior).

Demographic Assumption	Recommended Changes
Mortality	
Healthy Retired Members	Increase Life Expectancy
Beneficiaries	Increase Life Expectancy
Disabled Members	Increase Life Expectancy
Active Members	Increase Life Expectancy
Service Retirement	
Retirement from Active Membership	Small Increase Overall
	Add Assumption for 2% @ 62 Members
Retirement from Vested Membership	Increase Age to 62 for 2% @ 62 Members
Disability	
Coverage A	Lower Rates
Coverage B	No Change
Other Terminations of Membership	
Termination	Increases < 10 yrs / Decreases > 10 yrs
Probability of Refund	Reduce for 5-10 years of service
Salary Increases for Merit	Small Increases and Decreases
Miscellaneous Assumptions	
Load for Sick Leave Service	Reduction
Probability of Marriage	Small Reduction
Number of Children	No Change
Offsets for Death & Disability	No Offsets Assumed
Valuation of Current Inactive Members	Explicitly Value Deferred Benefit
Split between 1990 and New Benefits for Current Retirees	Estimate based on Retirement Year

Summary of Recommend Changes (Demographic) (continued)	All assumptions recommended for the DB Program are also recommended to be used for the June 30, 2017 actuarial projection of the Supplemental Benefit Maintenance Account (SBMA) and the June 30, 2016 valuation of the Medicare Premium Payment (MPP) Program. Additional economic and demographic assumptions unique to the MPP Program will be developed in conjunction with the actuarial valuation.
Economic Assumptions	Section 2 discusses the economic assumptions: price inflation, general wage growth (includes price inflation and productivity), payroll growth, interest credit on member accounts, and the investment return assumption. We have recommended changes to the current economic assumptions, with the most significant of these being a reduction in the investment return assumption for the DB Program.
	As discussed in Section 2, price inflation historically has averaged higher than the current 3.00% assumption; however, experience over the last twenty years and forecasts for future inflation are lower. We are recommending the assumption be lowered from 3.00% to 2.75%.
	We are recommending a decrease in the general wage growth assumption (from 3.75% to 3.50%) consistent with our recommended reduction in price inflation. Over the last 50 years, wages have exceeded price inflation by 0.6%. We are recommending the difference between wage growth and inflation remain at 0.75%, resulting in a total general wage growth assumption of 3.50%. This assumption will also be used to project future payroll.
	Based on CalSTRS' current capital market assumptions and target asset allocation, the current 7.50% investment return assumption (net of administrative expenses) for the DB Program slightly exceeds the expected median long-term return. As discussed in more detail in Section 2, lower expected price inflation also argues for a lower expected return. Therefore, we are recommending a reduction in this assumption to 7.25%. As previously noted, this has the most significant impact of all our recommendations. We are also recommending the DBS Program assumption continue to be set equal to the DB Program (7.25%) since the DBS Program assets are invested similarly to the DB Program. For the CBB Program, we are recommending the assumption be set to 6.75% (0.50% less than the DB Program) due to the different asset mix.
	Note that our conclusion that the recommended investment return assumption, and the alternates discussed, are reasonable is based on the advice of experts, in this case the capital market assumptions adopted by CalSTRS based on advice from their investment staff and consultants.
	We are recommending a decrease in the interest assumed to be credited to members' accounts in the DB Program (from 4.50% to 3.00%). Since 2004, the actual return on two-year treasuries (which the interest rate is based on) has averaged less than price inflation. Therefore, we are recommending a reduction in the assumed interest credit so that it is closer to the price inflation assumption.

Economic Assumptions (continued)	For the CBB and DBS Programs, we recommend retaining the current practice of setting the assumed interest credit on member accounts equal to the investment return assumption, as the intention is to allocate all investment earnings to the member accounts over the long term.
	Under board policy, the calculation of the additional earnings credits for the CBB and DBS Programs is based on the funded ratio of the respective program and certain thresholds. These thresholds are based on the standard deviation of the program's portfolio and are reviewed with the experience study. We recommend the assumed standard deviation be set equal to 15.0% for the DBS Program (previously 13.9%) and 13.0% for the CBB Program (previously 13.2%). Note that the standard deviation of the DBS Program reflects the impact of the SBMA interest credit guarantee, as discussed at the end of Section 2.
Actuarial Methods and Miscellaneous Assumptions	Section 3 discusses the actuarial methods and other miscellaneous assumptions used in the valuation and administration of the system.
	We are recommending changes in this area as follows:

- **Sick Leave** – Reduction in the additional sick leave members are assumed to have at retirement.

- **Probability of Eligible Survivor** – Reduction in the probability an active member will have an eligible survivor to 85% of males (from 90%) and 65% of females (from 70%).

- **Benefit Offsets** – Assume no offsets for other public benefits expected to be paid to future survivors and disabilities.

- **Option Factors** – Update the assumed adjustments to the valuation mortality tables for Options 2 and 6.

- **Valuation of Inactive Members** – Explicitly value the deferred service retirement benefit for inactive members by estimating the compensation amount (which is not provided on the valuation data). Previously, the actuarial obligations for inactive members was estimated by applying a load to the member contributions.

- **1990 Benefits for Retirees** – To split the retiree benefits between 1990 benefits and new benefits, the difference between the one-year and three-year final compensation is estimated. We are recommending the estimate be made based on actual salaries by year of retirement. Currently, a flat adjustment is made for all years.

Demographic Assumptions	Sections 4-10 discuss the demographic assumptions. Unlike the economic assumptions, which are more global in nature, the demographic assumptions are based heavily on recent CalSTRS experience. Demographic assumptions are used to predict future member behavior (e.g., when will the member retire? how long will the member live?).
	From a cost perspective, the most significant change to the demographic assumptions that we are recommending is the strengthening of the mortality assumption (i.e., increased life expectancies).

Demographic Assumptions (continued)	When reviewing the sections on demographic assumptions, please note the following:

- Our analysis uses the Actual-to-Expected (A/E) ratio to measure how well the current assumptions fit actual experience. For example, if the service retirement A/E is 80%, it indicates that there were 20% fewer actual service retirements than expected, and that we should consider decreasing the assumption. By decreasing the expected rates, the result is a higher ratio, in this case closer to 100%.

- When we refer to the "proposed" assumptions, these are the assumptions that we are recommending. The current assumptions are also referred to as the "expected" assumptions.

- For many of the assumptions, we show graphs of our analysis displaying the actual experience for the study (blue bar), the actual experience from the prior study (green bar), the current assumption (dark red line), and the new proposed assumption (orange line).

The recommended rates are shown in detail in Appendix A.

Individual Salary Increases due to Promotion and Longevity (Merit)	Section 4 discusses the individual salary increases due to promotion and longevity – the merit component of salaries. Overall, the results of our last two salary studies show increases have been close to the current rates predicted (as shown in the following graph). We are recommending small changes to this assumption to better fit the actual pattern, primarily increases in the 5-to-15 years of service range. See Section 4 for more details on this analysis.

Salary Increases Less Wage Inflation -- All Members
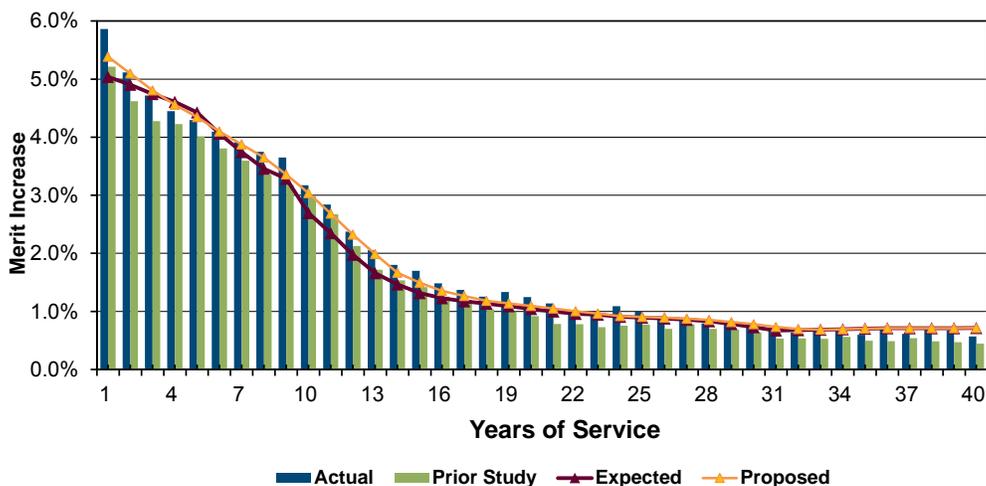
Mortality after Retirement

The mortality assumption is used to predict the life expectancy of both members currently in pay status and those expected to receive a benefit in the future. We are recommending small changes in the mortality assumptions that predict how long members are currently living. We are also recommending the addition of a projection scale that reflects the gradual year-to-year improvement in mortality that is expected to occur in the future. This approach is sometimes referred to as "generational mortality" because it assumes that succeeding generations of members will live longer than the preceding generations. Overall, the new mortality assumption will result in an increase in life expectancy compared to the prior assumption. This is partly due to the modified approach, but it is primarily due to adjustments we made to reflect the lower mortality observed over the recent study period. Additional details are provided in Section 5.

The following table shows that the recommended mortality tables project that members retiring in the next year will live approximately the same number of years as are projected by the current assumptions.

Expected Lifetime for Future Retirees (Retiring in 2016)				
	Males		Females	
	Current	Proposed	Current	Proposed
Age at Retirement	62.0	62.0	62.0	62.0
Expected Future Lifetime	25.9	25.6	27.9	28.3
Expected Age at Death	87.9	87.6	89.9	90.3

For members early in their career who will not be retiring for a number of years, the expectation is that they will live two to three years longer than is projected by the current assumptions. Note that this generation of members (those retiring 30 years from now) is expected to live significantly longer than the prior generation (those retiring in the current year) due to the projection of mortality improvement for an additional 30 years under the generational mortality approach.

Expected Lifetime for Future Retirees (Retiring in 2046)				
	Males		Females	
	Current	Proposed	Current	Proposed
Age at Retirement	62.0	62.0	62.0	62.0
Expected Future Lifetime	25.9	28.2	27.9	30.7
Expected Age at Death	87.9	90.2	89.9	92.7

Service Retirement

Overall, the number of service retirements from active status was close to what the assumptions predicted, although there were some differences in the various service groups. In particular, members with between 25 and 30 years of service retired at a higher rate than expected during the period.

We are recommending some modifications in the service retirement rates for 2% at 60 members to reflect actual experience. In particular, we have proposed raising the rates for 25 to 30 years of service and slightly reducing the rates at 30 or more years of service.

Service Retirement (continued)

We have also recommended separate service retirement rates for the 2% at 62 members. These rates are slightly lower overall than the rates for the 2% at 60 members and reflect an expected later retirement age for 2% at 62 members due to the maximum benefit percentage being at an older age. Note that there is no service retirement experience for these members, since they are a relatively new group.

The table below illustrates the actual number of service retirements, along with the expected number based on the proposed assumptions, for males and females combined.

Number of Service Retirements (2% at 60) -- Proposed			
	Actual	**Proposed**	**Actual / Proposed**
Less than 25 Years of Service	26,363	26,948	98%
25 to 30 Years of Service	9,319	8,816	106%
30 Years or More of Service	19,435	20,780	94%
Total	55,117	56,544	97%

Further analysis is shown in Section 7 of this report.

Disability Retirement

Overall, the actual number (2,448) of disability retirements was slightly lower than what the assumptions predicted (2,659). We are recommending reduced rates of disability retirement for Coverage A and no changes to Coverage B. Further analysis is shown in Section 8 of this report.

Other Terminations of Employment

The actual rates of termination were lower than the assumptions predicted, primarily early in a member's career; therefore, we are recommending reductions in these rates. Additionally, we have proposed higher rates later in a member's career. This is illustrated in the following graph, which shows rates of termination by years of service for females. Note that the shift in the termination rate pattern between the prior and current studies is primarily due to a change in methodology we use to account for rehires and is not representative of a shift in member behavior. Further analysis is shown in Section 9 of this report.

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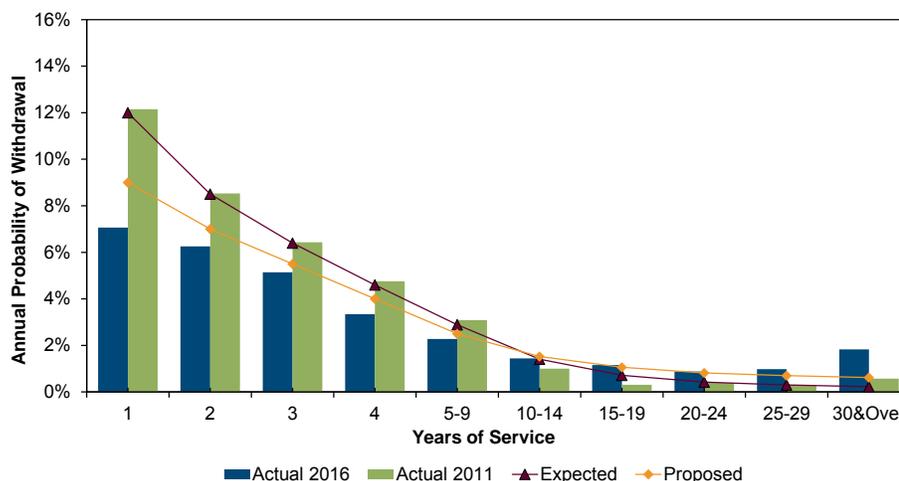
Probability of Refund upon Vested Termination

The actual number of refunds (6,594) paid to vested members at termination was greater than the assumptions predicted (5,551). We are recommending small increases in this assumption. The changes are for entry ages less than 40 and are primarily for service levels between five and ten years. The results based on the proposed assumptions are shown below. Further analysis is shown in Section 10 of this report.

Actual to Proposed Number of Refunds			
Gender	Actual	Proposed	Ratio
Males	2,140	2,141	100%
Females	4,454	4,266	104%
Total	6,594	6,407	103%

Financial Impact of the Recommended Assumptions (DB Program)

The following exhibit shows the expected financial impact the proposed changes would have on the funding of the DB Program. If the proposed changes are adopted, the total level funding rate needed would increase (relative to if the changes were not made). The Funded Ratio of the DB Program would decrease under the new assumptions.

The financial impact was evaluated by performing additional valuations with the June 30, 2015 valuation data and reflecting the proposed assumption changes. We then projected the results to June 30, 2016 with a 1.0% investment return for the fiscal year ended June 30, 2016. The actual financial impact will vary somewhat for the June 30, 2016 valuation due to year-to-year changes.

The 35.58% level funding rate needed represents an estimated 3.57% increase in the combined state and employer contribution rates that would be needed as of June 30, 2016 as compared to the prior assumptions. Additional projections are shown at the end of this section.

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Financial Impact of the Recommended Assumptions (DB Program) (continued)

As shown in the table, the proposed change in the economic assumption and the mortality change have the largest impact. The impact on the Normal Cost rate are shown separately for the 2% at 60 and 2% at 62 members. Note that the impact of the proposed mortality changes on the 2% at 62 members is greater because they are on average younger and therefore are expected to experience greater improvement in mortality than the 2% at 60 members. **All 2016 values are estimates.**

	Normal Cost %		Funded Ratio	Total Level Funding Rate Needed
	2% at 60	2% at 62		
June 30, 2015 Actuarial Valuation	**18.22%**	**15.61%**	**68.5%**	**31.15%**
Estimated Impact of 1% FYE2016 Return	0.00%	0.00%	-1.3%	0.86%
June 30, 2016 Actuarial Valuation (Est.)	**18.22%**	**15.61%**	**67.2%**	**32.01%**
Demographic Assumptions				
Termination Rate Changes	-0.11%	-0.07%	0.3%	-0.31%
Probability of Refund Changes	0.00%	0.01%	0.0%	0.00%
Service Retirement Rate Changes	0.11%	0.20%	-0.2%	0.25%
Disability Retirement Rate Changes	0.00%	0.00%	0.0%	0.00%
Merit Salary Rate Changes	0.25%	0.10%	0.0%	0.20%
Miscellaneous Assumption Changes[1]	-0.03%	-0.02%	0.1%	-0.07%
Mortality Rate Changes	0.39%	0.68%	-1.9%	1.87%
Inactive Member Valuation Changes	0.00%	0.00%	0.0%	0.01%
Demographic Subtotal	0.61%	0.90%	-1.7%	1.95%
Economic Assumptions				
Interest on Member Accounts (3.00%) Wage Inflation and Payroll Growth (3.50%) Consumer Price Inflation (2.75%) Investment Return (7.25%)	0.49%	0.40%	-1.6%	1.62%
Total Assumption Change	**1.10%**	**1.30%**	**-3.3%**	**3.57%**
June 30, 2016 Actuarial Valuation (Est.) with All Changes	**19.32%**	**16.91%**	**63.9%**	**35.58%**

1. Assumptions for number of children, eligible spouse, sick leave credit at retirement, and benefit offsets.

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Financial Impact – Alternative Investment Return Assumptions

Note that the recommended assumptions are not the only set of assumptions that would be considered reasonable. Within the parameters discussed in Section 2 (subsection "Possible Alternative Assumptions"), it would be reasonable for the board to select alternative economic assumptions. We have provided the estimated financial impact of two alternative investment return assumptions.

The table below shows the potential impact of a 7.00% investment return assumption.

	Normal Cost %		Funded Ratio	Total Level Funding Rate Needed
	2% at 60	2% at 62		
June 30, 2016 Actuarial Valuation (Est.)	**18.22%**	**15.61%**	**67.2%**	**32.01%**
Recommended Demographic Changes	0.61%	0.90%	-1.7%	1.95%
Economic Asssumptions with 7.00% Return	1.75%	1.47%	-3.6%	3.82%
June 30, 2016 Actuarial Valuation (Est.) (with assumption changes)	**20.58%**	**17.98%**	**61.9%**	**37.78%**

The table below shows the potential impact of a 7.50% investment return assumption.

	Normal Cost %		Funded Ratio	Total Level Funding Rate Needed
	2% at 60	2% at 62		
June 30, 2016 Actuarial Valuation (Est.)	**18.22%**	**15.61%**	**67.2%**	**32.01%**
Recommended Demographic Changes	0.61%	0.90%	-1.7%	1.95%
Economic Asssumptions with 7.50% Return	-0.73%	-0.68%	0.5%	-0.51%
June 30, 2016 Actuarial Valuation (Est.) (with assumption changes)	**18.10%**	**15.83%**	**66.0%**	**33.45%**

Financial Impact – Member Contribution Rates

Contribution rates for 2% at 60 members are based on a fixed schedule and are not impacted by the assumptions.

Contribution rates for 2% at 62 members are based on the group's Normal Cost rate and therefore may ultimately be impacted by the assumptions. In general, the rate is set equal to the base member contribution rate of one-half of the Normal Cost rate plus a fixed adjustment for the annual benefit adjustment. However, the base member contribution rate does not change if the increase or decrease in the Normal Cost rate for members is less than 1% of pay since the last adjustment.

Under the recommended assumptions, the Normal Cost rate for 2% at 62 members is 16.91% of pay. This compares to the rate at last adjustment of 15.90% of pay. Since the change is close to 1% of pay, it is possible that when the 2016 valuation is completed, the Normal Cost rate for 2% at 62 members may exceed 16.90% and we would therefore recommend an adjustment to the member rate. If this were to occur, we estimate that the increase would be in the neighborhood of 0.5% of pay.

Financial Impact – Member Contribution Rates (continued)	If the recommended assumptions were adopted but the investment return assumption were lowered to 7.00%, it would be almost certain that there would be an increase in the contribution rate for 2% at 62 members. If this were to occur, we estimate that the increase would be in the neighborhood of 1.0% of pay. Conversely if a 7.50% investment return assumption was adopted, we would not expect a change in the member rates would be needed.
Financial Impact – Projected 2046 Funding	The 2015 valuation showed the DB Program was projected to be fully funded by 2046 under the funding arrangement adopted in 2014. Applying the recommended assumptions to the 2015 valuation results in lower expected returns (due to the lower investment return assumption) and an increase in the time the expected benefits are to be paid (due to longer life expectancies). Under the recommended assumptions, the contributions to the DB Program are still projected to be sufficient to reach full funding by 2046; however, higher state and employer contribution rates (relative to those projected in the 2015 valuation report) would be required, with the increase primarily falling on the state.
	Under the 7.00% and 7.50% investment return assumption scenarios, the DB Program would also be projected to be approximately 100% funded in 2046. Increases in the state and employer contribution rates would also be expected but to varying degrees.
	The projection assumptions are the same as those stated on page 6 of our 2015 DB Program valuation report, except for the reflection of the assumptions recommended in this report and the inclusion of the estimated FYE2016 investment return of 1.0%.
Financial Impact – Projected State and Employer Contribution Rates	The financial analysis shown previously quantified the impact of the proposed assumptions on the contributions needed in total. The graph on the next page shows the projected impact on the total state contribution rate (excluding the SBMA contribution). The blue line shows the projected state contribution rate assuming no changes in assumptions, but reflecting the estimated 1.0% return for the prior fiscal year. The red line with red triangles shows the projected state contribution rate if the recommended demographic and economic changes are adopted.

Financial Impact –
Projected State and
Employer Contribution
Rates
(continued)

To provide an apples-to-apples comparison, we have shown the projections assuming a 7.25% return in each future year.

Projected State Contribution Rate (Excludes SBMA)
Reflects Market Value of Assets
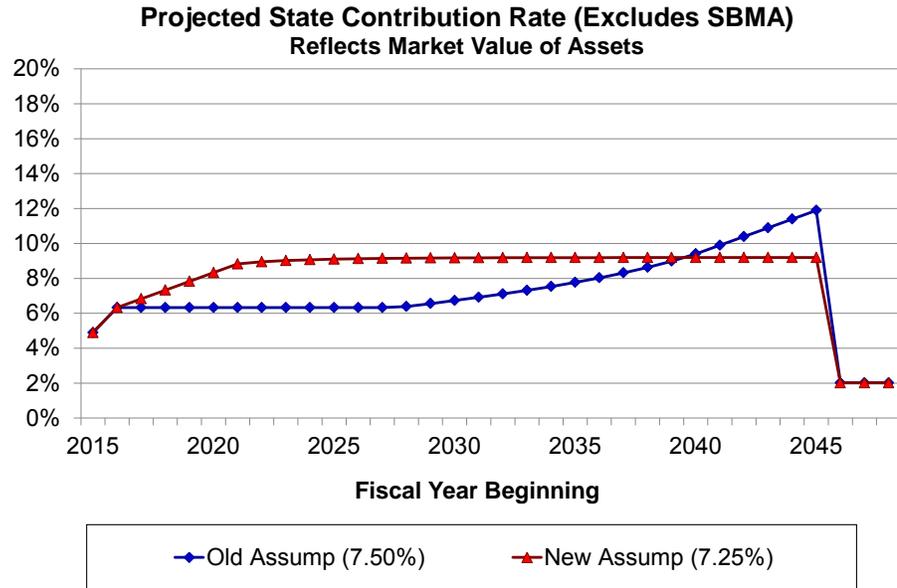
The graph below shows parallel information for the employer contribution rate. It shows an increase in the employer contribution rate under the new assumptions, but a much smaller increase than previously illustrated for the state.

Projected Total Employer Contribution Rate
Reflects Market Value of Assets

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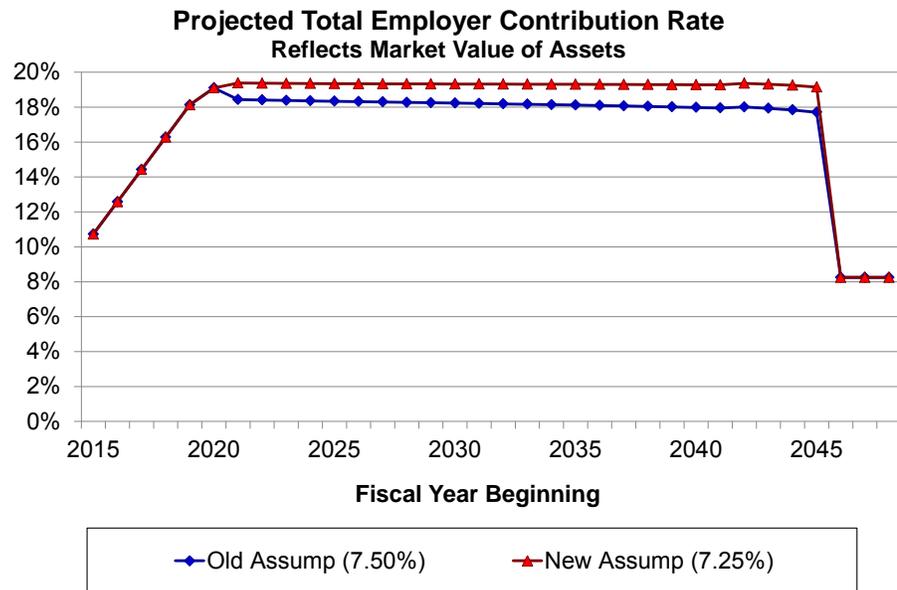
Financial Impact – Projected State and Employer Contribution Rates under Alternative Return Assumptions

The following two graphs repeat the graphs from the prior page but add two lines to show the projected contribution rates assuming all recommended demographic changes are adopted with an investment return assumption that is either 0.25% higher or lower than the recommended 7.25%. Once again, all of the scenarios illustrated assume that 7.25% is earned each year in the future, regardless of the assumed investment return for the particular scenario. The first graph shows that a lower investment return assumption causes the contribution rates to higher in the short term but lower in the long term. The converse is true if the return assumption is set higher.

Projected State Contribution Rate (Excludes SBMA)
Reflects Market Value of Assets

Legend:
- Old Assump
- New Assump (7.25%)
- New Assump (7.00%)
- New Assump (7.50%)
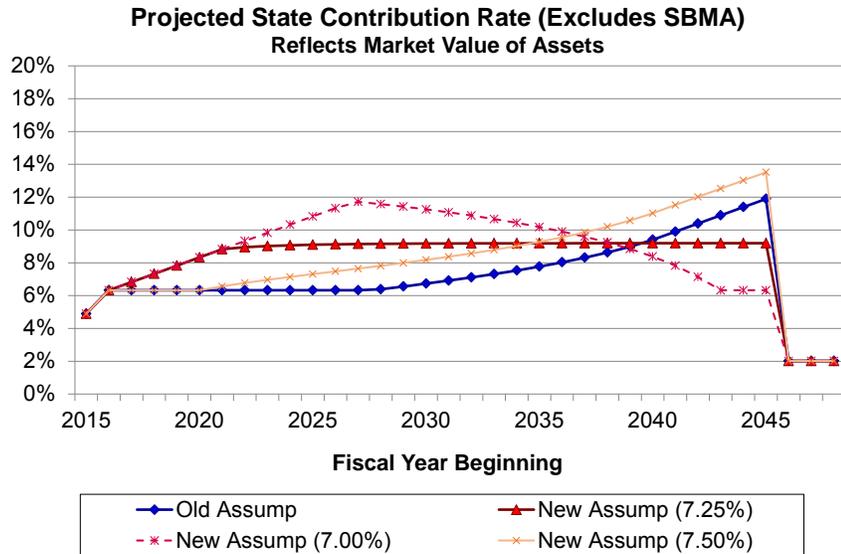
The graph below shows parallel information for the employer contribution rate. It shows a much smaller difference in the employer contribution rate under the alternate return assumptions than was shown above for the projected state contribution rate.

Projected Total Employer Contribution Rate
Reflects Market Value of Assets

Legend:
- Old Assump (7.50%)
- New Assump (7.25%)
- New Assump (7.00%)
- New Assump (7.50%)
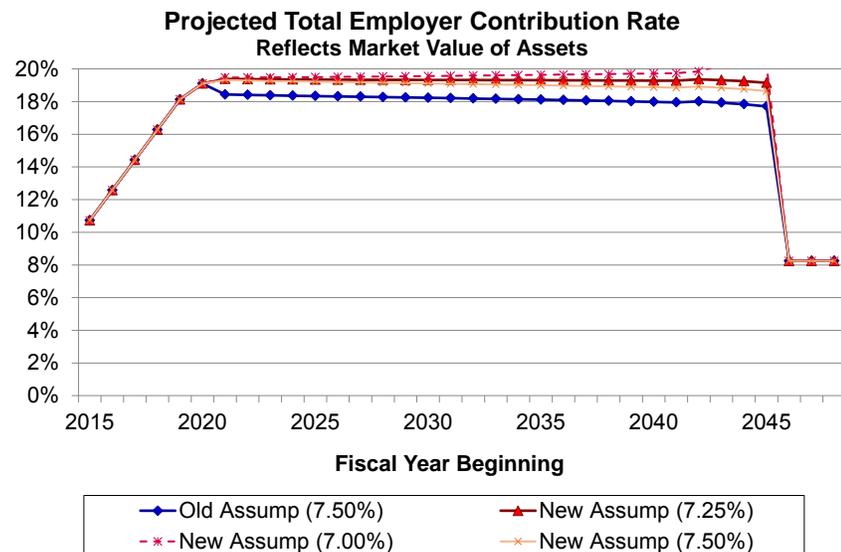
Financial Impact of the Recommended Assumptions (CBB and DBS Programs)

The following tables show the expected financial impact the proposed changes would have on the funded status of the CBB and DBS Programs. The proposed changes would have no impact on the obligation for active and inactive members of either plan, since these obligations are equal to the sum of the members' account balances.

There would be a small impact on the obligation for retirees due to the proposed changes in mortality and the investment return assumption. As the retiree obligation is only a small portion of the total obligation, the overall impact is very minor. Note that funded ratios shown are as of June 30, 2015. Values as of June 30, 2016 are expected to be a few percentage points less due to the actual return for the year ended June 30, 2016 being less than the interest credited to the accounts for the period.

CBB Program -- Financial Impact of Recommended Assumptions	
	Funded Ratio
June 30, 2015 Actuarial Valuation	**113.20%**
Mortality Rate Change	-0.05%
Investment Return Assumption 6.75%	-0.03%
June 30, 2015 Actuarial Valuation Changes	**113.12%**

DBS Program -- Financial Impact of Recommended Assumptions	
	Funded Ratio
June 30, 2015 Actuarial Valuation	**114.52%**
Mortality Rate Change	-0.23%
Investment Return Assumption 7.25%	-0.20%
June 30, 2015 Actuarial Valuation Changes	**114.09%**

Financial Impact of the Recommended Assumptions (SBMA)

The funding of the SBMA is currently projected to be sufficient at the 85% purchasing power level. There is some margin for possible adverse experience in the future. For example, if inflation was slightly higher than assumed for the next few years, the current funding is still expected to provide the same level of benefits. The recommended assumptions would increase this margin, since the lower inflation assumption would project lower purchasing power benefits. This would be somewhat offset by the lower investment return assumption.

Revised Assumptions and Methods

Appendix A illustrates the Summary of Actuarial Assumptions as it will appear in the June 30, 2016 valuation report, if all recommended assumptions and methods are adopted. Proposed changes in assumptions are highlighted in yellow. The recommended assumptions are for use with CalSTRS funding calculations. Modifications to the assumptions to be used for the GASB 67/68 valuation will be addressed at a separate time.

Section 2:   Economic Assumptions

Actuarial Standard of Practice (ASOP) No. 27, *Selection of Economic Assumptions for Measuring Pension Obligations*, provides guidance to actuaries giving advice on selecting economic assumptions for measuring obligations under defined benefit plans. Because no one knows what the future holds, the best an actuary can do is to use professional judgment to estimate possible future economic outcomes. These estimates are based on a mixture of past experience, future expectations, and professional judgment. The actuary should consider a number of factors, including the purpose and nature of the measurement, and appropriate recent and long-term historical economic data. However, the standard explicitly advises the actuary not to give undue weight to recent experience.

Recent changes in ASOP No. 27 have restricted what assumptions satisfy the standard. In particular, previously any assumption within the "best-estimate" range (a wide range in our opinion) was likely to satisfy the standard. To meet the new standard, the assumption "reflects the actuary's estimate of future experience" and "it has no significant bias (i.e., it is not significantly optimistic or pessimistic)…" We believe this reduces the range of assumptions that would be considered reasonable.

Each economic assumption should individually satisfy this standard. Furthermore, with respect to any particular valuation, each economic assumption should be consistent with every other economic assumption over the measurement period.

After completing the selection process, the actuary should review the set of economic assumptions for consistency. This may lead the actuary to recommend the same inflation component in each of the economic assumptions proposed.

This section will discuss the economic assumptions. In our opinion, the economic assumptions recommended in this report have been developed in accordance with ASOP No. 27. The following table summarizes our recommendations (changes are shown in bold). Note that this is not the only set of assumptions that would be considered reasonable. In the prior section, we show the financial impact of the recommended economic assumptions, plus the impact of investment return assumptions that are either 0.25% higher or lower than the recommended 7.25% (for the DB Program).

	DB Program		CBB / DBS Programs	
	Current	Recommended	Current	Recommended
Consumer Price Inflation	3.00 %	**2.75** %	3.00 %	**2.75** %
Net Real Rate of Return	4.50	4.50	4.00/4.50	4.00/4.50
Investment Return [1]	7.50 %	**7.25** %	7.00/7.50 %	**6.75/7.25** %
Interest on Member Accounts	4.50 %	**3.00** %	7.00/7.50 %	**6.75/7.25** %
Consumer Price Inflation	3.00 %	**2.75** %	n/a	n/a
Real Wage Inflation	0.75	0.75	n/a	n/a
Wage Growth [2]	3.75 %	**3.50** %	n/a	n/a
Portfolio Standard Deviation	N/A %	N/A %	13.90/13.20 %	**15.80/13.00** %

1. *Net of investment and administrative expenses.*
2. *Payroll growth is assumed to equal wage growth (See Payroll Increase discussion).*

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1.   Price Inflation

Use in the Valuation

When we refer to inflation in this report, we are referring to price inflation. The inflation assumption has an indirect impact on the results of the actuarial valuation through the development of the assumptions for the investment return, the interest rate on member accounts, the general wage increases and the payroll increase assumption. It also has a direct impact on the actuarial projection of the SBMA, as it will be used to determine the expected future purchasing power payments.

The long-term relationship between inflation and investment return has long been recognized by economists. The basic principle is that the investors demand a "real return" – the excess of actual investment returns over inflation. If inflation rates are expected to be high, investors will demand investment returns that are also expected to be high enough to exceed inflation, while lower inflation rates will result in lower expected investment returns, at least in the long run.

The current valuation assumption for inflation is 3.00% per year. Our recommendation is to lower the assumption to 2.75%.

Historical Perspective

The data for inflation shown below is based on the national Consumer Price Index, US City Average, All Urban Consumers (CPI-U) as published by the Bureau of Labor Statistics.

Although economic activities in general, and inflation in particular, do not lend themselves to prediction on the basis of historical analysis, historical patterns and long term trends are a factor to be considered in developing the inflation assumption.

There are numerous ways to review historical data, with significantly differing results. The tables below show the compounded annual inflation rate for various 10-year periods, and for the 50-year period ended in December 2015. Note that the 50-year average is heavily influenced by the inflation of the late 1970's and early 1980's.

Decade	CPI Increase
2006-2015	1.9%
1996-2005	2.5%
1986-1995	3.5%
1976-1985	7.0%
1966-1975	5.7%
Prior 50 Years	
1966-2015	4.1%

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Historical Perspective (continued)

These are national statistics. The inflation assumption as it relates to the investment return assumption should be based more on national and even global inflation; whereas, the inflation assumption used in the SBMA projection and the wage growth and payroll growth assumptions for the DB Program is tied to inflation in California. We believe that although there have been historical differences between U.S. and California CPI changes, in the long term there should be a high correlation. For comparison, the average CPI increase for California has been 4.2% for the 50-year period 1966-2015, compared to the national average of 4.1%.

The following graph shows historical national CPI increases. Note that the actual CPI increase has generally been less than 3.00% during the most recent 25 years.

Historical CPI-U

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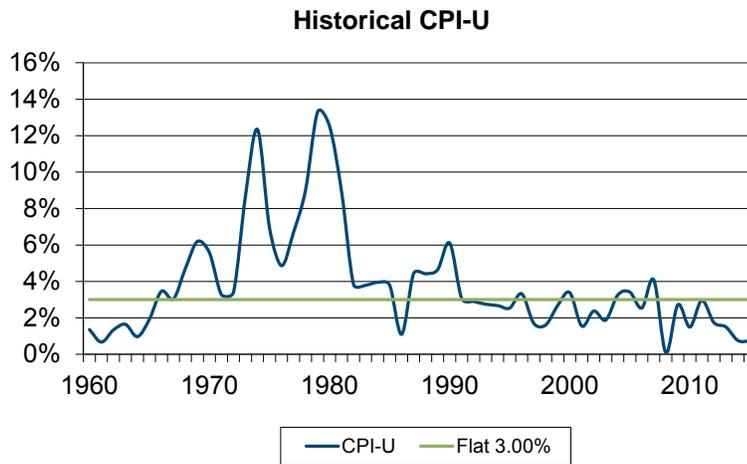
**Peer System
Comparison**

According to the Public Plans Database (a survey of over 150 state and local systems maintained by a collaboration between the Center for Retirement Research at Boston College, the Center for State and Local Government Excellence, and the National Association of State Retirement Administrators), the average inflation assumption for statewide systems has been steadily declining. As of the most recent study, the most common assumption is 3.00%, so CalSTRS is in the mainstream. However, it should be noted that the survey is based on valuations that are almost entirely from 2013 or 2014, and we believe that further declines have occurred since then. The following graph shows this distribution.

**Price Inflation Assumption
Public Plans Database**

Percent of Retirement Systems Using Assumption
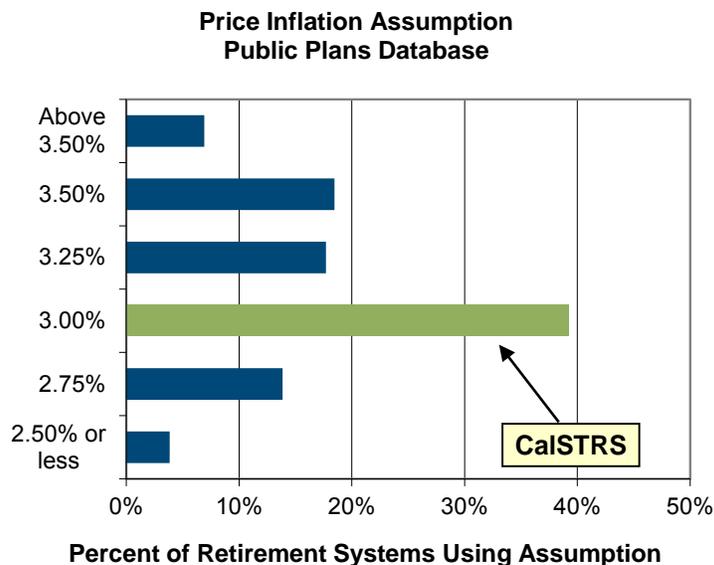
Forecasts of Inflation

Since the U.S. Treasury started issuing inflation indexed bonds, it is possible to determine the approximate rate of inflation anticipated by the financial markets by comparing the yields on inflation indexed bonds with traditional fixed government bonds. Current market prices as of December 2016 suggest investors expect inflation to be about 2.1% over the next 30 years.

CalSTRS' investment consultants also have lower expectations of inflation, with Meketa projecting 2.1% over the next 10 years and PCA projecting 2.5% over the next 20 years.

Additionally, we reviewed the expected increase in the CPI by the Office of the Chief Actuary for the Social Security Administration. In the 2016 Trustees Report, the projected average annual increase in the CPI over the next 75 years under the intermediate cost assumptions was 2.60%.

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Recommendation

The consumer price inflation assumption does not directly impact the funding of the DB Program; however, it is used to determine the sufficiency of the SBMA funding to pay purchasing power benefits. It is also used in the determination of the investment return assumption, the assumed interest credit to member accounts, and the wage growth assumption.

We recommend the long-term assumed inflation rate be decreased to 2.75% per year to reflect lower forecasts.

Consumer Price Inflation	
Current Assumption	3.00%
Recommended Assumption	2.75%

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2. Wage Growth

Use in the Valuation

Estimates of future salaries are based on two assumptions: 1) general wage increases and 2) merit increases. Rates of increase in the general wage level of the membership are directly related to inflation, while individual salary increases due to promotion and longevity occur even in the absence of inflation. The promotion and longevity assumptions, referred to as the merit scale, will be reviewed with the other demographic assumptions.

The current assumption is for wage growth to be 0.75% above the inflation assumption.

Historical Perspective

We have used statistics from the Social Security Administration on the National Average Wage dating from 1966 to 2015.

There are numerous ways to review this data. For consistency with our observations of other indices, the table below shows the compounded annual rates of wage growth for various 10-year periods and for the 50-year period ending in 2015. The excess of wage growth over price inflation represents "productivity" (or the increase in the standard of living, also called the real wage inflation rate).

Decade	Wage Growth	CPI Increase	Real Wage Inflation
2006-2015	2.4%	1.9%	0.5%
1996-2005	4.1%	2.5%	1.6%
1986-1995	3.9%	3.5%	0.4%
1976-1985	6.9%	7.0%	-0.1%
1966-1975	6.4%	5.7%	0.7%
Prior 50 Years			
1966-2015	4.7%	4.1%	0.6%

These are national statistics for all jobs. For comparison, the average increase in the real wage for members of CalSTRS has been 0.3% for the most recent 30-year period. This is significantly less than the national average which increased 0.9% more than inflation over the last 30 years.

Forecasts of Future Wages

Wage inflation has been projected by the Office of the Chief Actuary of the Social Security Administration. In the 2016 Trustees Report, the ultimate long-term annual increase in the National Average Wage is estimated to be 1.2% higher than the Social Security intermediate inflation assumption of 2.7% per year.

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Reasonable Range and Recommendation

Over the last 50 years, the actual experience, on a national basis, has been close to the current assumption. We believe that wages will continue to grow at a greater rate than prices over the long term, although not to the extent projected by Social Security. We are recommending that the long-term assumed real wage inflation rate remain at 0.75% per year.

Real Wage Inflation Rate	
Current Assumption	0.75%
Recommended Assumption	0.75%

The wage growth assumption is the total of the consumer price inflation assumption and the real wage inflation rate. If the real wage inflation assumption remains at 0.75% and the price inflation assumption decreases to 2.75%, this would result in a total wage growth assumption of 3.50%.

Payroll Increase Assumption

The aggregate payroll of CalSTRS is expected to increase, without accounting for the possibility of an increase in membership (our current and recommended assumption is that no growth in membership will occur). Note that we believe the zero population growth is a reasonable assumption. Although we do not have projections of active teacher population, the California Department of Finance publishes a projection of school age children on their website. This projects a relatively stable student population over the next 10 years, with an average annual decrease of less than 0.04% per year. Given that there is a correlation between the number of students and the number of teachers, we believe this supports the zero growth assumption for the number of active teachers.

The current payroll increase assumption is equal to the general wage growth assumption of 3.75%. It is our recommendation to set these two assumptions to be equal, unless there is a specific circumstance that would call for an alternative assumption. In the case of CalSTRS, members hired in 2013 and later are subject to a more restrictive definition of creditable compensation and therefore are expected to have slightly lower pay than comparable members hired prior to 2013. Based on our analysis, this is expected to reduce future payroll by about 0.02% per year. We believe this difference is not material, and we are not recommending any adjustment to the payroll increase adjustment to account for the new creditable compensation definition.

We are recommending that the payroll increase assumption be reduced to 3.50% to continue to be consistent with the general wage growth assumption. Note that if CalSTRS was closed to new teachers, that event would significantly impact this assumption.

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3. Investment Return

Use in the Valuation

The investment return assumption is one of the primary determinants in the calculation of the expected cost of the System's benefits, providing a discount of the future benefit payments that reflects the time value of money. This assumption has a direct impact on the calculation of liabilities, normal costs, and the factors for optional forms of benefits. The current investment return assumption for the CalSTRS DB and DBS Programs is 7.50% per year, net of administrative and investment-related expenses. For the CBB Program, the assumed return is 7.00%. Our recommendation is to decrease both assumptions by 0.25%.

Expected Long-Term Investment Return

We have determined the expected long-term investment return. As input, we have used the CalSTRS capital market assumptions (from Item 7 of the June 2015 Investment Committee meeting) and CalSTRS' target asset allocation (adopted at the November 2015 regular board meeting). CalSTRS' target asset allocation is summarized in the following table:

	Target Allocation	
	DB & DBS	CBB[1]
Global Equity	47 %	64 %
Private Equity	13	0
Real Estate	13	0
Inflation Sensitive	4	5
Risk Mitigation Strategies	9	10
Fixed Income	12	18
Cash	2	3
Total	100 %	100 %

1. CBB assets are not separately invested and receive earnings based on the total plan assets excluding real estate and private equity. This is Milliman's estimate of the effective CBB allocation.

Note that the actual composition of the Risk Mitigating Strategies (RMS) asset class has not yet been determined. For purposes of this analysis, we have used the RMS allocation shown in Meketa's memorandum for the November, 2015 Investment Committee meeting (see INV99 of item 10). We also modeled various alternative compositions of the RMS asset class and found the impact was fairly small, ranging from a decrease of 0.1% to an increase of 0.1% in the expected return, as compared to the target allocation used in our analysis.

Combining the capital market assumptions with the target asset allocation policy, we calculate the long-term (20 years) expected rate of return to be 7.47% (7.37% after adjusting for administrative expenses, which are discussed later). This expected return is the median return on a geometric basis for all State Teachers' Retirement Plan (STRP) assets and compares to the median compounded return of 7.4% reported by Meketa and PCA in their November, 2015 board presentation.

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Capital Market Assumptions

The capital market assumptions used in our analysis are from Agenda Item 7 (pages INV28-INV30) of the June 2015 Investment Committee meeting. They do not exactly map one-to-one to the target asset allocation, as some of the asset classes from the capital market assumptions are subclasses of those listed in the target allocation. We used a similar breakdown of asset allocation as that reported by Meketa in their memorandum for the November 2015 Investment Committee meeting (see INV99 of item 10). The allocation used is shown below:

	Allocation	Expected Return[1]	Standard Deviation
US Equity	24%	7.3 %	18.5 %
Non-US Equity	23	7.4	21.0
Private Equity	13	9.2	25.0
TIPS	1	2.7	7.3
Investment Grade Bonds	11	3.1	6.0
Cash[2]	2	2.0	1.0
High Yield Bonds	1	5.3	13.8
Private Real Estate	13	7.4	18.0
Infrastructure	3	7.0	14.0
Global Macro	1	5.7	7.0
CTA (Trend Following)	4	5.5	17.0
Systematic Risk Premia	1	5.2	14.0
Long Treasury	3	3.1	18.0
Total	100 %		

1. 20-year geometric average.
2. Used Milliman capital market assumptions for cash.

Impact of Lower Assumed Inflation on Expected Long-Term Investment Return

The CalSTRS capital market assumptions are based on the price inflation assumption of 3.0% used in the most recent valuation. Using a lower inflation assumption, as we are recommending, would result in lower capital market assumptions and a lower expected return. Inflation has a high correlation with bond yields, so lower expected inflation will generally correlate with lower bond yields in the long term. This may be somewhat offset by increased values of existing bonds when inflation decreases, making existing yields more attractive. In total, we would expect a 0.25% decrease in the inflation component of the capital market assumptions would result in a decrease in expected bond returns, but somewhat less than 0.25%.

Additionally, there is a correlation between inflation and equity returns. Investors expect a risk premium (the excess over the risk-free rate of return that an investment is expected to yield) when purchasing equities or other risky investments. To the extent the risk-free rate is low, which is correlated with low inflation, the price of the equity will decline, assuming the risk premium does not change.

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Investment and Administrative Expenses

The investment return used for the valuation is assumed to be net of all investment and administrative expenses. It is our understanding that CalSTRS' capital market assumptions are effectively net of investment expenses (except for some small indexing fees), so we only adjust for administrative expenses. The following table shows the ratio of total administrative expenses to the fair market value of CalSTRS assets over the last 10 fiscal years ending June 30. The expense ratio is calculated as the total administrative expense divided by the ending asset balance at fair market value.

($million) FYB	Market Assets	Admin. Expense	Expense Ratio
2006	$ 144,212	106	0.07%
2007	172,378	109	0.06
2008	161,498	113	0.07
2009	118,430	140	0.12
2010	129,768	110	0.08
2011	155,346	138	0.09
2012	151,318	137	0.09
2013	166,349	154	0.09
2014	190,312	145	0.08
2015	191,822	180	0.09

The ratio of administrative expenses to market assets has averaged close to 0.10% over the period shown. This amount does not have a direct impact on the actuarial valuation results, but it does provide a measure of the return on investments that will be needed to meet the actuarial assumption used for the valuation. For example, if the investment return assumption is set equal to 7.50%, then CalSTRS would need to earn a return on its assets, net of investment expenses, of about 7.60% in order to net the current 7.50% assumed return for funding purposes. It will also impact the discount rate used in the GASB 67/68 Financial Reporting Valuation, since GASB requires the discount rate to be gross of administrative expenses.

Peer System Comparison

According to the *Public Fund Survey*, the average investment return assumption for statewide systems has been steadily declining. As of the most recent study, the median rate is 7.50%. The following chart shows a progression of the distribution of the investment return assumptions. In 2001, very few systems had an assumption of 7.5% or lower and over 80% had an assumption of 8.0% or greater. As of fiscal year 2016, over 50% have an assumption of 7.5% or less and this is continuing to trend down.

Public Fund Survey, NASRA Jul-16
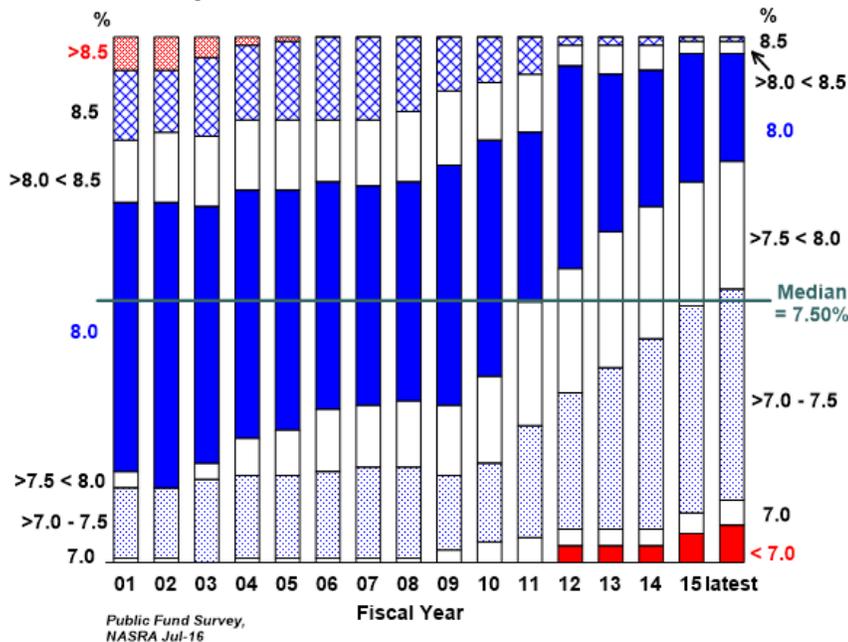
Capital Market Assumptions Relative to Others

As noted, our analysis of the expected return has been based on the CalSTRS capital market assumptions. Although we believe these are reasonable, it should be noted that there is currently a fair amount of variation among investment professionals. For example, the expected 30-year return based on Milliman's capital market assumptions is less than 7.0%; however, it should be noted that Milliman's capital market assumptions are based on a lower inflation assumption than the proposed assumption of 2.75%. The lower underlying inflation assumption will tend to lead to a lower expected return.

Impact on Contribution Rates and Funding

Under current law, a change in the investment return assumption (or almost any assumption) can impact the contribution rates paid by the 2% at 62 members, the employers and the state. The financial impact of the recommended changes in assumptions is shown at the end of the Executive Summary.

One feature of CalSTRS' funding is that the changes in the state contribution rate are not symmetrical. That is, increases in any year are limited to 0.50% of the applicable payroll, but there is no limit to decreases, except that the state supplemental rate cannot go below 4.311% of pay until the 1990 UAO is paid off. This means that if the assumptions understate the future costs, it may take a long time for future adjustments to reach the appropriate actuarial level.

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Expected Return for the CBB Program	The assets of the CBB Program are a subset of the STRP assets; however, the return credited to the CBB Program assets is based on a different allocation that excludes the private equity and real estate asset classes. Currently, the investment return assumption for this program is 0.5% less than the DB Program to account for this.
	We performed similar modeling for the allocation of the CBB Program and found that the expected return is 0.6% less than that for the DB Program. Therefore, we believe that continuing the assumption that the CBB Program return is 0.5% less than the DB Program is reasonable.
Additional Impact of Change	The investment return assumption also impacts the following:

- **Optional Forms of Payment**: CalSTRS members may elect to receive their DB Program benefit in several forms. The member's unmodified benefit amount is reduced to reflect the actual form of payment elected based on the investment return assumption and mortality rates used. Lowering the investment return assumption used in this calculation will tend to increase the expected cost of the optional form of payment and will therefore result in a slightly greater reduction in the benefit amount (all other things being equal).

- **Service Purchase Costs**: CalSTRS members may purchase service under certain circumstances. Some of these service purchases base the cost on the investment return assumption. If the actual rate of return earned in the long term is less than the investment return assumption used in the service purchase cost calculation, the system will have charged the member less than the true cost, and the employer will ultimately have to make up this shortfall. Conversely, if the actual rate of return earned in the long term is greater than the investment return assumption, the system will have charged the member more than the full cost, and the employer will have to contribute less in the future.

- **Interest Credited to SBMA**: As previously noted, the DB Program investment return assumption will be used to credit interest to the SBMA.

Possible Alternative Assumptions	Based on this analysis, our recommendation is to lower the investment return assumption by 0.25%; however, it is not the only assumption that the board could adopt that we would consider reasonable. In the prior section, we have shown the financial impact of the two alternative investment return assumptions discussed below.
	We also believe it would be reasonable to lower the investment return an additional 0.25% (0.50% total reduction). The argument for doing this is that although we may expect a 7.25% return over the next 20 years, the general consensus is that returns in the next 10 years are expected to be lower. As much as any of these projections are certain, the board may want to give a greater weight to the near term, since the board may feel that it has a higher likelihood of being realized than the higher returns expected after 10 years. Additionally, bond yields have declined since June 2015 when the CalSTRS capital market assumptions were established.

Possible Alternative Assumptions (continued)

Alternatively, the board could elect to make no change in the investment return assumption. The argument for keeping the assumption is that although the expected returns over the next 20 years are projected to be slightly less than the current assumption, funding a retirement system entails an even longer time horizon. For example, CalSTRS' time horizon to pay off the UAO is 30 years as of 2016. Further, the investment consultants that we work with that have capital market assumptions with a 30-year horizon are generally projecting higher returns than over shorter periods.

Conclusion

Based on portfolio analysis, the current 7.50% investment return assumption for the DB and DBS Programs is fractionally greater than the expected long-term median return (net of administrative expenses), based on CalSTRS' capital market assumptions. In other words, over a 30-year period there is a 47% probability of achieving a 7.5% return, after adjusting for all expenses, based on the CalSTRS capital market assumptions (prior to any potential adjustment for the proposed reduction in the price inflation assumption). We are recommending a reduction in this assumption to 7.25% to reflect the fractionally lower expectation, as well as the lower recommended inflation assumption. For the CBB Program, we are recommending a reduction to 6.75% due to the different asset mix.

Investment Return (net of all expenses)		
	DB & DBS	**CBB**
Current Assumption	7.50%	7.00%
Recommended Assumption	7.25%	6.75%

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4. Interest on Member Accounts

Use in the Valuation

This assumption is used to predict the level of future member account balances. In the DB Program, the account balance may be refunded upon termination of membership. In the CBB and DBS Programs, all benefits are dependent on the level of the account balance.

The current assumption is 4.50% per year for the DB Program. For the CBB and DBS Programs, the assumed interest credit is set equal to the investment return assumption.

DB Program

The board's policy is to credit interest to member accounts in an amount to be calculated annually based on the rate paid on two-year Treasury notes for the previous 12 months. The rate can go no higher than the actuarial assumed investment return, nor lower than a current passbook rate.

In light of this policy, the actuarial assumption in the valuation has been set equal to the assumed increase in the Consumer Price Index plus a margin to reflect the yield in excess of inflation on two-year Treasuries. The following table shows the average excess yield of two-year Treasuries over inflation since 1999.

Excess Yield over Inflation on 2-Year Treasuries			
Year	CPI	2-Year Treasury Rate	Excess
1999	1.6%	5.0%	3.4%
2000	3.2	5.7	2.5
2001	3.5	6.0	2.5
2002	1.1	3.5	2.4
2003	3.0	2.4	(0.6)
2004	1.7	1.8	0.1
2005	3.0	2.6	(0.4)
2006	3.6	4.1	0.5
2007	2.4	5.0	2.6
2008	4.0	3.9	(0.1)
2009	0.2	1.8	1.6
2010	2.1	0.9	(1.2)
2011	2.1	0.7	(1.4)
2012	2.9	0.3	(2.6)
2013	2.0	0.3	(1.7)
2014	1.1	0.3	(0.8)
2015	0.0	0.7	0.7
2016	1.0	0.8	(0.2)

As shown in the table, since 2003 the excess has been negative in many years as the average increase in the two-year Treasury rate has been less than inflation. For the four years prior to that, the average excess of the two-year Treasury rate over the CPI was 2.9%. We are recommending a partial reflection of the recent experience, so that the assumption decreases to 3.00%, which is 0.25% above the recommended inflation assumption.

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CBB and DBS Programs

For the CBB and DBS Programs, the board's policy is to credit interest to member accounts based on the statutory minimum rate for the year, plus a portion of the returns in excess of the statutory minimum. The board has the authority to establish a reserve for short-term fluctuations in the actual returns from year to year so that the minimum credit can be allocated from current invested assets. Nevertheless, the long-term intention is to allocate all of the investment earnings to the member accounts. Therefore, the assumed long-term credit to member accounts should be the same as the recommended investment return assumption for the DBS Program (7.25% per year) and the CBB Program (6.75% per year).

Recommendation

Our recommended assumptions are shown in the following table.

Interest on Member Accounts		
	DB	**CBB and DBS**
Current Assumption	4.50%	7.50% (DBS)
		7.00% (CBB)
Recommended Assumption	3.00%	7.25% (DBS)
		6.75% (CBB)

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5.   CBB and DBS Program Standard Deviation

Use in the Valuation

The standard deviation is not directly used in the valuation, but it is used in the determination of additional earnings credits.

CBB and DBS Programs Standard Deviation

Under board policy, the additional earnings credits for the CBB and DBS Programs are based on the funded ratio of the respective program and certain thresholds. These thresholds are based on the standard deviation of the program's portfolio.

The analysis so far has focused on the expected return for the STRP assets. However, the DB and DBS Program assets are only a portion of the total STRP assets. A growing portion of the STRP assets is attributable to the SBMA. In 2007, the SBMA represented only 2% of the total STRP assets. This percentage has grown to over 6% in 2015, and we project it will increase to around 15% over the next 30 years.

By law, the SBMA is guaranteed a return equal to the valuation assumption, so the SBMA portion of the STRP assets will experience no volatility return. Consequently, the rest of the assets will have higher return volatility than the total STRP assets.

We used stochastically generated returns based on the total asset allocation to estimate the impact of the SBMA guarantee on the volatility of the remainder of the assets. In comparing the assets excluding the SBMA to the total STRP assets, we found an increase in volatility as measured by the standard deviation (13.0% to 15.0%).

As previously discussed in the investment return section, the CBB Program assets are based on a separate allocation. We estimate that the standard deviation of the CBB Program allocation is 13.0%. Note that our understanding is that the CBB Program return is not affected by the return credited to the SBMA.

Recommendation

Our recommended assumptions are shown in the following table.

Standard Deviation for Additional Earnings Credits		
	DBS	**CBB**
Current Assumption	13.9%	13.2%
Recommended Assumption	15.0%	13.0%

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Section 3: Actuarial Methods and Miscellaneous Assumptions

As part of the current experience analysis, we have reviewed the valuation methods and other issues related to the actuarial assumptions. This section contains a discussion of actuarial cost methods, the valuation of assets, and other miscellaneous assumptions used in the valuation.

Actuarial Cost Method

DB Program

The cost method used for the DB Program valuation is referred to as the Entry Age Normal Cost Method (except where noted below). Under this method, the actuarial present value of projected benefits for each individual member included in the valuation is allocated on a level basis over the earnings of the individual between entry age (equal to age at membership date) and assumed exit ages. The portion of this actuarial present value allocated to the valuation year is called the Normal Cost; the portion of the actuarial present value not provided for at a valuation date by the actuarial present value of future Normal Costs is called the Actuarial Obligation.

The Entry Age Normal Cost Method with projected benefits allocated over earnings (often referred to as "Level Percent of Pay") is by far the most common cost method among public sector pension plans. The advantage to using this method is that the cost over time tends to remain fairly level as a percentage of overall payroll, all else being equal. This is well-suited to most public systems, which tend to contribute as a percentage of pay, and which benefit from a stable contribution rate for budgeting and planning purposes.

We believe that the Entry Age Normal Cost Method continues to be the most reasonable choice for the DB Program, and recommend no change.

CBB and DBS Programs

The cost method used for the CBB and DBS Program valuations is referred to as the Traditional Unit Credit Cost Method. Under this method, the projected benefits of each individual member are allocated by a consistent formula to valuation years. When the Traditional Unit Credit Method is applied to the CBB and DBS Programs, the result is that the Actuarial Obligation is equal to the accumulated account balances, and the Normal Cost is equal to the total annual contribution.

We believe that the Traditional Unit Credit Cost Method continues to be the most reasonable method for the valuation of the CBB and DBS Programs. In particular, if another cost method were used, then the situation could arise where the assets for either program were exactly equal to the associated accumulated account balances, and yet the Funded Ratio for the given program would be different from 100%. We believe such a situation would cause unnecessary confusion. We recommend no change to the cost method for the CBB and DBS Programs.

Note that for financial reporting under GASB 67/68, the Entry Age Normal Cost Method is required. However, we still recommend use of the Traditional Unit Credit Method for funding purposes.

Actuarial Cost Method (continued)

MPP Program

There are no active members eligible for the MPP Program, so no Normal Cost is calculated. The actuarial obligation for the MPP Program is equal to the value of all benefits expected to be paid in the future. This obligation, less any assets currently residing in the Teachers' Health Benefit Fund (THBF), is included with the obligation of the DB Program.

SBMA Program

No Normal Cost or actuarial obligation is calculated for funding, because only an actuarial projection is done, not a valuation. Therefore, no cost method is needed for funding purposes. For financial reporting under GASB 67/68, the Entry Age Normal Cost Method is required.

Valuation of Assets (DB Program)

The valuation of assets for an actuarial valuation of a defined benefit pension plan may be thought of in a different light than the value of assets for a retirement system's financial statement. The purpose in a financial statement disclosure is to make a representation of the current value of the assets on a fair value basis. Because the underlying calculations in the actuarial valuation are long term in nature, and one of the goals of the actuarial valuation process is to measure the funding stability of the DB Program, it can be advantageous to smooth out short-term fluctuations in the fair value of assets.

Like the majority of large public retirement systems, the DB Program uses an asset smoothing method to determine the Actuarial Value of Assets. Under this method, the assets are valued using a delay of the recognition of investment gains or losses. The expected actuarial value is the prior year's actuarial value increased with net cash flow of funds, and all increased with interest during the past year at the expected investment return assumption. One-third of the difference between the expected actuarial value of assets and the Fair Market Value of assets is added to the expected actuarial value of assets to arrive at the Actuarial Value of Assets.

The following chart shows a history of the Actuarial Value of Assets compared to the Fair Market Value of Assets.
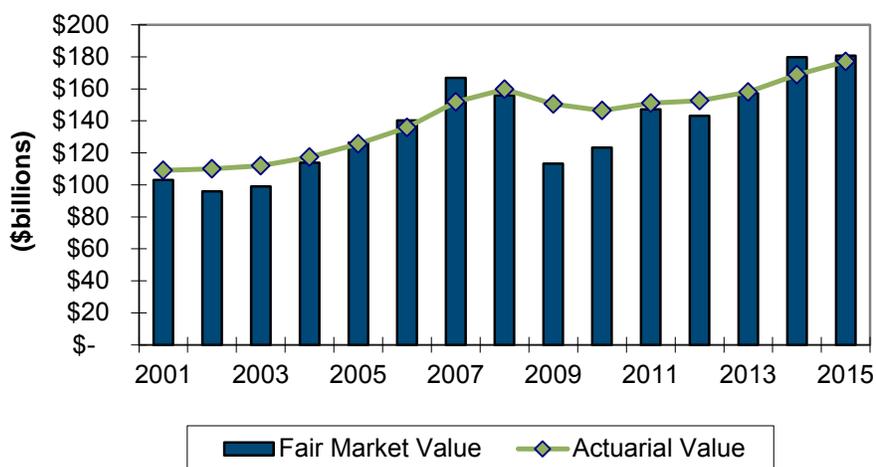
**Valuation of Assets
(DB Program)
(continued)**

Asset smoothing is a valuable tool for addressing contribution volatility. As CalSTRS moves to a variable rate funding arrangement, it is a good time to consider whether the current asset smoothing method continues to be appropriate. CalSTRS current method that smooths gains and losses over roughly three years provides a reasonable compromise between minimizing volatility and not straying too far from the market value. The only concern is that a shorter period (three years is shorter than the period most public plans use) could lead to significant year-to-year contribution rate volatility. However, there are caps on how much the state and employer contribution rates can increase, so this should mitigate that volatility. We recommend retaining the current method.

**Valuation of Assets
(CBB and DBS
Programs)**

The assets are valued at Fair Market Value and the Gain and Loss Reserve acts as a smoothing technique. We recommend this method be continued.

**Miscellaneous
Assumptions**

Valuation of Current Inactive Members: The data we receive for inactive members does not include salary information. To estimate the value of retirement benefits for current inactive members, we have projected the member's contribution account with assumed interest to the assumed retirement age (discussed in the next paragraph). We then have estimated the value based on a ratio of the member's projected account at retirement.

We are recommending moving to a more direct valuation of inactive members this year. We propose doing this by retrieving the inactive member's final compensation information from the active data in the year they were most recently active. For those we cannot locate on the active data, we propose estimating their compensation based on the average active compensation in the year the member terminated. Based on the compensation information and the age and service data, we can then estimate the benefit amount and value it accordingly. More details on this calculation are provided in Appendix A-1.

Inactive Member Retirement Age: We have studied the age at which inactive members commence retirement benefits. Based on the experience analysis, the average age at which such members retired over the period is 60.6. Our current assumption is age 60. We are recommending retaining the age 60 assumption for 2% at 60 members. Given the lower percentage factors for the 2% at 62 members, we are recommending a later assumed retirement age for inactive members of age 62.

Number of Children: We studied the number of children for surviving spouses and disability retirements. Based on this analysis, we are recommending no change in the number of children assumed for male and female members. The following table shows the results of our study of married members. Note that the number of children only reflects those expected to be eligible for survivor or disability benefits (generally age 21 or less).

Member's Gender	Actual # of Children	Current Assumption	Proposed Assumption
Male	0.70	0.65	0.65
Female	0.46	0.50	0.50

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Miscellaneous Assumptions (continued)

Assumed Offsets: A portion of disability and survivor benefits may be reduced (offset) if the member or beneficiary is receiving other public benefits related to the member's death or disability. We studied the benefit offset amounts for surviving spouses and disability retirements. Based on the current experience analysis, the actual offsets were significantly less than assumed. This is similar to findings from the prior study. Our analysis showed only 14 total members were having offsets applied to their benefits and the average offset was only 0.3% of final average compensation. Our recommendation is to assume no offsets for future death and disability benefits, but continue to value the offsets as they actually occur, thereby producing minimal actuarial gains at that time.

Probability of Eligible Survivor: Surviving beneficiaries may be eligible for a survivor benefit if a member dies during active employment. The valuation assumes a certain percentage of members will have an eligible survivor. The current assumption is that 90% of males and 70% of females will have an eligible survivor. We were unable to perform a statistically valid study of this assumption as we cannot identify deaths where the benefit is a refund of contributions, but we can look at other retirement systems. Based on recent studies of other California retirement systems we have performed, we recommend a reduction to 85% of males and 65% of females.

Sick Leave Load: We have studied the unused sick leave for those members who retired during the study period. We found that this service was generally proportional to credited service. On average, new retirees had 0.41 years of unused sick leave service and 24.1 years of credited service (including unused sick leave service). This implies that sick leave service is approximately 1.73% of non-sick leave credited service. The current assumption is a 2.0% load on credited service to account for future sick leave service; we recommend adjusting this to 1.8%. The following graph shows the results of our study.

Ratio of Eligible Sick Leave Service to Service Credit at Retirement
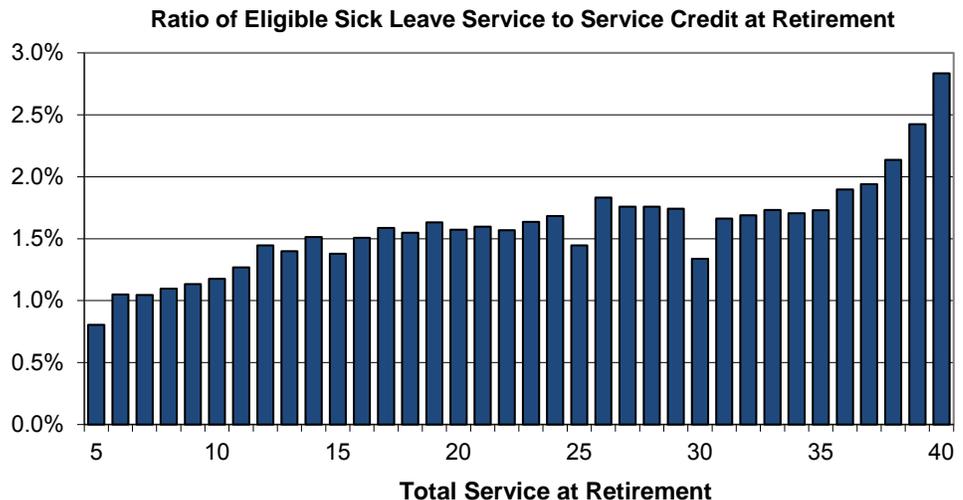
Option Factors: In general, option factors are based on the valuation assumptions. If changes in the mortality rates or investment return assumptions are adopted, the options factors should be updated to reflect these changes. Additionally, CalSTRS makes assumptions specific to the option factor, as discussed, below.

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Miscellaneous Assumptions (continued)

Members who retire and elect a 100% continuance benefit tend to have higher mortality in the first few years than the general population. We recommend the following adjustments be made to the mortality used in the calculation of the two options with a 100% continuance (Options 2 and 6):

Retirement Year	Multiply Standard Mortality Rate by		
	Actual	Expected	Proposed
Male Mortality			
1st	131%	240%	175%
2nd	138%	140%	140%
3rd	83%	120%	120%
4th	64%	105%	105%
Female Mortality			
1st	313%	400%	350%
2nd	149%	240%	180%
3rd	150%	150%	150%
4th	119%	110%	115%

Additionally, members who elect continuance benefits tend to have a higher proportion of male members than the general population. We recommend no change in the assumptions used in the calculation of the blended mortality rate for the optional factors:

Option	Male Percentage		
	Actual	Expected	Proposed
2	78.2%	80%	No Change
3	47.4%	55%	No Change
4	84.6%	75%	No Change
5	50.0%	70%	No Change
6	47.7%	50%	No Change
7	26.9%	30%	No Change
9	40.2%	45%	No Change

For all other administrative factors, we recommend blended mortality rates assuming 30% male and 70% female, consistent with the current assumption. Based on a study of service retirements during the last five years, we found the benefit amount payable to male retirees was 30.8% of the total benefit amounts.

If generational mortality is adopted, mortality rates by age will change every year. In theory, this would cause the mortality rates used in the option factors to need to be updated every year. We recommend CalSTRS consider some simplification. One possibility would be to change the mortality tables used for the option factors only following each experience study, instead of every year. If this option were selected, the mortality tables should be projected to the midpoint of the period the options factors would apply. For example, if the option factors were to apply to 2017-2021, the mortality tables would be projected to 2019 using the projection scale discussed in Section 5.

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Miscellaneous Assumptions (continued)

Estimated Impact of 1-Year Final Compensation: To isolate the value of the 1990 benefits for current retirees, CalSTRS provides the value of the increased benefit for various components of the new benefits (career average bonus, longevity bonus, ad hoc COLA, sick leave, etc.) on the retiree valuation data, where "new benefits" are those attributable to benefit changes after 1990. The increase in benefit amount for those member who are eligible to have their final average calculation based on one year (instead of three years) is not provided on the data. The current assumption is that the increase for these members is equal to 5% of the estimated 1990 benefit. We are recommending a change to this approach to estimate the impact of using one-year compensation on a year-by-year basis.

We determined the impact for each year by comparing the actual final compensation for each retiree eligible for the one-year final compensation with their estimated three-year final compensation. The results are as follows:

Retirement Year	Actual 1-Year Final Comp	Est. 3-Year Final Comp	Increase
2002	6,115	5,727	6.8%
2003	6,202	5,964	4.0%
2004	6,451	6,174	4.5%
2005	6,495	6,293	3.2%
2006	6,685	6,458	3.5%
2007	7,067	6,702	5.5%
2008	7,148	6,809	5.0%
2009	7,140	6,966	2.5%
2010	7,235	7,146	1.2%
2011	7,230	7,141	1.2%
2012	7,389	7,249	1.9%
2013	7,335	7,162	2.4%
2014	7,363	7,127	3.3%
2015	7,637	7,323	4.3%
2016	7,923	7,547	5.0%

1. *Compensation amounts are earnable amounts and are monthly figures.*

We are recommending the actual increase, as shown in the table above, be applied to the individual's 1990 benefit to determine the new benefit attributable to the one-year final compensation. Note that this is only applied to the benefits of retirees who were eligible for the one-year final compensation. For retirement years prior to 2002, 5.0% is used. For retirement years after 2016, 4.3% is used. 4.3% represents the assumed 3.5% general wage growth assumption plus 0.8% for merit. We recommend this table be updated with each following experience analysis study.

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Section 4: Salary Increases Due to Promotion and Longevity (Merit)

Estimates of future salaries are based on assumptions for two types of increases:

1) Increases in each individual's salary due to promotion or longevity, which occur even in the absence of inflation (merit increases); and

2) Increases in the general wage level of the membership, which are directly related to inflation and increases in productivity.

Results

In Section 2, we recommend that the second of these rates, the general wage inflation, be lowered to 3.50%. See that section of the report for discussion. This section addresses the first of these rates, the merit salary increase.

The merit increases shown in this section are calculated as the total increase for each individual, less the observed general wage inflation during the five-year study period of 1.11%.

Exhibit 4-1 shows the actual merit increases in salary over the period July 1, 2010 – June 30, 2015. Increases were higher earlier in a member's career (lower service) and then decreased over time, consistent with the current assumptions. Overall, the actual increases were close to those predicted by the current assumptions, although there were some small differences in the pattern in the first 15 years.

The current salary assumptions are separated by entry age. Exhibit 4-2 shows the average increases by entry age group. This exhibit illustrates the varying pattern of merit increases based on the age at which a member enters the system. Specifically, at any given service level, members with younger entry ages tend to receive larger merit increases.

Recommendation

Based on the results of the prior two experience studies, we are recommending small changes in the pattern of the merit increase assumption, primarily in the first 15 years of employment.

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Exhibit 4-1 **Total Rates of Increase in Salary Due to Merit and Longevity**
All Members
(Excluding Actual General Wage Growth)

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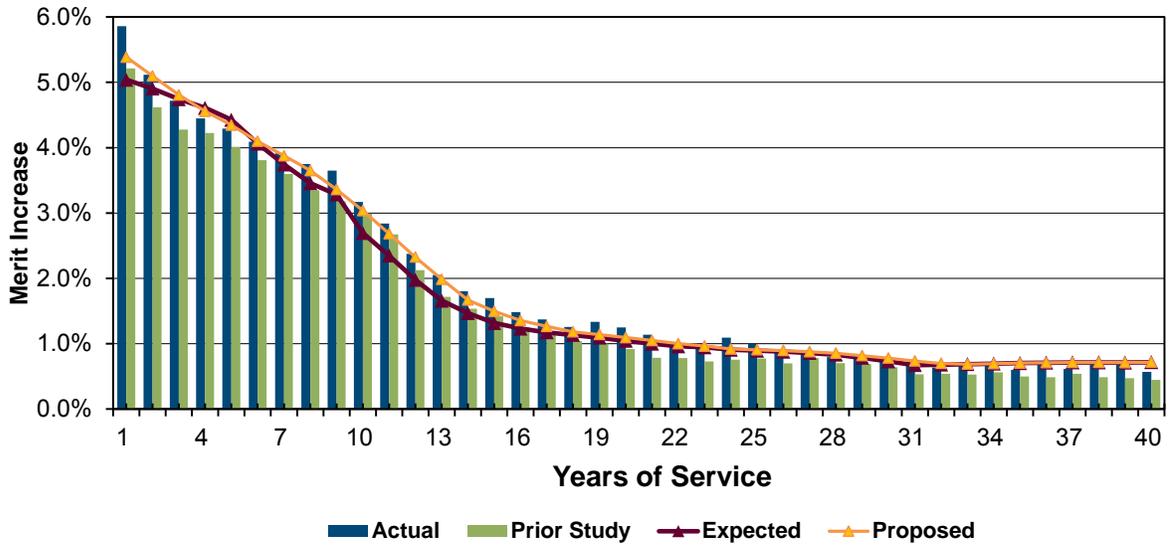
Exhibit 4-2 **Annual Rates of Increase in Salary by Entry Age**
Due to Merit and Longevity
(Excluding Actual General Wage Growth)

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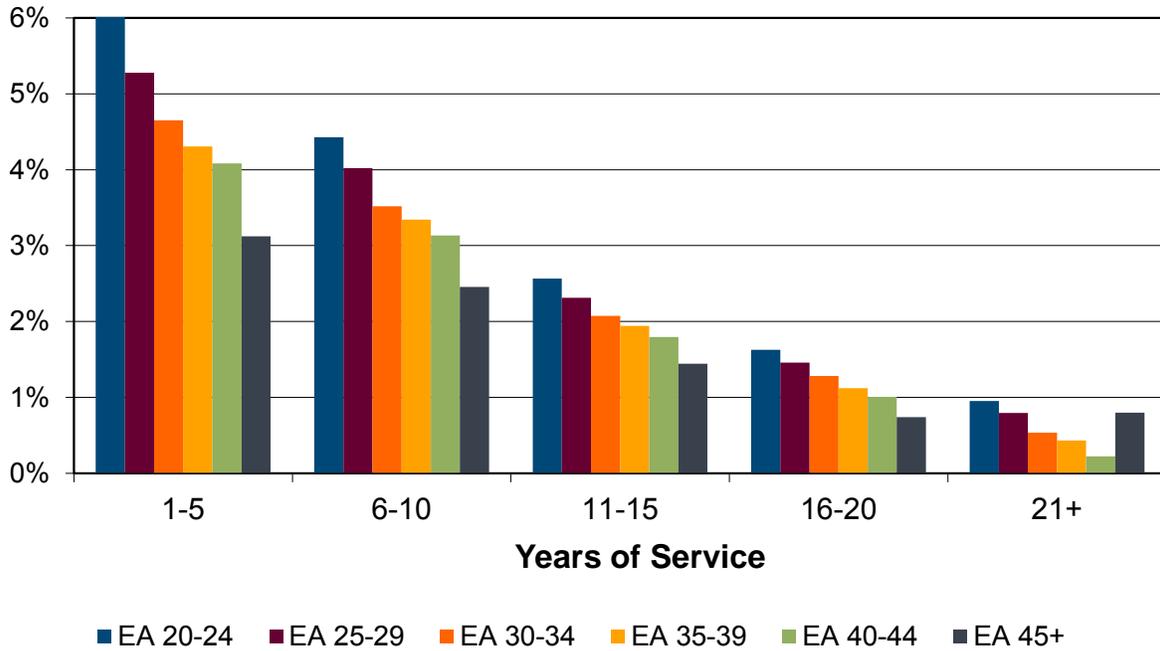
Section 5: Retired Mortality

In this section we look at the results of the study of actual and expected death rates of retired members. We studied rates of mortality among healthy and disabled retired members, as well as beneficiaries. Valuation mortality is a critical assumption, since, if members live longer than expected, we will be understating the true cost of the future plan obligations.

Mortality has been improving in this country and is expected to continue to improve. Recent studies by the Society of Actuaries have shown marked increases in life expectancies since their previous study in 2000. We recommend using generational mortality tables (see later discussion) to account for projected future improvements in mortality. Generational mortality is reflected by including a mortality improvement scale that projects small annual decreases in mortality rates.

The Actuarial Standards of Practice require expected future mortality improvements to be considered in selecting the assumption. Using generational mortality tables achieves this. If generational mortality tables are not used, a margin in the mortality assumption should be used to account for future improvements in mortality.

Results

Overall, we found the number of deaths over the study period for healthy retirees was very close to the number predicted by the current rates: 28,636 actual deaths, compared to 28,322 expected deaths for a total actual/expected ratio of 101%. For disabled retiree mortality, the overall actual/expected ratio was 93%, indicating disabled retirees are living longer than the current assumptions are predicting. (See graphs at the end of this section for details).

In general, we propose mortality rates such that the ratio of actual-to-proposed deaths will be close to, but slightly above, 100%, if a projected mortality improvement scale is used.

In our experience studying the mortality of public pension plan retirees, we have consistently found that retirees with larger benefits tend to live the longer than retirees with smaller benefits. We have studied the mortality for CalSTRS with an adjustment for actual benefit amounts and found this to be true, although the impact is less than we have observed in most other systems, probably because members of CalSTRS are relatively homogenous. Our proposed mortality assumptions take this into account by including a small margin (actual-to-proposed ratio slightly greater than 100%).

Results
(continued)

The following shows a summary of the results of the study. Detailed results are shown graphically on the following pages.

Status	Actual to Expected			Actual to Proposed		
	Actual	Expected	A/E Ratio	Actual	Proposed	A/P Ratio
Healthy Male	12,017	11,511	104%	12,017	11,362	106%
Healthy Female	16,619	16,811	99%	16,619	15,549	107%
Healthy Total	28,636	28,322	101%	28,636	26,911	106%
Disabled Male	496	527	94%	496	468	106%
Disabled Female	943	1,023	92%	943	915	103%
Disabled Total	1,439	1,550	93%	1,439	1,383	104%
Beneficiary Male	1,085	1,175	92%	1,085	1,150	94%
Beneficiary Female	3,345	3,424	98%	3,345	3,196	105%
Beneficiary Total	4,430	4,599	96%	4,430	4,346	102%
Grand Total	**34,505**	**34,471**	**100%**	**34,505**	**32,640**	**106%**

Generational Mortality
Tables

There is a trend in the actuarial profession to use generational mortality tables, which explicitly reflect expected future improvements in mortality. Generational mortality tables include a *base table* and a *projection table*. The projection table reflects the expected annual reduction in mortality rates at each age. Therefore, each year in the future, the mortality at a specific age is expected to decline slightly (and people born in succeeding years are expected to live slightly longer).

For example, if the mortality rate at age 75 is 2.00% for a member currently aged 75 and the projected improvement is 1.00%, the mortality rate at age 75 for a member currently aged 74 will be 1.98% [2.00% x (100.00% - 1.00%)]. Therefore, the life expectancy for a 75-year old in the current year will be less than a 75-year old in the next year. This can result in significant differences in life expectancies when projecting improvements 30-plus years into the future.

One of the main benefits of generational mortality tables is the valuation assumptions should effectively update each year to reflect improved mortality, and the base tables should rarely need to be changed.

One reason we had not recommended generational mortality previously is that issues with the calculation of option factors would have been administratively unfeasible. Our understanding from CalSTRS staff is that the calculation of option factors and service purchases, which by law use the valuation assumptions, can be made compatible with the use of generational mortality tables.

Projection Scale for
Mortality Improvement

There is a strong consensus in the actuarial community that future improvements in mortality should be reflected in the valuation assumptions. There is less consensus, however, about how much mortality improvement should be reflected. The most recent projection scale published by the Society of Actuaries (SOA) incorporates a complex matrix of rates of improvement that vary by both age and birth year. Ultimately, the projection scale (Scale MP-2016) goes to a flat 1% annual improvement in years 2032 and later for ages 85 or less.

Projection Scale for Mortality Improvement (continued)	Our recommendation is to use 110% of the ultimate portion of the MP-2016 scale. In other words, our recommendation is to assume 1.1% annual improvements in mortality (for ages less than 85). We believe this reasonably reflects the long-term expectation of mortality improvement. We have compared our recommended projection scale with actual mortality improvement from the most recent 60 years of experience of the US Social Security system and found them to be reasonably consistent.
	As noted, the recommended projection scale is a flat 1.1% improvement through age 85. For subsequent ages, the projected improvement is fractionally less, grading down to 0.0% at age 115. For example, the projected improvement is 0.64% per year at age 100.
Recommendation	We recommend strengthening the mortality assumption (i.e., increasing life expectancies), by slightly reducing mortality rates and adding a projection scale to reflect expected future improvements in mortality. Note that this brings the total healthy retiree actual/proposed ratio to 106% based on the base rates. We believe this combined with the projection scale allows for a reasonable expectation of future life expectancy increases.
	CalSTRS uses custom mortality tables to best fit the patterns of mortality among its members. These custom tables are based on standard mortality tables adjusted to fit CalSTRS experience. The table on the next page describes the new tables being recommended for healthy and disabled retirees. Note these are based a recent study of retiree pensioners published by the Society of Actuaries in 2014 (hence, the table name RP-2014). The White Collar version of these tables were used as we believe it best reflects the teacher population.
	Note that for beneficiaries of healthy and disabled retirees, we recommend that the mortality for healthy retirees be used, as observed experience showed a significant amount of consistency between retirees and beneficiaries.

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Recommendation (continued)

Rates of mortality among active members prior to retirement are discussed separately in Section 6 of this report.

Healthy (Service) Retirees and Beneficiaries -- Males
Current: RP-2000 Healthy Male White Collar -2 to age 70 smoothed to -1 at age 90
Proposed: RP-2014 Healthy Male White Collar -1 to age 70 smoothed to +1 at age 95

Healthy (Service) Retirees and Beneficiaries -- Females
Current: RP-2000 Healthy Female White Collar -4 to age 75 smoothed to -0 at age 90
Proposed: RP-2014 Healthy Female White Collar -4 to age 70 smoothed to +1 at age 95

Disabled Retirees -- Males
Current: Age < 70: 2% at age 40 & under, graded to 3.2% at age 70 Age > 70: RP-2000 Male White Collar +7 at age 70 smoothed to +1 age 85 (select rates in first three years, regardless of age)
Proposed: All Ages: RP-2014 Disabled Male -2 (select rates in first three years, regardless of age)

Disabled Retirees -- Females
Current: Age < 70: 1.5% at age 40 & Less graded to 2.25% at age 70 Age > 70: RP-2000 Female White Collar +6 at age 70 smoothed to +2 at age 80 (select rates in first three years, regardless of age)
Proposed: All Ages: RP-2014 Disabled Female -2 (select rates in first three years, regardless of age)

Notes:
1. *All proposed tables use 110% of the MP-2016 Ultimate Projection Scale.*
2. *All proposed tables to be used in the 6/30/2016 actuarial valuations include two years of mortality improvement from the 2014 tables shown above.*

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Exhibit 5-1   Mortality for Service (Healthy) Retirees – Males
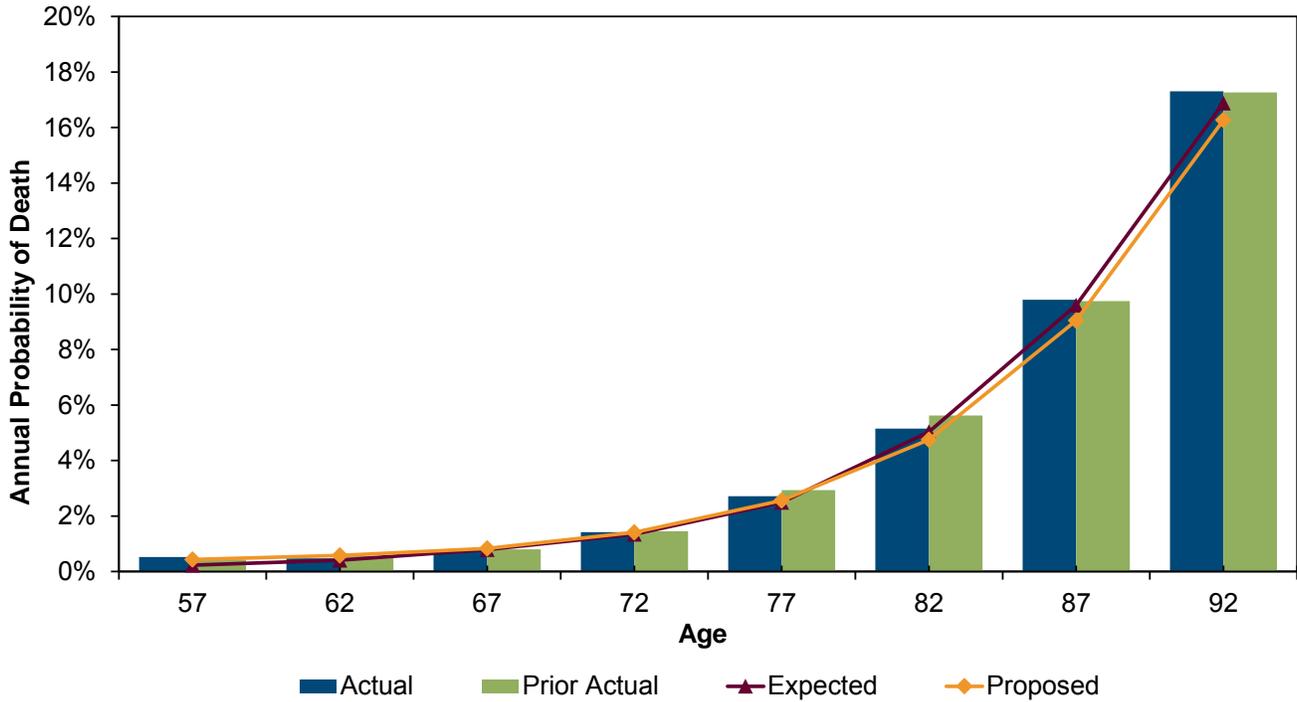
All Ages

	Expected	Actual	Proposed
Total Count	11,511	12,017	11,362
Actual / Expected	104%		106%

Exhibit 5-2   **Mortality for Service (Healthy) Retirees – Females**
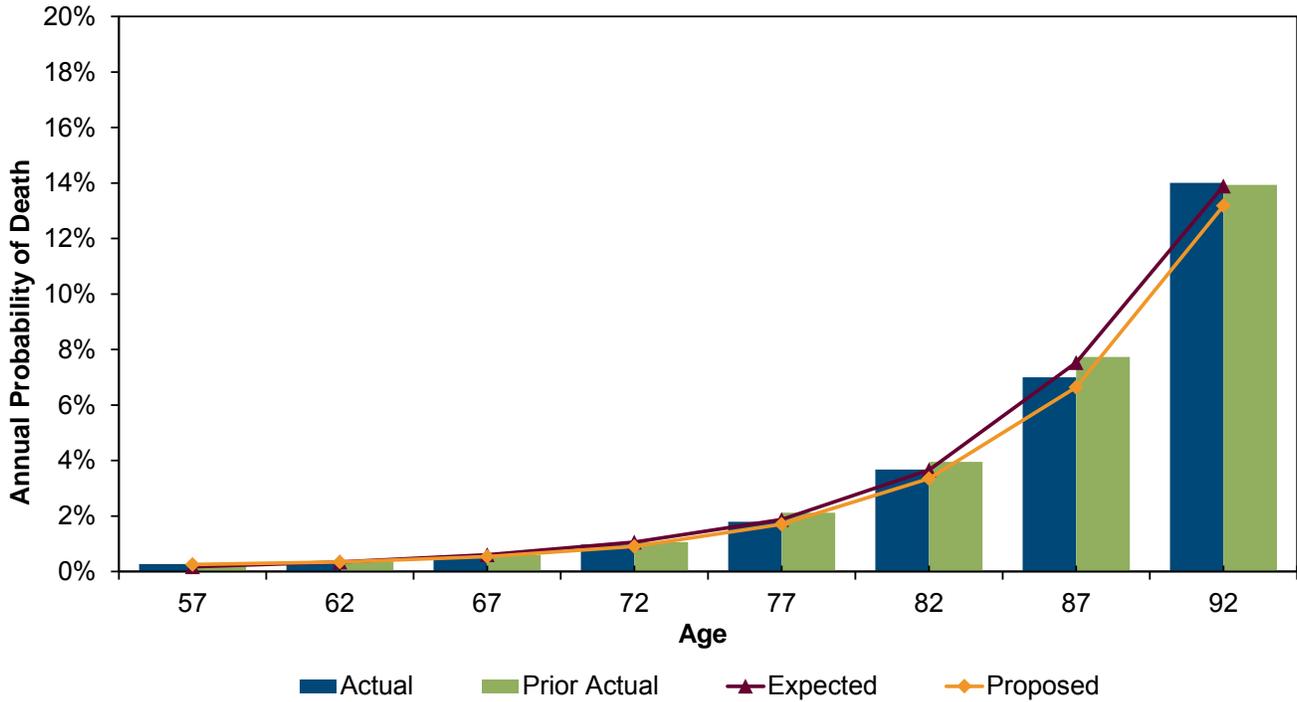
All Ages

	Expected	Actual	Proposed
Total Count	16,811	16,619	15,549
Actual / Expected	99%		107%

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Exhibit 5-3   **Mortality for Disabled Retirees – Males**
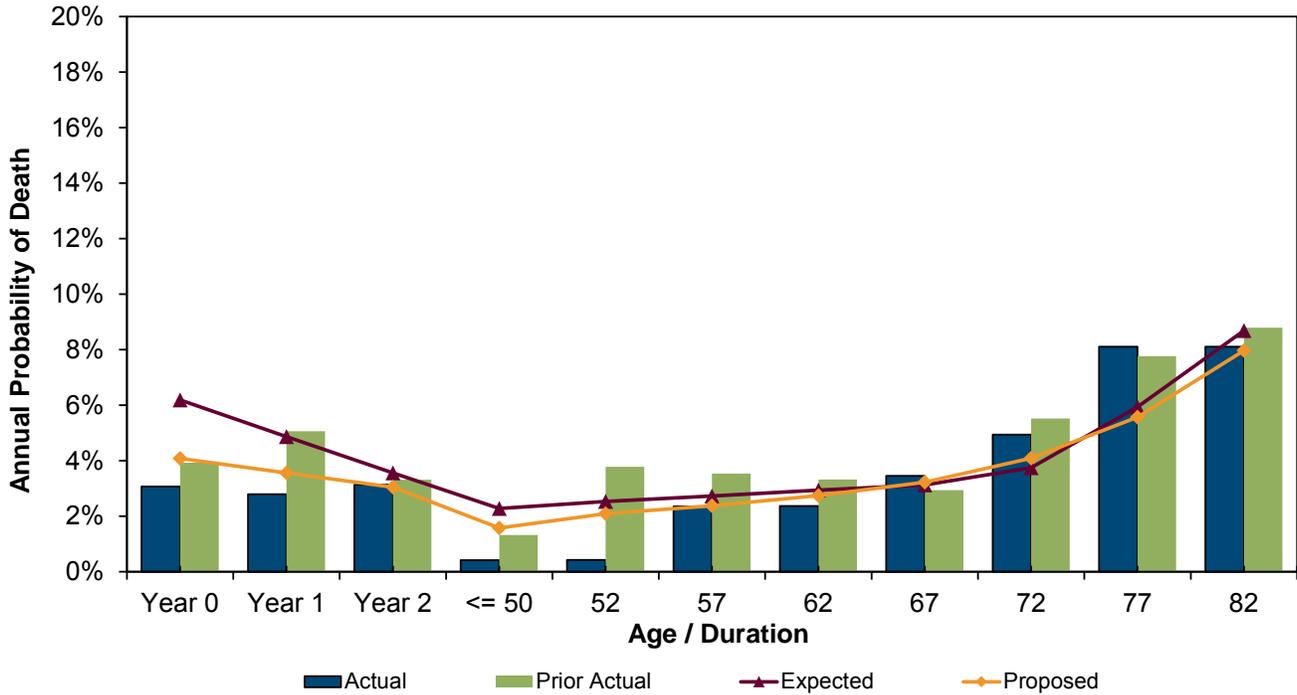
All Ages

	Expected	Actual	Proposed
Total Count	527	496	468
Actual / Expected	94%		106%

First Three Years of Retirement

	Expected	Actual	Proposed
Total Count	129	79	94
Actual / Expected	61%		84%

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Exhibit 5-4   **Mortality for Disabled Retirees – Females**
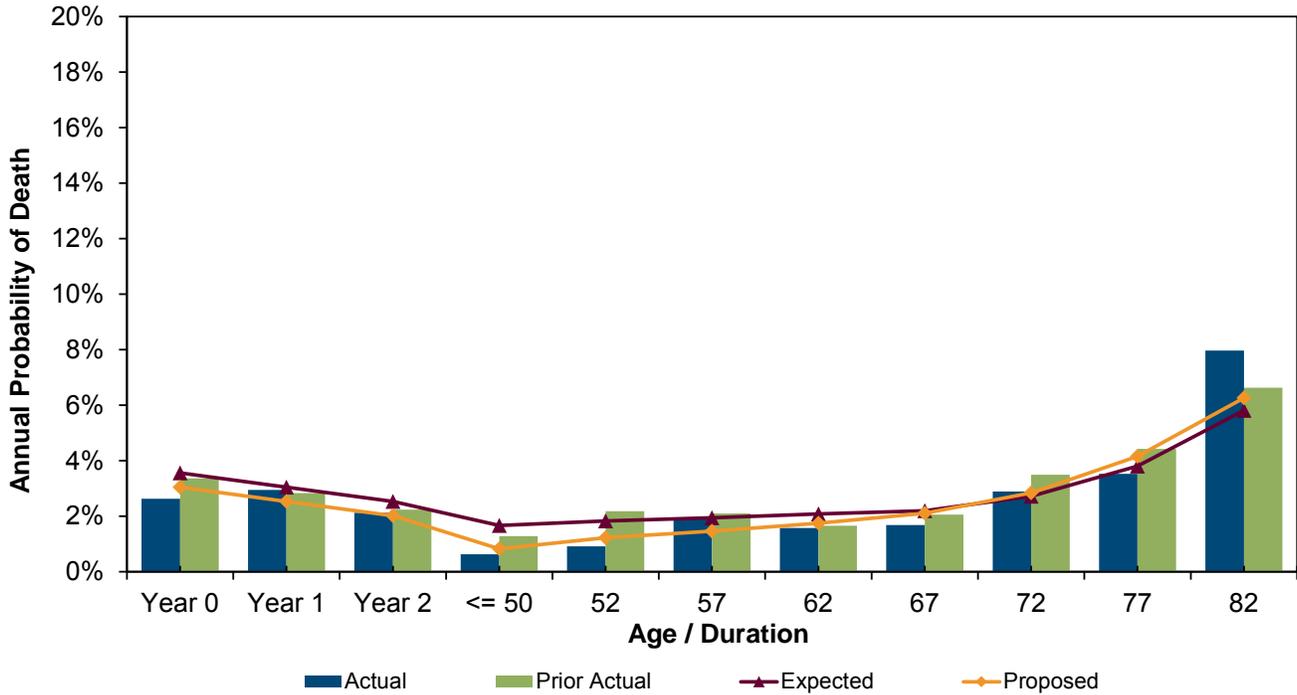
All Ages

	Expected	Actual	Proposed
Total Count	1,023	943	915
Actual / Expected	92%		103%

First Three Years of Retirement

	Expected	Actual	Proposed
Total Count	223	188	186
Actual / Expected	84%		101%

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Exhibit 5-5 **Mortality for Beneficiaries – Males**
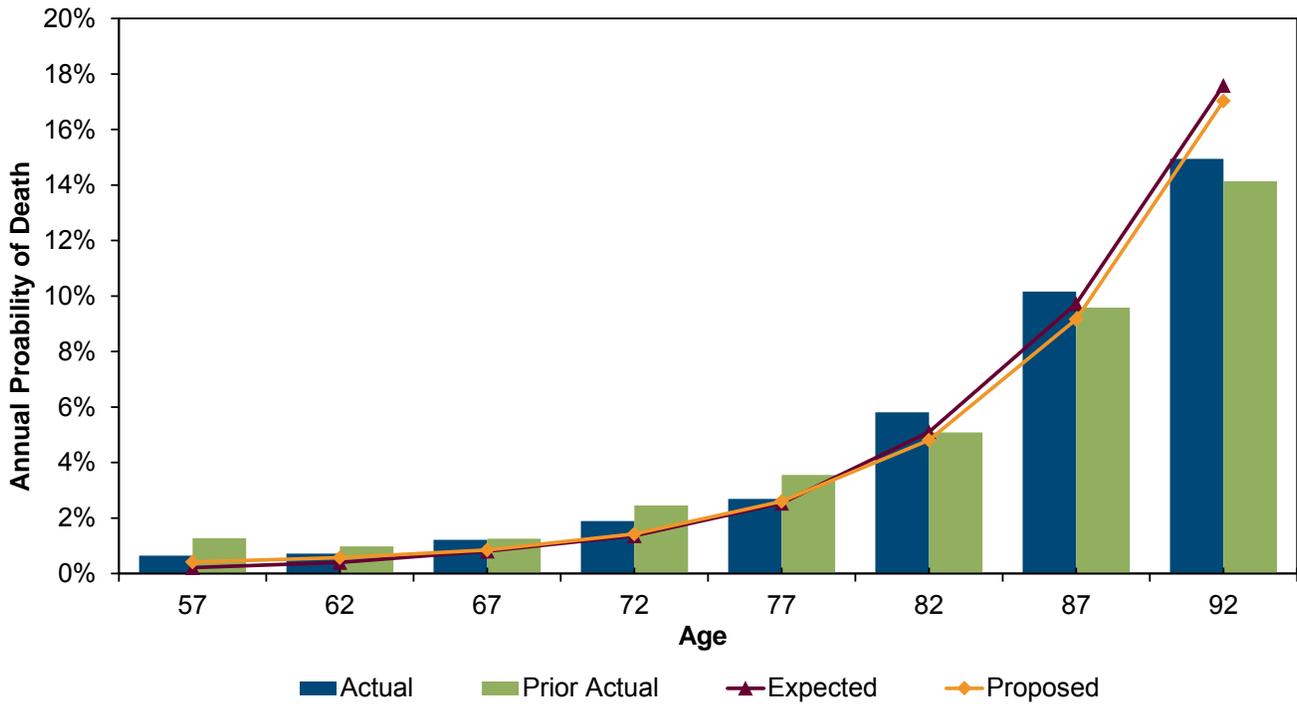
All Ages

	Expected	Actual	Proposed
Total Count	1,175	1,085	1,150
Actual / Expected	92%		94%

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Exhibit 5-6   **Mortality for Beneficiaries – Females**
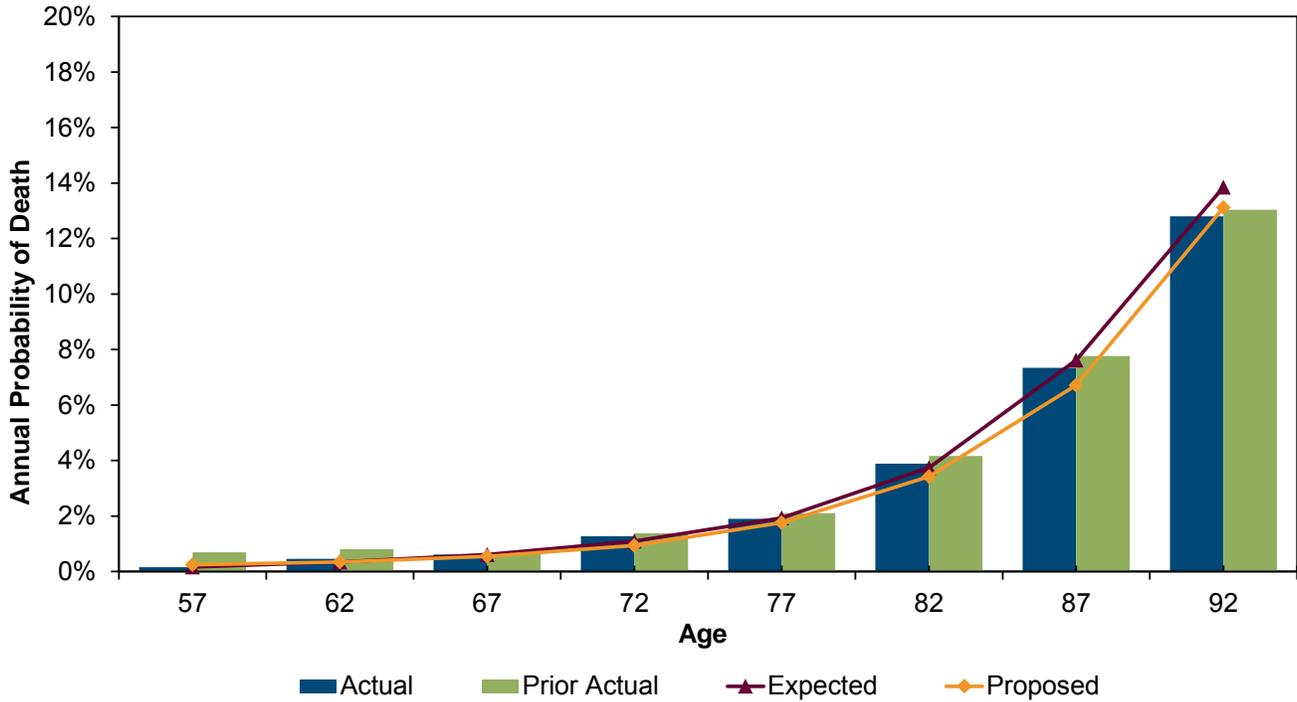
All Ages

	Expected	Actual	Proposed
Total Count	3,424	3,345	3,196
Actual / Expected	98%		105%

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Section 6: Probability of Death from Active Status

In this section we look at the results of the study of actual and expected death rates for members in active status.

The current approach has been to use the same mortality rates for active members as for healthy retired members, but with an additional setback of two years to explicitly provide for assumed mortality improvements in the future.

Consistent with the retired mortality assumption, we are recommending using a projection scale for active mortality to recognize expected improvements in future mortality.

Results

The number of active deaths was slightly less than expected, with an actual-to-expected ratio of 96%. The proposed rates project similar mortality in the short term, but include the projection scale to reflect future improvements.

Status	Actual to Expected			Actual to Proposed		
	Actual	Expected	A/E Ratio	Actual	Proposed	A/P Ratio
Active Male	807	795	101%	807	796	101%
Active Female	1,105	1,194	93%	1,105	1,167	95%
Active Total	1,912	1,989	96%	1,912	1,963	97%

Recommendation

We recommend new tables be adopted based on standard tables for white collar employees. These tables are adjusted for consistency with CalSTRS experience. The recommended tables are as follows:

Active Members -- Males	
Current:	RP-2000 Healthy Male White Collar -4 Projected to 2025 to age 70 smoothed to -3 at age 90
Proposed:	RP-2014 Healthy Male White Collar Employee -2

Active Members -- Females	
Current:	RP-2000 Healthy Female White Collar -6 Projected to 2025 to age 75 smoothed to -2 at age 90
Proposed:	RP-2014 Healthy Female White Collar Employee -2

Notes:
1. All proposed tables use 110% of the MP-2016 Ultimate Projection Scale.
2. All proposed tables to be used in the 6/30/2016 actuarial valuations include two years of mortality improvement from the 2014 tables shown above.

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Section 7:   Service Retirement from Active Status

Exhibits 7-1 through 7-6 show the actual and expected rates of service retirement from active status. Our analysis of rates of service retirement was by attained age and gender, and only includes active members who are eligible for service retirement.

Due to the different benefit provisions, we reviewed rates of retirement separately, depending on an individual member's years of service. Therefore, there are essentially three service retirement assumption categories for 2% at 60 members:

1. Less than 25 years of service: This is the basic group.

2. Between 25 and 30 years of service: This group is eligible for one-year final compensation.

3. 30 or more years of service: This group is eligible for the career factor (additional 0.2% in percentage formula). Some members of this group will be eligible for the longevity bonus; however, this will be a declining group.

Exhibits 7-1 through 7-6 study retirements for the following groups:

■ Exhibit 7-1: Members with < 25 Years of Service – Males
■ Exhibit 7-2: Members with < 25 Years of Service – Females

■ Exhibit 7-3: Members with 25 to 30 Years of Service – Males
■ Exhibit 7-4: Members with 25 to 30 Years of Service – Females

■ Exhibit 7-5: Members with >=30 Years of Service – Males
■ Exhibit 7-6: Members with >=30 Years of Service – Females

Results

For members with less than 25 years of service, the total actual retirements from active service was very close to what the assumptions predicted. For members with 25 to 30 years of service, it was higher. For those with 30 or more years, it was slightly lower.

The table below illustrates the actual and expected number of decrements for males and females combined, split by service level.

Number of Service Retirements (2% at 60) -- Expected			
	Actual	**Expected**	**Actual / Expected**
Less than 25 Years of Service	26,363	27,014	98%
25 to 30 Years of Service	9,319	7,631	122%
30 Years or More of Service	19,435	21,422	91%
Total	55,117	56,067	98%

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2% at 62 Members

There is currently insufficient data to study service retirement rates for 2% at 62 members. We expect these members will have different retirement patterns than the 2% at 60 members due to lower benefit percentages and less generous provisions (e.g., no career bonus, longevity or one-year final compensation), although it is difficult to estimate at this point. There may still be some correlation with service, where members with more years of service have a higher probability of retirement; however, the differences at 25 and 30 years of service will not be as significant.

Recommendation 2% at 60 Members

We are recommending small changes to the retirement rates for members with less than 25 years and 30 or more years of service to better fit the observed patterns.

For members with 25 to 30 years of service, we are recommending an increase in the retirement rates, since the actual rates were greater than the expected rates. Note that this assumption is actually broken down into two pieces: 1) 25 to 27 years of service where we are recommending rates are set equal to 225% of the rates for service less than 25; and 2) 28 to 29 years of service where the rates are set equal to 125% of the rates for service less than 25. The current assumptions are adjustments of 200% and 100% respectively.

As illustrated in the following graphs, we have reflected only part of the recent experience. We have also taken the previous experience study into account to give more of a long-term picture of the recent retirement rates.

A comparison of the actual and expected retirements under the recommended assumptions is shown in the table below.

Number of Service Retirements (2% at 60) -- Proposed			
	Actual	**Proposed**	**Actual / Proposed**
Less than 25 Years of Service	26,363	26,948	98%
25 to 30 Years of Service	9,319	8,816	106%
30 Years or More of Service	19,435	20,780	94%
Total	55,117	56,544	97%

Recommendation 2% at 62 Members

Due to the lower benefit percentages for ages less than 65, we would expect that 2% at 62 members will retire somewhat later than the 2% at 60 members. Additionally, we would not expect the attainment of 25 and 30 years of service to have the same impact. We have recommended revised rates for 2% at 62 members that do not vary by service to reflect this. The proposed rates are shown in Table A-3.

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Exhibit 7-1   **Service Retirement Rates (2% at 60 Members)**
                                  Males—Less than 25 Years of Service
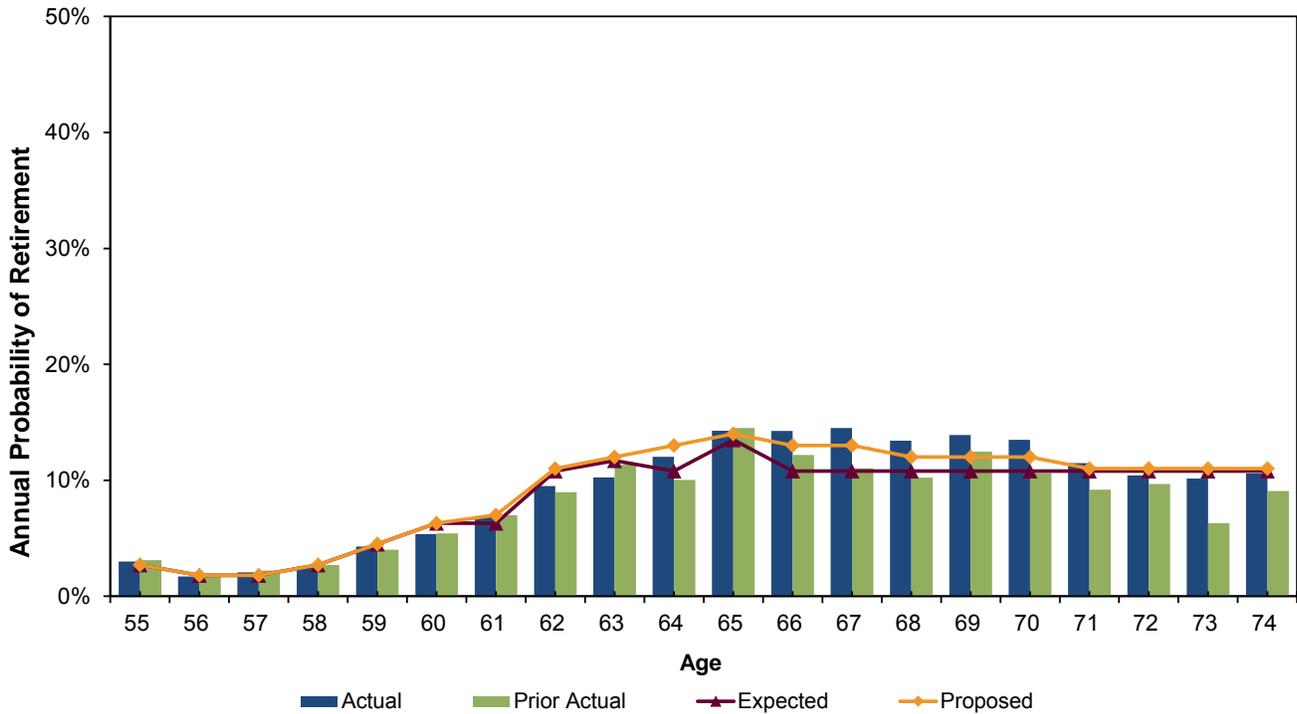
<25 Years of Svc	Expected	Actual	Proposed
Total Count	6,915	7,210	7,401
Actual / Expected	104%		97%

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Exhibit 7-2   **Service Retirement Rates (2% at 60 Members)**
Females—Less than 25 Years of Service
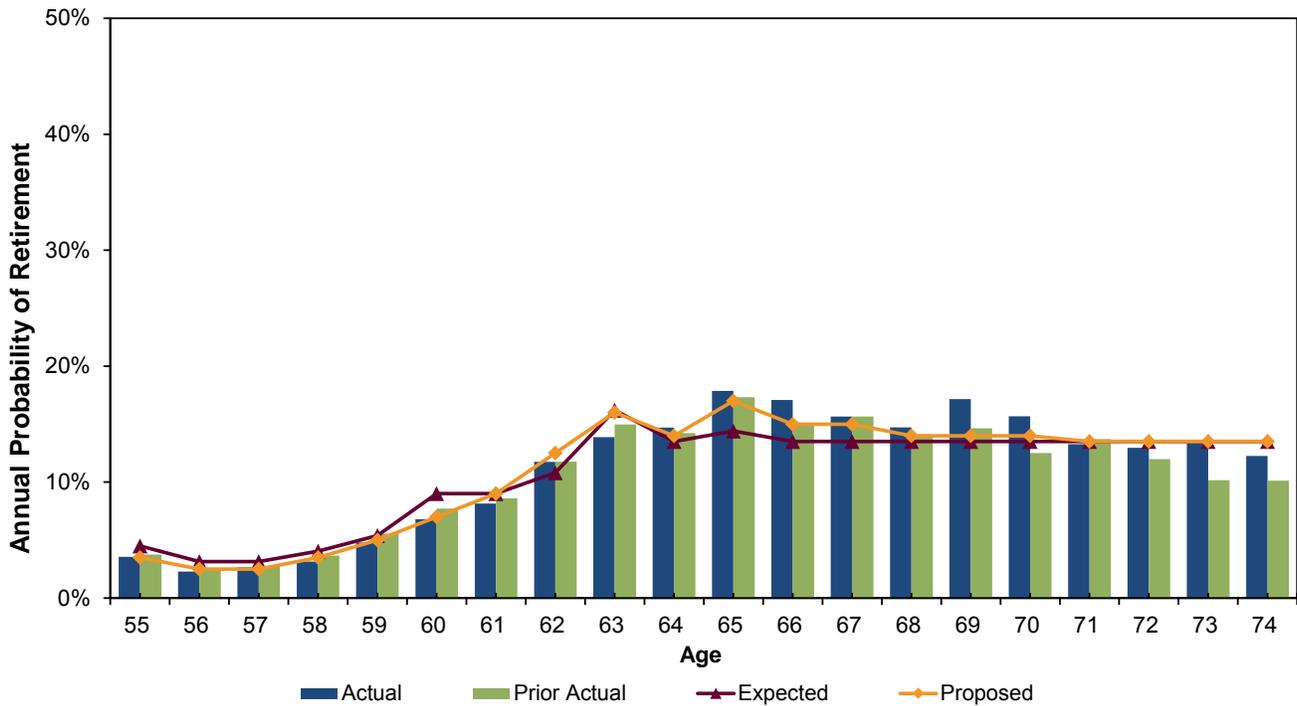
<25 Years of Svc	Expected	Actual	Proposed
Total Count	20,099	19,153	19,547
Actual / Expected	95%		98%

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Exhibit 7-3   **Service Retirement Rates (2% at 60 Members)**
                         Males—25 to 30 Years of Service
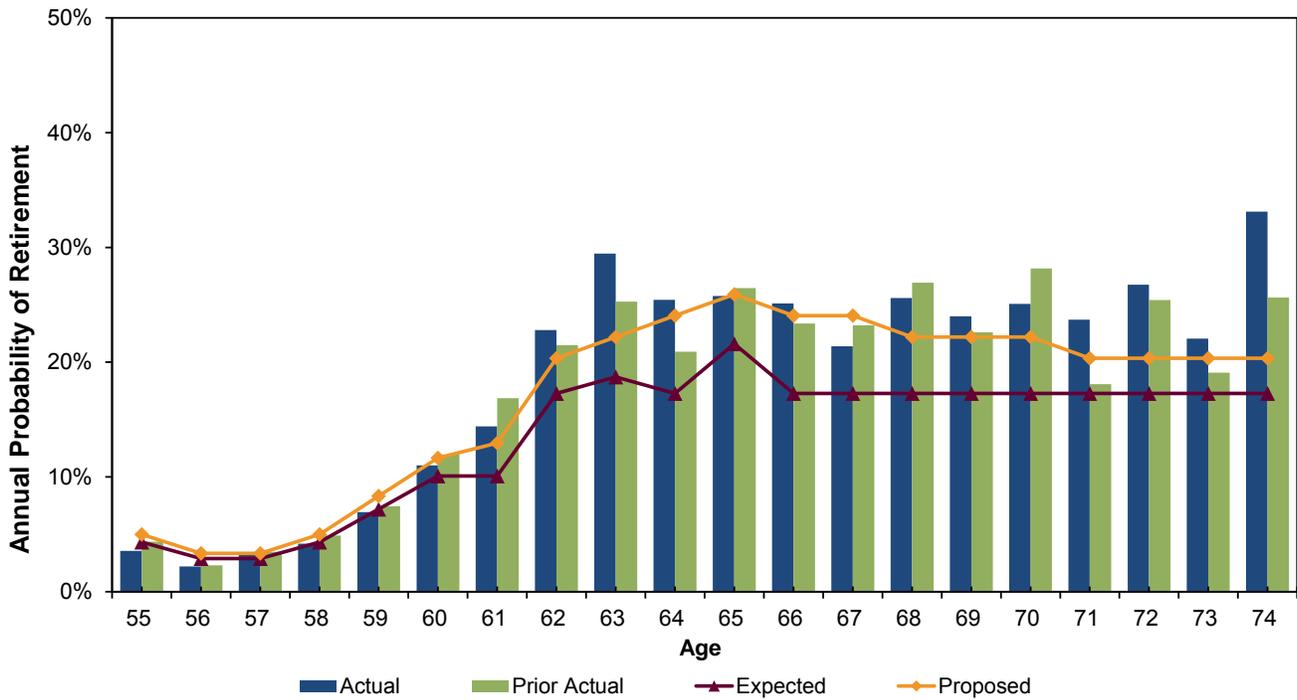
25 to 30 Years of Svc	Expected	Actual	Proposed
Total Count	1,851	2,342	2,291
Actual / Expected	127%		102%

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Exhibit 7-4   **Service Retirement Rates (2% at 60 Members)**
Females—25 to 30 Years of Service
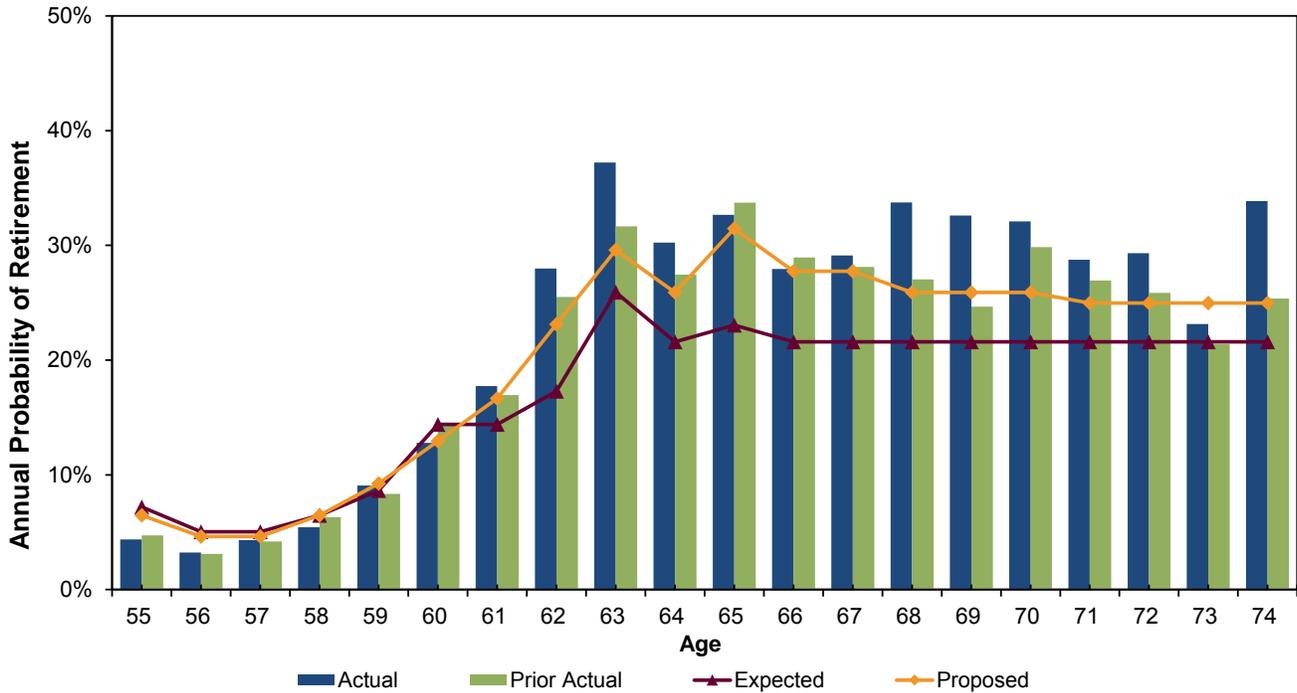
25 to 30 Years of Svc	Expected	Actual	Proposed
Total Count	5,780	6,977	6,525
Actual / Expected	121%		107%

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Exhibit 7-5   **Service Retirement Rates (2% at 60 Members)**
                              Males—30 or more Years of Service
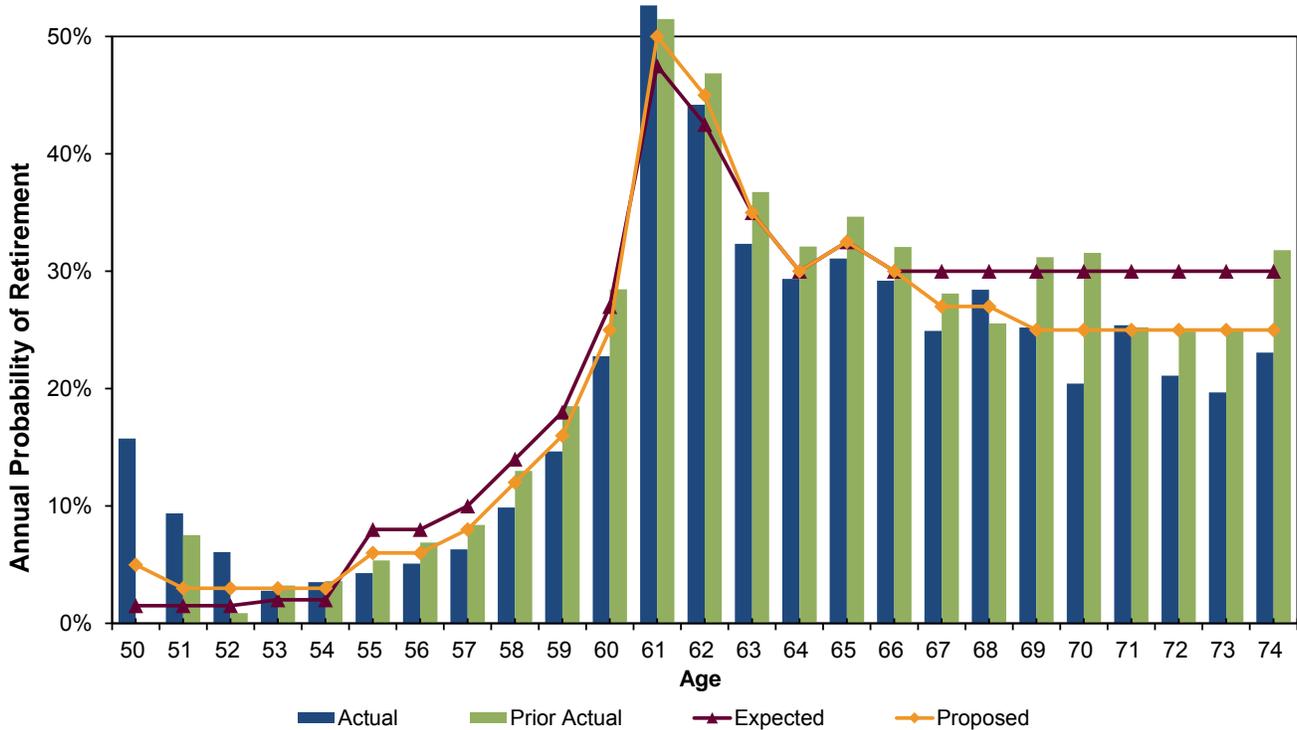
30+ Years of Svc	Expected	Actual	Proposed
Total Count	7,174	6,583	6,893
Actual / Expected	92%		96%

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Exhibit 7-6   **Service Retirement Rates (2% at 60 Members)**
Females—30 or more Years of Service
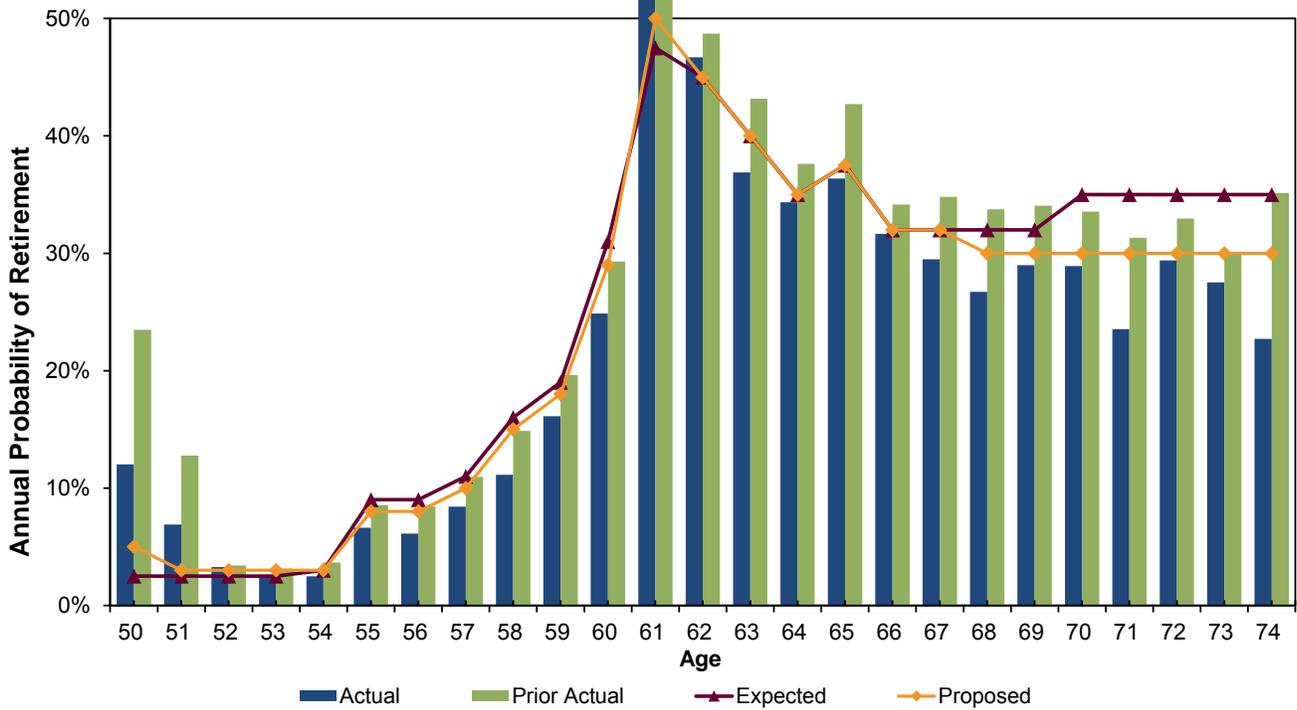
30+ Years of Svc	Expected	Actual	Proposed
Total Count	14,248	12,852	13,887
Actual / Expected	90%		93%

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Section 8: Disability Retirement

Results

CalSTRS allows a member to start receiving benefits prior to eligibility for service retirement if they become disabled.

Rates of disability are studied separately for Coverage A and Coverage B members due to the different benefit provisions.

The following tables show the actual versus expected number of disabilities for Coverage A and Coverage B males and females. In all categories, there were fewer disabilities than expected.

Actual vs. Expected Disability Retirements		
Coverage A		
	Actual	Expected	Actual / Expected
Male	113	130	87%
Female	311	389	80%
Total	424	519	82%
Coverage B		
	Actual	Expected	Actual / Expected
Male	543	570	95%
Female	1,482	1,569	94%
Total	2,024	2,140	95%

Recommendation

We are recommending decreasing the rates of disability slightly for Coverage A members.

Actual vs. Proposed Disability Retirements		
Coverage A		
	Actual	Proposed	Actual / Proposed
Male	113	124	91%
Female	311	354	88%
Total	424	478	89%
Coverage B		
	Actual	Proposed	Actual / Proposed
Male	543	570	95%
Female	1,482	1,569	94%
Total	2,024	2,140	95%

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Section 9: Other Terminations of Employment (Withdrawal)

This section of the report summarizes the results of our study of terminations of employment for reasons other than death, service retirement, or disability. Rates of termination vary by years of service – the greater the years of service, the less likely a member is to terminate employment.

The current assumptions also vary by gender, with females having a slightly higher probability of terminating than males.

Results

Overall, the actual number of terminations was close to expected, with males being very close to expected and females being slightly lower than expected. Note that we exclude retirement-eligible members from the study of non-retirement terminations. Additionally, we reduce the number of terminations by any rehires at the corresponding service level.

Actual vs. Expected Terminations[1]		
	Actual	Expected	Actual / Expected
Males	12,498	13,460	93%
Females	28,111	34,113	82%
Total	40,609	47,573	85%

1. Excludes first year of service.

Recommendation

The results of the study are shown in Exhibits 9-1 and 9-2. As noted, the actual rates were close to the assumptions. Therefore, we have not recommended a change in the assumption.

However, we did observe some difference for females at service levels between 10 and 25 years, with the actual rates being less than the assumptions. This appears to be due to a larger number of rehires during the study period. We will monitor this going forward to see if it develops into a trend.

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Exhibit 9-1   **Termination by Years of Service – Males**[1]
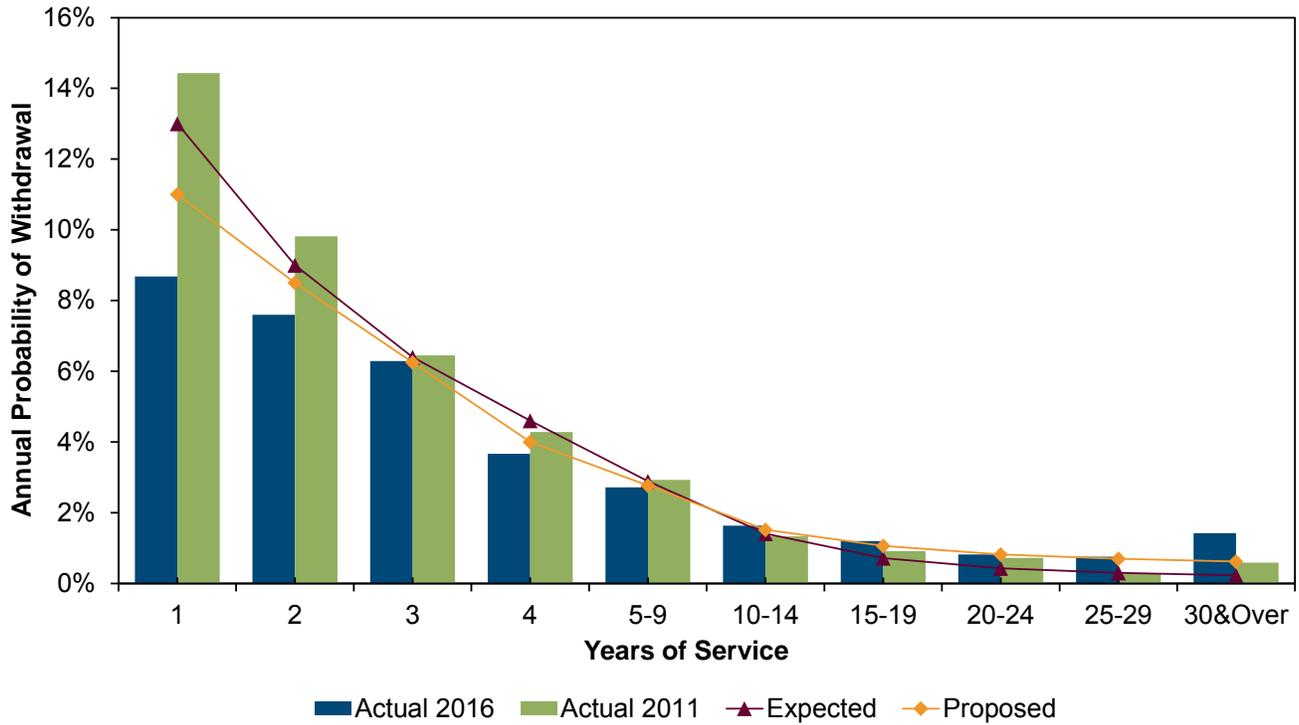
	Expected	Actual	Proposed
Total Count[1]	13,460	12,498	13,157
Actual / Expected	93%		95%

1. Excludes retirement-eligible members and members with less than a year of service.

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Exhibit 9-2   **Termination by Years of Service – Females**[1]
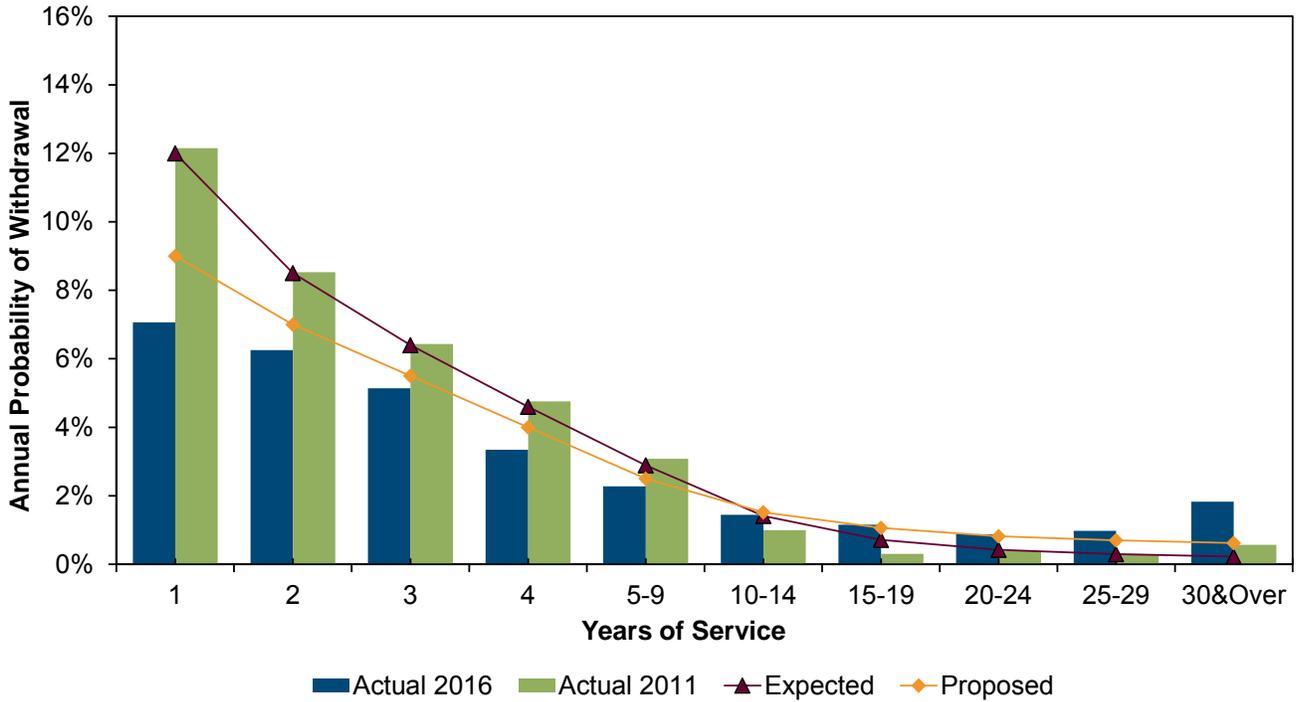
	Expected	Actual	Proposed
Total Count[1]	34,113	28,111	30,822
Actual / Expected	82%		91%

1. Excludes retirement-eligible members and members with less than a year of service.

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Section 10: Probability of Refund Upon Vested Termination

This section of the report deals with the rates at which employees elect a refund of their contributions upon termination of service. It only considers vested members who are not yet eligible for service retirement. Under the current assumptions, members who terminate with fewer years of service have a greater probability of electing to withdraw their contributions. All non-vested members are assumed to take a refund at termination. Note that the assumed probability of refund varies by entry age group.

Results

The following table shows actual and expected number of refunds split by entry age group. Note that each entry age shown represents the midpoint of a five-year entry age group (so Entry Age 22 represents the group with entry ages between 20 and 25, etc.). Members with higher entry ages (who are closer to retirement at a given level of service) have a lower probability of refund. In aggregate, the actual total number of refunds was somewhat higher than the assumptions predicted, mainly for members with between five and ten years of service.

Actual to Expected Number of Refunds			
Males			
Entry Age	Actual	Expected	Ratio
22	86	87	99%
27	746	694	108%
32	545	399	137%
37	293	253	116%
42	153	184	83%
47	317	386	82%
Total	2,140	2,004	107%
Females			
Entry Age	Actual	Expected	Ratio
22	451	383	118%
27	1,998	1,390	144%
32	846	599	141%
37	435	373	117%
42	308	312	99%
47	416	490	85%
Total	4,454	3,548	126%
Grand Total	6,594	5,551	119%

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Recommendation
Based on the experience, we are recommending increases in the assumed rates at which members withdraw their contributions from CalSTRS. The changes are for entry ages less than 40 and are primarily for service levels between five and ten years. The results based on the proposed assumptions are shown below.

Actual to Proposed Number of Refunds			
Males			
Entry Age	Actual	Proposed	Ratio
22	86	95	91%
27	746	752	99%
32	545	449	121%
37	293	274	107%
42	153	184	83%
47	317	386	82%
Total	2,140	2,141	100%
Females			
Entry Age	Actual	Proposed	Ratio
22	451	460	98%
27	1,998	1,813	110%
32	846	755	112%
37	435	437	100%
42	308	312	99%
47	416	488	85%
Total	4,454	4,266	104%
Grand Total	6,594	6,407	103%

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Appendix A-1: Summary of Proposed Assumptions (Changes in Yellow)

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 DB Program and on current expectations as to future economic conditions. The assumptions are intended to estimate the future experience of the members of the DB Program and of the DB 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 DB Program's benefits.

Actuarial Cost Method	The accruing costs of all benefits with future accruals are measured by the Entry Age Normal Actuarial Cost Method. For measurements where no future service is earned (i.e., those with service fixed as of June 30, 2014), the actuarial obligation uses the Projected Unit Credit Actuarial Cost Method.
	The projected revenue in excess of the Normal Cost is tested for sufficiency to amortize the Unfunded Actuarial Obligation created by this method. Amortization is calculated on a level percentage of salary including general wage inflation but no increase or decrease in the number of active members.
Entry Age Normal Cost Method:	The actuarial present value of projected benefits for each individual member included in the valuation is allocated on a level basis over the earnings of the individual between entry age and assumed exit ages. The portion of this actuarial present value allocated to a valuation year is called the Normal Cost. For 2% at 60 members, the Normal Cost is based on the Coverage B benefit structure. For 2% at 62 members, the Normal Cost is based on their benefit structure. The portion of this actuarial present value not provided for at a valuation date by the actuarial present value of future Normal Costs is called the Actuarial Obligation. The excess of the Actuarial Obligation over the Actuarial Value of Assets is called the Unfunded Actuarial Obligation. If the Actuarial Value of Assets exceeds the Actuarial Obligation, the difference is called the Actuarial Surplus.
Entry Age:	The ages at entry of future active members are assumed to average the same as the entry ages of the present active members they replace. If the number of active members should increase (or decrease), it is further assumed that the average entry age of the larger (or smaller) group will be the same, from an actuarial standpoint, as that of the present active group. Under these assumptions, the Normal Cost Rate will not vary significantly due to the termination of the present active membership, or with an expansion or contraction of the active membership.
	Entry age is determined as age at membership date.
Projected Unit Cost Method:	This cost method is used for calculations of the actuarial obligation where there are no future service accruals. Under the PUC method, the actuarial present value of projected benefits for each individual member included in the valuation is determined based on the current service and salary projected to the age the member leaves active employment. The Normal Cost is $0, since no benefits are being earned.

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Asset Valuation Method	The assets are valued using a method that delays recognition of investment gains or losses. The expected actuarial value is the prior year's actuarial value increased with net cash flow of funds, and all increased with interest during the past year at the expected investment return assumption. One-third of the difference between the expected actuarial value of assets and the Fair Market Value of assets is added to the expected actuarial value of assets to arrive at the Actuarial Value of Assets.

The asset smoothing method was adopted for the 1999 Actuarial Valuation and is effective for the investment experience beginning in July of 1993. |
| **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 DB 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 A.1** and illustrated at selected ages and duration combinations in **Tables A.2** – **A.7**. |
| **Payroll Growth Assumption** | The wage growth assumption is equal to 3.50%, and the active population is assumed to be stable. |

Table A.1
List of Major Valuation Assumptions

I.   Economic Assumptions

   A. Investment Return   7.25%
       (net of investment and administrative expenses)

   B. Interest on Member Accounts   3.00%

   C. Wage Growth   3.50%

   D. Inflation   2.75%

II.   Demographic Assumptions

A.   Mortality*

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

*All proposed 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. See Table A.9 of this report for a key to the custom mortality tables used for CalSTRS.

B.	Service Retirement	Experience Tables	Table A.3
C.	Disability Retirement	Experience Tables	Table A.4
D.	Withdrawal	Experience Tables	Table A.5
E.	Probability of Refund	Experience Tables	Table A.6
F.	Merit Salary Increases	Experience Tables	Table A.7
G.	Supplemental Assumptions	Experience Tables	Table A.8
H.	Custom Mortality Table Key	Experience Tables	Table A.9

Table A.2[1]
Mortality as of 6/30/2016

Active Members

Age	Male	Female
25	0.035%	0.014%
30	0.030	0.016
35	0.034	0.021
40	0.039	0.028
45	0.054	0.044
50	0.093	0.075
55	0.157	0.118
60	0.259	0.173
65	0.451	0.257

Age	Retired Members and Beneficiaries[1]		Disabled Members (After Year 3)[1]	
	Male	Female	Male	Female
50	0.243%	0.124%	1.868%	1.055%
55	0.358	0.213	2.172	1.320
60	0.480	0.283	2.464	1.558
65	0.682	0.427	2.867	1.861
70	1.091	0.704	3.556	2.416
75	1.958	1.294	4.689	3.438
80	3.592	2.482	6.491	5.092
85	6.907	4.950	9.430	7.566
90	13.297	10.051	14.273	11.159
95	22.668	18.791	21.289	16.477

Select minimum rates for disability:

	Male	Female
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. *Projected improvement based on 110% of the MP-2016 Ultimate Projection Scale. Projection scale does not apply to select minimum rates.*

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Table A.3
Service Retirement

| Age | Only for the 1990 Benefit Structure | | DB Program – 2% at 60 Members | | | | DB Program – 2% at 62 Members | |
| | | | Under 30 Years[1] | | 30 or More Years | | All Years | |
	Male	Female	Male	Female	Male	Female	Male	Female
50	0.0%	0.0%	0.0%	0.0%	5.0%	5.0%	0.0%	0.0%
51	0.0	0.0	0.0	0.0	3.0	3.0	0.0	0.0
52	0.0	0.0	0.0	0.0	3.0	3.0	0.0	0.0
53	0.0	0.0	0.0	0.0	3.0	3.0	0.0	0.0
54	1.5	1.5	0.0	0.0	3.0	3.0	0.0	0.0
55	5.8	7.0	2.7	3.5	6.0	8.0	3.0	4.0
56	3.9	4.5	1.8	2.5	6.0	8.0	2.0	3.0
57	4.9	4.5	1.8	2.5	8.0	10.0	3.0	3.5
58	6.8	7.0	2.7	3.5	12.0	15.0	4.0	4.0
59	17.5	14.0	4.5	5.0	16.0	18.0	6.0	6.0
60	25.0	22.0	6.3	7.0	25.0	29.0	9.0	9.0
61	16.5	15.0	7.0	9.0	50.0	50.0	15.0	15.0
62	16.5	15.0	11.0	12.5	45.0	45.0	15.0	17.0
63	15.0	15.0	12.0	16.0	35.0	40.0	15.0	18.0
64	17.5	18.0	13.0	14.0	30.0	35.0	15.0	18.0
65	20.0	18.0	14.0	17.0	32.5	37.5	30.0	30.0
66	16.0	18.0	13.0	15.0	30.0	32.0	25.0	25.0
67	16.0	18.0	13.0	15.0	27.0	32.0	25.0	25.0
68	16.0	16.0	12.0	14.0	27.0	30.0	20.0	20.0
69	16.0	16.0	12.0	14.0	25.0	30.0	20.0	20.0
70	100.0	100.0	12.0	14.0	25.0	30.0	20.0	20.0
71			11.0	13.5	25.0	30.0	20.0	20.0
72			11.0	13.5	25.0	30.0	20.0	20.0
73			11.0	13.5	25.0	30.0	20.0	20.0
74			11.0	13.5	25.0	30.0	20.0	20.0
75			100.0	100.0	100.0	100.0	100.0	100.0

1. If credited service is equal to or greater than 25 but less than 28 years, the assumed retirement rates shown above for members with less than 25 years of credited service are multiplied by 225%. For example, a 63-year old female member with 26 years of credited service would have a 36.0% probability of retirement (2.25 times the rate for service less than 25 years of 16.0%). For members with 28 but less than 30 years of credited service, the rates are equal to 125% of the assumed retirement rates shown above for members with less than 25 years of credited service.

The assumptions shown above are for retirement from active status. It is assumed that all vested terminated members retire at age 60 (2% at 60 members) or age 62 (2% at 62 members).

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Table A.4
Disability Retirement

Coverage A

Age	Male	Female
25	0.018%	0.018%
30	0.027	0.027
35	0.045	0.054
40	0.072	0.081
45	0.099	0.099
50	0.144	0.198
55	0.189	0.252

Coverage B

Age	Male	Female
25	0.010%	0.020%
30	0.020	0.020
35	0.030	0.040
40	0.060	0.070
45	0.100	0.110
50	0.140	0.185
55	0.245	0.300
60	0.365	0.380
65	0.400	0.400
70	0.400	0.400

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Table A.5
Withdrawal

Year[1]	Male	Female
0	16.0%	15.0%
1	11.0	9.0
2	8.5	7.0
3	6.3	5.5
4	4.0	4.0
5	3.5	3.0
10	1.8	1.8
15	1.2	1.2
20	0.9	0.9
25	0.7	0.7
30	0.6	0.6

1. Based on elapsed service since membership date.

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Table A.6
Probability of Refund

Entry Ages – Male

Year[1]	Under 25	25 - 29	30 - 34	35 - 39	40 and Up
Under 5	100%	100%	100%	100%	100%
5	60	60	60	56	45
10	46	46	38	36	36
15	38	38	31	21	
20	31	31	15		
25	15	15			
30	10				

Entry Ages – Female

Year	Under 25	25 - 29	30 – 34	35 - 39	40 and Up
Under 5	100%	100%	100%	100%	100%
5	60	60	60	52	35
10	34	34	32	32	29
15	27	24	24	24	
20	19	14	14		
25	10	10			
30	10				

1. Based on elapsed service since membership date. Members who terminate with less than 5 years of credited service are assumed to have a 100% probability of refund.

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Table A.7
Merit Salary Increases

Entry Age - Annual Increase in Salaries Due to Merit

Year[1]	Under 25	25 - 29	30 - 34	35 - 39	40 - 44	45 & up
0	6.4%	5.8%	5.3%	4.8%	4.5%	3.7%
1	6.4%	5.8%	5.3%	4.8%	4.5%	3.7%
2	6.0	5.5	5.0	4.5	4.3	3.5
3	5.6	5.3	4.8	4.3	4.1	3.3
4	5.4	5.0	4.5	4.1	3.9	3.0
5	5.2	4.8	4.3	3.9	3.8	2.8
10	3.7	3.4	3.0	2.7	2.5	1.8
15	1.8	1.7	1.5	1.2	1.2	0.9
20	1.3	1.2	1.2	0.8	0.8	0.6
25	1.1	1.0	0.9	0.6	0.6	
30	0.9	0.8	0.7	0.5		
35	0.8	0.7	0.6			
40	0.8	0.7				
45	0.8					

1. Based on elapsed service since membership date.

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Table A.8
Supplemental Assumptions

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PEPRA Coverage	All members hired on or after the valuation date are assumed to be subject to the provisions of PEPRA.
Unused Sick Leave	Credited Service is increased by 1.8%.
Optional Forms	Active and Inactive: Based on single life annuity assumed. Retirees and Beneficiaries: Based on optional form in data.

Probability of Marriage

Male:	85%
Female:	65%

Male spouses are assumed to be three years older than female spouses.

Number of Children

Married members are assumed to have the following number of children:

Member's Gender	Assumed Number of Children
Male	0.65
Female	0.50

Assumed Offsets

The following offsets, expressed as a percentage of Final Compensation, are assumed to cease at age 60:

	Coverage A		Coverage B (including 2% at 62)	
	Male	**Female**	**Male**	**Female**
Death	0.0%	0.0%	0.0%	0.0%
Disability	0.0%	0.0%	0.0%	0.0%

Valuation of Inactive Members

Salary and benefit information is not available on the valuation data provided for inactive members. Therefore, we estimate the projected retirement benefits for inactive members as follows:

1) The inactive member's earnable salary information is retrieved from when they were active by matching with a database of active valuation data back to 2001 and taking the highest earnable salary for the member during the period.

2) For those members who cannot be located on the active database (because they terminated prior to 2001 or another reason), their earnable salary is estimated based on 120% of the average earnable salary for all active members in the year the member terminated.

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3) The earnable salary amount from the prior steps is treated as the member's final compensation with two additional adjustments.

    a. An additional load of 5% for all inactive members is applied to their salary amount to account for potential post-termination increases in salary due to factors such as reciprocity.

    b. Final compensation is increased by an additional 5% if the member has 25 or more years of credited service.

4) Based on the salary data described above and the birth date and credited service from the current year's valuation data, the projected benefit amount is calculated and valued as a deferred service retirement.

5) All non-vested members are assumed to take an immediate refund of their member contributions.

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Table A.9
Custom Mortality Table Key

Healthy (Service) Retirees and Beneficiaries -- Males

Current:	RP-2000 Healthy Male White Collar -2 to age 70 smoothed to -1 at age 90
Proposed:	RP-2014 Healthy Male White Collar -1 to age 70 smoothed to +1 at age 95

Healthy (Service) Retirees and Beneficiaries -- Females

Current:	RP-2000 Healthy Female White Collar -4 to age 75 smoothed to -0 at age 90
Proposed:	RP-2014 Healthy Female White Collar -4 to age 70 smoothed to +1 at age 95

Disabled Retirees -- Males

Current:	Age < 70: 2% at age 40 & under, graded to 3.2% at age 70
	Age > 70: RP-2000 Male White Collar +7 at age 70 smoothed to +1 age 85
	(select rates in first three years, regardless of age)
Proposed:	All Ages: RP-2014 Disabled Male -2
	(select rates in first three years, regardless of age)

Disabled Retirees -- Females

Current:	Age < 70: 1.5% at age 40 & Less graded to 2.25% at age 70
	Age > 70: RP-2000 Female White Collar +6 at age 70 smoothed to +2 at age 80
	(select rates in first three years, regardless of age)
Proposed:	All Ages: RP-2014 Disabled Female -2
	(select rates in first three years, regardless of age)

Active Members -- Males

Current:	RP-2000 Healthy Male White Collar -4 Projected to 2025 to age 70 smoothed to -3 at age 90
Proposed:	RP-2014 Healthy Male White Collar Employee set back 2 years

Active Members -- Females

Current:	RP-2000 Healthy Female White Collar -6 Projected to 2025 to age 75 smoothed to -2 at age 90
Proposed:	RP-2014 Healthy Female White Collar Employee set back 2 years

Notes: 1. *All proposed tables use 110% of the MP-2016 Ultimate Projection Scale. Projection scale does not apply to select minimum rates.*

2. *All proposed tables to be used in the 6/30/2016 actuarial valuations include two years of mortality improvement from the 2014 tables shown above.*

Appendix A-2:   **Cash Balance Benefit Program**
Actuarial Methods and Assumptions

This section of the report discloses the actuarial methods and assumptions used in the Actuarial Valuation of CBB Program. These methods and assumptions have been chosen on the basis of recent experience of the DB Program and on current expectations as to future economic conditions.

The assumptions are intended to estimate the future experience of the members of the CBB Program and of the CBB 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 CBB 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 CBB 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 A-2.1** and illustrated at selected ages in **Table A-2.2**.

Table A-2.1
List of Major Valuation Assumptions for CBB Program

I.   Economic Assumptions

A.   Investment Return   6.75%
(net of investment and administrative expenses)

B.   Interest on Member Accounts   6.75%

C.   Wage Growth   3.50%

D.   Inflation   2.75%

E.   Standard Deviation of Portfolio   13.00%

II.   Demographic Assumptions

A.   Mortality[1]

Retired & Beneficiary	- Male	2016 CalSTRS Retired Male	Table A-2.2
	- Female	2016 CalSTRS Retired Female	Table A-2.2
Disabled	- Male	RP-2014 Disabled Retiree Male set back 2 years	Table A-2.2
	- Female	RP-2014 Disabled Retiree Female set back 2 years	Table A-2.2
		(select rates in first three years for both Males and Females)	

1. *All proposed tables use 110% of the MP-2016 Ultimate Projection Scale, except projections scale does not apply to select rates. The combined base tables and projection scale specified contain a margin for expected future mortality improvement. See Table A.9 of this report for a key to the custom mortality tables used for CalSTRS.*

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

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Table A-2.2
Mortality

Age	Retired Members and Beneficiaries[1]		Disabled Members (After Year 3) [1]	
	Male	**Female**	**Male**	**Female**
50	0.243%	0.124%	1.868%	1.055%
55	0.358	0.213	2.172	1.320
60	0.480	0.283	2.464	1.558
65	0.682	0.427	2.867	1.861
70	1.091	0.704	3.556	2.416
75	1.958	1.294	4.689	3.438
80	3.592	2.482	6.491	5.092
85	6.907	4.950	9.430	7.566
90	13.297	10.051	14.273	11.159
95	22.668	18.791	21.289	16.477

Select minimum 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. *Projected improvement based on 110% of the MP-2016 Ultimate Projection Scale. Projection scale does not apply to select minimum rates.*

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Appendix A-3: **Defined Benefit Supplement Program**
Actuarial Methods and Assumptions

This section of the report discloses the actuarial methods and assumptions used in the Actuarial Valuation of DBS Program. These methods and assumptions have been chosen on the basis of recent experience of the DB Program and on current expectations as to future economic conditions.

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 A-3.1** and illustrated at selected ages in **Table A-3.2**.

Table A-3.1
List of Major Valuation Assumptions for DBS Program

I.   Economic Assumptions

A.   Investment Return   7.25%
(net of investment and administrative expenses)

B.   Interest on Member Accounts   7.25%

C.   Wage Growth   3.50%

D.   Inflation   2.75%

E.   Standard Deviation of Portfolio   15.00%

II.   Demographic Assumptions

A.   Mortality[1]

Retired & Beneficiary	- Male	2016 CalSTRS Retired Male	Table A-3.2
	- Female	2016 CalSTRS Retired Female	Table A-3.2
Disabled	- Male	RP-2014 Disabled Retiree Male set back 2 years	Table A-3.2
	- Female	RP-2014 Disabled Retiree Female set back 2 years	Table A-3.2
		(select rates in first three years for both Males and Females)	

*1. All proposed 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. See Table A.9 of this report for a key to the custom mortality tables used for
CalSTRS.*

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

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Table A-3.2
Mortality

Age	Retired Members and Beneficiaries[1]		Disabled Members (After Year 3) [1]	
	Male	Female	Male	Female
50	0.243%	0.124%	1.868%	1.055%
55	0.358	0.213	2.172	1.320
60	0.480	0.283	2.464	1.558
65	0.682	0.427	2.867	1.861
70	1.091	0.704	3.556	2.416
75	1.958	1.294	4.689	3.438
80	3.592	2.482	6.491	5.092
85	6.907	4.950	9.430	7.566
90	13.297	10.051	14.273	11.159
95	22.668	18.791	21.289	16.477

Select minimum 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. *Projected improvement based on 110% of the MP-2016 Ultimate Projection Scale. Projection scale does not apply to select minimum rates.*

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